



DOE Award No.: DE-FE0023919

Quarterly Research Performance Progress Report

Period Ending 03/31/2018

Deepwater Methane Hydrate Characterization and Scientific Assessment

Project Period 3: 01/15/2018-09/30/2019

Submitted by:

Peter B. Flemings

A handwritten signature in cursive script that reads 'Peter B. Flemings'. The signature is written in black ink and is positioned above a horizontal line.

Signature

The University of Texas at Austin

DUNS #: 170230239

101 East 27th Street, Suite 4.300

Austin, TX 78712-1500

Email: pflerings@jsg.utexas.edu

Phone number: (512) 475-8738

Prepared for:

United States Department of Energy

National Energy Technology Laboratory

April 30, 2018



U.S. DEPARTMENT OF
ENERGY

**NATIONAL ENERGY
TECHNOLOGY LABORATORY**

Office of Fossil Energy

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

1 ACCOMPLISHMENTS

1.1 WHAT ARE THE MAJOR GOALS OF THE PROJECT?

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 Tables 1-1, 1-2, and 1-3.

Table 1-1: Previous Milestones

Project Phase	Task	Milestone	Milestone Description	Planned Completion	Actual Completion	Verification Method
Phase 1	1.0	M1A	Project Management Plan	03/02/15	03/18/15	Project Mgmt. Plan
	1.0	M1B	Project Kick-off Meeting	01/14/15	12/11/14	Presentation
	2.0	M1C	Site Location and Ranking Report	09/30/15	09/30/15	Phase 1 Report
	3.0	M1D	Preliminary Field Program Operational Plan Report	09/30/15	09/30/15	Phase 1 Report
	4.0	M1E	Updated CPP Proposal Submitted	05/01/15	10/01/15	Phase 1 Report
	2.0	M1F	Demonstration of a viable PCS Tool: Lab Test	09/30/15	09/30/15	Phase 1 Report
	--	M1G	Document results of BP1/Phase 1 Activities	12/29/15	01/12/16	Phase 1 Report
Phase 2	6.0	M2A	Complete Updated CPP Proposal Submitted	11/02/15	Nov-15	QRPPR
	6.0	M2B	Scheduling of Hydrate Drilling Leg by IODP	05/18/16	May-15	Report status to DOE PM
	7.0	M2C	Demonstration of a viable PCS tool for hydrate drilling through completion of land-based testing	12/21/15	Dec-15	PCTB Land Test Report (in QRPPR)
	8.0	M2D	Demonstration of a viable PCS tool for hydrate drilling through completion of a deepwater marine field test	01/02/17	May-17	QRPPR
	11.0	M2E	Update Field Program Operational Plan	02/28/18	In progress	Phase 2 Report
	--	M2F	Document results of BP2/Phase 2 Activities	04/15/18	In progress	Phase 2 Report

Table 1-21:- Current Milestones

Project Phase	Task	Milestone	Milestone Description	Planned Completion	Actual Completion	Verification Method
Phase 3	14.0	M3A	Demonstration of a viable PCS tool for hydrate drilling: Lab Test	12/31/18	--	PCTB Lab Test Report (in QRPPR)
	14.0	M3B	Demonstration of a viable PCS tool for hydrate drilling: Land Test	03/29/19	--	PCTB Land Test Report (in QRPPR)
	15.0	M3C	Complete Refined Field Program Operational Plan Report	12/31/18	--	QRPPR
	15.0	M3D	Completion of required Field Program Permit(s)	12/31/18	--	QRPPR
	--	M3E	Document results of BP3/Phase 3 Activities	12/31/19	--	Phase 3 Report

Table 1-3: Future Milestones

Project Phase	Task	Milestone	Milestone Description	Planned Completion	Actual Completion	Verification Method
Phase 4	16.0	M4A	Completion of planned field Research Expedition operations	03/31/20	--	QRPPR
	17.0	M4B	Complete Preliminary Expedition Summary	09/30/20	--	Report directly to DOE PM
	17.0	M4C	Complete Project Sample and Data Distribution Plan	05/31/20	--	Report directly to DOE PM
	17.0	M4D	Contribute to IODP Proceedings Volume	09/30/21	--	Report directly to DOE PM
	17.0	M4E	Initiate comprehensive Scientific Results Volume with appropriate scientific journal	09/30/21	--	Report directly to DOE PM

1.2 WHAT WAS ACCOMPLISHED UNDER THESE GOALS?

1.2.1 PREVIOUS PROJECT PERIODS: PHASE 1 - PHASE 2

Tasks accomplished in previous project phases (Phase 1 and Phase 2) are summarized in Table 1-4.

