Oil & Natural Gas Technology

DOE Award No.: DE-FE0023919

Quarterly Research Performance Progress Report (Period Ending 09/30/2015)

Deepwater Methane Hydrate Characterization and Scientific Assessment

Project Period 10/01/2014 – 09/30/2020

Submitted by:
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Signature

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1. ACCOMPLISHMENTS:

This report outlines the progress of the fourth quarter of the first budget period.

A. What are the major goals of the project?

The goals of this project are to plan and execute a state of the art field program in the Gulf of Mexico to characterize methane hydrates. The project team will acquire conventional core, pressure core, and downhole logs, and perform in situ testing and measure physical properties in methane hydrate reservoirs in the Gulf of Mexico (GOM) to meet this goal.

Current Milestones

Milestone Description	Status	Verification Method	Comments
M1A: Project Management Plan	Complete: 03/18/2015	Project Management Plan	Revised PMP being created as part of Budget Period transition
M1B: Project Kick-off Meeting	Complete: 12/11/2014	Presentation	
M1C: Site Location and Ranking Report	Complete: 9/30/2015	Phase 1 Report	Potential sites identified and general prioritization set
M1D: Preliminary Field Program Operational Plan Report	Complete: 9/30/2015	Phase 1 Report	Scientific plans set for each potential site, progress made on operational and logistics planning
M1E: Updated CPP Proposal Submitted	Complete: 10/1/2015	Phase 1 Report	Updated CPP submitted April 2015, Revisions due to review responses in process (due October 2015)
M1F: Demonstration of a viable PCS Tool	Complete: 9/30/2015	Phase 1 Report	
M1G: Document results of BP1/Phase 1 Activities	Planned Completion: 12/29/2015 (BP2, Q1)	Phase 1 Report	

Table 1: Milestones BP1

Future Milestones

Milestone Description	Planned Completion	Verification Method
M2A: Complete Updated CPP Proposal Submitted	11/2/2015 (BP3, Q1)	Quarterly Report
M2B: Scheduling of Hydrate Drilling Leg by IODP	5/18/2016 (BP2, Q3)	report status immediately to DOE PM
M2C: Demonstration of a viable PCS tool for hydrate drilling through completion of land-based testing	12/21/2015 (BP2, Q5)	PCTB Land Test Report, in Quarterly Report

M2D: Demonstration of a viable PCS tool for hydrate drilling through completion of a deepwater marine field test	1/2/2017 (BP2, Q6)	Marine Field Test Report, in Quarterly Report
M2E: Complete Refined Field Program Operation Plan	9/26/2017 (BP2, Q8)	Quarterly Report
M2F: Document results of BP2/Phase 2 Activities	12/29/2017 (BP3A, Q1)	Phase 2 Report
M3A: Field Program Operational Plan report	12/18/2018 (BP3A, Q5)	Quarterly Report
M3B: Completion of Field Program Permit	12/9/2018 (BP3A, Q5)	Quarterly Report
M3C: Completion of Hazards Analysis	10/9/2018 (BP3A, Q5)	Field Program Hazards Report, in Quarterly Report
M3D: Demonstration of a viable PCS tool for hydrate drilling through completion of field operations	4/4/2019 (BP3A, Q7)	Quarterly Report
M3E: Complete IODP Preliminary Expedition Report	6/27/2019 (BP3A, Q7)	Send directly to DOE PM
M3F: Complete Project Sample and Data Distribution Plan	8/8/2019 (BP3A, Q8)	Send directly to DOE PM
M3G: Initiate Expedition Scientific Results Volume	4/3/2020 (BP3B, Q3)	Send directly to DOE PM
M3H:Complete IODP Proceedings Expedition Volume	8/24/2020 (BP3B, Q4)	Send directly to DOE PM

Table 2: Milestones BP2, BP3A, and BP3B

B. What was accomplished under these goals?

<u>CURRENT - BUDGET PERIOD 1 – SITE SELECTION</u>

Task 1.0 Project Management and Planning *(Plan Finish: 09/30/20, Status: In progress)*

Objectives and Achievements

Objective 1: Assemble teams according to project needs.

- Recruited RSA II Lab Technician, and RSA V Research Engineer
- Hired Sr. Program Coordinator

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

- Managed the compilation and delivery of revised CPP
- Coordinated logistics of land test procedure, tool delivery, and personnel
- Finalized details of BP1 continuation application
- Monitored costs

Objective 3: Communicate with project team and sponsors

- Organized regular team meetings
    - Monthly Sponsor Meetings
    - Monthly Mapping Team Meetings
    - Monthly PCTB Development Team Meetings
- Managed SharePoint sites developed for each project team to facilitate online communication and collaboration

- Managed email list serves for key project teams
- Managed archive/website for project deliverables

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.
- Coordinated subcontractor Statements of Work

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 2.0 Site Analysis and Selection (*Complete)*

Subtask 2.1 Site Analysis *(Status: Complete*): Reported in Y1Q2 quarterly report

Subtask 2.2 Site Ranking (*Status: Complete)*

Analyzed proposed sites, with detailed mapping and integration of seismic and well log datasets. Sites of focus include, Terrebonne, Orca Basin, Sigsbee, and Perdido. Work included developing structure and amplitude maps of key hydrate bearing horizons. Work also focused on doing log-seismic ties to interpret the potential for significant sand-bearing reservoirs at both locations.

