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Quarterly Research Performance Progress Report

Period Ending 12/31/2018

Deepwater Methane Hydrate Characterization and Scientific Assessment

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

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DISCLAIMER

1 ACCOMPLISHMENTS

What was done? What was learned?

This report outlines the progress of the fourth quarter of the fourth fiscal year in the third budget period. Highlights from this period include:

- **GOM^2-2 will not be pursued by IODP**: In the 3rd quarter (Sept. 18), the European Consortium for Ocean Research Drilling (ECORD) Facility Board (EFB) recommended that the GOM^2 expedition (IODP Complimentary Proposal CPP2-887) be implemented by the European Science Operator (ESO) on a Mission Specific Platform in 2021. However, in November 2018, the ECORD Council and ECORD Science Support and Advisory Committee determined that previously-postponed Arctic and Antarctic expeditions will be prioritized for implementation in 2021-2022. Therefore ECORD Council determined it would not implement CPP2-887.
- **GOM^2-2 Path Forward:** As a result of the ECORD Council's decision, there is no longer a path forward within the IODP. Therefore, UT, in coordination with its partners and the GOM^2 Advisory Team, has begun to develop the optimal science plan to achieve the project science. UT has initiated steps to contract a vessel independently as was done for GOM^2-1.
- **Core Analysis**: On November 12, 2018, UT received an X-ray CT system with integrated P-wave measurement capability that will be installed on mPCATS at the UT pressure core center. The system will be installed in January, 2019. This will enable pressure cores transferred from storage chambers to be fully inspected and characterized using either 2D X-ray transmission or 3D X-ray CT.
- **Pressure Core Transfer**: December 2-6, 2018, UT transferred two full-length pressure cores from GOM^2-1 to the United States Geological Survey (USGS) at Woods Hole, MA. H002 3FB-1 and H002 4FB-6 were transferred into USGS-style pressure core chambers and transported in a refrigerated truck.
- **Products**: Fourteen papers presenting results from this project were presented at the American Geophysical Union Meeting held in Washington D.C. in December 2018. Three papers were submitted to a special volume of the American Association of Petroleum Geologists Bulleting on the UT-GOM^2-1 expedition.

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	Milestone	Task	Milestone Description	Planned Completion	Actual Completion	Verification Method
Phase 1	M1A	1.0	Project Management Plan	03/02/15	03/18/15	Project Mgmt. Plan
	M1B	1.0	Project Kick-off Meeting	01/14/15	12/11/14	Presentation
	M1C	2.0	Site Location and Ranking Report	09/30/15	09/30/15	Phase 1 Report
	M1D	3.0	Preliminary Field Program Operational Plan Report	09/30/15	09/30/15	Phase 1 Report
	M1E	4.0	Updated CPP Proposal Submitted	05/01/15	10/01/15	Phase 1 Report
	M1F	2.0	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	M2A	6.0	Complete Updated CPP Proposal Submitted	11/02/15	Nov-15	QRPPR
	M2B	6.0	Scheduling of Hydrate Drilling Leg by IODP	05/18/16	May-15	Report status to DOE PM
	M2C	7.0	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)
	M2D	8.0	Demonstration of a viable PCS tool for hydrate drilling through completion of a deepwater marine field test	01/02/17	May-17	QRPPR
	M2E	11.0	Update Field Program Operational Plan	02/28/18	04/12/18	Phase 2 Report
	M2F	--	Document results of BP2/Phase 2 Activities	04/15/18	04/13/18	Phase 2 Report

Table 1-2: Current Milestones

Project Phase	Milestone	Task	Milestone Description	Planned Completion	Actual Completion	Verification Method
Phase 3	M3A	14.0	Demonstration of a viable PCS tool for hydrate drilling: Lab Test	12/31/18	--	PCTB Lab Test Report (in QRPPR)
	M3B	14.0	Demonstration of a viable PCS tool for hydrate drilling: Land Test	03/29/19	--	PCTB Land Test Report (in QRPPR)
	M3C	15.0	Complete Refined Field Program Operational Plan Report	12/31/18	--	QRPPR
	M3D	15.0	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	Milestone	Task	Milestone Description	Planned Completion	Actual Completion	Verification Method
Phase 4	M4A	16.0	Completion of planned field Research Expedition operations	03/31/20	--	QRPPR
	M4B	17.0	Complete Preliminary Expedition Summary	09/30/20	--	Report directly to DOE PM
	M4C	17.0	Complete Project Sample and Data Distribution Plan	05/31/20	--	Report directly to DOE PM
	M4D	17.0	Contribute to IODP Proceedings Volume	09/30/21	--	Report directly to DOE PM
	M4E	17.0	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

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	**Site Analysis and Selection**	Y1Q1 - Y1Q4
	Subtask 2.1	*Site Analysis*	
	Subtask 2.2	*Site Ranking / Recommendation*	
	Task 3.0	**Develop Pre-Expedition Operational Plan**	Y1Q3 - Y1Q4
	Task 4.0	**Complete IODP CPP Proposal**	Y1Q2 - Y1Q4
	Task 5.0	**Pressure Coring and Core Analysis System Modifications and Testing**	Y1Q2 - Y1Q4
	Subtask 5.1	*Pressure Coring Tool with Ball Scientific Planning Workshop*	
	Subtask 5.2	*Pressure Coring Tool with Ball Lab Test*	
	Subtask 5.3	*Pressure Coring Tool with Ball Land Test Prep*	
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	**Cont'd. Pressure Coring and Core Analysis System Mods. and Testing**	Y2Q1 - Y3Q2
	Subtask 7.1	*Review and Complete NEPA Requirements (PCTB Land Test)*	
	Subtask 7.2	*Pressure Coring Tool with Ball Land Test*	
	Subtask 7.3	*PCTB Land Test Report*	
	Subtask 7.4	*PCTB Tool Modification*	
	Task 8.0	**Pressure Coring Tool with Ball Marine Field Test**	Y2Q1 - Y4Q1
	Subtask 8.1	*Review and Complete NEPA Requirements*	
	Subtask 8.2	*Marine Field Test Operational Plan*	
	Subtask 8.3	*Marine Field Test Documentation and Permitting*	
	Subtask 8.4	*Marine Field Test of Pressure Coring System*	
	Subtask 8.5	*Marine Field Test Report*	
	Task 9.0	**Pressure Core Transport, Storage, and Manipulation**	Y2Q2 - Y3Q3
	Subtask 9.1	*Review and Complete NEPA Requirements*	
	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 *Subtask 10.1* *Subtask 10.2* *Subtask 10.3*	**Pressure Core Analysis** *Routine Core Analysis* *Pressure Core Analysis* *Hydrate Core-Log-Seismic Synthesis*	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

TASK 1.0 - PROJECT MANAGEMENT AND PLANNING

Status: Ongoing

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 project costs.
- Managed ongoing experimental analysis of pressure cores.
- Managed and coordinated transfer of GOM^2-1 pressure core samples from UT to USGS.
- Drove meeting schedules and deadlines for GOM^2-2 planning teams developed during the GOM^2 Workshop at Ohio State University, Sep 24-25 (Nuts & Bolts Team, Operations Team, Wireline & In-Situ Test Team, and Core Analysis Team).
- Continued planning alternate path forward for the GOM^2-2 expedition after ECORD declined to implement GOM^2-2 as a Mission Specific Platform (MSP).
- Organized and planned a workshop for early January to develop multiple GOM^2-2 operational plans that meet science objectives.

Objective 3: Communicate with project team and sponsors.

- Organized and coordinated regular project team meetings:
  - Monthly sponsor meetings, and
  - PCTB development team meetings.
- Organized and coordinated GOM^2-2 field program planning team meetings (Nuts & Bolts Team, Operations Team, Wireline & In-Situ Team, and Core Analysis Team), and conveyed recommendations with DOE and sponsors.
- Managed SharePoint sites, email lists, and archive/website.
- Provided timely updates to project team and sponsors pertaining to communications with ECORD.

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

- Actively managed subcontractors and service agreements.
- Monitored progress and schedule of Geotek preparations for PCTB bench test.
- Monitored progress and schedule of Reaction Engineering International (Reaction Engineering) work scope of computation fluid dynamics (CFD) modeling of the Pressure Coring Tool with Ball-valve (PCTB).

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 as needed and reported identified risks to project team and stakeholders.

TASK 6.0 - TECHNICAL AND OPERATIONAL SUPPORT OF COMPLIMENTARY PROJECT PROPOSAL

Status: Closed (See *Task 15: Field Program / Research Expedition Preparation* for GOM^2-2 plan forward.

In the previous reporting period (July 1 – September 30, 2018) UT presented a technical overview of the GOM^2-2 field program the European Facilities Board (EFB) of the International Ocean Discovery Program (IODP), and provided multiple scenarios of how the program could be achieved as a Mission Specific Platform (MSP) implemented by the European Consortium for Ocean Research Drilling (ECORD). The ECORD Facility Board (EFB) met on September 10, 2018 to review CPP2-887 and evaluate implementing GOM^2-2 as an MSP. Subsequently, the EFB recommended that the European Science Operator (ESO) support an abridged CPP2-887 program as an MSP for implementation in 2021.

The ECORD Council (funding entity that coordinates a common approach to IODP policy) and ECORD Science Support and Advisory Committee (ESSAC) met on November 7-8, 2018 to plan operations and allocate budgets. The ECORD Council determined that previously-postponed Arctic and Antarctic expeditions will be prioritized for implementation in 2021-2022. Therefore ECORD Council determined it was not possible to implement CPP2-887 as an MSP. The ECORD Council Consensus statements from the November meeting are provided as **Appendix A**.

