NATIONAL ENERGY TECHNOLOGY LABORATORY

# DOE Award No.: DE-FE0023919

## Quarterly Research Performance Progress Report

## (Period Ending 09/30/23)

## Deepwater Methane Hydrate Characterization & Scientific Assessment

## Project Period 5: 10/01/20 - 09/30/23


Submitted by:

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Signature

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

Office of Fossil Energy

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# DISCLAIMER

# 1 ACCOMPLISHMENTS

This report outlines the progress of the fourth quarter of the ninth fiscal year of the project, Jul. 1 – Sep. 30, 2023 (Budget Period 5, Year 3). Highlights from this period include:

- **UT-GOM2-2 Scientific Drilling Program**
  UT-GOM2-2: Gulf of Mexico Deepwater Hydrate Coring Expedition (utexas.edu)
    - The UT-GOM2-2 drilling program was executed from July 30 to September 1, 2023 in the Gulf of Mexico, Walker Ridge Block 313.
    - Two holes were drilled: H003 and H002. In hole H003, conventional coring, pressure coring, and temperature measurements were made to a total depth of 999 ft below seafloor (fbsf). Hole H002 was drilled to a total depth of 2826 fbsf to sample the deeper part of the hydrate system where two coarse-grained hydrate reservoirs (the Blue and Orange sands) were interpreted to be present.
    - Sample were collected to meet the top four of the five outlined science objectives for the expedition. Samples were collected to meet the highest scientific priority to characterize deep hydrate reservoirs and their bounding muds. Approximately 1.5 ft of the reservoir and ~6.5 ft of the bounding seal were obtained from the Blue interval, and ~6.5 ft of reservoir and ~26 ft of bounding seal were obtained from the Orange interval.
    - 561.4 ft of conventional core and 179.8 ft of pressure core were acquired and processed onboard and at the Geotek Coring facility in Salt Lake City, Utah.
    - The UT-GOM2-2 science party consisting of 42 researchers from 7 universities including the USGS, JAMSTEC, and Geotek.

## 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 | Feb-22 | 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 | Mar-23 | Jul-23 | QRPPR |
| | M5E | Complete UT-GOM2-2 Operational Plan Report | May-21 | Sep-21 | QRPPR |
| | M5F | Complete UT-GOM2-2 Field Operations | Jul-23 | Sep-23 | 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-23 | - | Phase 5 Report |
| | M6B | Complete Preliminary Expedition Summary | Dec-23 | - | Report directly to DOE PM |
| | M6C | Initiate comprehensive Scientific Results Volume | Jun-24 | - | Report directly to DOE PM |
| | M6D | Submit set of manuscripts for comprehensive Scientific Results Volume | Sep-25 | - | 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** | **UT-GOM2-1 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** | **UT-GOM2-1 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** | **UT-GOM2-1 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** | **UT-GOM2-1 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* |
| **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* | *Execute UT-GOM2-2 Field Program* |
| *Optional Subtask 16.2* | *Add Conventional Coring* |
| *Optional Subtask 16.3* | *Add Spot Pressure Coring* |
| *Optional Subtask 16.4* | *Add Second Hole at H-Location* |
| *Optional Subtask 16.5* | *Add Additional Cores and Measurements* |
| **Task 17.0** | **UT-GOM2-2 Core Analysis** |
| *Subtask 17.1* | *Routine UT-GOM2-2 Core Analysis* |
| *Optional Subtask 17.2* | *UT-GOM2-2 Expanded Core Analysis* |

#### 1.2.2.1 Task 1.0 – Project Management & Planning

**Status**: Ongoing

- **Coordinate the overall scientific progress, administration and finances of the project:**
  - UT continued to monitor and control the overall project budget, scope, and schedule.
  - UT continued to organize weekly planning meetings with members of UT Austin, Geotek, and others to coordinate and prepare for all aspects of the UT-GOM2-2 premobilization, operational, and logistical activities.
  - UT continued to organize weekly planning meetings with members of the UT-GOM2-2 Science Party, including UT, USGS, Subaward Universities, and Geotek, to coordinate and prepare for all aspects of the UT-GOM2-2 science program.

- **Communicate with project team and sponsors:**
  - UT organized daily 'rig-calls' to communicate real-time status updates from the Helix Q4000 to US DOE throughout the UT-GOM2-2 expedition.
  - UT organized sponsor and stakeholder meetings.
  - UT organized task-specific working meetings, as needed, to plan and execute project tasks per the Project Management Plan and Statement of Project Objectives.
  - UT managed SharePoint sites, email lists, the project website, and the UT-GOM2-2 expedition website.

- **Coordinate and supervise service agreements:**
  - UT procured services from additional third party vendors required to complete UT-GOM2-2 field operations.

- **Coordinate subcontractors:**
  - UT continued to monitor and control subaward and contractor efforts.
  - UT continued to hold 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.
  - UT continued to hold recurring technical meetings with Helix to plan the 2023 UT-GOM2-2 field program, and refine requirements for third party subcontracts covering drill pipe-make up, wireline operations, Drilling Fluid, supply boats, Dock services, Well certification, Deck layouts, etc.

#### 1.2.2.2 Task 10.0 – UT-GOM2-1 Core Analysis

**Status:** Ongoing

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

- In previous quarters, we focused on investigating the visco-plastic properties of sediments containing hydrates. By conducting geomechanical tests on pressure cores 8FB3-3 and 8FB1-2, we showed that these materials behave visco-plastically (Cardona et al. 2023).
- In this quarter, we explored the geomechanical behavior of the Reconstituted Green Canyon 955 Sandy Silt (RGCSS) without hydrate. These hydrate-free analyses help reveal the role of hydrates in the geomechanical response of hydrate-bearing reservoirs and provides critical input parameters for gas production and geological models.
    - The compression curve of the reconstituted Green Canyon sandy silt (RGCSS) follows a concave-down curvature in the void ratio (or porosity) vs. the logarithm of stress space. Figure 1-1a shows the compression results for oedometer and uniaxial strain compression in a triaxial device. In all cases, the curvature of the compression curve is concave-down, an observation consistent with the typical sand behavior.
    - Figure 1-1b shows the evolution of the ratio of radial ($\sigma'_r$) to axial ($\sigma'_a$) effective stress under uniaxial strain ($K_0 = \sigma'_r / \sigma'_a$) with axial effective stress. The RGCSS specimens were initially loaded from hydrostatic conditions ($K_0$~1.0). As the axial stress increases, $K_0$ decreases rapidly to 0.50 at 2.5 MPa. The $K_0$ remains nearly constant at 0.50 – 0.52 during further increments of the axial effective stress, even at high stresses ($\sigma'_a \approx 15$ MPa). The constant $K_0$ means that axial and radial stresses are linearly related.
- In the last quarter, we refined our experimental approach to studying the geomechanical behavior of pressure cores. In this quarter, UT continued to monitor these equipment modifications to ensure correct operation of the Hydrate Core Effective Stress Chamber (see details in Section 1.2.2.5).

