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

- 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

UT-GOM2-2
Scientific Program
WR 313

- 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

2015	2016	2017	2018	2019	2020	2021	2022	2023	2024

Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
10/14-09/15	10/15-01/18	01/18-09/19	10/19-09/20	10/20-09/22	10/22-09/24

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

Oregon State University

TEXAS The University of Texas at Austin

Lamont-Doherty Earth Observatory
COLUMBIA UNIVERSITY | EARTH INSTITUTE

University of New Hampshire

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*

NATIONAL ENERGY TECHNOLOGY LABORATORY

U.S. DEPARTMENT OF ENERGY

USGS science for a changing world

BOEM Bureau of Ocean Energy Management

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)

BOEM Bureau of Ocean Energy Management

University of Washington

University of New Hampshire

U.S. Department of Energy

UTIG Institute for Geophysics

Lamont-Doherty Earth Observatory, The Earth Institute at Columbia University

USGS science for a changing world

The Ohio State University

University of Oregon

Expedition Website:

- 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

EXPEDITION HOME	EXPEDITION SCIENTISTS	EXPEDITION REPORTS	DATA DIRECTORY	SAMPLE REQUESTS	PROJECT HOME

Project Website:

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

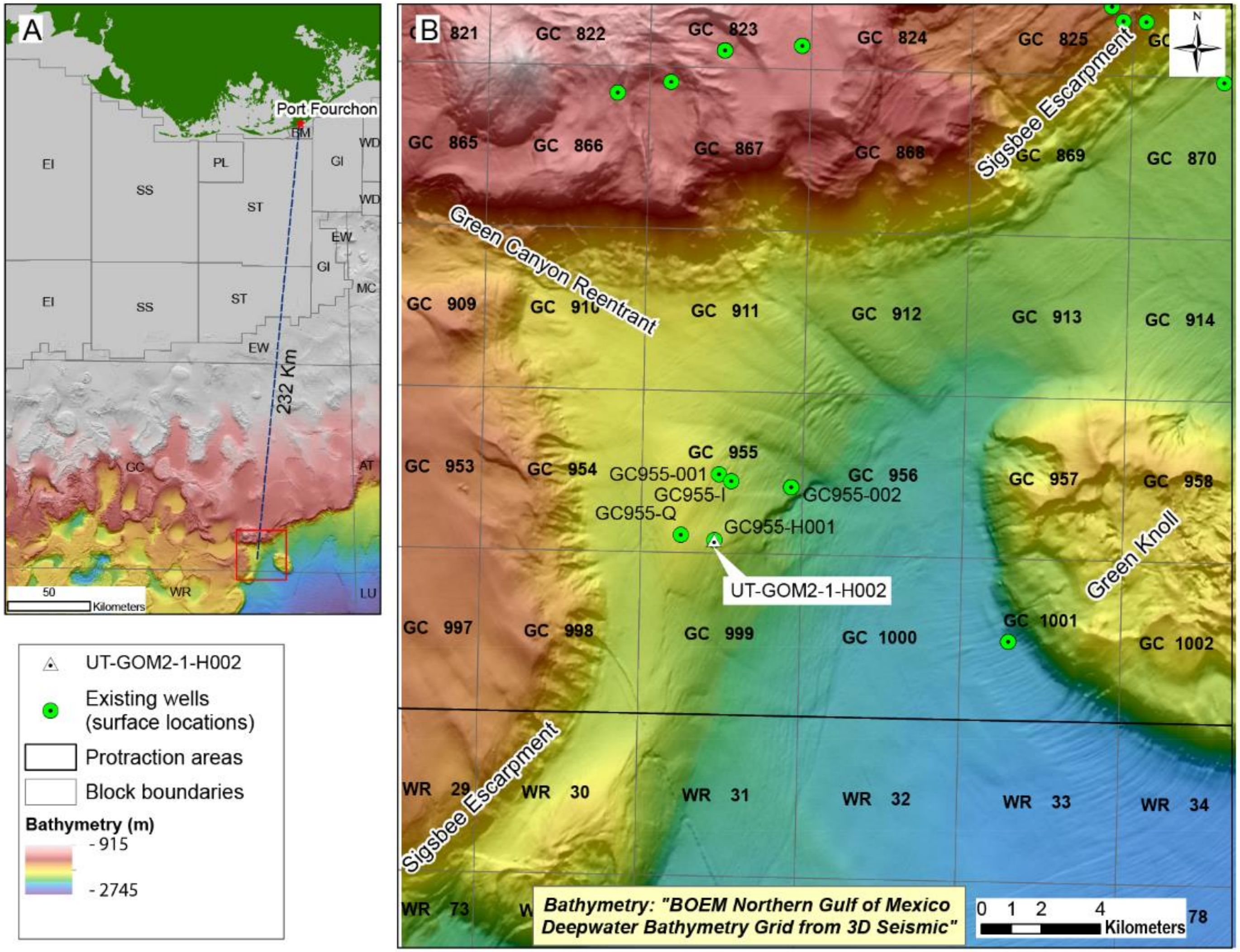
GOM²: Methane Hydrates at the University of Texas