The relevant ECORD Council Consensuses are:

- **ECORD Council Consensus 18-11-06**
    - Considering the EFB recommendation to implement Expedition 377 'Arctic Ocean Paleoceanography (ArcOP)' as a first-priority expedition before the end of IODP (EFB Consensus 18-03-05) and ECORD Council Consensus 18-11-04, the ECORD Council decides to schedule this expedition in FY21.
- **ECORD Council Consensus 18-11-07**
    - Considering ECORD Council Consensus 18-11-06, the ECORD Council does not consider it possible to schedule an MSP expedition based on proposal #887-CPP2 'Gulf of Mexico Methane Hydrate', as proposed by the EFB following its e-meeting held on September 10, 2018. This decision is based on the new information received from ESO and on the EFB priorities supported by the ECORD Council.
- **ECORD Council Consensus 18-11-08**
    - The ECORD Council decides to schedule Expedition 373 'Antarctic Cenozoic Paleoclimate' in FY23 and tasks the EFB to explore alternative scenarios in case ESO is not able to identify a suitable platform to implement it within the $12.2M budget limit set by ECORD Council Consensus 18-03-01.

As a result of the ECORD Councils decision, there is no longer a path forward to gain access to an IODP or ECORD drilling program through CPP2-887. Therefore, UT, in coordination with the GOM^2 Advisory Team, will pursue an alternate means of gaining access to a vessel suitable for the planned research expedition. Refer to Task 15 for further discussion of GOM^2-2 expedition planning.

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

DATE	ACTIVITY
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: Exp. 386, Jan-March 2020
May 15-16, 2018	Expedition 386 removed from *JR* schedule
September 10, 2018	EFB recommends that ESO support an MSP expedition based on Plan B-3 for implementation in 2021
November 7-8, 2018	ECORD Council and ESSAC determine that it is not possible to implement CPP2-887 as an MSP.

TASK 9.0 - PRESSURE CORE TRANSPORT, STORAGE, AND MANIPULATION

Status: Complete (See Task 13 for continued UT Pressure Core Center (PCC) activities).

TASK 10.0 - PRESSURE CORE ANALYSIS

Status: Ongoing

Subtask 10.4 - Continued Pressure Core Analysis

A. Pressurized Core Analysis

A.1. Quantitative Degassing and Gas Analysis

- Quantitative depressurization of pressure core and analysis of the resultant gasses continues:
    - UT is now analyzing sections from uncompromised cores (Table 1-6). Samples were selected to fill in the gaps and increase the resolution of estimated variation in hydrate saturation downhole. During Q4, we degassed intervals from core sections H005-3FB-4 and H005-8FB-2 (see section A.3). The gases collected from these experiments will be analyzed during Q1 of 2019.

Table 1-6: Results of five sections of compromised core and two sections of uncompromised core containing multiple lithofacies that were degassed in the UT Pressure Core Lab, including total methane, methane, saturation, and C1/C2.

Hole	Core-Section	Depth in section (top) (cm)	Length (cm)	Top depth (mbsf)	Bottom depth (mbsf)	Lithofacies	Core volume (L)	Total methane (L)	Maximum dissolved methane (mmol)	Methane hydrate saturation (% of pore volume)	C1/C2
H005	03FB-4	60.8	16.5	421.41	421.57	multiple	0.26	5.64	19	27	-
H005	06FB-2	5	10	428.47	428.57	compromised	0.18	10	12	74	-
H005	06FB-2	20	7	428.62	428.69	compromised	0.14	3.13	10	32	-
H005	06FB-2	40	20	428.82	429.02	compromised	0.41	9.52	28	33	8333
H005	06FB-2	60	8	429.02	429.10	compromised	0.16	4.82	11	44	-
H005	06FB-2	68	32	429.10	429.42	compromised	0.65	32.61	44	76	-
H005	08FB-2	104	14.1	435.68	435.82	3	0.29	2.99	20	13	-

- UT continued work on estimating downhole in-situ salinity from depressurization curves based on the initial pressure and temperature of dissociation during degassing. It appears that the salinity of the samples have decreased over 1.5 years of storage due to mixing with the freshwater in the storage vessel. The samples degassed during Q4 indicate in situ salinities between 27 and 35 ppt in contrast to salinities of 35 to 48 ppt observed in degassing experiments performed soon after core collection.
- UT has submitted a manuscript to the AAPG Bulletin special issue summarizing and interpreting the hydrate saturation, gas composition, and sample salinity from quantitative degassing experiments titled

“Extremely high concentration of methane hydrate in a deepwater silt reservoir from the northern Gulf of Mexico (Green Canyon 955)”. *Phillips, S. C., P. B. Flemings, M. E. Holland, P. J. Schultheiss, W. F. Waite, J. Jang, E. G. Petrou, and H. H., in review, extremely high concentration of methane hydrate in a deepwater silt reservoir from the northern Gulf of Mexico (Green Canyon 955): American Association of Petroleum Geologist Bulletin.*

A2. Index properties, permeability and compressibility of GC 995 lithofacies

- A new effort this quarter at UT is to use reconstituted sediment to study the index properties, permeability, and compressibility of the lithofacies in the UT-GOM^2-1 pressure cores. Specifically, we took sediment from lithofacies 2 (a sandy silt lithofacies) and lithofacies 3 (a clayey silt lithofacies) and measured their liquid limits. We then reconstituted those sediments to measure the intrinsic permeability and compressibility. Specifically, we used a sand pack technique for lithofacies 2, while we used a resedimentation technique for lithofacies 3. The steady state permeability of lithofacies 2 sediments was measured by the constant flow of water and observation of the pressure gradient. Compressibility was measured on both lithofacies using uniaxial, constant rate of strain (CRS), experiments. Data from the CRS experiments was used to calculate the permeability of lithofacies 3 sediments.
- The permeability of lithofacies 2 was ~12 mD at a porosity of 39% (the in-situ porosity) (Figure 1-1). The permeability of lithofacies 3 decreased exponentially with porosity (1.2×10^{-2} to 2.6×10^{-4} mD over 44 to 26% porosity). The permeability at the in-situ porosity of lithofacies 3 is 3.3×10^{-3} mD, approximately 3 orders of magnitude less than that of lithofacies 2.
- Lithofacies 3 is more compressible than lithofacies 2 over an effective stress range of 0.1 to 3.8 MPa, but its compressibility increases with the effective stress over 3.8 MPa (Figure 1-2).

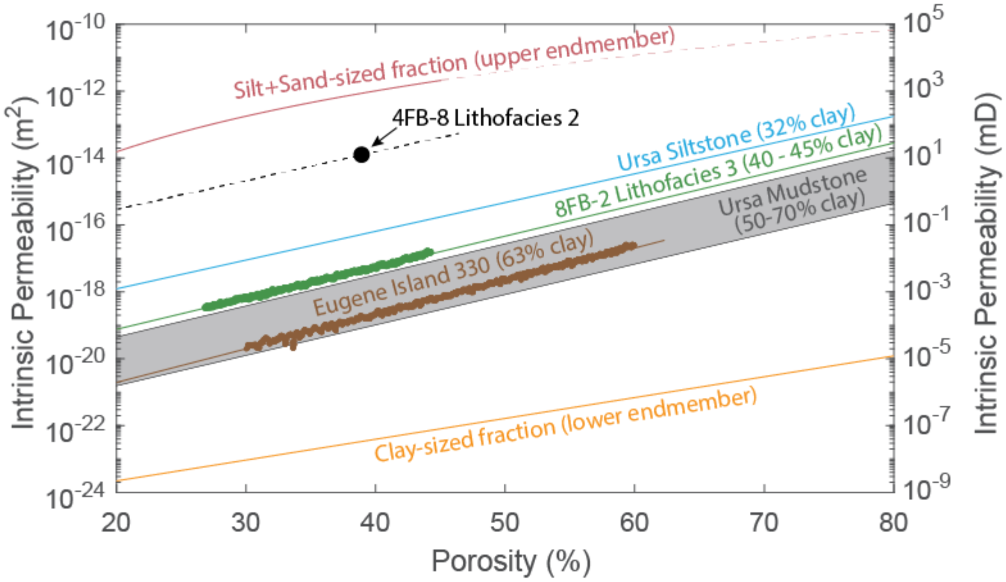

Figure 1-1: Comparison of in-situ permeabilities with previously published data. The permeability of 8FB-2 lithofacies 3 sediments is measured in uniaxial CRS test (green dots). Log-linear permeability and porosity of Ursa Siltstone is marked in blue line. Gray area shows the permeability range of Ursa Mudstone sample (Reece et al., 2012). The measured average permeability with porosity constrained by two endmembers (Daigle et al., 2015): high bound is silt/sand sized sediments and low bound represents the clay-sized sediments.