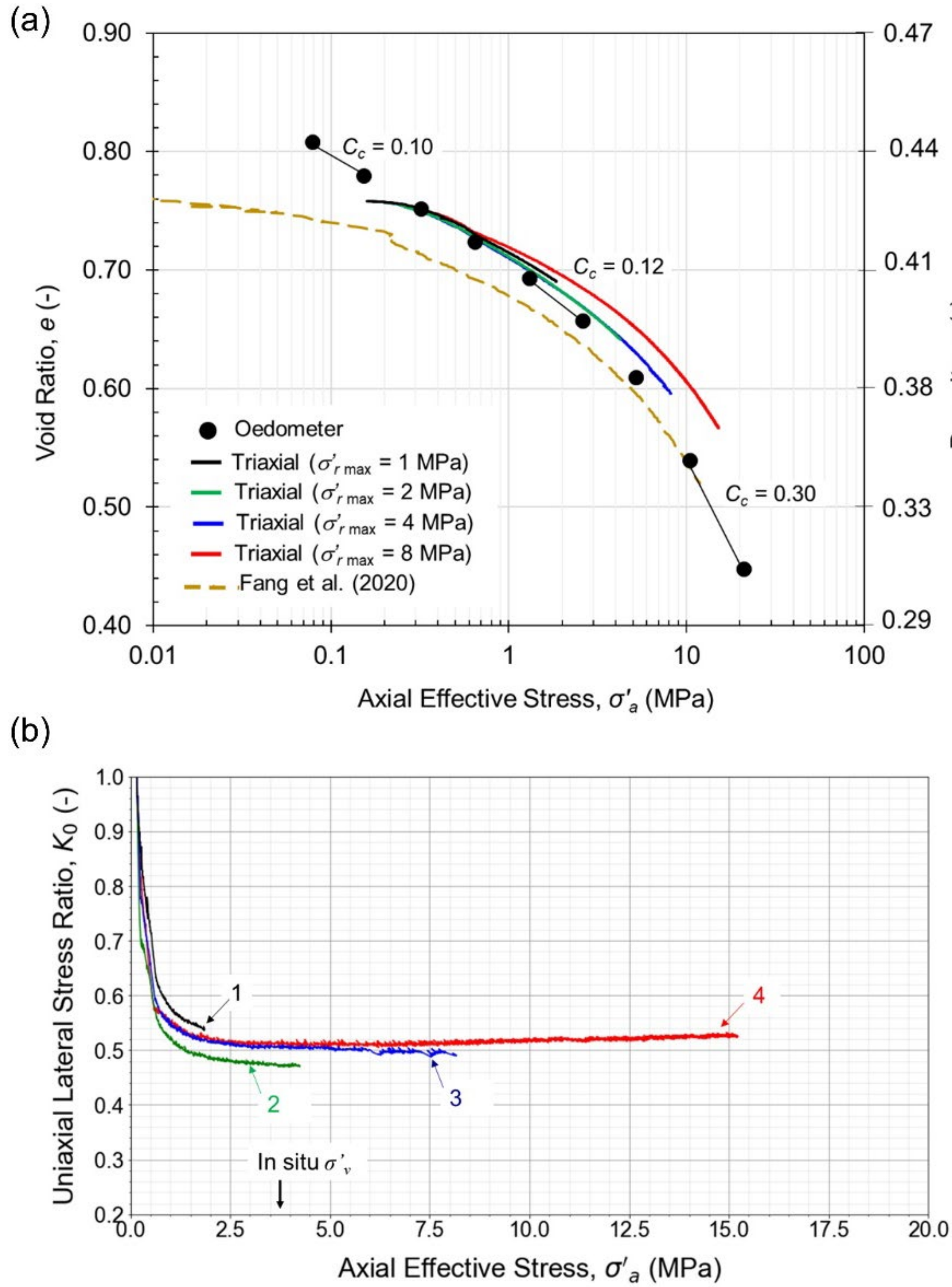


*Figure 1-1: Geomechanical behavior of Reconstituted GC 955 Sandy Silt (RGCSS). (a) Compression for all tests conducted, including oedometer (black circles) and triaxial data (solid lines). The compression curve (yellow dashed line) obtained by Fang et al. (2020) using a constant rate of strain (CRS) test in a rigid wall cell is superimposed. (b) Evolution of the radial to axial effective stress ratio, $K_0 = \sigma'_r / \sigma'_a$, with the axial effective stress during uniaxial strain compression (black-1: $\sigma'_r$-max = 1 MPa; green-2: $\sigma'_r$-max = 2 MPa; blue-3: $\sigma'_r$-max = 4 MPa; red-4: $\sigma'_r$-max = 8 MPa). The in-situ vertical effective stress for GC 955 sandy silt sediments is ~3.8 MPa.*

#### 1.2.2.2.2 *Subtask 10.5 – Continued Core-Log-Seismic Synthesis (UT-GOM2-1)*

- No updates.

#### 1.2.2.2.3 *Subtask 10.6 – Additional Core Analysis Capabilities*

- No updates

#### 1.2.2.2.4 *Subtask 10.7 – Hydrate Modeling*

- No update

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

**Status:** Complete (Milestone 5C, 5E)

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

**Status:** Complete (Milestone 5B)

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

**Status:** Ongoing

#### 1.2.2.5.1 *Long-Term Pressure Core Storage Optimization*

- UT continues to explore measures to mitigate methane hydrate dissolution by saturating the pressure core storage chamber water with dissolved methane. UT has assembled all the components to create methane-saturated water in a pressurized vessel and is pressure testing the system to quantify and stop system leaks. In this quarter, UT conducted a long-term pressure test of the methane saturation vessel to ensure viable leak protection and prevent system/core pressure loss.

#### 1.2.2.5.2 *Subtask 13.1 – Hydrate Core Manipulator and Cutter Tool*

- The mini-PCATS system underwent a full pressure test. The X-ray system underwent quarterly calibration.

#### 1.2.2.5.3 *Subtask 13.2 – Hydrate Core Effective Stress Chamber*

- UT took delivery of a computer system upgrade from Geotek the previous quarter. This system has been staged for an installation during a Geotek service visit in the next quarter.
- The Effective Stress Chamber underwent a general cleaning and sediment flush before loading RBBC samples for uniaxial testing.

- Over the past year, we have improved our experimental methodology for investigating the geomechanical response to uniaxial strain deformation, where the samples deform only along the axial direction. To accomplish this condition, the Hydrate Core Effective Stress Chamber adjusts the confining pressure during testing using the sample length and pore volume expelled during deformation.
    - In previous quarters, we identified the data communication between the pump software and Geotek software is interrupted when transferring large data sets. UT, Geotek and the pump company corrected this effect by developing a new software application.
    - In this quarter, UT conducted a long-term ~1 month test (i.e., soak test) to monitor and evaluate the performance and stability of the Hydrate Core Effective Stress Chamber. The software successfully ran over this extended period under normal operating conditions.

#### 1.2.2.5.4 *Subtask 13.3 – Hydrate Core Depressurization Chamber*

- UT conducted quantitative degassing of pressure core remnants to empty pressure core storage chambers for use in the UT-GOM2-2 expedition.
- After conducting the quantitative degassing of core remnants, the manifold plumbing of the system was fully disassembled for sediment removal and cleaning.