HOME	WHO WE ARE	NEWS & MEDIA	ADVISORY BOARD
PUBLICATIONS	REPORTS	2017 EXPEDITION	2022 EXPEDITION

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*

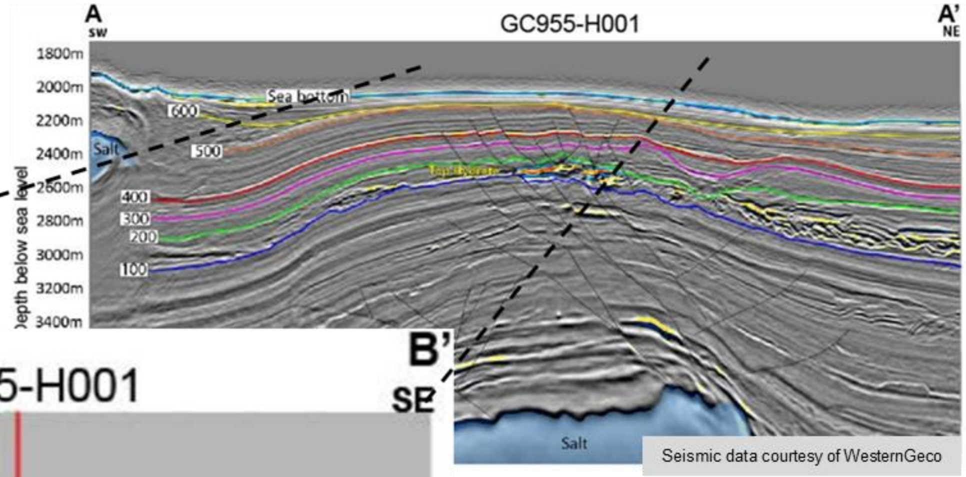
GOM2-1 Expedition (2017) Location (GC-955)