Table 1-4: Tasks completed during Phase 1 and Phase 2

Project Phase	Task	Description	QRPPR with Task Information
Phase 1	Task 1.0	Project Management and Planning	Y1Q1 - Y1Q4
	Task 2.0 <i>Subtask 2.1</i> <i>Subtask 2.2</i>	Site Analysis and Selection <i>Site Analysis</i> <i>Site Ranking / Recommendation</i>	Y1Q1 - Y1Q4
	Task 3.0	Develop Pre-Expedition Operational Plan	Y1Q3 - Y1Q4
	Task 4.0	Complete IODP CPP Proposal	Y1Q2 - Y1Q4
	Task 5.0 <i>Subtask 5.1</i> <i>Subtask 5.2</i> <i>Subtask 5.3</i>	Pressure Coring and Core Analysis System Modifications and Testing <i>Pressure Coring Tool with Ball Scientific Planning Workshop</i> <i>Pressure Coring Tool with Ball Lab Test</i> <i>Pressure Coring Tool with Ball Land Test Prep</i>	Y1Q2 - Y1Q4
Phase 2	Task 1.0	Project Management and Planning (Cont'd)	Y2Q1 - Y4Q1
	Task 6.0	Technical and Operational Support of CPP Proposal	Y2Q1 - Y4Q1
	Task 7.0 <i>Subtask 7.1</i> <i>Subtask 7.2</i> <i>Subtask 7.3</i> <i>Subtask 7.4</i>	Cont'd. Pressure Coring and Core Analysis System Mods. and Testing <i>Review and Complete NEPA Requirements (PCTB Land Test)</i> <i>Pressure Coring Tool with Ball Land Test</i> <i>PCTB Land Test Report</i> <i>PCTB Tool Modification</i>	Y2Q1 - Y3Q2
	Task 8.0 <i>Subtask 8.1</i> <i>Subtask 8.2</i> <i>Subtask 8.3</i> <i>Subtask 8.4</i> <i>Subtask 8.5</i>	Pressure Coring Tool with Ball Marine Field Test <i>Review and Complete NEPA Requirements</i> <i>Marine Field Test Operational Plan</i> <i>Marine Field Test Documentation and Permitting</i> <i>Marine Field Test of Pressure Coring System</i> <i>Marine Field Test Report</i>	Y2Q1 - Y4Q1
	Task 9.0 <i>Subtask 9.1</i> <i>Subtask 9.2</i> <i>Subtask 9.3</i> <i>Subtask 9.4</i> <i>Subtask 9.5</i> <i>Subtask 9.6</i> <i>Subtask 9.7</i>	Pressure Core Transport, Storage, and Manipulation <i>Review and Complete NEPA Requirements</i> <i>Hydrate Core Transport</i> <i>Storage of Hydrate Pressure Cores</i> <i>Refrigerated Container for Storage of Hydrate Pressure Cores</i> <i>Hydrate Core Manipulator and Cutter Tool</i> <i>Hydrate Core Effective Stress Chamber</i> <i>Hydrate Core Depressurization Chamber</i>	Y2Q2 - Y3Q3
	Task 10.0 <i>Subtask 10.1</i> <i>Subtask 10.2</i> <i>Subtask 10.3</i>	Pressure Core Analysis <i>Routine Core Analysis</i> <i>Pressure Core Analysis</i> <i>Hydrate Core-Log-Seismic Synthesis</i>	Y3Q3 - Y4Q1
	Task 11.0	Update Pre-Expedition Operational Plan	Y3Q3 - Y4Q1
	Task 12.0	Field Program / Research Expedition Vessel Access	Y3Q3

1.2.2 CURRENT PROJECT PERIOD: PHASE 3

TASK 1.0 - Project Management and Planning

Status: Ongoing

Activity this Period:

Objective 1: Assemble teams according to project needs.

- No new hires this period.

Objective 2: Coordinate the overall scientific progress, administration and finances of the project.

- Managed current project phase tasks
- Monitored costs
- Worked with DOE PM to finalize Budget Period 2 transition on January 18, 2018.

Objective 3: Communicate with project team and sponsors.

- Organized regular project team meetings:
 - Monthly sponsor meetings
 - PCTB development team meetings
 - Operations team meetings
- Managed SharePoint sites, email lists, and archive/website.
- Coordinated DOE visit to University of Texas at Austin, on January 30, 2018. Attendees included Jared Ciferno (Director: Strategic Center for Natural Gas and Oil, NETL), Maria Vargas (Deputy Director: Strategic Center for Natural Gas and Oil, NETL), Tim Reinhardt (Director: Oil & Gas Supply and Delivery, DOE), Richard Baker (Lead: Methane Hydrates Team, NETL), and Gabby Intihar (Sr. Program Mgr.: Office of Fossil Energy, DOE).

Objective 4: Coordinate and supervise all subcontractors and service agreements to realize deliverables and milestones according to the work plan.

- Actively managed subcontractors and service agreements.

Objective 5: Compare identified risks with project risks to ensure all risks are identified and monitored.

Communicate risks and possible outcomes to project team and stakeholders.

- Actively monitored project risks and as needed reported to project team and stakeholders.

TASK 6.0 - Technical and Operational Support of Complimentary Project Proposal

Status: Ongoing

Activity this Period:

- Continued to refine the planned science within the CPP proposal.
- Continued to develop the operational project plan for UT-GOM²-2 expedition.
- Continued to develop G&G component of Exploration Plan for UT-GOM²-2.

A timeline of tasks associated with the submittal of the Complimentary Project Proposal is provided in Table 1-5.