#### 1.2.2.5.5 *Subtask 13.4 – Develop Hydrate Core Transport Capability for UT-GOM2-2*

**Status:** Complete

#### 1.2.2.5.6 *Subtask 13.5 – Expansion of Pressure Core Storage Capability for UT-GOM2-2*

- UT has assembled all components required to expand the pressure maintenance and relief system (PMRS) for long-term pressure core storage.
- The quantity of pressure cores acquired during the GOM2-2 Expedition can be accommodated with the existing PMRS system. As a result, installation of the PMRS expansion components was put on hold. Expansion components will be retained as replacements for the current system parts.
- Evaluation and maintenance testing of methane monitoring system is being assessed.

#### 1.2.2.5.7 *Subtask 13.6 – Continued Storage of Hydrate Cores from UT-GOM2-1*

- The UT Pressure Core Center is capable of accommodating the four remaining pressure cores from UT-GOM2-1 as well as the 13 pressure cores collected during UT-GOM2-2.

#### 1.2.2.5.8 *Subtask 13.7 – Maintain X-ray Computed Tomography*

- The X-Ray CT continues to operate as designed.
- The Dell Image Reconstruction computer was found to have a problem which is preventing the computer monitor from seeing any signals from the computer. It is currently being evaluated for repair.

#### 1.2.2.5.9 *Subtask 13.8 – Maintain Pre-Consolidation System*

The system will continue to be evaluated to ensure proper pressure maintenance to generate effective stresses in pressure cores.

#### 1.2.2.5.10 *Subtask 13.9 – Transportation of Hydrate Core from UT-GOM2-2 Scientific Drilling Program*

At the conclusion of the UT-GOM2-2 drilling program, all cores were transported by supply vessel to Port Fourchon, LA. Thirteen pressure cores were transported in the Geotek PTRANS System to the UT Pressure Core Center in Austin, TX. Additional pressure cores were sent to Geotek Coring Inc., in Salt Lake City, UT for quantitative degassing and subsampling. Conventional and depressurized cores were transported to Geotek Coring's facility in College Station, TX for logging and CT scanning before being shipped to Geotek Coring Inc. for the UT-GOM2-2 land-based core analysis program.

#### 1.2.2.5.11 *Subtask 13.10 – Storage of Hydrate Cores from UT-GOM2-2 Scientific Drilling Program*

Geotek delivered thirteen UT-GOM2-2 pressure cores to the UT Pressure Core Center (PCC) on September 9, 2023. The pressure cores were transferred from the Geotek PTrans unit to the UT PCC cold storage laboratory and connected to the PMRS (Figure 1-2). The UT PCC keeps the cores at 6°C. The pressure maintenance system supplies one-way high-pressure water into the pressure storage chambers. Since delivery this quarter, the pressure cores have continued to maintain stable storage pressures and each chamber's pressure is recorded weekly. Table 1-9 lists the 13 new pressure cores stored at UT from UT-GOM2-2.

*Figure 1-2. Thirteen pressure cores from UT-GOM2-2 (WR313) and four from UT-GOM2-1 (GC955) stored in Geotek SC120 containers on quad bases in the UT Pressure Core Center.*

*Table 1-9. Inventory of thirteen pressure cores from UT-GOM2-2 in Walker Ridge 313, with their respective Geotek SC120 Storage chambers stored in the UT Pressure Core Center.*

| No. | Core ID | Geotek Chamber ID | Expedition | Location | Well |
|---|---|---|---|---|---|
| 1 | H002-02FB-3 | 35-SC120-002 | UT-GOM2-2 | WR313 | H002 |
| 2 | H002-03FB-3 | 35-SC120-054 | UT-GOM2-2 | WR313 | H002 |
| 3 | H002-05CS-1 | 35-SC120-045 | UT-GOM2-2 | WR313 | H002 |
| 4 | H002-05CS-2 | 35-SC120-053 | UT-GOM2-2 | WR313 | H002 |
| 5 | H002-06CS-3 | 35-SC120-024 | UT-GOM2-2 | WR313 | H002 |
| 6 | H002-06CS-4 | 35-SC120-010 | UT-GOM2-2 | WR313 | H002 |
| 7 | H002-07CS-2 | 35-SC120-018 | UT-GOM2-2 | WR313 | H002 |
| 8 | H002-08CS-1 | 35-SC120-011 | UT-GOM2-2 | WR313 | H002 |
| 9 | H002-08CS-2 | 35-SC120-015 | UT-GOM2-2 | WR313 | H002 |
| 10 | H002-10CS-1 | 35-SC120-032 | UT-GOM2-2 | WR313 | H002 |
| 11 | H003-24CS-4 | 35-SC120-003 | UT-GOM2-2 | WR313 | H003 |
| 12 | H003-27CS-2 | 35-SC120-035 | UT-GOM2-2 | WR313 | H003 |
| 13 | H003-29CS-2 | 35-SC120-060 | UT-GOM2-2 | WR313 | H003 |

#### 1.2.2.5.12 *Subtask 13.11 – Hydrate Core Distribution*

**Future Task**

### 1.2.2.6 Task 14.0 – Performance Assessment, Modifications, And Testing of PCTB

**Status:** Complete

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

**Status:** Complete

#### 1.2.2.7.1 *Subtask 15.3 – Permitting for UT-GOM2-2 Scientific Drilling Program*

All pre-drill permits were completed in July, 2023, prior to UT-GOM2-2 mobilization. The final regulatory authorizations and permit approvals that were required prior to executing UT-GOM2-2 are shown in Table 1-10

*Table 1-10: UT-GOM2-2 Permit Status*

| AGENCY | PERMIT / REQUIREMENT | SUBMITTED | APPROVED | TRACKING INFO |
|---|---|---|---|---|
| BOEM | Qualified Operator Certification | 03/17/17 | 03/21/17 | No. 3487 |
| BOEM | Right-of-Use and Easement (RUE) | 04/15/21 | 11/12/21 | OCS-G 30392 |
| BOEM | Right-of-Use and Easement (RUE) Amendment | 10/21/22 | 12/08/22 | OCS-G 30392 |
| BOEM | Shallow Hazard Reports (H, G, F Locations) | 04/16/21 | 11/12/21 | N-10162 |
| BOEM | Exploration Plan (Initial) | 04/16/21 | 11/12/21 | N-10162 |
| BOEM | Exploration Plan (Revised) | 10/20/22 | 12/08/22 | R-7211 |
| BOEM | Leasee's or Operator's Bond (Terminated) | 07/08/21 | 07/19/21 | Bond No. ROG000193 |
| BOEM | Leasee's or Operator's Bond (Replacement) | 06/28/23 | 07/11/23 | Bond No. 651168 |
| BOEM | Permit to Conduct Geological or Geophysical Exploration | 12/02/22, 01/04/23 | 07/17/23 | L22-025 |
| BSEE | Application for Permit to Drill (APD) WR313 H002 | 04/04/23, 05/15/23 | 07/11/23 | API: 608124014800 |
| BSEE | Application for Permit to Drill (APD) WR313 H003 | 04/04/23, 05/15/23 | 07/11/23 | API: 608124014900 |
| BSEE | Burning & Welding Plan | 05/08/23 | 07/18/23 | 323906991 |
| DOE | NEPA Environmental Questionnaire (EQ) / Categorical Exclusion | 02/16/22 | 03/10/22 | NA |
| EPA | NPDES Electronic Notice of Intent (eNOI) | 06/22/23 | 06/22/23 | GMG29062W |
| LDNR | CZM Consistency Cert. | 04/16/21 | 11/05/21 | C20210156 |
| USCG | Emergency Evacuation Plan | 05/11/23 | 05/25/23 | EEP-23131RMS001 |
| USCG | Letter of Determination (LOD) | 05/23/23 | 05/31/23 | LOD-23143RMS001 |

#### 1.2.2.7.2 *Subtask 15.4 – Review and Complete NEPA Requirements*
**Status:** Complete

#### 1.2.2.7.3 *Subtask 15.5 – Finalize Operational Plan for UT-GOM2-2 Scientific Drilling Program*
**Status:** Complete (Milestone M5C, M5E)

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

#### 1.2.2.8.1 *Subtask 16.1 – Execute UT-GOM2-2 Field Program*
An initial summary of the expedition as similarly provided to BOEM is provided below. A more extensive preliminary summary will be released on December 31, 2023 and the full Expedition Proceedings on Dec 31, 2024.