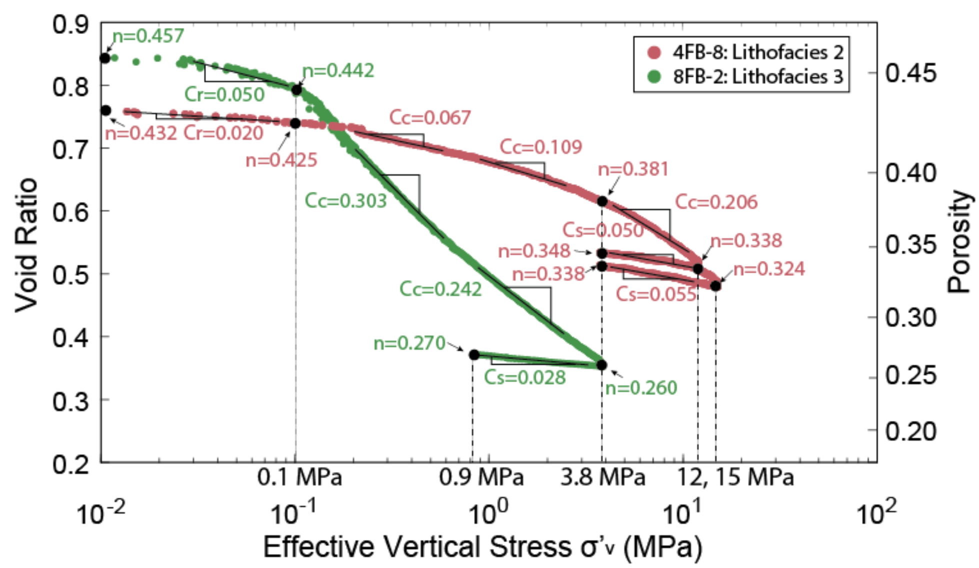

Figure 1-2: Evolution of void ratio under effective vertical stress. (a) Result of "sand packed" specimen of lithofacies 2 sediments (Core H005-4FB-8-1) during the loading under a constant rate of 2.5%/hr. (b) Result of a resedimented specimen of lithofacies 3 sediments (Core H005-8FB-2-1) during the loading under a constant rate of 0.4%/hr.

- Ohio State University continued working to see if we could determine gas hydrate saturation from the expedition X-ray image data of the pressure cores to compare to quantitative degassing results. To date, four core sections that were also quantitatively degassed have been analyzed. The data shows the predicted saturation from the images to match the measured saturation with in the measured saturation margin of error (Table 1-7). The method uses the subset of X-ray image data that matches the section degassed with image artifacts and, where needed of the edge of the core was damaged or uneven, the image outer edge of the core removed. Figure 1-3 shows the X-ray image for Core H005-3FB-3, Lithofacies 2. An image artifact at the center of the core was removed (Figure 1-3 B, inner black circle). The method, then compares the X-ray image with the X-ray data from a section of Lithofacies 2 we assumed was water-saturated to determine hydrate saturation (i.e. the hydrate saturated core has lower CT values and we use that difference to determine saturation).

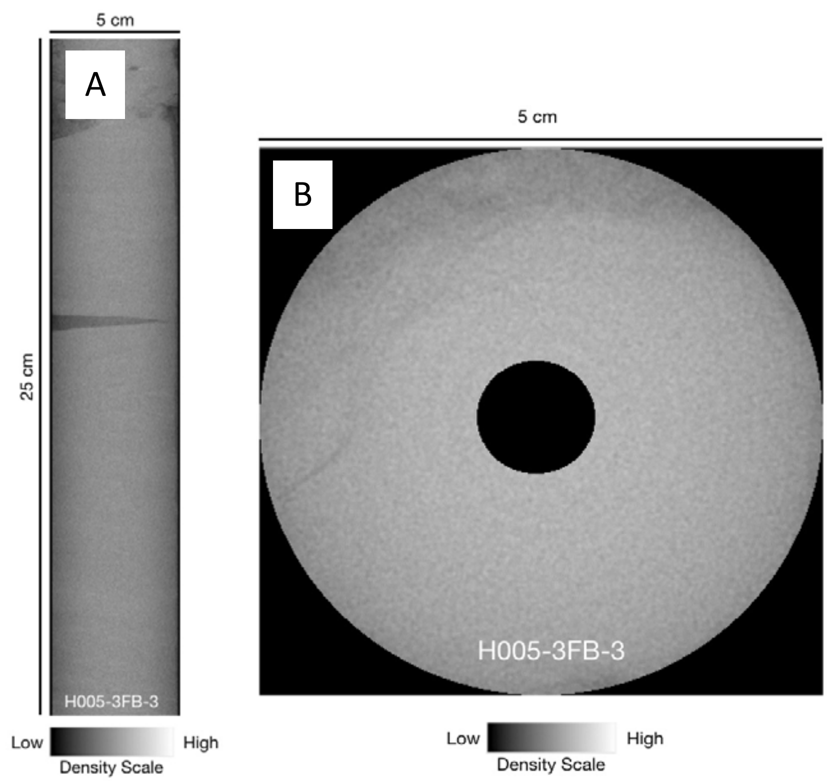

Figure 1-3: XCT scans from core section H005-3FB-3 from the UT-GOM^2-1 Data Directory. A. The interval which was selected for X-ray image hydrate saturation analysis and was also quantitatively degassed. B. A slice of the volume showing where the center image artifact was removed (inner black circle)

Table 1-7: Preliminary results presented at AGU Fall meeting.

Core Section	Lithofacies	Quantitative Degassing Methane Saturation %	CT Derived Methane Saturation %
3FB-3	Quartz silt	88% ± 6%	84%
4FB-2	Quartz silt	93% ±6%	94%
4FB-4	Quartz silt	87% ± 6%	92%
4FB-7	Quartz silt	86% ± 6%	92%

- Oregon State is helping prepare for the microbial analysis of the GOM^2-1 pressure cores, collaborating with Zara Summers (Exxon) following their best protocols for extracting DNA from low biomass samples acquired during the GOM^2-1 research cruise. Using their methods they plan to work with Bill Waite, Junbong Jang (both of USGS), and Jenn Glass and Sheng Dai (both of Georgia Tech) to characterize microbial communities stored in the pressure cores preserved since the GOM^2-1 cruise. Experiments are being planned that can be conducted with the preserved cores to determine which microbial communities are stimulated as a result of depressurization in a lab study that would be somewhat analogous to a depressurization in the field aimed at producing methane from hydrates. Based on discussions with Summers we estimate that we will need at least 20 g of pressure-preserved core material each time that we perform an extraction due to the exceedingly low biomass. This finding of marginally detectable microbial biomass in Gulf of Mexico sediments is consistent with other investigations of deep subsurface microbial communities. We have anticipated this "low biomass challenge" since the beginning of the project and continue to prepare for this by incorporating new approaches to gleaning the minimal amounts of microbial DNA and other microbially-associated macromolecules as required to characterize these cells. These pressure-preserved microbiological samples can ultimately be transferred into so-called BIO chambers (Santamarina et al. 2012; Figure 1-4) and then separated from the primary core material to allow experiments to proceed that would test the microbiological viability at pressure or under different quasi-in situ conditions.

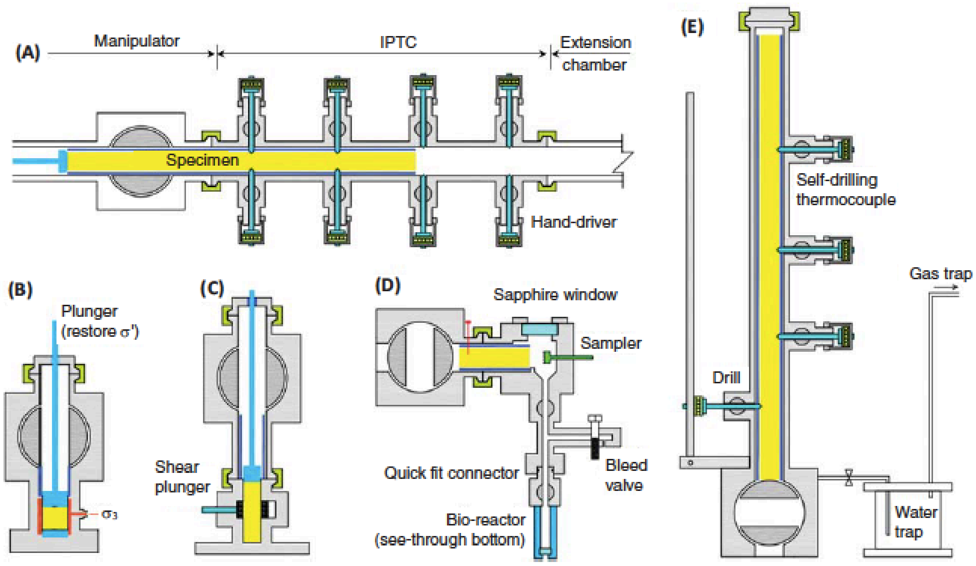

Figure 1-4: Diagram of pressure core characterization tools (PCCTs) showing the biochamber or bio-reactor (D, center bottom of diagram) that can be used for microbiological experiments with subsamples of the primary core material. Image from Santamarina JC, Dai S, Jang J, Terzariol M. 2012. Pressure Core Characterization Tools for Hydrate-Bearing Sediments. Scientific Drilling doi:10.2204/iodp.sd.14.06.2012:44-48.

A3. Pressure Core Distribution

- From December 2-6, 2018, two full length pressure cores were transferred from the UT Pressure Core Center to the United States Geological Survey (USGS). The pressure cores were successfully transferred from mPCATS into USGS-style chambers and transported to the USGS Woods Hole in a refrigerated truck (Figure 1-5).
- Pressure cores transferred:
  - H002 3FB-1
  - H002 4FB-6
- UT continued working on the research agreement and material transfer agreement between UT and the National Institute of Advanced Industrial Science and Technology (AIST) (Japan) for the transfer of two 35 cm pressure core sections from UT-GOM^2-1-3FB-5 and 5FB-3.

