GOM$^2$
Deepwater Methane Hydrate Characterization and Scientific Assessment
DE-FE0023919

DOE MHAC

Peter B. Flemings and the GOM$^2$ Project Team

Methane Hydrates Advisory Committee (MHAC) Report: 2/26/2020
Agenda

• Project Overview
• Review & Highlights of GOM2-1 Expedition (2017)
• Current Research Activities
• Tool Development
• The GOM2-2 Expedition
• Conclusions

Note: GOM2 = Genesis of Methane Hydrates in Coarse-grained deposits in the Gulf of Mexico
GOM$^2$ OBJECTIVES
Deepwater Methane Hydrate Characterization and Scientific Assessment

- To locate, drill, and sample methane hydrate deposits through multiple expeditions
- To store, manipulate, and analyze pressurized hydrates samples
- To maximize science possible through sample distribution and collaboration

**UT-GOM2-1**
Marine Test GC 955
- Obtain and Equip Pressure Core Center
- Modification and Testing of Coring equipment

**UT-GOM2-2**
Scientific Program WR 313
- Test of deep-water pressure coring
- Test of Pressure core transport and handling
- Test of scientific procedures
  - Tests of analysis capabilities
  - GC 955 characterization
  - Sample distribution and analysis
  - Workshops and publications
- Modification and Testing of coring equipment
- Characterization of GOM hydrate-bearing sands
- Comparison within a dipping sand
- Downhole Dissolved methane and gas composition
- Measurement of in-situ P-T
- Geochemical profile

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2/26/20 MHAC Presentation
PROJECT LEADS

- **The University of Texas at Austin**: Peter Flemings
  - Prime contractor, overall scientific and technical lead, experimental design, core handling/storage, hydrologic and geomechanical core analysis, GOM lease operator

- **Ohio State University**: Ann Cook, Derek Sawyer
  - Site characterization technical and science lead with added contributions in well determination, permitting, core analysis and geochemistry

- **LDEO**: David Goldberg, Alberto Malinverno
  - Wireline and LWD lead

- **University of New Hampshire**: David Divins, Joel Johnson
  - Lithostratigraphy lead

- **University of Washington**: Evan Solomon
  - Organic and inorganic geochemistry lead

- **Oregon State University**: Fredrick Colwell
  - Microbiology lead
PROJECT SPONSORS / ADVISORS

• US Department of Energy
  – Stoffa, Baker, Boswell, Vargas, Intihar,

• US Geological Survey
  – Collett

• Bureau of Ocean Energy Management
  – Frye, Shedd, Palmes

• Pettigrew Engineering
  – Pettigrew
DEMONSTRATED SUCCESS TO DATE

• Linked 7 universities, DOE, BOEM, USGS, and international contractors in a systematic hydrate coring and analysis program.
• Developed/tested a viable deep-water pressuring coring technology (three bench tests, two land tests, one deepwater marine test).
• Built the University of Texas Pressure Core Center to advance geomechanical and geochemical analysis of hydrate reservoirs.
• Insured, bonded, permitted, contracted, & executed demonstration of pressure coring capability in the Gulf of Mexico outer continental shelf (GOM2-1).
• Acquired 21 meters of coarse-grained hydrate-bearing reservoir core. First successful recovery of this reservoir type in US waters. Provides the foundation for a national effort to understand these reservoirs
• Dedicated volume in press summarizing GOM2-1 expedition
• Successfully distributed pressure cores and conventionalized cores to USGS, AIST, USGS, and subaward universities.
• Demonstrated ability to measure permeability, compressibility, concentration, and composition of hydrates-bearing pressure core.
• Have produced extensive results, including initial online results and data reports, manuscripts, papers, and conference presentations.
Review & Highlights of GOM2-1 Expedition (2017)
Expedition Website:

- [https://ig.utexas.edu/energy/genesis-of-methane-hydrate-in-coarse-grained-systems/expedition-ut-gom2-1/](https://ig.utexas.edu/energy/genesis-of-methane-hydrate-in-coarse-grained-systems/expedition-ut-gom2-1/)

**UT-GOM2-1: Hydrate Pressure Coring Expedition at GC 955**
Project Website:

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

GOM²: Methane Hydrates at the University of Texas

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<th>WHO WE ARE</th>
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<td>PUBLICATIONS</td>
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<td>2017 EXPEDITION</td>
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AAPG Volume 1 Publications