**INTRODUCTION**

The University of Texas at Austin (UT Austin) drilled two vertical deep stratigraphic test wells, H002 and H003, in Block 313 of the Walker Ridge protraction area (WR313), Gulf of Mexico Outer Continental Shelf (OCS). These wells were drilled to gain insight into the nature, formation, occurrence and physical properties of coarse-grained methane hydrate-bearing sediments. This was accomplished by collecting pressure cores (cores recovered to the surface at in-situ pressure) from coarse-grained hydrate-bearing intervals at depths of approximately 2214 fbsf (8720 fbrf) (the Upper Blue Sand) and 2644 fbsf (9150 fbrf) (the Orange sand) and their bounding muds. In addition, conventional cores, pressure cores, and in situ temperature measurements were recovered from muds and thin silts and sands in the shallow stratigraphic section above the hydrate-bearing intervals.

Drilling and coring operations were conducted by Geotek Coring Inc., and Helix Well Ops., from the Helix Q4000 dynamically-positioned multi-service vessel (MSV). Operations commenced on July 30 and concluded on September 1, 2023. Mobilization occurred over 5.0 days, the drilling program occurred over 26.8 days, and demobilization completed in 2.2 days.

H002 and H003 are located laterally adjacent to the existing well H001 (API: 608124004000), drilled as an LWD well by Chevron in 2009 for the *Gulf of Mexico Gas Hydrate Joint Industry Project Leg II.* H002 was drilled 65 ft SSW of H001, and H003 was drilled 62 ft NNE of H001. The water depth at H002 and H003 is 6454 ft msl (6506 fbrf).

H002 and H003 were drilled riserless, using seawater and viscous sweeps from seafloor to approximately 1600 fbsf (8106 fbrf). Weighted water-based mud (WBM) and viscous sweeps were used to drill below 1600 fbsf

(8106 fbrf) through the target hydrate zones to total depth for wellbore stability and to assist with cuttings removal. Both wells, H002 and H003, were stable throughout the drilling process.

Conventional and pressure coring tools were deployed through the drill string via slickline. Conventional cores were taken using the *Geotek Advanced Piston Corer* (G-APC) and the *Geotek eXtended Core Barrel* (G-XCB). Pressure cores were taken using the *Pressure Coring Tool with Ball Valve* (PCTB). The PCTB has two configurations: a face-bit configuration (FB) and cutting shoe configuration (CS). Temperature measurements were taken using the International Ocean Discovery Program (IODP) Advanced Piston Corer Temperature Tool (APCT-3), in combination with the G-APC.

On board the vessel, pressure core was logged and X-ray imaged, measurements of dissolved methane were taken, and 9 samples were cryogenically frozen before depressurization and stored at -80 C for subsequent microbiological analysis. Conventional core underwent Infrared imaging and measurement of sediment strength. In addition, subsamples were taken on the vessel for the analysis of microbiology, paleontology, and gas and pore fluid composition.

At the conclusion of the drilling program, all cores were transported by vessel to Port Fourchon, LA. Some time-sensitive samples were then shipped to specific labs. Pressure cores were transported to UT and Geotek Coring for future analysis. Conventional and depressurized cores were transported to Geotek Coring's facility in College Station, TX for logging and CT scanning before being shipped to Geotek Coring's facility in Salt Lake City, Utah. All labs, equipment, and remaining samples were shipped to Geotek Coring's facility in Salt Lake City, Utah.

**MOBILIZATION**

The Helix Q4000 completed transit to the location to the existing H001 well in WR313 on August 1, 2023. Testing of the drilling system internal blowout preventers (IBOPS) and Full Open Safety Valve (FSOV), and night cap assembly were successfully completed prior to drilling activities. Two ROVs were deployed to the seafloor to locate the Chevron H001 well and place marker buoys at the proposed locations of H002 and H003. The bottom hole assembly (BHA) was made up and the drill string was lowered to the seafloor. The seafloor was tagged at a depth of 6454 ft msl (6,506 ft fbrf). Tests of the PCTB were successful, but we were unable to deploy the temperature pressure penetrometer (T2P).

**H003 WELL**

H003 was spud on August 4, 2023 at a water depth of 6454 ft msl (6,506 fbrf). 18 conventional cores (utilizing the G-APC), 7 intermittent pressure cores (utilizing the PCTB-CS), and 12 in situ temperature measurements (utilizing the APCT-3) were taken from seafloor to a depth of 509 fbsf (7015 fbrf).

A 1.5-day delay occurred on August 6 at a depth of 153 fbsf (6659 fbrf) when the slickline parted while installing the PCTB retrieval tool due to an operator error. Initial fishing attempts were unsuccessful, so the drill string was pulled out of the hole to above seafloor, where circulation was reestablished and the PCTB retrieval tool was successfully fished. H003 was re-entered with assistance from the ROV and the BHA was tripped back to the previous total depth of 153 fbsf (6659 fbrf) to continue coring operations.

On August 10 at a depth of 509 fbsf (7015 fbrf), the blower motor on the Helix Q4000 top drive system failed. Drilling operations ceased while efforts were made to repair or replace the blower motor. During this time the H003 borehole was conditioned by circulating seawater and reciprocating the drill string. A new blower motor was procured and installed, and operations resumed on August 14 at 0030 after 3.5 days.

The decision was made to drill ahead from the wellbore depth of 509 fbsf (7015 fbrf) to a core-point depth of 914 fbsf (7420 fbrf), as a result of the delay. H003 was drilled to the target core-point depth on August 14. Conventional coring resumed using the G-XCB, which is designed to acquire cores in more lithified sediment formations. One conventional core (utilizing the G-XCB) and 3 pressure cores (utilizing the PCTB-CS) were taken from 914 fbsf (7420 fbrf) to 974 fbsf (7480 fbrf).

H003 was drilled from 974 fbsf (7480 fbrf) to 999 fbsf (7505 fbrf) on August 15, and a gyroscopic survey was conducted. The borehole was found to have an inclination of 6.06 degrees at an azimuth of 123.32 degrees at seafloor, and an inclination of 7.765 degrees at azimuth of 124.38 degrees at total depth. It was determined that the borehole was too deviated to achieve the target depth of 3010 fbsf (9516 fbrf) and the decision was made to abandon H003.