Table 1-5: Timing of Complimentary Project Proposal Submission

Apr 1, 2015:	First Submittal of CPP
May 1, 2015:	Upload data to IODP SSDB
Oct 1, 2015:	Revised Submittal of CPP
Jan 8, 2016:	Upload data to IODP SSDB
Jan 12-14, 2016:	SEP Review Meeting
Apr 1, 2016:	CPP Addendum Submittal
May 2, 2016:	Upload data to IODP SSDB
May 15, 2016:	Proponent Response Letter Submitted
Jun 21-23, 2016:	SEP Review Meeting
June 2016	Safety Review Report Submitted
July 2016	Safety Presentation PowerPoint
July 11 – 13, 2016	Environmental Protection and Safety Panel Meeting
March 2, 2017	Submit CPP Addendum2
March 10, 2017	Upload Revised Site Survey Data
April 2017	Submit EPSP Safety Review Report V2
May 3, 2017	EPSP Safety Review Presentation V2
May 24, 2017	Scheduling of CPP-887 Hydrate Drilling Leg by JR Facility Board
Jan-March 2020	CPP-887 / IODP Expedition 386

TASK 9.0 - Pressure Core Transport, Storage, and Manipulation

Status: Ongoing

Activity this period:

- Continued to store, stabilize, and perform tests on pressure core acquired from UT-GOM2-1 marine field test (May-June 2017).
- Performed weekly pressure checks on pressure chambers.

TASK 10.0 - Pressure Core Analysis

Status: Ongoing

Activity this Period:

Subtask 10.4: Continued Pressure Core Analysis

- Depressurized core from the UT-GOM²-1 marine test was divided, stored, and shipped according to sample handling protocols established for mud lab operations on the rig and at the dock. Initial results from the analysis are included in the Expedition Report.
- The third and final round of pressure core sample and data requests was reviewed and approved by the council. Samples are expected to be distributed to the University of Texas, USGS Woods Hole, Georgia Tech, NETL, and AIST.
- Protocols for Pressure Core cutting and analysis were tested at UT using synthetic cores made from concrete and one of the compromised core, UT-GOM2-1-H005-06FB.
- Gas sampling and hydrate saturation calculations were performed at UT through quantitative depressurization experiments of Core H005-06FB-2.
- Completed permeability analysis using benchmark sample.
- Completed multiple steady-state permeability tests on 6FB2:
 - Completed 9 consolidation tests (hydrostatic and K_0).
 - Completed 14 permeability tests over a stress range of 1 to 5 MPa (vertical stress).
 - Depressurized sample.
 - Initiated steady state permeability analysis on disassociated sediment core (6FB-2).

Subtask 10.5: Continued Hydrate Core-Log-Seismic Synthesis

- UT is currently comparing measurements at the core scale to the logging results from previous drilling at GC955 and building models to relate core velocity measurements to actual velocity measurements.

Subtask 10.6: Additional Core Analysis Capabilities

- Coordinated purchase order for X-ray Diffraction (XRD) for sediment mineralogy.
- Requested cost estimates and developed specs for Sidewall Core Microanalysis.
- Requested cost estimates and developed specs for Pre-consolidation Chamber.

TASK 13.0 – Maintenance and Refinement of Pressure Core Transport, Storage, and Manipulation

Status: On Schedule

Activity this Period:

Subtask 13.1: Hydrate Core Manipulator and Cutter Tool

- Two maintenance teardowns of the cutter, rotation, and viewing units after the cutting of samples in Mini-PCATS.
- One bi-annual teardown of the Power Balance Drive for the purpose of preventative maintenance.
- All teardowns have the following steps:
 - Removal of sediment from sample cutting
 - Removal and mitigation of corrosion
 - Complete replacement of all bearings, seals, and O-rings
 - Lubrication of necessary bearings and components

Subtask 13.2: Hydrate Core Effective Stress Chamber

- Completely disassembled the hydrate core effective stress chamber and actuator motor, cleaned out debris and cleaned surfaces of all components, replaced all seals and O-rings, and reassembled.
- A fourth pump has been delivered and the manifold altered, allowing us to operate the load cell chamber independently from the pore and radial confining pumps.

Subtask 13.3: Hydrate Core Depressurization Chamber

- Successfully transferred a section of pressure core from mini-PCATS to a small storage chamber and then attached to the degassing manifold.
- Performed a slow quantitative degassing while quantifying the amount of gas and liquid released, collecting gas samples, and monitoring pressure and temperature conditions within the sample chamber.
- Currently working with Ohio State University to improve our gas sampling capability.

Subtask 13.4: Hydrate Core Transport Capability for Field Program

- Continued to store, stabilize, and perform tests on pressure core acquired from UT-GOM2-1 marine field test (May-June 2017).
- Initiated technical assessment of current capabilities and required modifications to store additional core in the UT pressure core center that will be acquired in Phase 4, during UT-GOM2-2.