Figure 1-5: Images from the Pressure Core transfer from UT to NETL. Top right – USGS storage and transfer chamber attached to UT Mini-PCATS. Bottom right – chamber tagged w/ core info, certified by PCC lab manager and staff scientist. Center left – USGS storage chambers ready for transfer to refrigerated transport vehicle.

B. Depressurized Pressure Core Analysis

- UT has submitted a manuscript to the AAPG Bulletin special issue summarizing the sedimentology of the main reservoir at GC 955 based on grain size analysis, quantitative X-ray diffraction mineralogy, and sedimentary structures observed in X-ray CT images, titled “Silt-rich channel-levee hydrate reservoirs of Green Canyon 955”. *Meazell, K., P. Flemings, and M. Santra, in review, Silt-rich channel-levee hydrate reservoirs of Green Canyon 955: American Association of Petroleum Geologist Bulletin.*
- The University of New Hampshire analyzed bulk C, N, and S isotopes from holes H002 and H005 (Figure 1-6). These preliminary results show a moderate amount of organic matter ~0.t to 1.5 wt% of a mixed marine and terrestrial origin. Most intervals show low total sulfur <0.2 wt% with a few intervals of high total S (> 1 wt%) suggesting precipitation of sulfide minerals due to anaerobic oxidation of methane during early burial. Ongoing efforts will focus on running additional samples/replicates, and relating the elemental results to grain size/lithofacies.

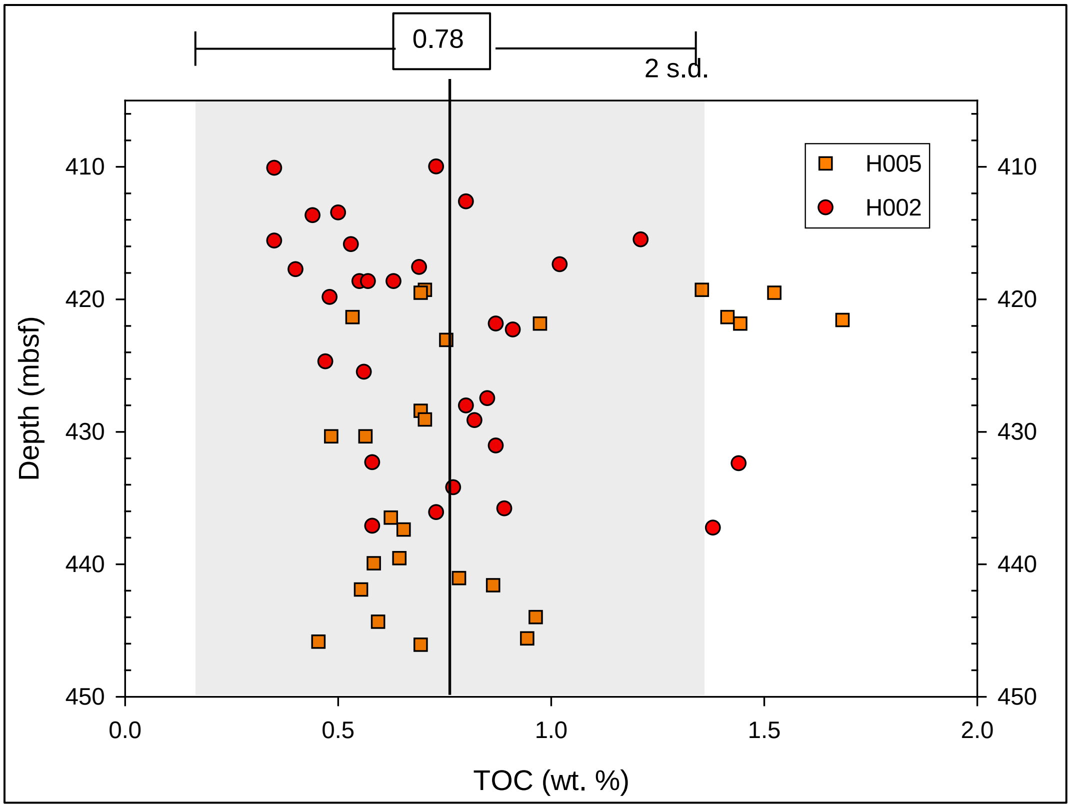

Figure 1-6: TOC results of Bulk sediment samples after acidified from CHNS Elemental Analyzer at UNH from Holes H002 and H005, mean TOC is 0.78 with two standard deviations shown.

- The University of New Hampshire continued working on Grain size using a laser particle size analyzer. Over the course of several weeks, visible reaction of the samples continued to persist after repeated additions of hydrogen peroxide, suggesting an unrealistic amount of organic carbon was still present in the samples. The additions were discontinued and the continued apparent reaction of the hydrogen peroxide is suspected to be occurring due to the catalyzing effect calcium carbonate has on the dissolution of hydrogen peroxide. Once TOC content has been measured in each of these samples, the hydrogen peroxide treated sample set can be revisited to confirm additional additions of peroxide are not needed. Once convinced the organic carbon is removed, the grain size of the organic carbon-free sediments will be measured. Splits of the original samples are now being run for bulk sediment grain size (without peroxide treatment), which will be compared directly to existing, non-peroxide treated samples measured post-cruise by GOM^2 collaborators at UT-Austin.
- Oregon State University (Oregon State) worked on determining whether CT-scanning of geological cores alters the microbial community profiles in the cores which is important to optimize success of the microbiological component of the upcoming coring expedition. Their experiments to determine whether microbial communities are altered by the x-ray CT scanning were completed this quarter and presented at the 2019 AGU meeting by OSU Honors College student Erica Ewton. The premise of the study was that x-ray CT scanning may cause changes in native microbial communities in geological cores with the potential that microbial community analyses would reveal different species (also called “taxa” or

“operational taxonomic units” or “OTUs”) in scanned versus un-scanned cores. This question has not been examined in detail and yet x-ray CT scanning is routinely used by geologists to characterize core lithology. To test our premise, we collected paired, 1.5 m-long, shallow sediment cores each of which intersected three distinct geological intervals that varied between being organic-rich and sandy. Immediately after sample collection, one of each of the paired cores was submitted to x-ray CT scanning, as used for typical geological core analysis, while the other paired core was not exposed to x-ray CT scanning. After scanning, each of the paired cores was held at approximate in situ temperature and at several time intervals over a month of storage samples were taken from distinct lithologic intervals. After sampling, microbial community DNA was extracted from each of the samples (54 total), and then the 16S rRNA gene was sequenced in each sample as a way to determine the number of microbial taxa (species) present as well as the microbial diversity in each sample. Alpha-diversity is a measure of the average species diversity or number of different species in a single location or sample interval. Using two-way test and one-way analysis of variance (ANOVA) we found no evidence that x-ray CT scanning has any effect on the key microbial species in these core samples (Table 1-8). Alpha-diversity did not change in samples that were scanned compared to their unscanned replicates. Furthermore, the alpha-diversity of scanned samples did not change over time of sample storage after scanning. When the data are examined using non-metric multidimensional scaling (data not shown) it is apparent that core location, depth of an individual sample (i.e., geological strata), and sediment lithology are the primary factors that control community structure which is consistent with past studies. Our general conclusion is that x-ray CT scanning such as that used to examine geological cores does not alter microbial community diversity as determined by DNA sequence-based studies.

Table 1-8: Statistical tests performed on core samples to determine effect of scanning on microbial diversity. OTUs = operational taxonomic units.

Does scanning change community α-diversity?			
metric	test	p-value	conclusion
OTUs observed	two-way t	0.989	no
inverse Simpson index	two-way t	0.180	no
Does α-diversity change over time after scanning?			
metric	test	p-value	conclusion
OTUs observed	one-way ANOVA	0.785	no
inverse Simpson index	one-way ANOVA	0.644	no

Subtask 10.5: Continued Hydrate Core-Log-Seismic Synthesis

- No update

Subtask 10.6: Additional Core Analysis Capabilities

- UT received the X-ray CT system with P-wave attachment for Mini-PCATS from Geotek on November 12, 2018. Installation and training by Geotek scheduled for January, 2018 (Figure 1-7).

- The UT Pressure Core Center with its Mini-PCATS facility has no way to image the cores within the pressure vessels, which is causing some issues for properly cutting distinct lithofacies from each other in Mini-PCATS. We have been relying on the images taken of the pressure cores when they were originally analyzed at sea or dockside. Unfortunately, the cores, especially compromised cores, have shifted somewhat and thus; we cannot locate exactly where we are in the section. To rectify that we have purchases an X-ray, p-wave attachment to image the cores inside mini-PCATS so that when we subsample our cores, we know exactly the sample we are taking.

- UT continued discussions with UT groups on developing specifications for the Plug sampler and determined not to pursue the sampler as we would not be able to image the methane hydrate in the pore space of the finer than expected UT-GOM^2-1 sediment at this time or in the near future. Other possible applications were too complex and not within the scope of this project.
- UT continued discussions with Geotek concerning possible purchase of a Pre-consolidation System and identified new science/uses for the chamber. The possibilities of such are still to be determined. The system would at a minimum all for multiple K0 permeameter samples to be cut, stored, and prepared for analysis saving time and the amount of core we need to allocate and discard to the PCATS grabber. With the current equipment we can only cut one sample at a time.