On August 15, UT Austin submitted a request to BSEE for an alternate compliance for well abandonment. UT proposed to permanently abandon H003 at the total depth of 999 fbsf (7505 fbrf) by filling the hole with heavy WBM. UT Austin provided the technical justification that the weight and pumping pressure of cement would exceed the fracture gradient of the shallow formation, and that the uppermost hydrate-bearing unit was over 1000 beneath the total depth of the well. BSEE approved the alternate compliance request on August 15, and the well was abandoned be displacing the hole with 11.0 ppg WBM from total depth of 999 fbsf (7505 fbrf) to the seafloor on August 15, 2023.

A total of 19 conventional cores (561.4 ft), 10 pressure cores (74.8 ft) , and 12 in situ temperature measurements were recovered from H003. Lithology was dominated by mudstone. There was 75% core recovery in the pressure cored interval and more than 100% in the conventional-cored interval (due to core expansion). Figure 1-3 displays the cored interval, core recovery, and the previously drilled LWD gamma and resistivity logs at the adjacent H001 well.

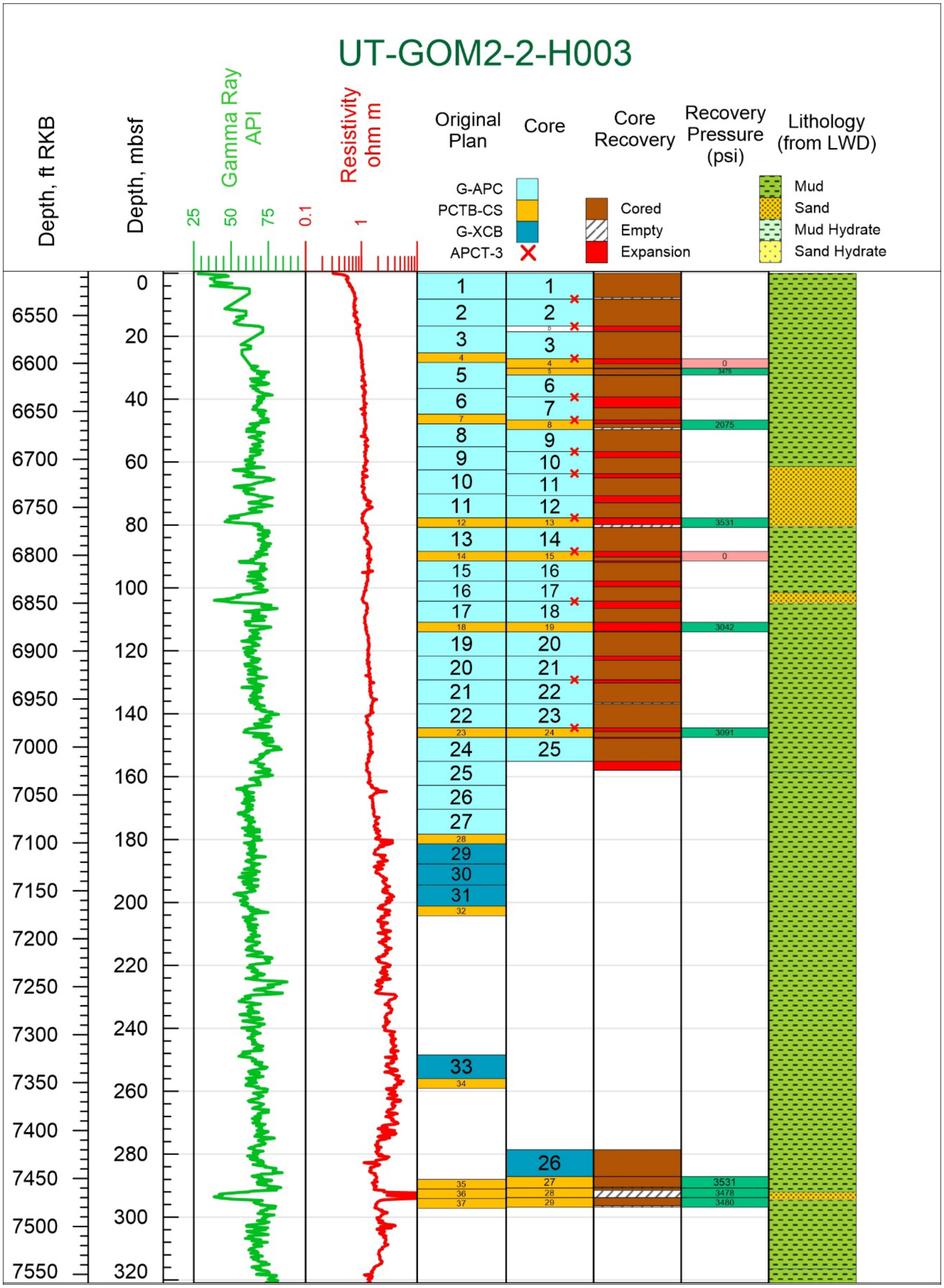


*Figure 1-3. Depth intervals cored during drilling of H003. The ring resistivity and gamma ray from the adjacent H001 well are displayed (red and green). Cored intervals and pressure in pressure cores are shown far right along with core recovery. The brown boxes delineate the length of the recovered core in each coring interval.*

**H002 WELL**

H002 was spud on August 17, 2023 at a water depth of 6454 ft msl (6,506 fbrf). H002 was advanced to a core-point depth of 2115 fbsf (8621 fbrf) with frequent gyroscope deployments to assess borehole inclination. H002 was drilled with seawater and occasional viscous sweeps from seafloor to a depth of 1594 fbsf (8100 fbrf). At a depth of 1594 fbsf (8100 fbrf), 9.0 ppg WBM was used to continue drilling, increasing to 10.5 ppg as needed.

The first core-point depth of 2115 fbsf (8621 fbrf) was achieved on August 20. One pressure core was taken utilizing the PCTB-FB. The borehole was then drilled ahead to the second core point depth of 2212 fbsf (8718 fbrf).

The second core point depth of 2212 fbsf (8718 fbrf) (Upper Blue sand) was achieved on August 20. Three pressure cores were taken from a depth of 2212 fbsf (8718 fbrf) to 2242 fbsf (8748 fbrf). On August 21, the core barrel failed to unlatch from the BHA when attempting to recover the third pressure core. After multiple attempts to unlatch the tool, the slickline parted at the top drive system. The severed end of the slickline was recovered from the drill string and further attempts were made to unlatch the tool. After numerous unsuccessful attempts the decision was made to trip out of the hole. The PCTB-FB BHA was recovered to the rig floor and the core barrel was released from the BHA. The PCTB-FB BHA was swapped out for the PCTB-CS BHA, and the drill string was re-deployed to the seafloor.

H002 re-entry attempts began on August 23 at 0000 by stabbing the bit into the seafloor location of H002 with assistance from the ROV and monitoring weight on bit. H002 was successfully re-entered at 0600 when the bit advanced to a depth of 323 fbsf (6829 fbrf) with no weight-on-bit or rotation. The bit was tripped to the previously achieved total depth of 2242 fbsf (8748 fbrf). UT Austin drilled ahead from 2242 fbsf (8748 fbrf) to the core point depth of 2678 fbsf (9132 fbrf).