Over the past year, the GOM^2 gas hydrate group considered seven possible drilling and coring locations in the northern Gulf of Mexico: Alaminos Canyon 21 (AC21), Perdido, Tiger Shark, Terrebonne, Orca Basin, Sigsbee and Mad Dog (Figure 1, Table 3). These sites were identified by a variety of different methods. Several sites, AC 21, Terrebonne and Sigsbee were previously drilled during the Gulf of Mexico Gas Hydrate Joint Industry Project (JIP) (Boswell et al., 2012) Leg 2. Mad Dog was also identified by the JIP, but not drilled (Hutchinson et al., 2010). Shedd et al. (2012) identified Orca Basin as having a prominent, discontinuous BSR. Perdido and Tiger Shark (Boswell et al., 2009) were previously drilled by the oil and gas industry and measured well logs suggested significant gas hydrate accumulations.

During the fall and winter of 2014-2015, we collected and assessed scientific well log data, public industry log data, published articles and public reports on each available site. From this data, we decide to eliminate two sites: AC 21 and Tiger Shark.

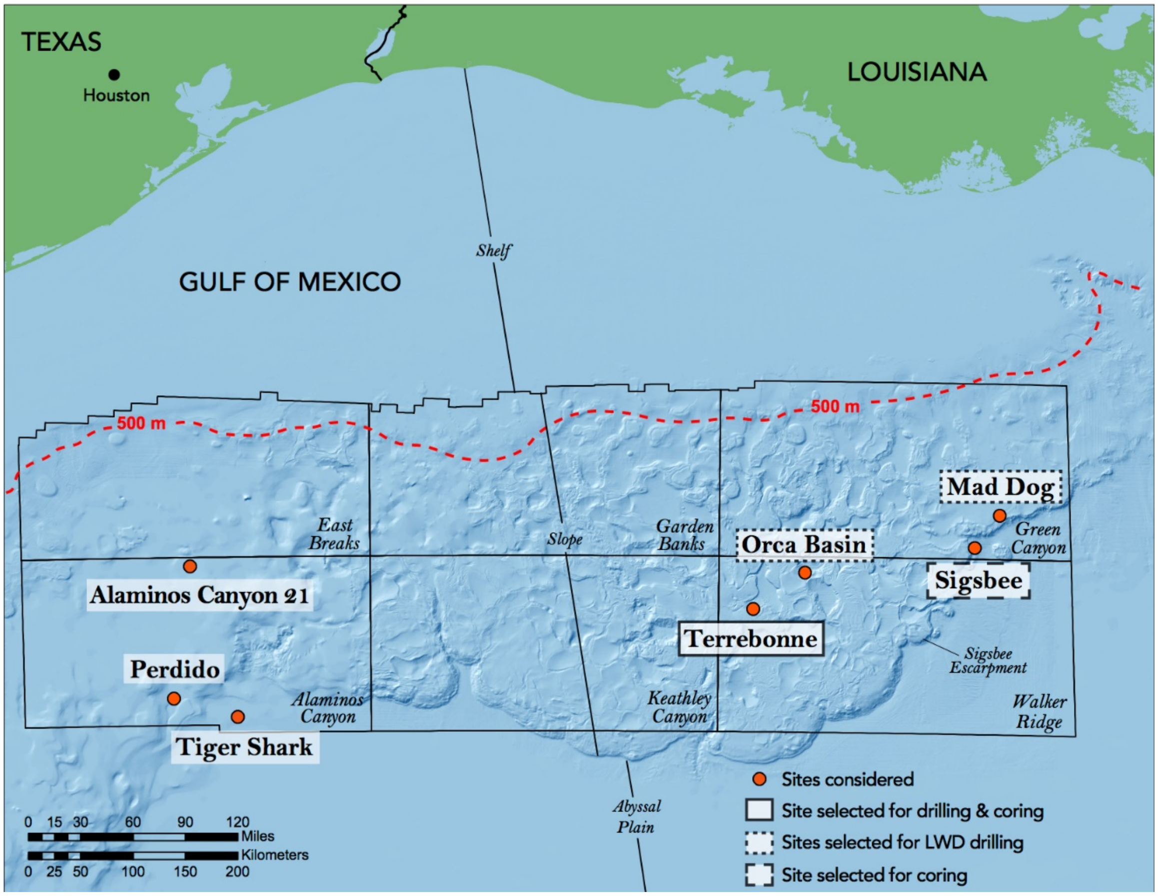

Figure 1: The seven sites considered for drilling and/or coring as a part of GOM2.

The JIP Leg 2 drilled two logging-while-drilling (LWD) holes at AC 21 in 2009 (Boswell et al., 2012). The target was a prominent, extensive, positive amplitude reflector within the gas hydrate stability zone (GHSZ), which could indicate a gas hydrate filled sand layer. A thick sand layer was identified in both AC 21 LWD holes, however, it still remained unclear of the sand contained gas hydrate due to a severe wash out in the target sand. A washout in a hydrate-filled sand is unusual, as hydrate generally contributes to sediment stability and an in-gauge borehole. It could be that a low-saturation of hydrate occurs in the layer, as a small increase in both resistivity and compressional velocity was measured in the layer; Lee et al., (2012) suggest this layer contains ~20% gas hydrate saturation. Others argue that the small increase in resistivity and compressional velocity can be explained by a lower porosity in the sand layer and gas hydrate likely does not occur (Cook and Tost, 2014). Aside from the uncertainty surrounding the occurrence of gas hydrate, the GOM^2 team was also concerned about the ability to collect and recover sand sediment in a core barrel, as this is often an issue for scientific ocean drilling (Kominz et al., 2011). Further LWD or wireline logging would most likely not be able to resolve whether gas hydrate occurs in the sand layer. For these reasons, AC 21 was removed from the list of potential sites.