- Portnov et al. (in press, DOI:10.1306/10151818125) Salt-driven evolution of a gas hydrate reservoir in Green Canyon, Gulf of Mexico
- Santra et al. (in press, DOI:10.1306/04251918177) Evolution of gas-hydrate-bearing deep-water channel-levee system in abyssal Gulf of Mexico – levee growth and deformation
- Flemings et al. (in press) Concentrated hydrate in a deepwater Gulf of Mexico turbidite reservoir: initial results from the UT-GOM2-1 Hydrate Pressure Coring Expedition
- Phillips et al. (in press, DOI: 10.1306/01062018280) High concentration methane hydrate in a silt reservoir from the deep water Gulf of Mexico
- Meazell et al., (accepted), Silt-rich channel-levee hydrate reservoirs of Green Canyon 955
- Thomas (in press, DOI: 10.1306/02262019036) Pressure-coring operations during Expedition UT-GOM2-1 in Green Canyon Block 955, northern Gulf of Mexico
- Fang et al. (in press, DOI:10.1306/01062019165) Petrophysical Properties of the GC 955 Hydrate Reservoir Inferred from Reconstituted Sediments: Implications for Hydrate Formation and Production
GOM2-1 Expedition (2017) Location (GC-955)
LOCATION: GC 955

GC 955 hydrate structural position
- Crest of levee channel system anticline
- Highly faulted
- 4-way closure

Seismic images courtesy of WesternGeco

Flemings et al. 2020, Santra et al. 2019
**H001 Horizons and Interpreted Units**

With H002 and H005 Pressure Core Depths

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84+% successful recovery after process and tool modifications

Flemings et al. 2020
Pressure Core Images

Upper mud

Unit A

Clay silt deformation around a silty sand biscuit during coring

Cross laminations

Unit #3

Flemings et al. 2020
Hydrate Concentration ($S_h$) Detail

29 total Pressure Core samples tested

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<th>Core-Section</th>
<th>Length (cm)</th>
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<th>Methane hydrate saturation (% of pore volume)</th>
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Phillips et al. 2020
## Unit A Lithology and Hydrate Saturation

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<th>A: Gamma Density</th>
<th>B: P-Wave Velocity</th>
<th>C: X-ray</th>
<th>D: Lithofacies</th>
<th>E: Sh</th>
<th>F: Sand</th>
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- Flemings et al. 2020
- Phillips et al. 2020
- Meazell et al. 2020

**Clay:** 11FB-1
Hydrate saturation in Clayey-silt lies in sandy silt silt layers

---

**Decreasing hydrate saturation**

- Sandy silt
  - \(d(50) = 48 \mu m\)
  - \(S_h: 87\%\)
  - \(V_p (m s^{-1})\)

- Clayey silt
  - \(d(50) = 13 \mu m\)
  - \(S_h: 30\%\)
  - \(V_p (m s^{-1})\)

- Clayey silt
  - \(d(50) = 16 \mu m\)
  - \(S_h: 14\%\)
  - \(V_p (m s^{-1})\)

- Clayey silt
  - \(d(50) = 7 \mu m\)
  - \(S_h: 2\%\)
  - \(V_p (m s^{-1})\)

- Silty clay
  - \(d(50) = 3 \mu m\)
  - \(S_h: <1\%\)
  - \(V_p (m s^{-1})\)

---

Phillips et al. 2020

2/26/20

MHAC Presentation
Water bearing Units #2 and #3: thin bedded hydrate-bearing sandy silts washed away.

Flemings et al. 2020
Microbial Source

Phillips et al. 2020
Petrophysics, Geomechanics

What is the response of methane hydrate deposits in coarse-grained systems to natural and induced perturbations?