Subtask 13.5: Maintenance and Expansion of Pressure Core Storage Capability

- Continued to store, stabilize, and perform tests on pressure core acquired during Phase 2.
- Performed weekly pressure checks on pressure chambers.
- Completed drawings to redesign the pressure chamber storage bases to increase capacity.
- Completed a preliminary budgetary analysis to expand the pressure, maintenance, and relief system (PMRS) to accommodate the increased capacity described above.

Subtask 13.6: Transportation of Hydrate Core (Field Program)

- Future Task.

Subtask 13.7: Storage of Hydrate Cores (Field Program)

- Future Task.

Subtask 13.8: Hydrate Core Distribution

- UT assisted NETL by providing technical feedback on their pressure core transport system design to ensure compatibility.
- Began dialogue with USGS regarding transfer chambers.
- Discussed testing logistics with Georgia Tech personnel.

TASK 14.0 – Performance Assessment, Modifications, and Testing of DOE Pressure Coring System

Status: On Schedule

Activity this Period:

Held meetings with Geotek to clarify work plan and goals of PCTB testing program. Developed a draft Scope of Work document and provided to Geotek for review and comments. Initiated contracting discussions with UT PCTB Development Team (including members of UT, DOE, and Pettigrew Engineering), UT Contracting Office, and Geotek.

Subtask 14.1: PCTB Lab Testing and Analysis

- Future Task

Subtask 14.2 Pressure Coring System Modifications/Upgrades

- Future Task

Subtask 14.3: PCTB Land-Based Testing and Analysis

- Future Task

TASK 15.0 – Field Program / Research Expedition Operations

Status: On Schedule

Activity this Period:

Subtask 15.1: Review and Complete NEPA Requirements

- Future Task

Subtask 15.2: Finalize Detailed Operational Plan for Field Program

- An Operational Plan has been developed, and will be submitted to DOE along with the GOM2 Phase 2 Report by April 15, 2018. The Operational Plan is a living document, which will continue to be updated and refined as required.

Subtask 15.3: Permitting for Field Program

- Held webex meeting on March 30, 2018 with Texas A&M University, members of *JOIDES Resolution* Facility Board, *JOIDES Resolution* Science Operator, National Science Foundation, and DOE, to discuss path forward for permitting *JOIDES Resolution* and ability to meet regulations promulgated by BSEE, BOEM, and US Coast Guard to operate in the Gulf of Mexico as a drilling vessel.

- A critical outcome of this meeting was that the *JOIDES Resolution* must meet the 1989 mobile offshore drilling unit (MODU) requirements in order to operate as a drilling unit in the Gulf of Mexico. This requires substantial modifications to be made to the ship, including, potential thickening of the hull, building blast walls, and elimination of ignition sources on the deck. UT and the USIO are currently performing further review to find out if it will be possible to modify the JR or receive 'alternative compliances' to meet the MODU requirements.

Subtask 15.4: Assemble and Contract Pressure Coring Team Leads for Field Program

- Future Task

Subtask 15.5: Contract Project Scientists and Establish Project Science Team for Field Program

- Future Task

1.3 WHAT DO YOU PLAN TO DO DURING THE NEXT REPORTING PERIOD TO ACCOMPLISH THE GOALS?

TASK 1.0: Project Management and Planning (Cont'd from prior phase)

UT will continue to execute the project in accordance with the approved PMP, 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.

Key project management and planning goals for the next quarter include:

- Complete and submit Phase 2 Report and Operational Plan Report.
- Finalize service agreements and business contracts for PCTB performance assessment, modifications, and testing tasks.

TASK 6.0: Technical and Operational Support of Complimentary Project Proposal (Cont'd from prior phase)

- UT will continue to engage IODP/Texas A&M University on the critical issue of the ability of the *JOIDES Resolution* to operate in the Gulf of Mexico, and clarify the path forward for UT-GOM²-2.

Task 9.0: Pressure Core Transport, Storage, and Manipulation (Cont'd from prior phase)

- UT will continue to store pressure cores acquired in Phase 2 during UT-GOM²-1 and investigate current capabilities and requirements for storing pressure cores that will be acquired in Phase 4 during UT-GOM²-2.

Task 10.0: Pressure Core Analysis (Cont'd from prior phase)

- UT will work with other institutions on plans for transferring pressure core per the final distribution plan. Pressure core distribution will start in late spring / summer 2018.
- Gas analysis will continue and KO permeability studies on pressure cores will commence.

Task 13.0: Maintenance and Refinement of Pressure Core Transport, Storage, and Manipulation

- Mini PCATS, the PMRS, and all storage chambers will undergo continued observation and maintenance at regularly scheduled intervals and on an as-needed basis

Task 14.0: Performance Assessment, Modifications, and Testing of DOE Pressure Coring System

- Complete Contract with Geotek for continuation of PCTB Development.
- Submit purchase orders for XRD.
- UT continues to generate required specifications for the sidewall core tool.

Task 15.0: Field Program Preparations

- Clarify path forward for utilization of the *JOIDES Resolution* for UT-GOM²-2.

- Hold Operational Planning Team meetings and develop draft science plan for UT-GOM²-2.
- Continue to make progress on G&G section of BOEM Exploration Plan.
- Refine Operational Plan as needed.
- Initiate review of NEPA requirements.