Chevron drilled the Tiger Shark exploration well in Alaminos Canyon Block 818 in 2004 (Boswell et al., 2009). A 13-m thick sand was encountered near the base of the GHSZ that contained high saturations of gas hydrate. Hydrate was not recovered from the well, but sidewall cores were taken in the hydrate-bearing formation. The sidewall cores confirmed the hydrate-bearing unit is part of the Frio Sand, an Oligocene volcanoclastic sand. The Frio is considerably older and a significantly different lithologic type (as it is composed of volcanoclastic sand with a low grain density) than most shallow sand units in the northern Gulf of Mexico within the GHSZ. This suggested that the information learned by further drilling at Tiger Shark might not be applicable to other areas within the Gulf of Mexico. In addition, the Tiger Shark gas hydrate accumulation is positioned on the top of a large, steeply dipping anticlinal fold raising serious concerns that drilling Tiger Shark could be dangerous without a riser. For these reasons, Tiger Shark was eliminated from possible drilling sites.

Following the elimination of the first two sites, seismic data and industry well log data was ordered or obtained over our five remaining sites of interest: Perdido, Terrebonne, Orca Basin, Sigsbee and Mad Dog. At each site, potential drilling locations were selected and each site was included as a primary site in our March 2015 (initial submission) proposal submission to the International Ocean Discovery Program (IODP).

In July of 2015, we received the reviews of our March 2015 IODP proposal. There were two main comments that affected our site selection process. First, the reviewers thought it was not always clear what hypothesis or questions we were asking at each site because our priorities at each site were varied. Second, the reviewers noted that including all five sites would result in a cruise that was much too long, and that further refinement of the sites and drilling plan was needed.

To address these concerns, we chose to focus our IODP proposal questions on methane migration mechanisms within sand and we identified sites with observable seismic patterns in dipping sand bodies suggestive of gas hydrate occurrence for the October 2015 IODP proposal resubmission. The observable seismic patterns consist of these three traits: a strong, leading-positive reflection above the GHSZ or bottom simulating reflector (BSR), a phase reversal at the BSR, and a leading negative below the BSR. The Terrebonne location, drilled by JIP Leg 2 in 2009 and originally named 'WR 313', has two dipping sand bodies, the Blue Sand and the Orange Sand, that have both the observable seismic pattern as well as confirmed high gas hydrate saturations in the GHSZ (Boswell et al., 2012; Frye et al., 2012). It is highly likely that the observable seismic pattern is caused by high saturation of gas hydrate within the GHSZ, and free gas in the sand below the GHSZ.

Terrebonne is considered our main drilling and coring site because high gas hydrate saturations occur in dipping sand units. In the October 2015 IODP proposal, we propose to drill 2-3 locations at Terrebonne to recover gas hydrate samples from the Blue and Orange Sands preserved in pressure cores, to study the geochemical, microbiological and physical properties of these samples. We will also measure basic physical properties in the Blue and Orange Sands in hole, including permeability, shear velocity, temperature and pore pressure.

Two other sites, Orca Basin and Mad Dog, also have similar observable seismic patterns as Terrebonne, where a leading-positive reflector changes phase at the BSR. This suggests that Orca Basin and Mad Dog also have gas hydrate filled sands within the gas hydrate stability zone, however, this hypothesis is unconfirmed. To confirm that gas hydrate occurs in sand at Mad Dog and Orca Basin, we proposed in the October 2015 IODP proposal to drill two LWD holes at each site, targeting the strong positive reflectors with the GHSZ. If either Mad Dog or Orca Basin yields high saturation gas hydrate within coarse-grained units, we may return to the site for further coring instead of drilling and coring a third hole at Terrebonne.

The Sigsbee location, first drilled by JIP Leg 2 in 2009 and called 'GC 955', also has a sand unit with high saturation gas hydrate (Boswell et al., 2012). Unlike Terrebonne, Sigsbee does not have a dipping sand layer that causes a phase reversal at the BSR. Instead, Sigsbee is an uplifted, highly faulted 4-way closure. For this reason, we have relisted Sigsbee on our October 2015 IODP proposal as an alternate site. More importantly, Sigsbee has been selected as the primary location to test the pressure-coring tool before the IODP cruise. Currently, 10 pressure cores are planned to be collected in the Sigsbee sand reservoir in Spring or Fall of 2016.

Lastly, the Perdido location was removed from the possible sites. It is unclear if a gas hydrate filled sand occurs at Perdido, as the one interpretation of the measured industry well logs suggest Perdido may have a gas hydrate filled sand, while another interpretation of the well log patterns indicate Perdido may only contain gas hydrate in fractured mud. Moreover, Perdido does not have the observable seismic pattern indicating gas hydrate in a dipping sand unit, and thus, lacks similarity to the main sites in the October 2015 IODP proposal: Terrebonne, Mad Dog and Orca Basin.