$S_{gh} \sim 80\%$

$K$ (in situ/effective) $\sim 0.1 - 10 \text{ md}$

$K$ (seal) $\sim 0.01 - 0.3 \text{ md}$

$S_{gh} \sim 0\%$

$K$ (intrinsic/pre-consolidation) $\sim 300 - 1000 \text{ md}$

$K$ (final/post-consolidation) $\sim 1 - 100 \text{ md}$ $f(\text{grain size, depth})$

$S_{gh} \sim 0\%$

(Boswell et al., 2011)
UT-GOM2-1 Experimental Results

(a) Pressure Core Chamber and Mini-PCATS

(b) K0 Permeameter
Intrinsic Permeability: \( k_0 = \frac{Q \cdot \mu \cdot L}{A \cdot \Delta P} \)

Sample Extrusion
Leak Test and Sealing Integrity Test
Uniaxial Consolidation (Ko condition)
Permeability Measurement
Hydrate Dissociation
Re-saturation
Permeability Measurement
Sample Characterization

Intrinsic Permeability

Fang et al. 2020
Capillary Pressure, Porosity

- Capillary entry pressure of the clayey silt is much higher and Pore throat radius much lower than the sandy silt

Daigle et al. coming soon
Ongoing Research:
AAPG Publication Collaboration

• Editors: Ray Boswell, Ann Cook, Tim Collet, Peter Flemings
• Vol 1 anticipated, now, in April 2020
• Three author workshops to clarify and build synergy for Vol 2 and possible Vol 3

<table>
<thead>
<tr>
<th>Lead</th>
<th>Possible Title</th>
<th>by June 1</th>
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<tbody>
<tr>
<td>Lei</td>
<td>Pore-scale imaging of methane hydrate bearing sediments, Green Canyon 955, northern Gulf of Mexico</td>
<td>Maybe</td>
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<tr>
<td>Fang</td>
<td>Hydro-mechanical behaviors of coarse-grained methane hydrate-bearing sediments in the deepwater Gulf of Mexico</td>
<td>Yes</td>
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<tr>
<td>Yoneda</td>
<td>Comprehensive study on mechanical-hydrological properties of hydrate-bearing pressure core sediments from Gulf of Mexico CG955</td>
<td>Maybe</td>
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<tr>
<td>Jang</td>
<td>Geomechanical and hydrological properties of gas hydrate reservoir sediment preserved in pressure cores from site GC-955, Gulf of Mexico</td>
<td>Yes</td>
</tr>
<tr>
<td>Dai</td>
<td>Stress state and geomechanical responses of sediment from Green Canyon 955, Gulf of Mexico</td>
<td>Yes</td>
</tr>
<tr>
<td>Daigle</td>
<td>Pore structure and transport properties of resedimented channel-levee lithofacies from Green Canyon 955</td>
<td>Yes</td>
</tr>
<tr>
<td>Oti</td>
<td>Using X-ray Computed Tomography (XCT) to Estimate Hydrate Saturation in Sediment Cores from UT-GOM2-1 H005, Green Canyon 955, Gulf of Mexico</td>
<td>Yes</td>
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<tr>
<td>Moore</td>
<td>Improved quantitative degassing technique for sampling gases from pressurized hydrate-bearing sediment cores</td>
<td>Yes</td>
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<tr>
<td>Moore</td>
<td>Biogenic source of natural gas in hydrates in Green Canyon Block 955 in the Gulf of Mexico</td>
<td>Yes</td>
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<tr>
<td>Myshakin</td>
<td>Numerical simulations of depressurization-induced gas production from gas hydrate reservoirs at the Green Canyon 955 site, northern Gulf of Mexico</td>
<td>Yes</td>
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<tr>
<td>You</td>
<td>Impact of coupled free gas flow and microbial methanogenesis on the formation and evolution of concentrated hydrate deposits</td>
<td></td>
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<tr>
<td>Johnson</td>
<td>Deciphering Primary Deposition and Early Diagenesis in Sediments from the Methane Hydrate System at Green Canyon 955, northern Gulf of Mexico</td>
<td>Maybe</td>
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<tr>
<td>Santra</td>
<td>Gas sourcing and gas entrapment</td>
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<td>Phillips</td>
<td>Methane isotopologues in a high-concentration gas hydrate reservoir in the northern Gulf of Mexico</td>
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<tr>
<td>Phillips</td>
<td>Salinity evolution during hydrate dissociation in Gulf of Mexico silt reservoir sediments</td>
<td>Yes</td>
</tr>
<tr>
<td>Colwell</td>
<td>Microbial Communities in Hydrate-Bearing Sediments Following Long-Term Pressure Preservation</td>
<td>Maybe</td>
</tr>
</tbody>
</table>
Microbiology Team

- Exxon Mobil Depressurized Core Analysis
- Oregon State, Georgia Tech, USGS Pressure Core Analysis