2 PRODUCTS

2.1 PUBLICATIONS, CONFERENCE PAPERS, AND PRESENTATIONS

- Cook, A. E., and Waite, W. F., (2018). Archie's saturation exponent for natural gas hydrate in coarse-grained reservoirs. *Journal of Geophysical Research*. DOI: 10.1002/2017JB015138
- Cook, A. E., & Sawyer, D. (2015). Methane migration in the Terrebonne Basin gas hydrate system, Gulf of Mexico. Presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
- Cook, A.E., & Sawyer, D. (2015). The mud-sand crossover on marine seismic data. *Geophysics*, v. 80, no. 6, A109-A114. 10.1190/geo2015-0291.1.
- 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.
- Cook, A.E., Hillman, J., & Sawyer, D. (2015). Gas migration in the Terrebonne Basin gas hydrate system. Abstract OS23D-05 presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
- Cook, A.E., Hillman, J., Sawyer, D., Treiber, K., Yang, C., Frye, M., Shedd, W., Palmes, S. (2016). Prospecting for Natural Gas Hydrate in the Orca & Choctaw Basins in the Northern Gulf of Mexico. Poster presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
- Fang, Y., Flemings, P.B., Daigle, H., O'Connell, J., Polito, P., (2018). Measure permeability of natural hydrate-bearing sediments using K0 permeameter. Presented at Gordon Research Conference on Gas Hydrate, Galveston, TX. Feb 24- Mar 02, 2018.
- Flemings, P., Phillips, S., and the UT-GOM2-1 Expedition Scientists, (2018). Recent results of pressure coring hydrate-bearing sands in the deepwater Gulf of Mexico: Implications for formation and production. Talk presented at the 2018 Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX, February 24-March 2, 2018.
- Flemings, P.B., Phillips, S.C, Collett, T., Cook, A., Boswell, R., and the UT-GOM2-1 Expedition Scientists (2018). UT-GOM2-1 Hydrate Pressure Coring Expedition Summary. 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. University of Texas at Austin Institute for Geophysics, Austin, TX.
<https://ig.utexas.edu/energy/genesis-of-methane-hydrate-in-coarse-grained-systems/expedition-ut-gom2-1/reports/>
- Fortin, W. (2016). Properties from Seismic Data. Presented at IODP planning workshop, Southern Methodist University, Dallas, TX.
- Fortin, W. (2018). Waveform Inversion and Well Log Examination at GC955 and WR313 in the Gulf of Mexico for Estimation of Methane Hydrate Concentrations. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Fortin, W., Goldberg, D.S., Holbrook, W.S., and Küçük, H.M. (2016). Velocity analysis of gas hydrate systems using prestack waveform inversion. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.

- Fortin, W., Goldberg, D.S., Küçük, H.M. (2016). Methane Hydrate Concentrations at GC955 and WR313 Drilling Sites in the Gulf of Mexico Determined from Seismic Prestack Waveform Inversion. EOS Trans. American Geophysical Union, Fall Meeting, San Francisco, CA.
- Fortin, W., Goldberg, D.S., Küçük, H. M. (2017). Prestack Waveform Inversion and Well Log Examination at GC955 and WR313 in the Gulf of Mexico for Estimation of Methane Hydrate Concentrations. EOS Trans. American Geophysical Union, Fall Meeting, New Orleans, LA.
- Darnell, K., Flemings, P.B., DiCarlo, D.A. (2016). Nitrogen-assisted Three-phase Equilibrium in Hydrate Systems Composed of Water, Methane, Carbon Dioxide, and Nitrogen. Presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
- Goldberg, D., Küçük, H.M., Haines, S., Guerin, G. (2016). Reprocessing of high resolution multichannel seismic data in the Gulf of Mexico: implications for BSR character in the Walker Ridge and Green Canyon areas. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Hammon, H., Phillips, S., Flemings, P., and the UT-GOM2-1 Expedition Scientists, (2018). Drilling-induced disturbance within methane hydrate pressure cores in the northern Gulf of Mexico. Poster presented at the 2018 Gordon Research Conference and Seminar on Natural Gas Hydrate Systems, Galveston, TX, February 24-March 2, 2018.
- Heber, R., Kinash, N., Cook, A., Sawyer, D., Sheets, J., and Johnson, J.E. (2017). Mineralogy of Gas Hydrate Bearing Sediment in Green Canyon Block 955 Northern Gulf of Mexico. Abstract OS53B-1206 presented at American Geophysical Union, Fall Meeting, New Orleans, LA.
- Hillman, J., Cook, A. & Sawyer, D. (2016). Mapping and characterizing bottom-simulating reflectors in 2D and 3D seismic data to investigate connections to lithology and frequency dependence. Presented at Gordon Research Conference, Galveston, TX.
- Hillman, J, Cook, A.E., Sawyer, D., Küçük, H.M., and Goldberg, D.S. (2017). The character and amplitude of bottom-simulating reflectors in marine seismic data. *Earth & Planetary Science Letters*, doi:<http://dx.doi.org/10.1016/j.epsl.2016.10.058>
- Hillman, J.I.T., Cook, A.E., Daigle, H., Nole, M., Malinverno, A., Meazell, K. and Flemings, P.B. (2017). Gas hydrate reservoirs and gas migration mechanisms in the Terrebonne Basin, Gulf of Mexico. *Marine and Petroleum Geology*, doi:10.1016/j.marpetgeo.2017.07.029
- Johnson, J. (2018). High Porosity and Permeability Gas Hydrate Reservoirs: A Sedimentary Perspective. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Kinash, N. Cook, A., Sawyer, D. and Heber, R. (2017). Recovery and Lithologic Analysis of Sediment from Hole UT-GOM2-1-H002, Green Canyon 955, Northern Gulf of Mexico. Abstract OS53B-1207 presented at American Geophysical Union, Fall Meeting, New Orleans, LA.
- Küçük, H.M., Goldberg, D.S, Haines, S., Dondurur, D., Guerin, G., and Çifçi, G. (2016). Acoustic investigation of shallow gas and gas hydrates: comparison between the Black Sea and Gulf of Mexico. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Majumdar, U., Cook, A. E., Shedd, W., and Frye, M. (2016). The connection between natural gas hydrate and bottom-simulating reflectors. *Geophysical Research Letters*, DOI: 10.1002/2016GL069443
- Malinverno, A. (2015). Monte Carlo inversion applied to reaction-transport modeling of methane hydrate in continental margin sediments. Abstract OS23B-2003 presented at American Geophysical Union, Fall Meeting, San Francisco, CA.