Sites	Previous drilling in area of interest	Gas hydrate in sand confirmed	Gas hydrate suspected in sand	Outcome
Alaminos Canyon 21	JIP Leg 2, AC 21	possibly	possibly	Eliminated because of lack of confirmed hydrate in sand. There were additional concerns that coring in the potential hydrate sand may be difficult because the sand easily washes out.
Perdido	Statoil, 2001	possibly	possibly	Eliminated because of lack of confirmed hydrate in sand and no phase reversal. There is some evidence that this site contains only gas hydrate in fractured muds.
Tiger Shark	Chevron, 2004	yes		Eliminated because of drilling safety questions, deep water,, and strong concerns that Tiger Shark does not represent a typical GOM hydrate accumulation because of reservoir age and lithology.
Terrebonne	JIP Leg 2, WR 313	yes		Selected for drilling & coring because high saturation gas hydrate found in multiple sand layers.
Orca Basin			yes, phase reversal	Selected for LWD drilling because of strong phase reversal and high amplitudes within stability zone.
Sigsbee	JIP Leg 2, GC 955	yes		Selected for pressure coring because gas hydrate was found in high saturation in a thick, ~30 m sand unit.
Mad Dog			yes, phase reversal	Selected for LWD drilling because of strong phase reversal and high amplitudes within stability zone.

Table 3: Summary of sites considered for GOM2 including reasons for elimination or selection.

Task 3.0 Develop Pre-Expedition Drilling/Logging/Coring/Sampling Operational Plan

(*Status: Complete)*

Operational Plan

The expedition is designed as a standard 56-day scientific IODP expedition (Tables 4&5). The scientific objectives are best achieved with 2 operational phases. Phase 1 will drill four (4) LWD holes at Mad Dog and Orca. Phase 2 will conduct coring and wireline operations at three Terrebonne locations. Coring will feature conventional APC/XCB and RCB coring tools, as many as 30 PBCT runs, wireline logging (including NMR and penetrometer testing), in situ fluid sampling and short-duration formation pressure tests using the MDT straddle packer tool.

This two-phase strategy allows for shipboard analysis of the LWD results prior to Phase 2 and improved time and cost efficiency with mid-expedition personnel and equipment transfers. We estimate preliminary rig times for Phase 1 and 2 activities, including transits, BHA assembly, and drilling, coring, and logging operations (Tables 4&5). These estimates are computed using the Coring Time Estimator with input from the JR Science Operator at Texas A&M University.

Phase 1 Activities

We will drill four (4) LWD holes at Mad Dog and Orca sites. The LWD program will include: geoVISION (GVR), EcoScope, SonicScope, SonicVison, TeleScope, and ProVision-Plus (NMR) tools. Based on prior experience, operational times are estimated assuming that LWD tools are combined and penetrate at 25 m/hr (average) in a separate lowering at each site.

A. PHASE 1 OPERATIONS

Operations	Mob & Transit (hr)	Set Up (hr)	Coring (hr)	Downhole Meas. (hr)	Cum. Time (hr)	Cum. Time Days
Mobilization, Galveston TX and transit	44.0				44.0	1.8
MADOG-01A: Drill and LWD to 648 mbsf						
-LWD rig up		6.0			6.0	0.3
-Run pipe to SF		4.5			10.5	0.4
-Hole A: drill with LWD at 25 m/hr to TD				30.9	41.4	1.7
-Pull pipe		3.7			45.1	1.9
Total, incl. transit to MADOG-02A (3.0 nmi)	3.0				48.1	2.0
MADOG-02A: Drill and LWD to 607 mbsf						
-LWD rig up		6.0			6.0	0.3
-Run pipe to SF		4.6			10.6	0.4
-Hole A: drill with LWD at 25 m/hr to TD				29.3	39.9	1.7
-Pull pipe		3.7			43.6	1.8
Total, incl. transit to ORCA-03A (61 nmi)	5.8				49.4	2.1
ORCAB-03A: Drill and LWD to 619 mbsf						
-LWD rig up		6.0			6.0	0.3
-Run pipe to SF		5.3			11.3	0.5
-Hole A: drill with LWD at 25 m/hr to TD				29.8	41.1	1.7
-Pull pipe		4.4			45.5	1.9
Total, incl. transit to ORCAB-04A (0.5 nmi)	0.5				46.0	1.9
ORCAB-04A: Drill and LWD to 695 mbsf						
-LWD rig up		4.0			4.0	0.2
-Run pipe to SF		5.2			9.2	0.4
-Hole A: drill with LWD at 25 m/hr to TD				32.8	42.0	1.7
-Pull pipe		4.4			46.4	1.9
Total, incl. transit to TBONE-01A (22 nmi)	2.1				48.5	2.0

Table 4: GOM2 CPP Preliminary Operational Plan and Time Estimates for Phase 1 drilling. Times are based on the JRSO Time Estimator and recent hydrate drilling experience. Average rate assumptions:

LWD 25 m/hr; APC 9 m/hr; RCB/XCB 4.5 m/hr; PCBT 4 hr/run; penetrometer 2 hr/run; RIH, Pulling pipe