Jang working the BIO chamber in the UT PCC

- Very Low Bioactivity
- High level of contamination
- Initial results show no evidence of methane forming microbes in the GC 955 hydrate-bearing sands
• Total S is variable downhole: consistent with OSR and AOM
• TOC is moderately low and proportional to the fines
• Source of TOC is mixture of terrestrial and marine org. matter
• Excess S suggests some methane was present in the sediments early, during SO$_4^{2-}$ availability to drive AOM

Johnson et al. coming soon
Petrophysics Team

- WebEx meetings covering methodology and results
- Pressure cores transferred to team members

4 - 30 cm pressure core segments transferred to NETL – Y. Soul

2 ~110 cm pressure core segments transferred for PCCT analysis to Woods Hole

2 - 35 cm pressure cores transferred for PNATS assessment to AIST (Japan)

- 6-8 AAPG Special Volume Papers anticipated from this group
National and International Collaborative Effort

• Project has provided the foundation for widespread advances in analysis of properties of methane hydrate reservoirs.

• 3 U.S. institutions with pressure core analysis capability
  – USGS, DOE-NETL, U.T.

• Through this, we have linked a great number of institutions.
  – Oregon State, University of Washington, Georgia Tech, Texas A&M Corpus Christie, AIST, ExxonMobil,
Tool Development

[Images of construction equipment and workers]
PCTB Development

**Land Test**

- The Land Test is the final task of the PCTB development program
- We will conduct full-function coring tests of the PCTB at Schlumberger’s Cameron Test and Training Facility (CTTF)
- Purpose: fully vet PCTB prior to marine deployment.
- Land Test Process:
  - 3 full-function tests of the PCTB-face-bit
  - 3 full-function tests of the PCTB-cutting-shoe
PCTB Development

Land Test

- Draft Schedule

<table>
<thead>
<tr>
<th>Day</th>
<th>Date</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mon, March 16</td>
<td>Mobilization, Shipping</td>
</tr>
<tr>
<td>2</td>
<td>Tue, March 17</td>
<td>Staging, Spotting, Rig-Up</td>
</tr>
<tr>
<td>3</td>
<td>Wed, March 18, 2020</td>
<td>FB Test 1, FB Test 2</td>
</tr>
<tr>
<td>4</td>
<td>Thu, March 19, 2020</td>
<td>FB Test 3, BHA change</td>
</tr>
<tr>
<td>5</td>
<td>Fri, March 20, 2020</td>
<td>CS Test 2, CS Test 2, CS Test 3</td>
</tr>
<tr>
<td>6</td>
<td>Sat, March 21, 2020</td>
<td>Possible additional test, Rig down</td>
</tr>
<tr>
<td>7</td>
<td>Sun, March 22, 2020</td>
<td>Rig-down, Demobilization</td>
</tr>
<tr>
<td>8</td>
<td>Mon, March 23, 2020</td>
<td>Demobilization</td>
</tr>
</tbody>
</table>
1. GOM\(^2\)-2 Planning

- Working Group Recommendations
- Development of Science + Ops. Plan (UT + Advisory Team)
- DOE project modification that includes revised in-budget GOM2-2 program

**CURRENT STATUS**

- In-Situ/Wireline Team
- Core Analysis Team
- Operations Team
- Nuts & Bolts Team

12/1/18 → 1/15/19 → 9/30/19

- Develop draft GOM\(^2\)-2 Plan
- GOM\(^2\) Advisory Team Feedback
- DOE review of Advisory Team Recommendation
- Budget Period Transition
UT-GOM$^2$-1 was a ‘technology test’. True science in terms of developing a systems understanding of the hydrate reservoir will be from the second expedition (UT-GOM$^2$-2).

Coring of a second coarse-grained system with laterally extensive sandstone more characteristic of high-volume hydrocarbon reservoirs; Acquiring pressure cores from marine mud to reservoir to understand the biogenic factory, seal rock, and system evolution; and
PROJECT LOCATION
SCIENCE OBJECTIVES

1. Characterize the primary and secondary hydrate reservoirs and their bounding units (Orange Sand, and Blue Sand, respectively).
2. Contrast hydrate reservoir properties at different structural levels within a dipping sand (Blue Sand).
3. Characterize dissolved methane concentration and gas molecular composition with depth.
4. Measure in-situ temperature and pressure profile.
5. High-resolution geochemical and sedimentary profiles.
6. Reservoir characterization of other targets of interest.
Science Objective #1