Figure 1-7: Geotek X-ray CT and P-wave scanner attachment for mPCATS.

TASK 13.0 – MAINTENANCE AND REFINEMENT OF PRESSURE CORE TRANSPORT, STORAGE, & MANIPULATION

Status: Ongoing

Continued to store, stabilize, and perform tests on pressure core acquired from GOM^2-1 marine field test (May-June 2017). Performed weekly pressure checks on pressure chambers.

Subtask 13.1: Hydrate Core Manipulator and Cutter Tool

- Received two USGS pressure chambers and transferred two, 1.2 meter pressure cores (4FB-6 and 3FB-1) in December, 2018 (see *Subtask 10.4, A3 – Pressure Core Distribution* for further details).
- Completed system maintenance of cutter, rotator, and viewing chamber in December, 2018.
- Cut one sample for K_0 from core 4FB-8.
- Prepared system to receive Geotek X-ray system upgrade in 2019 which will become an integral part of Mini-PCATS.

Subtask 13.2: Hydrate Core Effective Stress Chamber

- Completed full K_0 system maintenance in November, 2018.
- One pressure core sample from core 4FB-8 was tested and dissociated in the effective stress chamber in Late October-November, 2018. Sediments from sample collected for additional analysis.
- Consulted with Ingersoll-Rand to upgrade PCC compressed air system to reduce moisture in air lines.
- Conducted maintenance on K_0 pump system by replacing all valve solenoids across 4 pumps.
- Completed system maintenance in December, 2018.

Subtask 13.3: Hydrate Core Depressurization Chamber

- Ran two degassing tests during Q4. The results of these experiments are discussed above in Subtask 10.4
    - H005-08FB-2, 60.8-77.3 cm was degassed in October, 2018
    - H005-03FB-4, 104.1-118.1 cm was degassed in November, 2018

Subtask 13.4: Hydrate Core Transport Capability for Field Program

- Future Task (GOM^2-2).

Subtask 13.5: Maintenance and Expansion of Pressure Core Storage Capability

- Continued to assess current capabilities and requirements for storing pressure cores that will be acquired in during GOM^2-2.

Subtask 13.6: Transportation of Hydrate Core (Field Program)

- Future Task (GOM^2-2).

Subtask 13.7: Storage of Hydrate Cores (Field Program)

- Future Task (GOM^2-2).

Subtask 13.8: Hydrate Core Distribution

- Future Task (GOM^2-2).

TASK 14.0 – PERFORMANCE ASSESSMENT, MODIFICATIONS, AND TESTING OF DOE PRESSURE CORING SYSTEM

Status: Ongoing

Subtask 14.1: PCTB Lab Testing and Analysis

- Geotek completed 3-dimensional CAD model of the PCTB to be used as input for CFD modeling, and coordinated with UT and Pettigrew Engineering to produce a matrix of proposed input variables for the CFD model.
- Reaction Engineering (REI) initiated the first phase of the CFD scope of work, which included:
  - Translating 3-dimensional CAD geometry into a format suitable for CFD modeling;
  - Evaluating fluid structure interaction effects and determining the likely position/geometry of PCTB, and estimates of uncertainty
  - Summarizing baseline inputs and results
  - Running subsets of the cleaned geometry to test the model.
- Geotek made preparations to conduct PCTB in-house lab testing in a vertical configuration at the Geotek Coring Inc. facility in Salt Lake City, Utah.

Subtask 14.2 Pressure Coring System Modifications/Upgrades

- Future Task.

Subtask 14.3: PCTB Land-Based Testing and Analysis

- UT and Pettigrew Engineering continued preliminary planning activities for PCTB Land Test:
  - Worked with Schlumberger on tentative land schedule for 10-12 days in late July, 2019 at Cameron, Texas Testing Facility (CTTF).

TASK 15.0 – FIELD PROGRAM / RESEARCH EXPEDITION OPERATIONS

Status: In Progress

Subtask 15.1: Review and Complete NEPA Requirements

Future Task.

Subtask 15.2: Finalize Detailed Operational Plan for Field Program

The clear path forward for the GOM^2-2 expedition is that UT will conduct the GOM^2-2 expedition independently as was done for GOM^2-1. Two key implications of a UT-led expedition:

- A revised budget will be required that includes all expedition-related and operational costs that would have been otherwise been absorbed by IODP or ECORD. This will inevitably result in a reduction of the original program as envisioned in CPP-887.
- A revised operational and science plan will be required that optimize the science that can be done with the revised expedition budget.

Upon recognition of ECORDs decision, UT began taking steps to complete a revised GOM2-2 operational and science plan to maximize scientific objectives. The GOM^2-2 planning teams initiated at the OSU Workshop during the previous reporting period were-refocused. The planning teams were charged with additional foci to address the need for a new GOM^2-2 expedition program that achieves the maximum amount of science is within the revised expedition budget (Table 1-9).

Table 1-9: GOM^2 Planning teams initiated during the GOM^2 Workshop at Ohio State University

TEAM	FOCUS	MEMBERS
Core Analysis Team	Make recommendation for Pressure Coring locations including locations of spot cores (new) Determine what analysis we really need to get on-board Determine prioritization of #1, considering cost, space, and berths Determine what analysis should be done immediately after expedition (dockside or somewhere close) Determine what analyses we should push to be done On-shore Provide recommendation by Dec 1	Thomas Phillips Johnson Colwell Solomon Jang Sawyer Collett Fang Moore Malinverno Cook
In-Situ / Wireline Team	Finalize plan with prioritized components	Collett Polito Waite Goldberg Boswell You Wei Fang Solomon

Operations Team	Develop possible operational scenarios	Flemings Johnson Cook Collett Boswell Thomas Santra Houghton Pettigrew
UT Nuts & Bolts Team	Support other teams and develop cost schedules for operational scenarios	Flemings Houghton Morrison Thomas Phillips Miller

Each GOM^2 Planning Team held formal and informal meetings this quarter to address assigned tasks and develop recommendations. Key recommendations developed by each team are summarized below:

<u>Core Analysis Team</u>

The Core Analysis Team evaluated two possible coring program scenarios approximately within the project budget and one with additional funds:

1. ***Pressure spot coring to obtain a limited geochemical profile in each 01B and 03B (old Plan B-4):***
    a. Possible scientific achievements:
        i. Characterization of reservoir properties, hydrate saturation, composition in 03B Blue and 01B Orange sands
        ii. Possible comparison of up-dip/down-dip blue sand (if there is a connection)
        iii. Very Limited information on fluid sources and microbial methane production
2. ***Redistributed Pressure spot coring to obtain a better geochemical profiles in 01B but capture limited sands in 03B (Table 1-10):***
    a. Possible scientific achievements:
        i. Characterization of reservoir properties, hydrate saturation, composition in 03B Lower Blue and 01B Orange sand
        ii. Limited but better understanding of fluid sources (dissolved methane profile, pore water and microbiology samples), especially around the 01B Orange sand
        iii. Possible comparison of up-dip/down-dip blue sand (if there is a connection)
        iv. Characterization of 01B Red Sand, 03B BSR in Kiwi Sand, and water-bearing 03B Orange sand (if possible)

3. ***Redistributed Pressure Spot coring combined with "continuous" conventional coring in 01B, Pressure coring of units/sands of interest in 03B***
    a. Possible scientific achievements:
        i. Characterization of reservoir properties, hydrate saturation, composition in Lower Blue and Orange sand
        ii. Robust high-resolution geochemistry and microbiology profiles for understanding fluid sources and microbial methane production
        iii. Limited background dissolved methane profile, especially around the 01B Orange sand
        iv. Information on Terrebonne Basin and impact on hydrate system
        v. Characterization of many targets of interest in 03B
            1. 03B Mendenhall Unit
            2. 03B Aqua Sand
            3. 03B JIP Unit
            4. 03B Purple Sand
            5. 03B Upper Blue Sand

Table 1-10: Prioritization and justification of the following pressure coring points for plans within the current budget

Priority	Capture	Scientific Justification
1	01B Orange Sand and transitions and Geochem/microbio background profiles	Characterization of reservoir properties, hydrate saturation, composition
2	Lower Blue Sand	Comparison of up dip-down dip hydrate
3	01B Red Sand and up hole hydrate-bearing fractures	Comparison of up dip-down dip hydrate
4	03B Kiwi Sand and 03B down dip water-bearing Orange sand	Characterization of BSR and hydrate to water bearing Orange Sand

In-Situ / Wireline Team

The In-Situ/Wireline Logging team defined the required components of the logging string and production string:

- Logging String:
  - Platform Express (PEX) with Rt-scanner
  - Sonic Scanner (MSIP)
  - Magnetic Resonance Tool (CMR)
  - Formation Micro Imager (FMI)
  - Hostile Natural Gamma Ray Sonde (HNGS)
- Production Test String:
  - Modular Formation Dynamics Tester (MDT)
    - Dual packer
    - Single probe
    - Pump out module
    - Sample module
    - Fluid analyzer module

The In-Situ/Wireline Logging team recommended that the primary target for MDT production test is Horizon 0300 (Orange sand) in TBONE-01B.