B. PHASE 2 OPERATIONS

Operations	Mob & Transit (hr)	Set Up (hr)	Coring (hr)	Downhole Meas. (hr)	Cum. Time (hr)	Cum. Time Days
TBONE-01A: Drill and Core to 940 mbsf						
-Coring setup		4.0			4.0	0.2
-Run pipe to SF		5.5			9.5	0.4
-Hole A: APC/XCB core to 500mbsf			88.9		98.4	4.1
-Acquire 10 PBCT cores (upper sand & blue)			40.0		138.4	5.8
-Hole B: RCB core 500m to TD			124.8		263.2	11.0
-Wireline penetrometer at ~8 depths to TD				17.6	280.8	11.7
-Deploy FFF and Re-enter with lg pipe			19.3		300.1	12.5
-GR logging & MDT formation testing				44.0	344.1	14.3
-Pull pipe		5.7			349.8	14.6
Total, incl. transit to TBONE-02A (1.0 nmi)	1.0				350.8	14.6
TBONE-02A: Drill and Core to 850 mbsf						
-Coring setup		4.0			4.0	0.2
-Run pipe to SF		5.5			9.5	0.4
-Hole A: APC/XCB core to 500mbsf			88.9		98.4	4.1
-Acquire 10 PBCT cores (upper sand & blue)			40.0		138.4	5.8
-Hole B: RCB core 500m to TD			104.7		243.1	10.1
-Wireline penetrometer at ~8 depths to TD				17.6	260.7	10.9
-Hole C: wash to TD and Re-enter with lg pipe			53.1		313.8	13.1
-NMR + GR logging & MDT testing				58.0	371.8	15.5
-Pull pipe		5.6			377.4	15.7
Total, incl. transit to TBONE-03A (3.0 nmi)	3.0				380.4	15.8
TBONE-03A: Drill and Core to 940 mbsf						
-Coring setup		4.0			4.0	0.2
-Run pipe to SF		5.6			9.6	0.4
-Hole A: APC/XCB core to 500mbsf			88.9		98.4	4.1
-Acquire 10 PBCT cores (upper sand & blue)			40.0		138.4	5.8
-Hole B: RCB core 500m to TD			124.9		263.3	11.0
-Wireline penetrometer at ~8 depths to TD				17.6	280.9	11.7
-Deploy FFF and Re-enter with lg pipe			19.4		300.3	12.5
-GR logging & MDT formation testing				44.0	344.3	14.3
-Pull pipe		5.7			350.0	14.6
Total, incl. transit/demob in Galveston TX	25.7				375.7	15.7
Total Times (hr):	**85.1**	**89.8**	**832.9**	**288.8**	**1342.9**	**56.0**

560 m/hr.

Table 5: GOM2 CPP Preliminary Operational Plan and Time Estimates for Phase 2 drilling. Times are based on the JRSO Time Estimator and recent hydrate drilling experience. Average rate assumptions: LWD 25 m/hr; APC 9 m/hr; RCB/XCB 4.5 m/hr; PCBT 4 hr/run; penetrometer 2 hr/run; RIH, Pulling pipe 560 m/hr.

Phase 2 Activities

Three coring holes will be drilled at Terrebonne. Conventional core will be processed according to standard IODP procedures and interspersed with pressure coring in hydrate bearing intervals. PCBT pressure coring tool will be deployed at approximately 10 different intervals in the Orange and Blue sands. Coring will be punctuated by in situ temperature and pressure measurements made using SETP/T2P wireline penetrometers. Temperature-depth record from the APCT-3 will be recorded.

We will deploy wide-diameter wireline logging tools, including NMR for direct measurement of pore structure and hydrate saturation, MDT to measure open-hole permeability and recover in situ fluid samples, and FMI to collect formation images with twice the borehole coverage. This will require leasing large-diameter drill pipe and using the new handling capability on the JR rig floor. These tools can be deployed in a new hole drilled explicitly for logging or in the RCB hole after coring. In both cases, a free fall funnel is placed at the seafloor for re-entry and the larger-diameter drill pipe is lowered and used as a conduit to the interval to be logged/tested. The MDT will be then be set at selected depths to perform a borehole drawdown test and recover in situ fluid samples (Tables 4&5).

Task 4.0 Complete and Update IODP CPP Proposal (*Status: Completed submissions within BP1 dates)*

Uploaded revised CPP addressing reviewer concerns.
The original proposal was submitted in March 2015 and reviewed by SEP in June 2015. The SEP review was thoughtful and insightful. Based on the SEP feedback we completely revised the proposal. The major changes were as follows:

1) We focused much more on describing how our drilling program would test how methane hydrate deposits in sandstone reservoirs are formed. We described 9 tests and research strategies to answer these tests.
2) The initial drilling program was too ambitious. We refocused the proposal on the specific problem of understanding how hydrates form in dipping sands, removed two drilling sites, and refined the operational plan.
3) We presented a more detailed plan for the investigation of microbial communities and their role in the carbon cycle. We worked closely with microbiologists and geochemists to develop this component of the proposal.

The revised outline of the proposal is below:

1. Introduction
    - 1.1. The problem: methane hydrates in coarse-grained sediments
    - 1.2. Proposal History and Response to Reviews
    - 1.3. Relationship to the IODP Science Plan
    - 1.4. Third Party Commitment to the CPP
2. Background
    - 2.1. Gas Hydrate Joint Industry Project
    - 2.2. Methane origin
    - 2.3. Genesis of Methane hydrate in coarse-grained sediments
3. Scientific Questions & Testable Hypotheses
    - 3.1. How is methane transported from the source to the site of hydrate formation in coarse-grained systems?