The third core-point depth of 2678 fbsf (9132 fbrf) (Orange sand and bounding muds) was achieved on August 23. Nine pressure cores were taken at from a depth of 2678 fbsf (9132 fbrf) to 2716 fbsf (9222 fbrf) utilizing the PCTB-CS. The borehole was advanced to two additional coring points at 2771 fbsf (9277 fbrf) and 2816 (9322 fbrf). One pressure core was taken at each core-point utilizing the PCTB-CS.

Upon achieving the H002 borehole depth of 2826 fbsf (9332 fbrf) on August 26, the decision was made to plug and abandon the well. On August 27, a cementing liner was deployed to the BHA by slickline in preparation for cementing. Upon landing the cement liner in the BHA, flow through the BHA became blocked by the wireline delivery tool creating a hydraulic lock between the tool and the BHA. Repeated attempts to retrieve the cement liner were unsuccessful and the BHA was tripped out of the hole to the rig floor by pulling up double lengths of pipe and cutting the wireline below the top drive system. A new cementing BHA was assembled and successfully

re-entered the hole on August 28, utilizing the same technique described previously, to the previously achieved total depth of 2826 fbsf (9332 fbrf).
H002 was cemented on August 29 by spotting 11.5 ppg pad mud from total depth to 2042 fbsf (8548 fbrf), and emplacing a 16.4 ppg Class H cement plug. The cement was allowed to cure for 24 hours. The cement top was tagged on August 30 at a depth of 1599 fbsf (8105 fbrf) with 15k lbs. weight on bit. The upper section of the hole above the 443 ft cement plug was filled with 11 ppg WBM.

A total of 15 pressure cores (105.0 ft) were recovered from H002. Lithology was characterized by interbedded upper fine sand and mudrock.  Core recovery was 70%. Figure 1-4 displays the cored interval,  core recovery, and the previously drilled LWD gamma and resistivity logs at the adjacent H001 well.

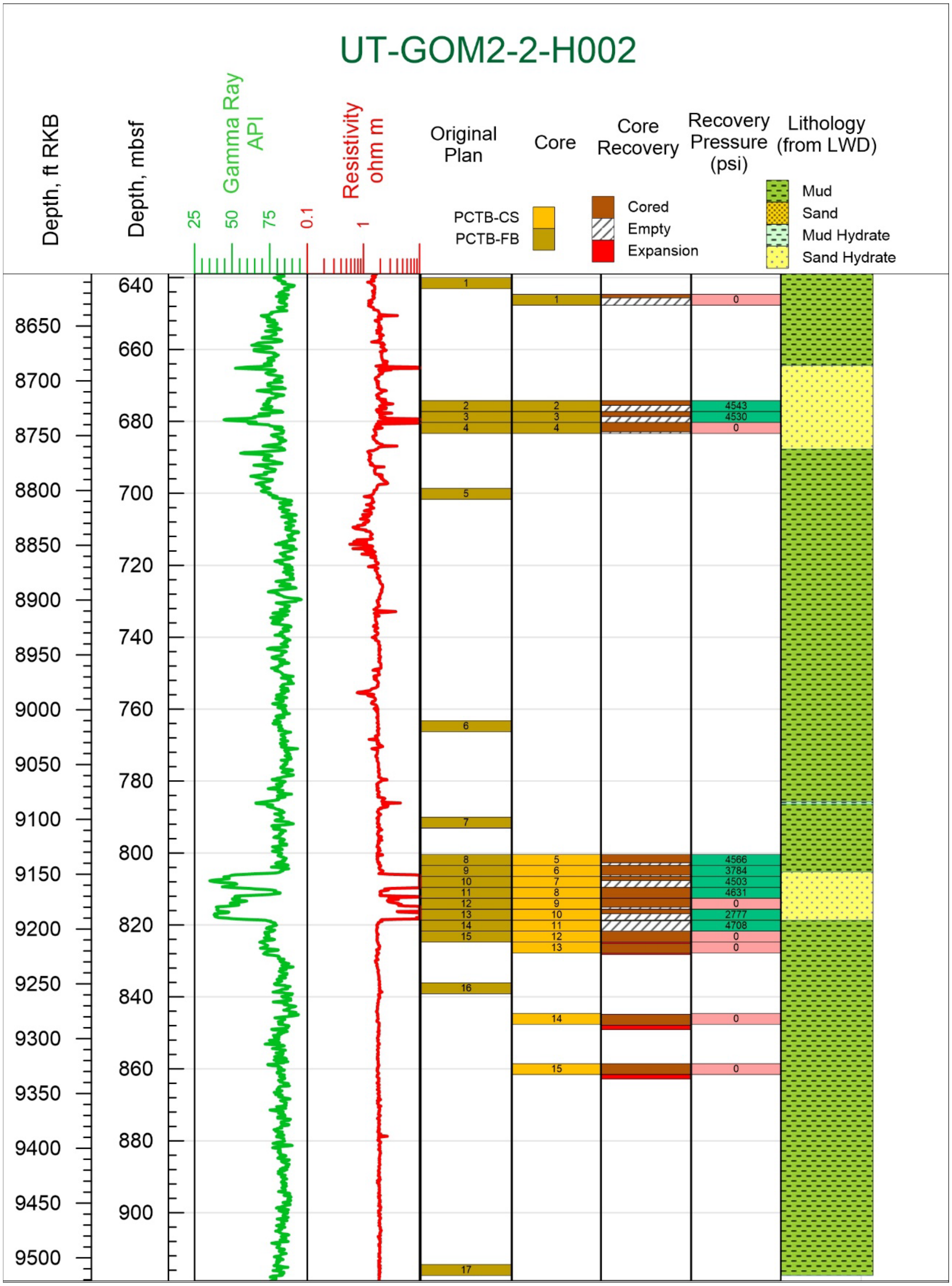


*Figure 1-4. Depth intervals cored during drilling of H002. The ring resistivity and gamma ray from the adjacent H001 well are displayed (red and green). Cored intervals and pressure in pressure cores are shown far right along with core recovery. The brown boxes delineate the length of the recovered core in each coring interval.*

**DEMOBILIZATION AND REMOBILZATION IN SALT LAKE CITY**

The UT Austin science party personnel and equipment departed from the Helix Q4000 by helicopter and supply vessels, and disembarked in Houma, Louisiana and Port Fourchon, Louisiana, receptivity. All equipment, samples, Conventional cores, and pressure cores were transported by supply vessel to Port Fourchon, LA. Pressure cores were transported to UT Austin and Geotek Coring Inc. in Salt Lake City, UT for future analysis. Conventional and conventionalized cores were transported to Geotek Coring Inc.'s facility in College Station, TX for whole core logging and CT scanning before they were also shipped to Geotek Coring Inc. in Salt Lake City, UT. All equipment and discrete samples were shipped to Geotek Coring Inc. in Salt Lake City, UT. All containers were hooked up in the Geotek yard to prepare for additional core processing by the science party in Salt Lake City.

**SALT LAKE CITY**

In September, 2023, project scientists began an intensive 2-week analysis of the core at Geotek headquarters in Salt Lake City, UT. Pressure core sections were depressurized while measuring the volume of gas produced and collecting gas samples for later analysis. Conventionalized core sections were logged for magnetic susceptibility. Conventional and conventionalized whole rounds were then cut from sections for moisture and density measurements and geomechanical analyses. Measurements of sediment strength were made on each section and thermal conductivity was measured in the center of at least one section per core. Finally, conventional and conventionalized cores were split and imaged, archival halves were laid out for lithostratigraphy visual description, and working halves for discrete sampling of major and minor lithologies.