- Malinverno, A. (2016). Modeling gas hydrate formation from microbial methane in the Terrebonne basin, Walker Ridge, Gulf of Mexico. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Malinverno, A., Cook, A. E., Daigle, H., Oryan, B. (2017). Methane Hydrate Formation from Enhanced Organic Carbon Burial During Glacial Lowstands: Examples from the Gulf of Mexico. EOS Trans. American Geophysical Union, Fall Meeting, New Orleans, LA.
- Meazell, K., Flemings, P. B., Santra, M., and the UT-GOM2-01 Scientists (2018). Sedimentology of the clastic hydrate reservoir at GC 955, Gulf of Mexico. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Meazell, K., & Flemings, P.B. (2016). Heat Flux and Fluid Flow in the Terrebonne Basin, Northern Gulf of Mexico. Presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
- Meazell, K., & Flemings, P.B. (2016). New insights into hydrate-bearing clastic sediments in the Terrebonne basin, northern Gulf of Mexico. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Meazell, K., & Flemings, P.B. (2016). The depositional evolution of the Terrebonne basin, northern Gulf of Mexico. Presented at 5th Annual Jackson School Research Symposium, University of Texas at Austin, Austin, TX.
- Meazell, K. (2015). Methane hydrate-bearing sediments in the Terrebonne basin, northern Gulf of Mexico. Abstract OS23B-2012 presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
- Moore, M., Darrah, T., Cook, A., Sawyer, D., Phillips, S., Whyte, C., Lary, B., and UT-GOM2-01 Scientists (2017). The genetic source and timing of hydrocarbon formation in gas hydrate reservoirs in Green Canyon, Block GC955. Abstract OS44A-03 presented at American Geophysical Union, Fall Meeting, New Orleans, LA.
- Morrison, J., Flemings, P., and the UT-GOM2-1 Expedition Scientists (2018). Hydrate Coring in Deepwater Gulf of Mexico, USA. Poster presented at the 2018 Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Oryan, B., Malinverno, A., Goldberg, D., Fortin, W. (2017). Do Pleistocene glacial-interglacial cycles control methane hydrate formation? An example from Green Canyon, Gulf of Mexico. EOS Trans. American Geophysical Union, Fall Meeting, New Orleans, LA.
- Oti, E., Cook, A. (2018). Non-Destructive X-ray Computed Tomography (XCT) of Previous Gas Hydrate Bearing Fractures in Marine Sediment. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Oti, E., Cook, A., Buchwalter, E., and Crandall, D. (2017). Non-Destructive X-ray Computed Tomography (XCT) of Gas Hydrate Bearing Fractures in Marine Sediment. Abstract OS44A-05 presented at American Geophysical Union, Fall Meeting, New Orleans, LA.
- Phillips, S.C., Flemings, P.B., Holland, M.E., Schultheiss, P.J., Waite, W.F., Petrou, E.G., Jang, J., Polito, P.J., O'Connell, J., Dong, T., Meazell, K., and Expedition UT-GOM2-1 Scientists, (2017). Quantitative degassing of gas hydrate-bearing pressure cores from Green Canyon 955. Gulf of Mexico. Talk and poster presented at the 2018 Gordon Research Conference and Seminar on Natural Gas Hydrate Systems, Galveston, TX, February 24-March 2, 2018.