4.0 Research Strategies
- 4.1. Strategy 1: Determination of methanogen biomass
- 4.2. Strategy 2: Determination of methanogen activity

4.3. Strategy 3: Geochemical observations for reaction-transport models of the diagenetic pathways
4.4. Strategy 4: Geochemical, temperature, and pressure profiles
4.4.a. Thermogenic vs. Microbial Methane
4.4.b. Geochemical Profiles
4.4.c. Pressure and Temperature Profiles
4.5. Strategy 5: Material behavior to constrain transport models (Test 5)
4.5.a. In Situ Testing
4.5.b. Laboratory Testing:
5.0 Integrated Geochemistry, Microbiology, and Geotechnical Sampling Strategy
5.1. Conventional Coring
5.2. Pressure Coring
6. Geologic Setting
6.1. Terrebonne
6.2. Mad Dog
6.3. Orca Basin
7. Operational Plan
7.1. Phase 1 Activities
7.2. Phase 2 Activities
7.3. Alternate Sites

Task 5.0 Pressure Coring and Core Analysis System Modification and Testing
(*Status: Complete)*

Subtask 5.1: Pressure Coring Tool with Ball (PCTB) Scientific Planning Workshop (*Status: Complete***)**
Organized a Scientific Planning workshop (March 9 – 10, 2015) to assist with planning the pressure coring strategy and scientific objectives for the Task 5.0. The goals of the workshop were to:

1. review scientific, technical and logistical goals of the DOE drilling experiment;
2. review recent scientific achievements in pressure coring;
3. review current pressurized coring capabilities;
4. develop Science Plan for DOE Drilling;
5. shipboard science, and sampling
6. shore-based analysis
7. develop a project team composed of scientists and institutions enthused with participating in research program.

Results from workshop to be summarized in Phase 1 report.

Subtask 5.2: Pressure Coring Tool with Ball (PCTB) Lab Test (*Status: Complete***)**
Initial test results reported in Y1Q2 Quarterly report.

Objective: To obtain a high degree of confidence in overall PCTB operation with focus on pressure retention.

- Completed full function lab tests with heavy mud.
- Completed full function lab test of all subassemblies with water.

- Held Lab test data review meeting.
- Reviewed results from lab test

Final Lab Test Report to be included in Phase 1 report

Subtask 5.3: Pressure Coring Tool with Ball (PCTB) Land Test Prep (Status: Complete**)**
Performed all necessary activities in preparation for the Land Test of the PCTB tool. Activities included contracting vendors, tool modifications, developing a test plan, and shipping tool.

Work this period:

- Finalized Statement of Work for Schlumberger Cameron Test and Training Facility (CTTF). Completed necessary University paperwork to execute contract.
- Finalized Statement of Work for Geotek/Aumann
- Refined experimental plan.
- Tool Modifications
  - Meetings were held with subject experts and vendors to review tool issues and discussed possible modifications. We discussed possible modifications, the effects of mud weight, and filtrates.
  - Envisioned Plan Forward: First, we will determine which modifications can be performed prior to the field test. Second, we will work with subject matter experts to decide which of the longer term modifications to pursue.
- Tool Fabrications
  - Concurrent to discussions of tool modification we are moving forward with fabricating a 9 7/8 bit, bit sub, and stabilizer to be used in the BP2 Land Test.
  - There is a broad consensus that a narrower bit is advisable. Pettigrew calculated the annular velocities for a 10-5/8 BHA and a 9-7/8 BHA and got some interesting results. The annular velocity past the 8-1/2 drill collars is increased ~60% by going to a 9-7/8 BHA. Similarly, the annular velocity past 5-1/2 drill pipe is increased ~20% by going to a 9-7/8 BHA. Therefore, it is advisable we go with a 9-7/8 BHA for the sea trial and full deployment.
  - In terms of the ID (inner diameter), nothing changes. Thus, there is no impact on the ability to pass other tools.
  - The outer diameter (OD) of the main bit will change from 10-5/8” to 9-7/8”. The bit sub will be rebuilt so that its apparent OD will drop 10-5/8” to 9-7/8”.
  - We will build a 9-7/8” stabilizer that will go right on top of the outer core barrel assembly.
  - We are adding the new stabilized bit sub (4’ long), the new bit (order 18” long), and adding the stabilizer.
- Created service van and pipe shipping plan

<u>FUTURE – BUDGET PERIOD 2, 3, & 3A</u>: Not Started

C. What opportunities for training and professional development has the project provided?
We performed detailed geological analysis and site characterization of multiple locations to plan our drilling strategy. We trained 4 graduate students (2 at UT, 2 at Ohio State) and two post-doctoral scientists (one at UT, one at Ohio State) in geological mapping with seismic data. We provided the opportunity for an undergraduate to participate in this process. We held a general seminar to study methane in hydrate systems at the University of Texas.

D. How have the results been disseminated to communities of interest?
This project has only begun. However, we have several abstracts submitted to AGU and will be participating in upcoming Gordon Conference:

Cook, A., Hillman, J., Sawyer, D., 2015, Gas migration in the Terrebonne Basin gas hydrate system, Abstract OS23D-05 to be presented at 2015, Fall Meeting, AGU, San Francisco, CA, 14-18 Dec.