Characterize the Orange and Upper Blue sand
- hydrate concentration
- lithology (grain size, mineralogy, sedimentary structures)
- geochemistry (gas and pore water composition)
- permeability
- mechanical properties (compressibility and strength).
Science Objective #2

Contrast hydrate reservoir properties at different structural levels within a dipping sand (Blue Sand)

Comparing the Blue sand from 03B to 01B
- Lower section pinches up dip, does not extend to 01B
- Upper Blue sand connects but is of lower quality and the reservoir continuity is uncertain

2625 ft.
Science Objective #3

Characterize the gas source and the microbial methane production

Depth profile of dissolved gas concentration and the gas molecular/isotopic composition

- Methane concentration, the total amount of gas and its molecular composition (e.g. C1 to C5) will be determined quantitative degassing.
- Isotopes of C and H in methane to illuminate the pathways of methanogenesis.
Science Objective #4

• Measure pressure and temperature with a penetrometer to at least 1640 feet below seafloor (fbsf)

Is base of the hydrate stability zone is at the three-phase boundary (methane hydrate-seawater-methane vapor)?
Science Objective #5

Acquire a high resolution geochemical and sedimentary profile by high resolution sampling of pore water and microbiology.

- Measure organic carbon with depth to constrain degree of microbial biogenesis
- Observe transitions in the first 250 fbsf and general behavior to total depth of the pore water composition to infer fluid flow, hydrate formation/dissociation, diagenesis.
- Develop age model.
- Continuous record of lithologic properties in bounding seals and reservoirs.

Example geochemical data from IODP Site U1445 in the Mahanadi Basin, northern Bay of Bengal
Science Objective #6

Characterize other sands of interest
UT-GOM2-2 drilling and coring plan at WR313 G002 and WR313 H002. Dashed lines represent approximate sand locations as described in Hillman et al. (2017) and Boswell et al. (2012a). Not to scale.
SCHEDULE

• Target - Spring 2022
• ~78 day total program
  – 1 week period for staging at port of embarkation
  – 38.5 days at sea
    • 3.7 days mobilization
    • 31.8 days coring program
    • 3 days demobilization
  – 30 days shore-based analysis program

<table>
<thead>
<tr>
<th>No.</th>
<th>TASK</th>
<th>LOCATION</th>
<th>ESTIMATED DURATION (DAYS)</th>
<th>CUMULATIVE DURATION (DAYS)</th>
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<tr>
<td>1</td>
<td>Premobilization Staging</td>
<td>Port of Embarkation</td>
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<td>2</td>
<td>Mobilization</td>
<td>Port of Embarkation</td>
<td>3.7</td>
<td>10.7</td>
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<td>3</td>
<td>H002 Coring Program</td>
<td>Walker Ridge 313</td>
<td>15.2</td>
<td>25.9</td>
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<tr>
<td>4</td>
<td>G002 Coring Program</td>
<td>Walker Ridge 313</td>
<td>16.6</td>
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<td>5</td>
<td>Stage 1 Demobilization</td>
<td>Walker Ridge 313</td>
<td>2.9</td>
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<td>Dockside Core Processing</td>
<td>Port Fourchon, LA</td>
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<td>7</td>
<td>Stage 2 Demobilization</td>
<td>Port Fourchon, LA</td>
<td>3.0</td>
<td>78.4</td>
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# On-board Core Analysis

<table>
<thead>
<tr>
<th>Core Samples Type</th>
<th>Analysis</th>
<th>Where: Container or Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure core</td>
<td>Whole Core logging, CT scanning</td>
<td>PCATS11 + PCATS8 + Data Processing Laboratory</td>
</tr>
<tr>
<td>Pressure core</td>
<td>Quantitative degassing w/ gas sampling</td>
<td>R17</td>
</tr>
<tr>
<td>Gas samples</td>
<td>Hydrocarbons, CO2 and Fixed Gases (N2, O2)</td>
<td>Geotek Gas Chromatography (GC)/Data Processing Laboratory (20-foot)</td>
</tr>
<tr>
<td>Whole round conventional core</td>
<td>Thermal imaging</td>
<td>Geotek 40 ft Whole Core Processing Laboratory</td>
</tr>
<tr>
<td>Whole round core cutting</td>
<td>Cut whole round core into sections, headspace gas sampling</td>
<td>Geotek 40 ft Whole Core Processing Laboratory and Mud lab</td>
</tr>
<tr>
<td>Whole core sections</td>
<td>Microbiology samples for DNA, 16S-rRNA</td>
<td>Mud Lab</td>
</tr>
<tr>
<td>Whole core sections</td>
<td>Moisture and Density</td>
<td>Mud Lab</td>
</tr>
<tr>
<td>Whole core</td>
<td>Vane Penetrometer, Shear /Compressive Strength</td>
<td>Mud Lab</td>
</tr>
<tr>
<td>Whole core sections</td>
<td>Pore Water Squeezing and time-sensitive analysis</td>
<td>Geochemistry Laboratory</td>
</tr>
</tbody>
</table>