Three wireline scenarios were considered (Figure 1-8):

1) Plan 1 - Minimum logging interval: 800-825 mbsf
   i. Horizon 0300 only (Orange sand)
2) Plan 2 - Intermediate logging interval: 650-825 mbsf
   i. Horizon 0300 & 0400 (Orange and Blue sand)
3) Plan 3 - Maximum logging intervals: 275-875 mbsf
   i. All horizons between 0300-0900 (Orange and Red sand)

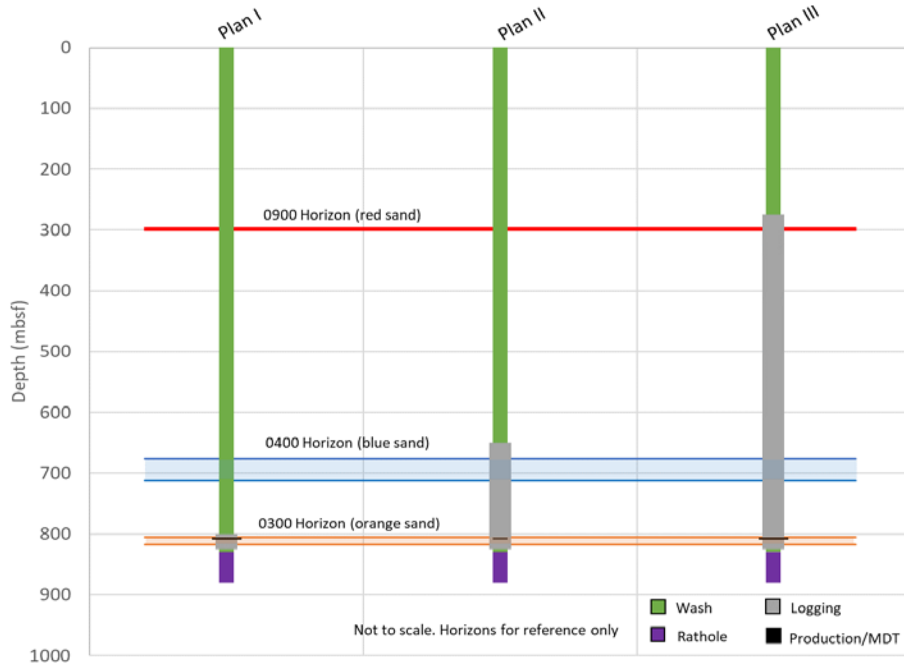

Figure 1-8: In-Situ/Wireline Team recommendations for possible wireline logging scenarios in TBONE-03B.

<u>Operations Team</u>

The Operations Team began development of a core program that represents the maximum science that can be achieved within the revised budget, and expanded program options. These are still under development.

The Operations Team also provided the following recommendations:

- The optimal window for expedition is between April and mid-June 2021.
- Agree with In-Situ/Wireline Team recommendation that optimal location to twin for in-situ and wireline testing is TBONE-01B.
- It will be challenging to include LWD in the revised budget, however we will provide cost estimates to for potential inclusion in an expanded program, if funding is available.
- Agree with Core Analysis Team recommendation that conventional coring at TBONE-01B would achieve optimal science if it is possible to do within budget.
- Spot pressure cores taken at varied intervals above and below hydrate bearing reservoirs should be taken in pairs to minimize potential for lost or compromised pressure cores.
- Regarding the TBONE-01 Orange Sand pressure coring program, we will collect multiple pressure cores within Orange sand if possible
- Sub-BHSZ Pore Water Sampling is highly desired as a component of the field program.

Nuts & Bolts Team

The Nuts & Bolts Team has begun to develop detailed time estimates and cost estimates for multiple GOM^2-2 expedition scenarios.

UT presented recommendations from the GOM^2-2 planning teams in the GOM^2-2 Sponsor meetings held on November 17 and December 18, 2018. UT is currently working to integrate the recommendations from the GOM^2-2 planning teams into prioritized science objectives and develop recommended operational programs. UT will present the prioritized science objectives and operational programs to the GOM^2 Advisory Group for feedback in early 2019 (Figure 1-9). Once a path forward is agreed upon, we will develop a detailed revised GOM^2-2 Operational Plan, final cost schedule, and initiate steps towards vessel acquisition.

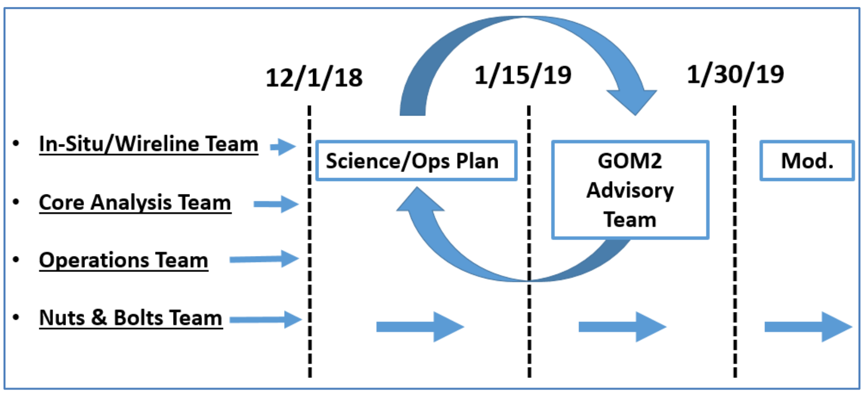

Figure 1-9: Envisioned process and timeline for team recommendations, plan write up, and review and modification to the project.

Subtask 15.3: Permitting for Field Program

- Continued to refine G&G section of BOEM Exploration Plan for GOM^2-2.
- In an effort to complete permitting documents.
- OSU and UT continue to work on the Geological and Geophysical (G&G) sections of the BOEM Exploration Plan for Orca Basin and Terrebonne Basin.

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

- UT finalized service agreement with Geotek for GOM^2-2 PCTB deployment, shipboard pressure core analysis using PCATS, handling and transportation of pressure cores, and contingency services including conventional coring.

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:

- Coordinate execution of Task 14.1: PCTB Lab Testing and Analysis.
- Continue to coordinate development of requirements and a scope of work for a GOM^2-2 drilling vessel.
- Complete optimized science and operational plans for GOM^2-2 based on recommendations from the GOM^2 Advisory Team.

TASK 6.0: TECHNICAL AND OPERATIONAL SUPPORT OF COMPLIMENTARY PROJECT PROPOSAL (CONT'D FROM PRIOR PHASE)

- Due to ECORDs decision that CPP2-886 will not be implemented as an MSP, there is no longer an avenue for UT to pursue the support of IODP or ECORD through CPP2-886. UT will continue to plan and prepare for the GOM^2-2 expedition independently, as was done in 2017 during the GOM^2-1 Marine Test. Technical and operational support of the UT-led GOM^2-2 field program will be conducted under Task 15 – Field Program Preparation.

TASK 10.0: PRESSURE CORE ANALYSIS (CONT'D FROM PRIOR PHASE)

Subtask 10.4: Continued Pressure Core Analysis

Pressure Core Analysis

A. Quantitative Degassing and Gas Analysis

- We will continue the quantitative depressurization of pressure core and gas analysis:
  - We are now analyzing uncompromised, high quality core, targeting gaps to increase resolution of estimated variation in hydrate saturation downhole.
  - We will analyze samples with distinct lithologies: lithofacies 2 (sandy silt, high hydrate saturation) and 3 (clayey silt, low hydrate saturation), particularly improving the number of lithofacies 3 samples.
  - We will continue to collect additional gas samples and continue to improve gas sampling methods to minimize atmospheric contamination.

B. Uniaxial Constant Rate of Strain (CRS) and Mercury Injection Capillary Pressure Measurement (MICP) Tests

- UT will continue the post-testing sample characterization of 8FB-2-1
    - Residual sample of 8FB-2-1 will be reconstituted by resedimentation method
    - The reconstituted sample of 8FB-2-1 will be trimmed in a CRS cell for compression index and permeability measurement.
    - The reconstituted sample of 8FB-2-1 will be measured for capillary pressure.
- UT will continue the post-testing sample characterization of pressure core sample 4FB-8-1.
    - Residual sample of 4FB-8-1 will be packed for the uniaxial constant rate of strain test
    - The packed 4FB-8-1 after CRS test will be measured for capillary pressure.

C. Steady-state Permeability Tests

- UT will continue the k0 permeability measurement of pressure core sample 4FB-8-3.
    - Sample 4FB-8-3 will be scanned by PCTAS X-CT and cut for K0 permeability measurement.

D. Microbiology of Pressure Cores

- Oregon State will continue planning for the microbiological analysis of pressure cores. One of the pressure-preserved cores for microbiology was collected within centimeters of the location of one of the Summers cores and so we will have a key reference sample to compare to. Current expectations are that these experiments will occur during the summer of 2019 based on the availability of the cores.

E. Pressure Core and Data Distribution

- UT will continue coordinating with other institutions on plans for transferring pressure core per the final distribution plan.

<u>Depressurized Core Analysis</u>

- Ohio State University will talk with the geochemistry lab about getting some organic matter concentrations and carbon isotopes of the organic matter from core subsamples from GC955.
- Ohio State University will continue to work on the XCT data and new saturation results; we are making several tweaks to the estimates and plan to add some sections that were collected while drilling mud was used.
- Ohio State University will measure the $\delta^{13}C$ and δD composition of methane and continue working on noble gas geochemistry results. OSU will make additional gas chromatography measurements to assist current interpretation.
- Ohio State University will work with Steve Phillips to pick a time for Myles and/or Tom to go to Austin to collect new noble gas samples and possibly collect molecular composition data in real time.