Meazell, K., 2015, Methane hydrate-bearing sediments in the Terrebonne basin, northern Gulf of Mexico , Abstract OS23B-2012 to be presented at 2015 Fall Meeting, AGU, San Francisco, CA., 14-18 Dec.

Phillips, S.C., Flemings, P.B., Meyer, D.W., You, K., Kneafsey, T.J., Germaine, J.T., Solomon, E.A., and Kastner, M., 2016, Extraction of pore fluids at in situ pressures from methane hydrate experimental vessels, Poster to be presented at 2016 Gordon Research Conference from Feb28 to Mar04 in Galveston, TX, United States.

E. What do you plan to do during the next reporting period to accomplish the goals?
In the next reporting period we will start the Phase 2/BP2 tasks and goals. The key goal of this quarter will be to successfully plan and complete a land-based test of the PCTB coring tool. We will also formalize plans for our Marine Field Test. In addition, we will continue to support our CPP proposal. This will involve extensive analysis of seismic data and communication of these results to the proposal review board.

Task 1.0: Project Management and Planning (continued from prior phase)

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.

Tasks initiated during BP2

Task 6.0: Technical and Operational Support of CPP Proposal

UT Austin will upload data, associated with the CPP proposal, to a designated site-survey databank. Presentations will be prepared, as required, for safety reviews.

Task 7.0: Continued Pressure Coring and Core Analysis System Modifications and Testing

UT Austin will continue to plan and undertake the modification or upgrade and testing of pressure coring and core analysis tools, as deemed necessary by mutual agreement of UT Austin, DOE and the Project Advisory Team.

Subtask 7.1: Review and Complete NEPA Requirements (PCTB Land Test)

UT Austin will complete all necessary NEPA documentation for the specific site / location to be included as part of the land test of the PCTB pressure coring system and / or any other necessary project tools.

Subtask 7.2: Pressure Coring Tool with Ball (PCTB) Land Test

UT Austin will perform a test of the DOE PCTB tool.

- Test 1 – Flow Test: To characterize pressure drop through bottom hole assembly (BHA) with the inner core barrel assembly in place for both the face bit and cutting shoe configurations. To determine if increasing the bit total flow area (TFA) and increasing the strength of the inner tube prevents collapse of the inner tube, and/or core liner, at various flow rates/pressure drops.
- Test 2 – Function Test: To characterize overall PCTB function, focusing on ball closure, pressure boosting, and pressure retention.
- Test 3 – Coring Test: To characterize overall PCTB function, focusing on core recovery capability, in simulated field conditions.
- Test 4 – Cutting Shoe Center Bit Drilling Test: To determine if the increased bit total flow area has increased the cutting shoe center bit penetration rate.

Task 8.0: Pressure Coring Tool with Ball (PCTB) Marine Field Test

UT Austin will work to set date of Marine Field Test and report on preparation plan.

2. PRODUCTS:

A. Publications, conference papers, and presentations

Cook, A., Sawyer, D., Accepted, August 31, The mud sand crossover on marine seismic data, Geophysics.

Cook, A., Hillman, J., Sawyer, D., 2015, Gas migration in the Terrebonne Basin gas hydrate system, Abstract OS23D-05 to be presented at 2015, Fall Meeting, AGU, San Francisco, CA, 14-18 Dec.

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Phillips, S.C., Flemings, P.B., Meyer, D.W., You, K., Kneafsey, T.J., Germaine, J.T., Solomon, E.A., and Kastner, M., 2016, Extraction of pore fluids at in situ pressures from methane hydrate experimental vessels, Poster to be presented at 2016 Gordon Research Conference from Feb28 to Mar04 in Galveston, TX, United States.

B. Website(s) or other Internet site(s)

Project Website: http://www.ig.utexas.edu/gom2/

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

C. Technologies or techniques

Nothing to Report.

D. Inventions, patent applications, and/or licenses

Nothing to Report.

E. Other products
Nothing to Report.

3. CHANGES/PROBLEMS:

A. Changes in approach and reasons for change
Nothing to report.

B. Actual or anticipated problems or delays and actions or plans to resolve them
Nothing to report.

C. Changes that have a significant impact on expenditures
Nothing to report

D. Change of primary performance site location from that originally proposed
Nothing to Report.

4. SPECIAL REPORTING REQUIREMENTS:

CURRENT - BP1 / Phase 1

Task 1 – Project Management Plan (Submitted to DOE)

Task 2 – Site Location and Ranking Report (Will be included as a sub report in the Phase 1 Report)

Task 3 – Preliminary Field Program Operational Plan Report (Will be included as a sub report in the Phase 1 Report)

FUTURE

BP2 / Phase 2

Task 1 – Revised Project Management Plan

Subtask 7.03 – PCTB Land Test Report

Subtask 8.05 – Pressure Core Marine Field Test Report

Task 11 – Refined Field Program Operational Plan Report

BP 3 / Phase 3

Phase 3A

A Phase 3A Report encompassing the refined Operational Plan, pressure coring team report, and permitting report

Task 14 - Field Program Operational Plan report

Task 15 – Field Program Hazards Report

Phase 3B

Task 16 – IODP Preliminary Expedition Report

Task 18 – Project Sample and Data Distribution Plan

Task 18 – IODP Proceedings Expedition Volume

Task 18 – Expedition Scientific Results Volume

5. BUDGETARY INFORMATION:

Budget Period 1 cost summary is outlined in Table 6 below. There is a variance of the federal share in the amount of $824,945. These funds will be expended in Q1 of BP2. These cost mostly account for pending invoicing from subawards/contracts, pending data purchases, and project overhead. The delay in data purchase is due to the need for more time to analyze what areas seismic data would be valuable to meet project objectives.