---

**On-Board**

- Geotek container
- UT provided container
- Pressure Cores
- Conventional Cores
- Depressurized Cores
- Gas Samples
- Water Samples

* Baskets not shown
## Dockside Core Analysis

<table>
<thead>
<tr>
<th>Core Samples Type</th>
<th>Analysis</th>
<th>Where: Container or Lab</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pressure core</td>
<td>Whole Core logging, CT scanning</td>
<td>PCATS11 + PCATS8 + Data Processing Laboratory</td>
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<tr>
<td>Pressure core</td>
<td>Quantitative degassing w/ gas sampling</td>
<td>R17</td>
</tr>
<tr>
<td>Gas samples</td>
<td>Hydrocarbons, CO2 and Fixed Gases (N2, O2)</td>
<td>Geotek Gas Chromatography (GC)/Data Processing Laboratory (20-foot)</td>
</tr>
<tr>
<td>Whole core sections</td>
<td>Microbiology samples for DNA, 16S-rRNA</td>
<td>Mud Lab</td>
</tr>
<tr>
<td>Whole core sections</td>
<td>Moisture and Density</td>
<td>Mud Lab</td>
</tr>
<tr>
<td>Whole core</td>
<td>Vane penetrometer, Shear /compressive strength</td>
<td>Mud Lab</td>
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<td>Whole core sections</td>
<td>Pore Water Squeezing and time-sensitive analysis</td>
<td>Geochemistry Laboratory</td>
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<tr>
<td>Whole core sections</td>
<td>XCT, 3D CT</td>
<td>Send to Stratum Reservoir</td>
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<tr>
<td>Whole core</td>
<td>Whole Core Logging</td>
<td>MSCL Container</td>
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<td>Gamma density, P-wave, Mag susceptibility, Resistivity; natural gamma</td>
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<tr>
<td>Split core</td>
<td>Core splitting</td>
<td>Geotek 40 ft Whole Core Processing Laboratory</td>
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<tr>
<td>Split core -plug</td>
<td>Visual description, and smear slide description</td>
<td>Geotek 40 ft Whole Core Processing Laboratory</td>
</tr>
<tr>
<td>Split core scanning</td>
<td>Linescan images, color reflectance scans, X-ray fluorescence (core scanning), near IR scan</td>
<td>MSCL Container</td>
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<tr>
<td>Split Core -plug</td>
<td>Sampling for XRD, CHNS elemental/isotopic analysis, nanofossil biostratigraphy, grain size, rock mag, biomarkers, carbonate/sulfide nodules.</td>
<td>Geotek 40 ft Whole Core Processing Laboratory</td>
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<tr>
<td>Split core</td>
<td>Thermal Conductivity probe</td>
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GOM²-2 Planning

GOM2-2 Will Accomplish…

– **Pressure coring at TB-01B:**
  
  Characterization of Orange Sand and bounding seals

– **Pressure coring Blue Sand at TB-01B & TB-03B:**

  *Limited* characterization of hydrate reservoir at different thermodynamic states.

– **Intermittent (spot) pressure coring at TB-01B & TB-03B:**

  *Limited* characterization of dissolved methane concentration and the hydrocarbon composition depth profile by intermittent pressure coring.