In parallel, additional whole round samples collected offshore were squeezed for pore water extraction and one pressure core section was cryogenically frozen before depressurization and this and all other cryogenically frozen samples in the -80C freezer were sub-cored for further microbiology analysis.
All archival halves will be logged for magnetic susceptibility and x-ray fluorescence by Geotek, then all archival and working halves will be shipped to UT Austin upon conclusion of analytical activities at Geotek Coring facilities.

**RESULTS**

Sample were collected to meet the top four of the five outlined science objectives for the expedition. Samples were collected to meet the highest scientific priority of characterizing two hydrate reservoirs and their bounding muds. Approximately 1.5 ft of the reservoir and ~6.5 ft of the bounding seal were obtained from the Blue interval, and ~6.5 ft of reservoir and ~26 ft of bounding seal were obtained from the Orange interval. Samples were collected to meet the second highest priority to obtain a high-resolution geochemical depth profile of the shallow muds from continuous coring to 484 fbsf and ephemeral measurements of salinity and alkalinity were captured. In-situ temperature measurements were acquired to 474 fbsf, but no pressure measurements were made. The dissolved methane concentration was characterized. Dissolved methane increased to saturation around 459-475 fbsf (140-145 mbsf). Intervals of undersaturated dissolved methane and low saturation methane hydrate were found in deeper intervals, including bounds of Blue and Orange Sands.

The UT-GOM2-2 science party consisted of 42 researchers from 7 universities including the USGS, JAMSTEC, and Geotek. 561.4 ft (171.1 m) of conventional core and 179.8 ft (54.8 m) of pressure core were acquired and processed. Core samples were preserved and shipped both nationally and internationally.

There were no safety or weather incidents.

#### 1.2.2.8.2 *Subtask 16.2 – Add Conventional Coring (Phase 5B)*

Subtask 16.2 is complete. For additional information, see above discussion in Section 1.2.2.8.1, Subtask 16.1 – Execute UT-GOM2-2 Field Program.

#### 1.2.2.8.3 *Subtask 16.3 – Add Spot Pressure Coring (Phase 5B)*

Subtask 16.2 is complete. For additional information, see above discussion in Section 1.2.2.8.1, Subtask 16.1 – Execute UT-GOM2-2 Field Program.

#### 1.2.2.8.4 *Subtask 16.4 – Add Second Hole at H-Location (Phase 5B)*

Subtask 16.2 is complete. For additional information, see above discussion in Section 1.2.2.8.1, Subtask 16.1 – Execute UT-GOM2-2 Field Program.

### 1.2.2.9 Task 17.0 – UT-GOM2-2 Core Analysis

Not started

## 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 (PMP) and Statement of Project Objectives (SOPO).
- 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 PMP.

### *1.3.2 Task 10.0 – UT-GOM2-1 Core Analysis*

- UT will continue the routine core analysis program for the remaining UT-GOM2-1- cores (H005-5FB-1, H005-13FB-2, H005-7FB-5, and H005-8FB-1). These tests will focus on assessing the uniaxial strain capabilities of the Hydrate Core Effective Stress Chamber in preparation for the characterization program of the UT-GOM2-2 cores (see Section 1.3.9 - Task 17.0 – UT-GOM2-2 Core Analysis for additional information).
- UT will perform a “gas production test” using UT-GOM2-1 samples where we will replicate field conditions: the pore pressure is decreased, the total vertical stress is maintained constant, and the sample undergoes uniaxial strain deformation (i.e., zero lateral strain). We will measure produced gas, lateral stress, compression and temperature throughout the entire test.

### *1.3.3 Task 11.0 – Update Science and 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*

- Task Complete

### *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 to repair the Dell Image Reconstruction computer.

- UT will pursue an annual Geotek service visit to provide preventative maintenance and evaluation to Mini-PCATS and the Effective Stress Chamber.
- Geotek and UT will install the Effective Stress Chamber computer system upgrade.
- UT will continue testing the methane-water mixer at high pressures. We will test the ability to generate and maintain high-pressure and the transfer to other pressurized systems (e.g., hydraulic pumps).
- UT will continue to evaluate and refine the temperature measurement capabilities of the Effective Stress Chamber test section.
- UT will continue to evaluate and pursue perfecting the uniaxial testing procedures and Effective Stress Chamber software.

### *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*

- Task complete

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

- UT-GOM2-2 field operations are complete.
- Post-expedition tasks including those listed below will continue:
    1. Post-expedition regulatory compliance reporting and permit termination
    2. UT-GOM2-2 invoice review, payments, and overall cost/budget reconciliation
    3. Insurance audits
    4. Inventory and shipping field supplies and equipment
    5. Expedition Report writing

### *1.3.9 Task 17.0 – UT-GOM2-2 Core Analysis*

- This task will start at the conclusion of the expedition as samples are shipped from Salt Lake City to various laboratories both nationally and internationally.
- UNH, USGS, and UT will start sedimentology and paleontology work on discrete samples of sediment.
- Tufts will start moisture and density measurements and ship a select subset of samples for x-ray powder diffraction. Tufts will select and possibly start measurement of the grain size distribution using the settling method.
- UW will start pore water analysis by first measuring chlorinity and reassessing salinity and alkalinity measurements for contamination from drilling fluids.
- Oregon St will start DNA extractions and amplifications.
- USGS and Ohio State will start assessing gas sample composition.

# 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.

Cardona A., Bhandari A., and Heidari M. and Flemings P.B. (2023). The viscoplastic behavior of natural hydrate bearing sediments under uniaxial strain compression (K0 loading), Journal of Geophysical Research: Solid Earth, v. 128, e2023JB026976, doi:10.1029/2023JB026976

Chen, X., and Espinoza, D. N., 2018a, Ostwald ripening changes the pore habit and spatial variability of clathrate hydrate: Fuel, v. 214, p. 614-622. https://doi.org/10.1016/j.fuel.2017.11.065

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Chen, X. Y., and Espinoza, D. N., 2018b, Surface area controls gas hydrate dissociation kinetics in porous media: Fuel, v. 234, p. 358-363. https://doi.org/10.1016/j.fuel.2018.07.030

Chen, X.Y., Espinoza, D. N., Tisato, N., Flemings, P. B., in press, Gas Permeability, Pore Habit and Salinity Evolution during Methane Hydrate Dissociation in Sandy Sediments: Energy & Fuels, Manuscript ID: ef-2022-017204.R2

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Cook, A. E., and Waite, W. F., 2018, Archie's Saturation Exponent for Natural Gas Hydrate in Coarse-Grained Reservoirs, v. 123, no. 3, p. 2069-2089. https://doi.org/10.1002/2017jb015138

Daigle, H., Fang, Y., Phillips, S.C., Flemings, P.B., 2022, Pore structure of sediments from Green Canyon 955 determined by mercury intrusion: AAPG Bulletin, v. 106, no. 5, p. 1051-1069. https://doi.org/10.1306/02262120123

Darnell, K. N., and Flemings, P. B., 2015, Transient seafloor venting on continental slopes from warming-induced methane hydrate dissociation: Geophysical Research Letters, p. n/a-n/a. https://doi.org/10.1002/2015GL067012

Darnell, K. N., Flemings, P. B., and DiCarlo, D., 2019, Nitrogen-Driven Chromatographic Separation During Gas Injection Into Hydrate-Bearing Sediments: Water Resources Research. https://doi.org/10.1029/2018wr023414

Ewton, E., 2019, The effects of X-ray CT scanning on microbial communities in sediment coresHonors]: Oregon State University, 21 p.