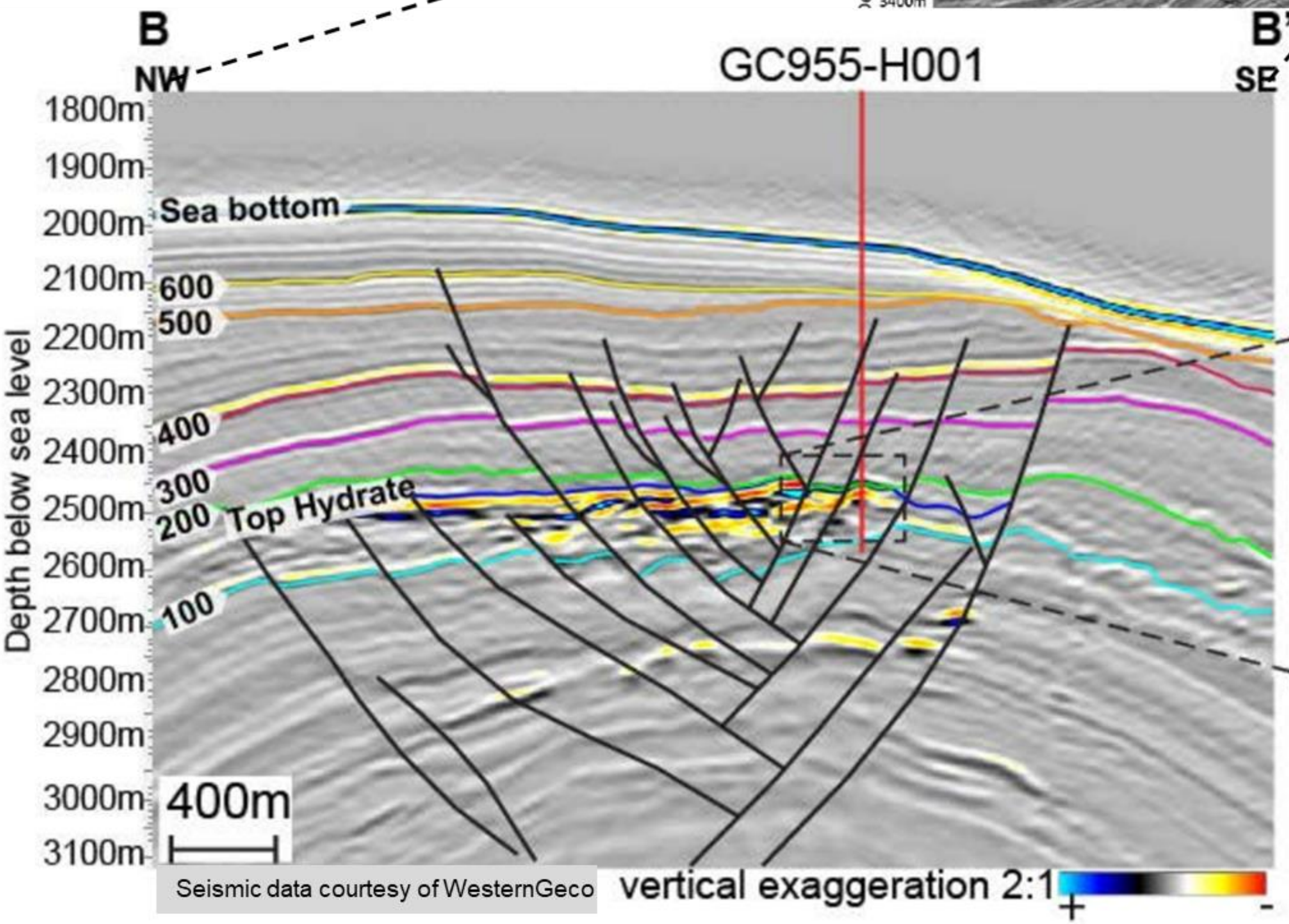


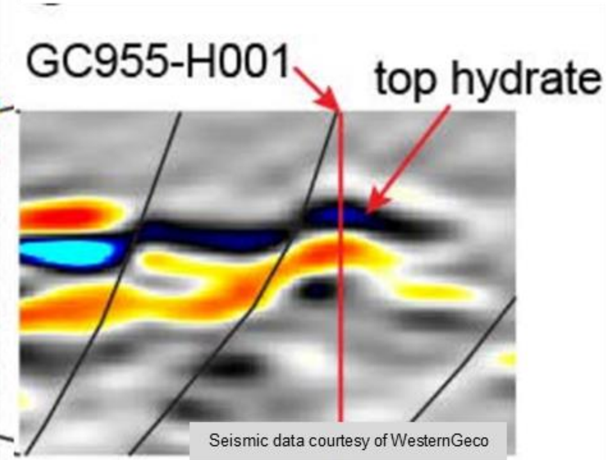
LOCATION: GC 955

GC 955 hydrate structural position

- Crest of levee channel system anticline