– **Deploy T2P at TB-03B:**

  Measurement of the thermal gradient

– **Intermittent conventional coring at TB-03B:**

  *Limited* high-resolution geochemical and sedimentary profiles
# Degree to which science plans meet Science Objectives

<table>
<thead>
<tr>
<th>Objective 1 &amp; 5</th>
<th>Objective 8 &amp; 3</th>
<th>Objective 6 &amp; 4</th>
<th>Objective 2</th>
<th>Objective 7</th>
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<tbody>
<tr>
<td>Characterization of the Orange Sand through pressure coring</td>
<td>Characterization of the dissolved methane concentration and the hydrocarbon composition depth profile</td>
<td>Characterizing hydrate reservoirs at different thermodynamic states within a dipping sand (up-dip, down-dip)</td>
<td>Reservoir characterization and in situ measurements through LWD in 02A</td>
<td>High resolution geochemical and sedimentary profiles – moving towards an exploration model</td>
</tr>
</tbody>
</table>

| C-6 | Yes | Yes | Limited | No | No | Limited |
| C-7 | Limited | No | Yes | Yes | Yes | Very limited |
| C-5 | No | No | Limited | No | No | Limited |
| C-1 | Limited | Yes | Yes | Yes | Yes | Limited |
CURRENT EFFORTS: PROJECT TIMELINE

Current/Future Project Periods

- Continued UT-GOM2-1 Core Analysis
- UT-GOM2-2 Planning & Preparation
  - UT-GOM2-2 Core Analysis

**CURRENT EFFORTS: PROJECT TIMELINE**

PCTB Modifications & Testing

Jan 2020

- PCTB Land Test
  - Mar 2020

- Submit Initial UT-GOM2-2 Permits
  - Mar 2020

- Initiate UT-GOM2-2 Drilling Vessel Contracting
  - Mar 2020

Finalize UT-GOM2-2 Operations Plan

May 2021

- Complete UT-GOM2-2 Drilling Vessel Contract
  - May 2021

UT-GOM2-2 Scientific Drilling Program

May (?) 2022

- Sample and Data Distribution/Archiving
  - 2022-

- Pressure Core Storage & Analysis
  - 2022-2024

Initiate Scientific Results Volume and Presentations

Jun 2023-

- Complete Preliminary Expedition Summary
  - 2022

<table>
<thead>
<tr>
<th>Year</th>
<th>Phase 4</th>
<th>Phase 5</th>
<th>Phase 6</th>
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<tbody>
<tr>
<td>2020</td>
<td>10/19-09/20</td>
<td>10/20-09/22</td>
<td>10/22-09/24</td>
</tr>
</tbody>
</table>
WHAT WE ARE DOING TODAY

• Working on initial permit submission (May 2020)
  – BOEM Exploration Plan
  – BOEM Right of Use & Easement (RUE)

• Completing upgrades and testing of PCTB & T2P

• Completing Science Plan
  – Relocation of a few coring points
  – Time available for PCATS and how to best use
  – How to minimize pressure core degradation
  – Details of primary and secondary conventional core analysis at the dock
WHAT WE ARE DOING NEXT

• Determine vessel selection & acquisition approach
• Contract vessel
• Contracting third party vendors (if Vessel Contractor will not subcontract)
• Planning & logistics
• Optimizing science plan and methods.
CHALLENGES

• My biggest concern: Institutional Challenges:
  – Maintaining Team/Rebuilding Team
  – Maintaining Morale/focus
  – Maintaining institutional commitment

• My second biggest concern:
  – Developing specific protocols to achieve proposed science

• Complete vessel contracting
• Complete permitting
• Execute Program
DEMONSTRATED SUCCESS TO DATE

• Linked 7 universities, DOE, BOEM, USGS, and international contractors in a systematic hydrate coring and analysis program.
• Developed/tested a viable deep-water pressuring coring technology (three bench tests, two land tests, one deepwater marine test).
• Built the University of Texas Pressure Core Center to advance geomechanical and geochemical analysis of hydrate reservoirs.
• Insured, bonded, permitted, contracted, & executed demonstration of pressure coring capability in the Gulf of Mexico outer continental shelf (GOM2-1).
• Acquired 21 meters of coarse-grained hydrate-bearing reservoir core. First successful recovery of this reservoir type in US waters. Provides the foundation for a national effort to understand these reservoirs
• Dedicated volume in press summarizing GOM2-1 expedition
• Successfully distributed pressure cores and conventionalized cores to USGS, AIST, USGS, and subaward universities.
• Demonstrated ability to measure permeability, compressibility, concentration, and composition of hydrates-bearing pressure core.
• Have produced extensive results, including initial online results and data reports, manuscripts, papers, and conference presentations.
References


END OF PRESENTATION
Thank you