- Phillips, S.C., Borgfeldt, T., You, K., Meyer, D., and Flemings, P. (2016). Dissociation of laboratory-synthesized methane hydrate by depressurization. Poster presented at Gordon Research Conference and Gordon Research Seminar on Natural Gas Hydrates, Galveston, TX.
- Phillips, S.C., *You, K., Borgfeldt, T., *Meyer, D.W., *Dong, T., Flemings, P.B. (2016). Dissociation of Laboratory-Synthesized Methane Hydrate in Coarse-Grained Sediments by Slow Depressurization. Presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
- Phillips, S.C., You, K., Flemings, P.B., Meyer, D.W., and Dong, T. (under review). Dissociation of Laboratory-Synthesized Methane Hydrate in Coarse-Grained Sediments By Slow Depressurization. *Marine and Petroleum Geology*.
- Portnov, A., Cook, A., Heidari, M., Sawyer, D., Santra, M., Nikolinakou, M. (2018). Salt-driven Evolution of Gas Hydrate Reservoirs in the Deep-sea Gulf of Mexico. Presented at Gordon Research Conference on Natural Gas Hydrate Systems, Galveston, TX.
- Santra, M., Flemings, P., Scott, E., Mezell, K. (2018). Evolution of Gas Hydrate Bearing Deepwater Channel-Levee System in Green Canyon Area in Northern Gulf of Mexico. Presented at Gordon Research Conference and Gordon Research Seminar on Natural Gas Hydrates, Galveston, TX.
- Sheik, C., Reese, B., Twing, K., Sylvan, J., Grim, S., Schrenk, M., Sogin, M., and Colwell, F. (2018). Identification and removal of contaminant sequences from ribosomal gene databases: lessons from the census of deep life. *Frontiers in Microbiology*. doi: 10.3389/fmicb.2018.00840
- Treiber, K, Sawyer, D., & Cook, A. (2016). Geophysical interpretation of gas hydrates in Green Canyon Block 955, northern Gulf of Mexico, USA. Poster presented at Gordon Research Conference, Galveston, TX.
- Worman, S. and, Flemings, P.B. (2016). Genesis of Methane Hydrate in Coarse-Grained Systems: Northern Gulf of Mexico Slope (GOM²). Poster presented at The University of Texas at Austin, GeoFluids Consortia Meeting, Austin, TX.
- Yang, C., Cook, A., & Sawyer, D. (2016). Geophysical interpretation of the gas hydrate reservoir system at the Perdido Site, northern Gulf of Mexico. Presented at Gordon Research Conference, Galveston, TX, United States.
- You, K.Y., DiCarlo, D. & Flemings, P.B. (2015), Quantifying methane hydrate formation in gas-rich environments using the method of characteristics. Abstract OS23B-2005 presented at 2015, Fall Meeting, AGU, San Francisco, CA, 14-18 Dec.
- You, K., Flemings, P.B. (2016). Methane Hydrate Formation in Thick Sand Reservoirs: Long-range Gas Transport or Short-range Methane Diffusion?. Presented at American Geophysical Union, Fall Meeting, San Francisco, CA.
- You, K., and Flemings, P. B. (2017). Methane Hydrate Formation In Thick Sand Reservoirs: 1. Short-Range Methane Diffusion, *Marine and Petroleum Geology*.
- You, K.Y., Flemings, P.B., & DiCarlo, D. (2015). Quantifying methane hydrate formation in gas-rich environments using the method of characteristics. Poster presented at 2016 Gordon Research Conference and Gordon Research Seminar on Natural Gas Hydrates, Galveston, TX.
- You, K., and Flemings, P. B. (2018). Methane Hydrate Formation in Thick Marine Sands by Free Gas Flow. Presented at Gordon Research Conference on Gas Hydrate, Galveston, TX. Feb 24- Mar 02, 2018.

2.2 WEBSITE(S) OR OTHER INTERNET SITE(S)

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

2.3 TECHNOLOGIES OR TECHNIQUES

Nothing to report.

2.4 INVENTIONS, PATENT APPLICATIONS, AND/OR LICENSES

Nothing to report.

3 CHANGES/PROBLEMS

3.1 CHANGES IN APPROACH AND REASONS FOR CHANGE

Nothing to report.

3.2 ACTUAL OR ANTICIPATED PROBLEMS OR DELAYS AND ACTIONS OR PLANS TO RESOLVE THEM

Current challenges:

- Coordinating with Texas A&M University, the operator of the *JOIDES Resolution* drillship, to illuminate the path forward for utilizing the *JOIDES Resolution* on UT-GOM²-2, and what that path forward is.
- In the event that insurmountable obstacles preclude the *JOIDES Resolution* from operating in the Gulf of Mexico, we expect that Expedition 386 (UT-GOM--2) will be removed from the schedule at the *JOIDES Resolution* Facility Board meeting in May, 2018. If this occurs, UT and the project advisory team will evaluate other platforms and reassess the science plan and operational plan for UT-GOM²-2.

3.3 CHANGES THAT HAVE A SIGNIFICANT IMPACT ON EXPENDITURES

Nothing to report.

3.4 CHANGE OF PRIMARY PERFORMANCE SITE LOCATION FROM THAT ORIGINALLY PROPOSED

Nothing to report.