- highly faulted
- 4-way closure





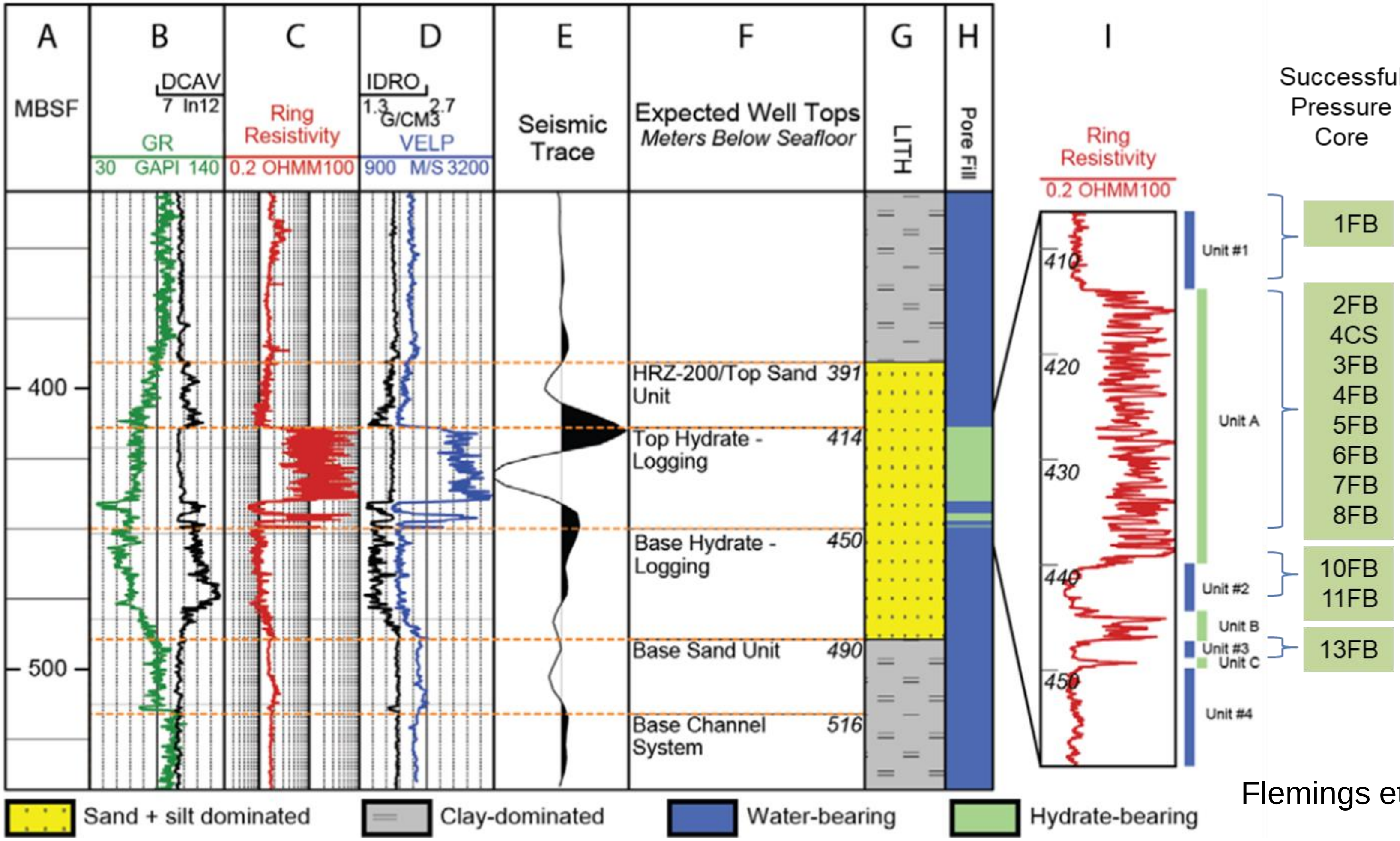


Seismic images courtesy of WesternGeco (Flemings et al., in review).