Baseline Reporting Quarter	Budget Period 1							
	Q1		Q2		Q3		Q4	
	10/01/14-12/31/14		01/01/15-03/31/15		04/01/15-06/30/15		07/01/15-09/30/15	
	Q1	Cumulative Total	Q2	Cumulative Total	Q3	Cumulative Total	Q4	Cumulative Total
Baseline Cost Plan								
Federal Share	$ 51,635	$ 51,635	$ 1,818,533	$ 1,870,168	$ 209,729	$ 2,079,897	$ 1,312,990	$ 3,392,887
Non-Federal Share	$ 15,345	$ 15,345	$ 501,005	$ 516,350	$ 129,045	$ 645,395	$ 14,654,507	$ 15,299,902
Total Planned	$ 66,980	$ 66,980	$ 2,319,538	$ 2,386,518	$ 338,774	$ 2,725,292	$ 15,967,497	$ 18,692,789
Actual Incurred Cost								
Federal Share	$ 51,635	$ 51,635	$ 1,818,533	$ 1,870,168	$ 209,729	$ 2,079,897	$ 488,045	$ 2,567,942
Non-Federal Share	$ 15,345	$ 15,345	$ 501,005	$ 516,350	$ 129,045	$ 645,395	$ 14,591,089	$ 15,236,484
Total Incurred Cost	$ 66,980	$ 66,980	$ 2,319,538	$ 2,386,518	$ 338,774	$ 2,725,292	$ 15,079,134	$ 17,804,426
Variance								
Federal Share	$ 0	$ 0	$ (0)	$ 0	$ -	$ 0	$ (824,945)	$ (824,945)
Non-Federal Share	$ -	$ -	$ -	$ -	$ -	$ -	$ (63,418)	$ (63,418)
Total Variance	$ 0	$ 0	$ (0)	$ 0	$ -	$ 0	$ (888,363)	$ (888,363)

Table 6: BP1 Cost Summary

6. REFERENCES

Boswell, R., Shelander, D., Lee, M., Latham, T., Collett, T., Guerin, G., Moridis, G., Reagan, M., and Goldberg, D., 2009, Occurrence of gas hydrate in Oligocene Frio sand: Alaminos Canyon Block 818: Northern Gulf of Mexico: Marine and Petroleum Geology, v. 26, no. 8, p. 1499-1512, http://dx.doi.org/10.1016/j.marpetgeo.2009.03.005.

Boswell, R., Collett, T. S., Frye, M., Shedd, W., McConnell, D. R., and Shelander, D., 2012, Subsurface gas hydrates in the northern Gulf of Mexico: Marine and Petroleum Geology, v. 34, no. 1, p. 4-30, doi:10.1016/j.marpetgeo.2011.10.003.

Cook, A. E., and Tost, B. C., 2014, Geophysical signatures for low porosity can mimic natural gas hydrate: An example from Alaminos Canyon, Gulf of Mexico: Journal of Geophysical Research: Solid Earth, v. 119, no. 10, p. 2014JB011342, 10.1002/2014JB011342.

Frye, M., Shedd, W., and Boswell, R., 2012, Gas hydrate resource potential in the Terrebonne Basin, Northern Gulf of Mexico: Marine and Petroleum Geology, v. 34, no. 1, p. 150-168, doi:10.1016/j.marpetgeo.2011.08.001.

Hutchinson, D., Boswell, R., Collett, T., Chun Dai, J., Dugan, B., Frye, M., Jones, E., McConnell, D., Rose, K., Ruppel, C., Shedd, W., Shelander, D., and Wood, W. T., 2010, Gulf of Mexico Gas Hydrate Joint Industry Project Leg II: Green Canyon 781 Site Selection.

Kominz, M. A., Patterson, K., and Odette, D., 2011, Lithology Dependence of Porosity In Slope and Deep Marine Sediments: Journal of Sedimentary Research, v. 81, no. 10, p. 730-742, 10.2110/jsr.2011.60.

Lee, M. W., Collett, T. S., and Lewis, K. A., 2012, Anisotropic models to account for large borehole washouts to estimate gas hydrate saturations in the Gulf of Mexico Gas Hydrate Joint Industry Project Leg II Alaminos Canyon 21 B well: Marine and Petroleum Geology, v. 34, no. 1, p. 85-95, http://dx.doi.org/10.1016/j.marpetgeo.2011.06.010.

Shedd, W., Boswell, R., Frye, M., Godfriaux, P., and Kramer, K., 2012, Occurrence and nature of “bottom simulating reflectors” in the northern Gulf of Mexico: Marine and Petroleum Geology, v. 34, no. 1, p. 31-40, http://dx.doi.org/10.1016/j.marpetgeo.2011.08.005.

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