- Ohio State University will begin to work on preparing manuscripts reporting on the gas source at GC 955.
- University of New Hampshire will continue working on the Bulk sediment CHNS elemental analysis, Bulk sediment TOC, N, and S isotopes
  - We will complete the remaining CHNS analyses, and C, N, and S isotopes from holes H002 and H005 prepared and start to quantify the bulk compositional trends for import gas and gas hydrate related sediment components (TOC and C/N =organic matter quantity and type, CaCO3 tracks authigenic and biogenic carbonate variations, TS tracks variations in pyrite and other Fe sulfides produced during sulfate reduction and AOM).
  - For TOC measurements, we acidified bulk sediment samples with sulfurous acid in silver capsules to remove any CaCO33 (biogenic or authigenic). The treated samples are then measured with an elemental analyzer and reflect the true TOC. We also will measure equivalent untreated samples in tin capsules to determine the TC (total carbon), and total N. The difference in TC and TOC represents the carbonate fraction in the samples. The acidification process can add sulfur and/or nitrogen, thus we use the untreated samples for TS and TN measurement. Isotopes of TOC are measured on the acidified sample and isotopes for TS and TN are measured on the unacidified samples using a mass spectrometer.
- University of New Hampshire will continue working on the Grain size analysis using a laser particle size analyzer
  - We will complete the bulk sediment grain size measurements of the 40 prepared samples using a Malvern Mastersizer laser particle size analyzer. We will start to determine the grain size effects on the gas hydrate distribution. These measurements will be also be compared to measurements of grain size taken at UT and other locations.
- Oregon State University will continue discussions with Colwell, Klasek, Summers, and Phillips with the aim to 1) assess the microbial communities collected during the Gulf of Mexico coring, and 2) determine how best to prepare for the upcoming Gulf of Mexico coring in 2020 from a microbiological perspective. We will begin analysis of data and planning the manuscript to be submitted that describes these communities.
- Oregon State University will continue working with Summers to obtain the best DNA extraction protocols, we will make the plans needed to conduct experiments with pressurized samples that are allocated for microbial analysis. These studies will also be coordinated with researchers at USGS and Georgia Tech as noted above. As the plan for coring in 2020 develops, we will enlist new microbiology investigators to participate in analysis of expedition samples.
- Oregon State will work with UT and ExxonMobil to produce a UT-GOM^2-1 Biogeochemical Report including:
  - Biogeochemical Data
  - Biogeochemical Data Analysis

- Identification of challenges associated with preliminary studies

Subtask 10.5: Continued Hydrate Core-Log-Seismic Synthesis

- OSU will continue work to see if there is significant lateral heterogeneity between holes especially to see if a tie can be done using compressional velocity measurements.

Subtask 10.6: Additional Core Analysis Capabilities

- UT will coordinate with Geotek on the installation of the X-ray computed tomography (CT) and P-wave velocity scanner onto Mini-PCATS.
- UT will continue conversation with Geotek concerning possible Pre-consolidation System purchase to estimate and increase its possible value to UT.

Other: AAGP Special Publication

- In support of the AAGP Special Publication Vol I and II, Cook and Flemings will continue to participate as Special Volume Editors.
- UT will submit two additional manuscripts in support of the AAPG special volume. Thomas et al. "Pressure-coring operations during Expedition UT-GOM^2-1 in Green Canyon Block 955, northern Gulf of Mexico" and Flemings et al. "Pressure coring a high-saturation coarse-grained methane hydrate reservoir in the northern Gulf of Mexico"

TASK 13.0: MAINTENANCE AND REFINEMENT OF PRESSURE CORE TRANSPORT, STORAGE, & 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

- UT will coordinate with Geotek to complete 3-D drawings of the PCTB.
- UT will coordinate with Geotek to finalize and initiate the PCTB In-House Testing Program.
- UT will arrange for transport of required PCTB components that are currently stored at UT to Geotek Coring Inc. in Salt Lake City, Utah. Geotek will initiate Pressure Function Testing and Pressure Actuation Testing of the PCTB per the PCTB Testing Program.
- UT will coordinate with Reaction Engineering to initiate computational fluid dynamics (CFD) modeling of the PCTB.

TASK 15.0: FIELD PROGRAM PREPARATIONS

- UT will complete a budget analysis to project how we will pursue GOM^2-2 through commercially available vessels. We will prioritize our science program and develop a series of options that include re-scoping the project to lower the total cost to the program.
- UT will continue to work with the GOM^2 Advisory Team, OSU, BOEM, DOE, and USGS to optimize GOM^2-2 drilling plans and locations.
- Once UT and the GOM^2 Advisory Team has developed a new science and operational plan, we will develop a vessel requirements scope of services that will be used as the basis for vessel acquisition.
- OSU and UT will continue to working to fulfill permitting requirements for Orca Basin and Terrebonne locations (see Subtask 15.3 for additional information).
- UT will continue to refine G&G section of Bureau of Ocean Energy Management (BOEM) Exploration Plan.
- Oregon State will lead the biogeochemical sampling and analytical strategies. Overall, this effort will sustain the biogeochemistry collaborations needed to successfully complete the UT-GOM^2-2.

  The full sampling strategy plan will:
    - Determine strategies to address sampling and analysis challenges discerned from the Marine Field Test (UT-GOM^2-1),
    - Focus on recovering high pressure samples and low biomass samples as experienced previously in hydrate bearing sediments and other deep biosphere samples by integrating approaches used in parallel science programs,
    - Develop/adapt protocols for collecting and analyzing:
        - High quality samples for microbiology and geochemistry measurements including the most discrete and effective tracer and QA/QC methods;
        - Samples with high resolution that enable differentiation of microbes present in coarse vs. fine grained materials, and at interfaces;
        - Samples as needed for high PT microbiology incubations including approaches that may involve manipulation or stimulation of samples to detect microbial activity;
        - Samples with low biomass and low biological activity;
        - Integrate biogeochemistry data collection with computational modeling (e.g., through collaborative research with A. Malinverno [Lamont-Doherty Earth Observatory]) to achieve a reactive transport model that includes microbial activities occurring in hydrate systems

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

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

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.

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., & 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.

Erica Ewton et al. (2018). The effects of X-ray CT scanning on microbial communities in sediment cores. Poster presented at American Geophysical Union, Fall Meeting, Washington, D.C. OS23D-1657

Yi Fang, et al. (2018). Permeability, compression behavior, and lateral stress ration of hydrate-bearing siltstone from UT-GOM2-1 pressure core (GC-955 – northern Gulf of Mexico): Initial Results. Poster presented at American Geophysical Union, Fall Meeting, Washington, D.C. OS23D-1650

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

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- GOM^2-1 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

2.3 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

In May, 2018, the JRFB canceled IODP Expedition 386 and withdrew it from the *JR* schedule. This presented a significant challenge to the project due to the comparatively low cost of the *JR* to commercial drilling vessels. The JRFB forwarded CPP2-887 to the EFB for consideration of the potential implementation of the project as an ECORD MSP.

In Fall, 2018, UT and the GOM^2 team began actively pursuing two alternate paths in order to achieve the scientific objectives of GOM^2-2:

1. **<u>ECORD MSP</u>**: Work with ECORD in their evaluation of implementing CPP2-887 as an MSP expedition.

2. **<u>UT-Led Expedition</u>**: Begin preparations to execute GOM^2-2 independently, as was done for GOM^2-1 in Green Canyon 955.

As discussed above, the EFB met on September 10, 2018 to review CPP2-887 and evaluate implementing GOM^2-2 as an MSP. As a meeting outcome, EFB recommended that the ESO support an abridged CPP2-887 expedition as an MSP for implementation in 2021. The ECORD Council and ECORD Science Support and Advisory Committee met in November met on November 7-8, 2018 to plan operations and allocate budgets. ECORD Council determined that previously-postponed Arctic and Antarctic expeditions would be prioritized for implementation in 2021-2022. Therefore ECORD Council determined it was not possible to implement CPP2-887 as an MSP.

It is now clear that the path forward for GOM^2-2 is for UT to contract a vessel independently as was done for GOM^2-1. UT has already begun this process. In Fall 2018, we began working with UT administration to prequalify drilling vessel vendors. In August, 2018, a request for qualifications (RFQ) was posted publicly and sent to targeted vessel contracts, with the intent to follow up with a Request for Proposal (RFP). However, UT canceled the RFQ in December, 2018 due to uncertainties in the expedition schedule, and the need to re-evaluate field program so that it fits within originally envisioned budget. Until we determine and commit to a plan, we are unable to cost-effectively contract a fit-for purpose vessel. Given then now-anticipated delay to 2021, the RFP will most likely be delayed until Spring 2019.

UT is currently developing the revised science plan and refining cost estimates based on input from the GOM^2-2 planning teams, and feedback from the GOM^2 Advisory Group. Once this is finalized we will develop a detailed vessel scope of work early in 2019 and evaluate the optimal path forward for vessel acquisition.

3.3 CHANGES THAT HAVE A SIGNIFICANT IMPACT ON EXPENDITURES

The budget for the GOM^2-2 drilling expedition was developed during the GOM^2 Phase 2/Phase 3 budget period transition, based on the assumption that a 56-day expedition would be executed using the *JR* for a pre-negotiated lump sum. It is now clear that GOM^2-2 will be executed independently using a commercial vessel that is privately contracted by UT, and without additional financial backing from the IODP or ECORD.