Fang, Y., Flemings, P. B., Daigle, H., Phillips, S. C., Meazell, P. K., and You, K., 2020, Petrophysical properties of the Green Canyon block 955 hydrate reservoir inferred from reconstituted sediments: Implications for hydrate formation and production: AAPG Bulletin, v. 104, no. 9, p. 1997–2028, https://doi.org/10.1306/01062019165

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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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### *2.3.4 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

None.

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

None.

## 3.3 Changes That Have A Significant Impact On Expenditures

We are currently reviewing final invoices from the UT-GOM2-2 offshore field program, incurred in Y9Q4. We anticipate that there is an approximate 5% ($1.3) overrun of the budgeted amount for UT-GOM2-2. This is primarily due to lengthy downtime of the Helix Q4000 and unexpectedly high costs and duration for cleaning the supply vessels.

UT has communicated the expected budget exceedance to DOE. UT and the DOE project/contract officers are determining how to best proceed with budget reconciliation.

## 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 18.1 – Project Sample and Data Distribution Plan

Subtask 18.3 – 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 10/01/20-12/31/20 | | Y1Q2 01/01/21-03/31/21 | | Y1Q3 04/01/21-06/30/21 | | Y1Q4 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 10/01/21-12/31/21 | | Y2Q2 01/01/22-03/31/22 | | Y2Q3 04/01/22-06/30/22 | | Y2Q4 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 | $ 617,836 | $ 33,948,642 | $ 543,438 | $ 34,492,080 | $ 3,743,308 | $ 38,235,387 |
| Non-Federal Share | $ 254,642 | $ 25,022,184 | $ 281,474 | $ 25,303,658 | $ 258,413 | $ 25,562,071 | $ 904,873 | $ 26,466,945 |
| Total Incurred Cost | $ 721,317 | $ 58,352,990 | $ 899,310 | $ 59,252,300 | $ 801,851 | $ 60,054,151 | $ 4,648,181 | $ 64,702,332 |
| **Variance** | | | | | | | | |
| Federal Share | $ (3,967,208) | $ (9,705,280) | $ (132,137) | $ (9,837,417) | $ (19,730,651) | $ (29,568,068) | $ 3,032,471 | $ (26,535,597) |
| Non-Federal Share | $ (445,590) | $ (1,244,581) | $ 163,033 | $ (1,081,548) | $ (2,943,422) | $ (4,024,969) | $ 792,613 | $ (3,232,356) |
| Total Variance | $ (4,412,798) | $ (10,949,860) | $ 30,896 | $ (10,918,964) | $ (22,674,073) | $ (33,593,037) | $ 3,825,084 | $ (29,767,953) |
| **Baseline Reporting Quarter** | **Budget Period 5** | | | | | | | |
| | Y3Q1 10/01/22-12/31/22 | | Y3Q2 01/01/23-03/31/23 | | Y3Q3 04/01/23-06/30/23 | | Y3Q4 07/01/23-09/30/23 | |
| | Y3Q1 | Cumulative Total | Y3Q2 | Cumulative Total | Y3Q3 | Cumulative Total | Y3Q4 | Cumulative Total |
| **Baseline Cost Plan** | | | | | | | | |
| Federal Share | $ 1,038,173 | $ 36,505,850 | $ 19,419,248 | $ 55,925,098 | $ 19,297,378 | $ 75,222,476 | $ 609,291 | $ 75,831,767 |
| Non-Federal Share | $ 356,923 | $ 25,399,611 | $ 4,475,093 | $ 29,874,704 | $ 4,447,789 | $ 34,322,493 | $ 260,835 | $ 34,583,328 |
| Total Planned | $ 1,395,096 | $ 61,905,461 | $ 23,894,341 | $ 85,799,802 | $ 23,745,167 | $ 109,544,969 | $ 870,126 | $ 110,415,095 |
| **Actual Incurred Cost** | | | | | | | | |
| Federal Share | $ 294,544 | $ 38,529,931 | $ 319,110 | $ 38,849,041 | $ 560,827 | $ 39,409,868 | $ 12,002,495 | $ 51,412,363 |
| Non-Federal Share | $ 207,066 | $ 26,674,011 | $ 269,715 | $ 26,943,726 | $ 226,242 | $ 27,169,968 | $ 2,776,780 | $ 29,946,748 |
| Total Incurred Cost | $ 501,610 | $ 65,203,942 | $ 588,825 | $ 65,792,767 | $ 787,069 | $ 66,579,836 | $ 14,779,276 | $ 81,359,111 |
| **Variance** | | | | | | | | |
| Federal Share | $ (743,629) | $ 2,024,082 | $ (19,100,138) | $ (17,076,057) | $ (18,736,551) | $ (35,812,608) | $ 11,393,204 | $ (24,419,404) |
| Non-Federal Share | $ (149,857) | $ 1,274,399 | $ (4,205,378) | $ (2,930,979) | $ (4,221,547) | $ (7,152,526) | $ 2,515,945 | $ (4,636,580) |
| Total Variance | $ (893,486) | $ 3,298,481 | $ (23,305,516) | $ (20,007,035) | $ (22,958,098) | $ (42,965,133) | $ 13,909,150 | $ (29,055,984) |

*Note: BP5 rescoped beginning Y3Q1; cumulatives re-set

# 6 ACRONYMS

*Table 6-1: List of Acronyms*

| ACRONYM | DEFINITION |
|---|---|
| AAPG | American Association of Petroleum Geologists |
| APD | Application for Permit to Drill |
| APM | Application for Permit to Modify |
| BOEM | Bureau of Ocean Energy Management |
| BSEE | Bureau of Safety and Environmental Enforcement |
| CDX | Central Data Exchange |
| CHNS | Carbon, Hydrogen, Nitrogen, Sulfur |
| CPP | Complimentary Project Proposal |
| DDE | Dynamic Data Exchange |
| DNA | Deoxyribonucleic Acid |
| DOE | U.S. Department of Energy |
| EPA | Environmental Protection Agency |
| GC | Green Canyon |
| GHSZ | Gas Hydrate Stability Zone |
| IODP | International Ocean Discovery Program |
| JCC | J. Connor Consulting, Inc. |
| JGR | Journal of Geophysical Research |
| JIP | Joint Industry Project |
| LDEO | Lamont-Doherty Earth Observatory |
| LOD | Letter of Determination |
| MD | Measured Depth |
| 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 |
| SOPO | Statement of Project Objectives |
| TVDSF | Total Vertical Depth Below Seafloor |
| UNH | University of New Hampshire |
| USCG | United States Coast Guard |
| USGS | United States Geological Survey |
| UT | University of Texas at Austin |
| UW | University of Washington |
| WR | Walker Ridge |
| XCT | X-ray Computed Tomography |

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