4 SPECIAL REPORTING REQUIREMENTS

4.1 CURRENT: PHASE 3

Task 1.0 – Revised Project Management Plan

Subtask 14.3 – PCTB Land Test Report

Subtask 15.2 – Final Research Expedition Operational Plan

4.2 FUTURE – PHASE 4

Task 1.0 – Revised Project Management Plan

Subtask 17.1 – Project Sample and Data Distribution Plan

Subtask 17.3 – IODP Proceedings Expedition Volume

Subtask 17.4 – Expedition Scientific Results Volume

5 BUDGETARY INFORMATION

Phase 3 (Budget Period 3) cost summary is outlined below. Note: Y2 in the table is Y3 of the overall project including BP1.

Table 5-1: Phase 3 (Budget Period 3) Cost Profile

Baseline Reporting Quarter	Phase 2 Extension	Budget Period 3							
		Y4Q2		Y4Q3		Y4Q4			
		01/01/18-03/31/18		04/01/18-06/30/18		07/01/18-09/30/18			
		Y4Q2	Cumulative Total	Y4Q3	Cumulative Total	Y4Q4	Cumulative Total		
Baseline Cost Plan									
Federal Share		\$ 1,066,233	\$ 1,066,233	\$ 788,190	\$ 1,854,423	\$ 1,270,466	\$ 3,124,889		
Non-Federal Share		\$ 358,558	\$ 358,558	\$ 358,558	\$ 717,116	\$ 358,558	\$ 1,075,674		
Total Planned		\$ 1,424,791	\$ 1,424,791	\$ 1,146,748	\$ 2,571,539	\$ 1,629,024	\$ 4,200,563		
Actual Incurred Cost									
Federal Share		\$ 394,532	\$ 394,532						
Non-Federal Share		\$ 211,985	\$ 211,985						
Total Incurred Cost		\$ 606,517	\$ 606,517						
Variance									
Federal Share		\$ (671,701)	\$ (1,460,765)						
Non-Federal Share		\$ (146,573)	\$ (146,573)						
Total Variance		\$ (818,274)	\$ (1,607,338)						

Baseline Reporting Quarter	Budget Period 3							
	Y5Q1		Y5Q2		Y5Q3		Y5Q4	
	10/01/18-12/31/18		01/01/19-03/31/19		04/01/19-06/30/19		07/01/19-09/30/19	
	Y5Q1	Cumulative Total	Y5Q2	Cumulative Total	Y5Q3	Cumulative Total	Y5Q4	Cumulative Total
Baseline Cost Plan								
Federal Share	\$ 5,665,774	\$ 8,790,663	\$ 458,336	\$ 9,248,999	\$ 6,464,836	\$ 15,713,835	\$ 458,336	\$ 16,172,171
Non-Federal Share	\$ 496,980	\$ 1,572,654	\$ 496,980	\$ 2,069,634	\$ 496,980	\$ 2,566,613	\$ 496,980	\$ 3,063,593
Total Planned	\$ 6,162,754	\$ 10,363,317	\$ 955,316	\$ 11,318,633	\$ 6,961,816	\$ 18,280,448	\$ 955,316	\$ 19,235,764
Actual Incurred Cost								
Federal Share								
Non-Federal Share								
Total Incurred Cost								
Variance								
Federal Share								
Non-Federal Share								
Total Variance								

*Note: Year reflects that of overall project

6 REFERENCES

- Flemings, P. B., 2016a, Y2Q1 Quarterly Research Performance Progress Report (Period ending 12/31/2015), Deepwater Methane Hydrate Characterization and Scientific Assessment, DOE Award No.: DE-FE0023919.
- Flemings, P. B., 2016b, Y2Q2 Quarterly Research Performance Progress Report (Period ending 3/31/2015), Deepwater Methane Hydrate Characterization and Scientific Assessment, DOE Award No.: DE-FE0023919.

7 ACRONYMS

Table 7-1: List of Acronyms

ACRONYM	DEFINITION
AIST	National Institute of Advanced Industrial Science and Technology
BOEM	Bureau of Ocean Energy Management
CPP	Complimentary Project Proposal
DOE	U.S. Department of Energy
EPSP	Environmental Protection and Safety Panel
IODP	International Ocean Discovery Program
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
PCS	Pressure Coring System
PCTB	Pressure Core Tool with Ball Valve
PM	Project Manager
PMP	Project Management Plan
PMRS	Pressure Maintenance and Relief System
QRPPR	Quarterly Research Performance and Progress Report
RPPR	Research Performance and Progress Report
SEP	Site Evaluation Panel
SSDB	Site Survey Data Bank
USGS	U.S. Geological Survey
UT	University of Texas at Austin
XRD	X-ray Diffraction

National Energy Technology Laboratory

626 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940

3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880

13131 Dairy Ashford Road, Suite 225
Sugar Land, TX 77478

1450 Queen Avenue SW
Albany, OR 97321-2198

Arctic Energy Office
420 L Street, Suite 305
Anchorage, AK 99501

Visit the NETL website at:
www.netl.doe.gov

Customer Service Line:
1-800-553-7681



U.S. DEPARTMENT OF
ENERGY

**NATIONAL ENERGY
TECHNOLOGY LABORATORY**