UT has analyzed the costs associated with executing the 56-day expedition originally planned in CPP2-886 if UT contracts all expedition-related activities, subcontractors, and vendors independently, as was done for the 2017 GOM^2-1 Marine Test. Expedition costs would increase significantly. Therefore, we are working with the GOM^2-2 planning teams and the GOM^2 Advisory Group to an expedition plan with reduced scope and reduced budget that still achieves our critical science objectives.

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 (Table 5-1). Note: Y4 in the table is Y5 of the overall project including BP1.

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

Baseline Reporting Quarter		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	Phase 2 Extension						
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	$ 433,578	$ 828,110	$ 518,480	$ 1,346,590
Non-Federal Share		$ 211,985	$ 211,985	$ 207,161	$ 419,146	$ 155,856	$ 575,002
Total Incurred Cost		$ 606,517	$ 606,517	$ 640,739	$ 1,247,256	$ 674,336	$ 1,921,592
Variance							
Federal Share		$ (671,701)	$ (671,701)	$ (354,612)	$ (1,026,313)	$ (751,986)	$ (1,778,299)
Non-Federal Share		$ (146,573)	$ (146,573)	$ (151,397)	$ (297,970)	$ (202,702)	$ (500,672)
Total Variance		$ (818,274)	$ (818,274)	$ (506,009)	$ (1,324,283)	$ (954,688)	$ (2,278,971)

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	$ 1,094,173	$ 2,440,763						
Non-Federal Share	$ 351,676	$ 926,678						
Total Incurred Cost	$ 1,445,849	$ 3,367,441						
Variance								
Federal Share	$ (4,571,601)	$ (6,349,900)						
Non-Federal Share	$ (145,303)	$ (645,976)						
Total Variance	$ (4,716,905)	$ (6,995,875)						

6 REFERENCES

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7 ACRONYMS

Table 7-1: List of Acronyms

ACRONYM	DEFINITION
AAPG	American Association of Petroleum Geologists
AIST	National Institute of Advanced Industrial Science and Technology
ASW	Air-Saturated Water
BET	Brunauer-Emmett-Teller
BGS	British Geological Survey
BOEM	Bureau of Ocean Energy Management
BSEE	Bureau of Safety and Environmental Enforcement
CFD	Computational Fluid Dynamics
CFR	Code of Federal Regulation
CNPL	Calcareous Nannofossil Plio-Pleistocene
CPP	Complimentary Project Proposal
CT	Computed Tomography
DOE	U.S. Department of Energy
ECORD	European Consortium for Ocean Research Drilling
EFB	ECORD Facility Board
EPSP	Environmental Protection and Safety Panel
ESSAC	ECORD Science Support and Advisory Committee
ESO	European Science Operator
GHSZ	Gas Hydrate Stability Zone
HPTC	High Pressure Temperature Corer
IMO	International Maritime Organization
IODP	International Ocean Discovery Program
JOGMEC	Japanese Oil, Gas, and Metals National Corporation
JR	JOIDES Resolution
JRFB	JOIDES Resolution Facility Board
JRSO	JOIDES Resolution Science Operator
mbsf	meters below sea floor
MODU	Mobile Offshore Drilling Unit
MS	Mass Spectrometry
MSP	Mission Specific Platform
NEPA	National Environmental Policy Act
NETL	National Energy Technology Laboratory
OCS	Outer Continental Shelf
ORCAB	Orca Basin
OSU	Ohio State University
PCATS	Pressure Core Analysis and Transfer System
PCC	Pressure Core Center
PCS	Pressure Coring System

ACRONYM	DEFINITION
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
RFP	Request for Proposal
RFQ	Request for Qualifications
RPPR	Research Performance and Progress Report
SEP	Site Evaluation Panel
SOPO	Scope of Project Objectives
SSDB	Site Survey Data Bank
TBONE	Terrebonne Basin
TOC	Total Organic Carbon
UNH	University of New Hampshire
USCG	United States Coast Guard
USGS	U.S. Geological Survey
USIO	United States Implementing Organization
UT	University of Texas at Austin
UW	University of Washington
XCT	X-ray Computed Tomography
XRD	X-ray Diffraction

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Quarterly Research Performance Progress Report Period Ending 12/31/2018

Deepwater Methane Hydrate Characterization and Scientific Assessment

APPENDIX A

ECORD Council – ESSAC Meeting #6

Consensus Statements

ECORD
EUROPEAN CONSORTIUM FOR
OCEAN RESEARCH DRILLING

ECORD Council - ESSAC Meeting #6

NWO, The Hague, The Netherlands

Consensus statements

Present (14):

Members (8): Bernhard Plunger (Austria), John W. Jamieson (Canada), Minna Räisänen (Finland), Guido Lüniger (Germany), Koen Verbruggen (Ireland), Bernard Westerop (Netherlands), Fatima Abrantes (Portugal), Martina Kern-Lütschg (Switzerland)

Alternates (6): Katinka Stenbjoern for Stine Vad Bovtrup (Denmark), Georges Ceuleneer for Eric Humler (France), Laura de Santis for Marco Sacchi (Italy), Helga Kleiven for Markus Engelhardt (Norway), Jorintje Henderiks for Magnus Friberg (Sweden), Antony Morris for Michael Webb (UK)

Absent (1): José Ramón Sánchez Quintana (Spain)

INTRODUCTION

ECORD Council Consensus 18-11-01

The ECORD Council approves the agenda of the ECORD Council-ESSAC Meeting #6.

IODP NEWS & THE FUTURE OF SCIENTIFIC OCEAN DRILLING

ECORD Council Consensus 18-11-02

The ECORD Council thanks Bernhard Plunger and Werner Piller for their committment and efforts regarding the organisation of the' PROCEED' meeting to be held on 6-7 April 2019 at the Austrian Academy of Sciences in Vienna.

CLOSED SESSION

ECORD Council Consensus 18-11-03

The ECORD Council approves the revised ESO FY19 budget of $10.5M USD, which includes the operational costs related to Expedition 389 'Hawaiian Drowned Reefs'.

ECORD Council Consensus 18-11-04

The ECORD Council approves the increase of the budget cap from $15M USD to $22M USD to implement Expedition 377 'Arctic Paleoceanography (ArcOP)', based on the updated cost estimates provided by ESO.

ECORD Council Consensus 18-11-05

The ECORD Council approves the scheduling of an MSP expedition based on proposal #866 'Japan Trench Paleoseismology' for FY20, as proposed by the EFB following its e-meeting held on September 10, 2018. The ECORD Council applauds the planned collaboration between ESO and JAMSTEC/CDEX for the implementation of this expedition.

ECORD Council Consensus 18-11-06

Considering the EFB recommendation to implement Expedition 377 'Arctic Ocean Paleoceanography (ArcOP)' as a first-priority expedition before the end of IODP (EFB Consensus 18-03-05) and ECORD Council Consensus 18-11-04, the ECORD Council decides to schedule this expedition in FY21.

ECORD Council Consensus 18-11-07

Considering ECORD Council Consensus 18-11-06, the ECORD Council does not consider it possible to schedule an MSP expedition based on proposal #887-CPP2 'Gulf of Mexico Methane Hydrate', as proposed by the EFB following its e-meeting held on September 10, 2018. This decision is based on the new information received from ESO and on the EFB priorities supported by the ECORD Council.

ECORD Council Consensus 18-11-08

The ECORD Council decides to schedule Expedition 373 'Antarctic Cenozoic Paleoclimate' in FY23 and tasks the EFB to explore alternative scenarios in case ESO is not able to identify a suitable platform to implement it within the $12.2M budget limit set by ECORD Council Consensus 18-03-01.

PROCEED

ECORD Council Consensus 18-11-09

The ECORD Council encourages the ECORD IODP national offices to provide financial support to facilitate attendance of their respective ESSAC Delegates at the PROCEED meeting to be held in Vienna on 6-7 April 2019.

OUTREACH

ECORD Council Consensus 18-11-10

The ECORD Council approves an additional annual outreach budget of $50,000 USD from 2019 through 2023 for the production of material dedicated to the organisation of temporary exhibitions at museums and aquariums. This budget will be administered by the ECORD Managing Agency at the CEREGE, Aix-en-Provence, France.

NEXT MEETINGS

ECORD Council Consensus 18-11-11

The ECORD Council decides that the next ECORD Council Spring meeting will be held for one day during the week of June 3 or the week of June 17 in Lisbon.

ECORD Council Consensus 18-11-12

The ECORD Council decides that the ECORD Council-ESSAC meeting #7 will be held in Dublin on November 5th and 6th, 2019.

ACKNOWLEDGEMENTS

ECORD Council Consensus 18-11-13

The ECORD community expresses its warm thanks to Patricia Maruéjol for her valued contributions to EMA and the IODP outreach entities since the start of ECORD in 2003. She has been instrumental in creating and developing the current ECORD outreach resources. Patricia received the first newly created 'ECORD Award' at the occasion of the ECORD Council-ESSAC #6 meeting in recognition of her outstanding contribution to ECORD.

We will miss her in ECORD meetings and at the conference booths. We wish her the best for her retirement during which she will certainly review the successive ECORD Newsletters issues.

ECORD Council Consensus 18-11-14

The ECORD Council warmly thanks Guido Lüniger for his bell-controlled leadership as Chair of the ECORD Council in 2018.

ECORD Council Consensus 18-11-15

The ECORD Council and ESSAC warmly thank Bernard Westerop and the NWO staff for organizing and hosting their 6th joint meeting during which all attendees have highly appreciated the NWO facilities and the city of Den Haag.