Flemings et al. 2020, Santra et al. 2019

H001 Horizons and Interpreted Units

With H002 and H005 Pressure Core Depths



Flemings et al. 2020

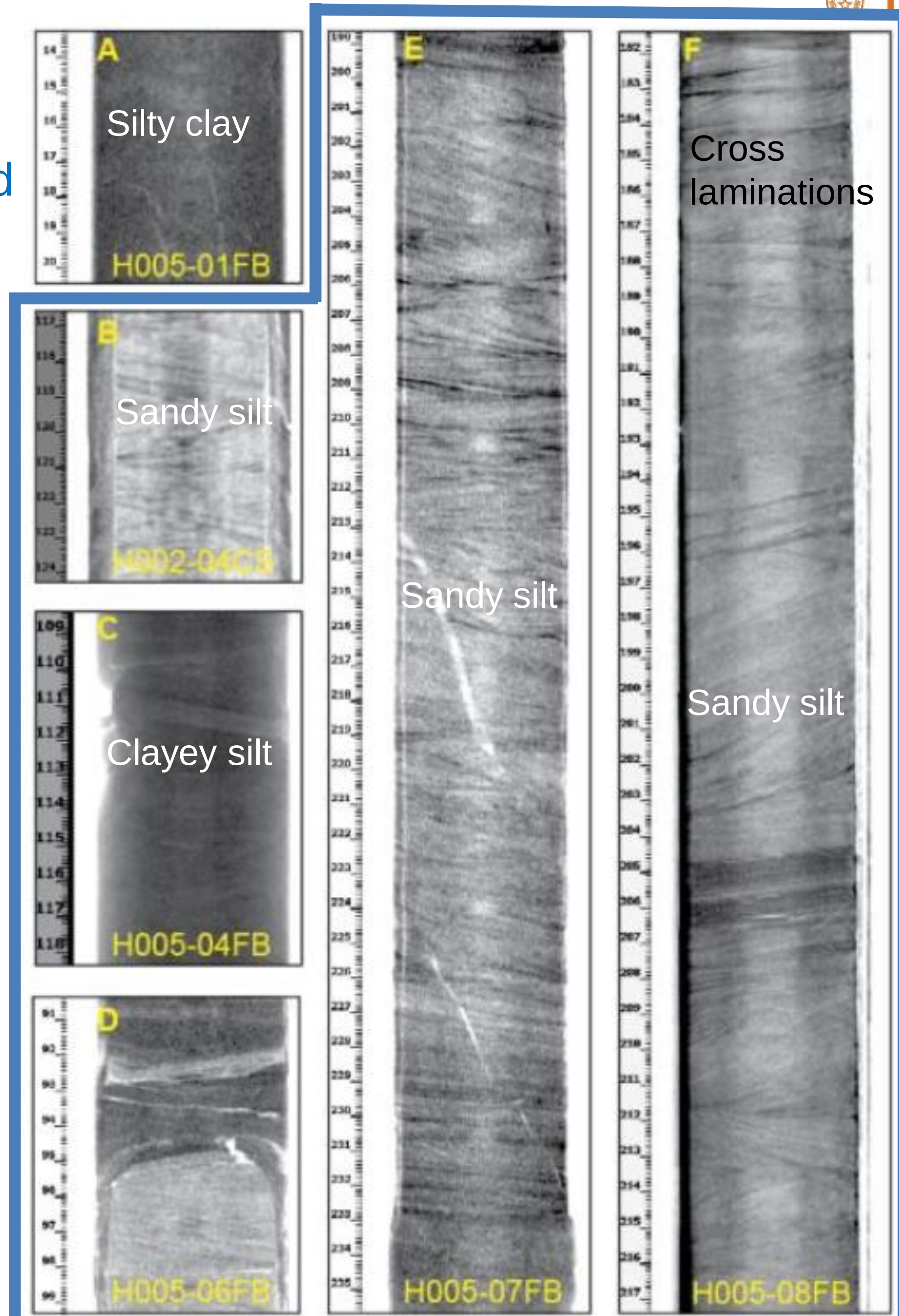
84+% successful recovery after process and tool modifications

Pressure Core Images

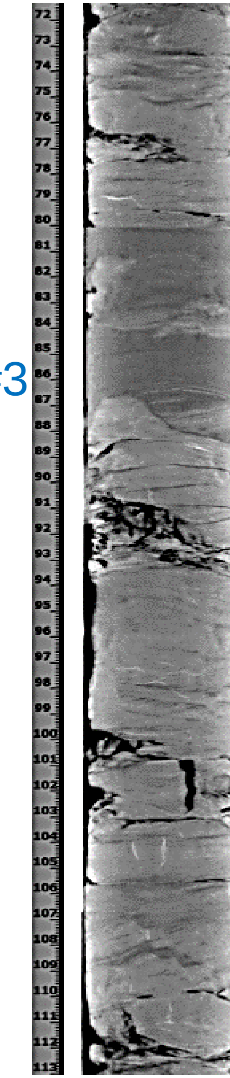
Upper mud

Unit A

Clay silt deformation around a silty sand biscuit during coring

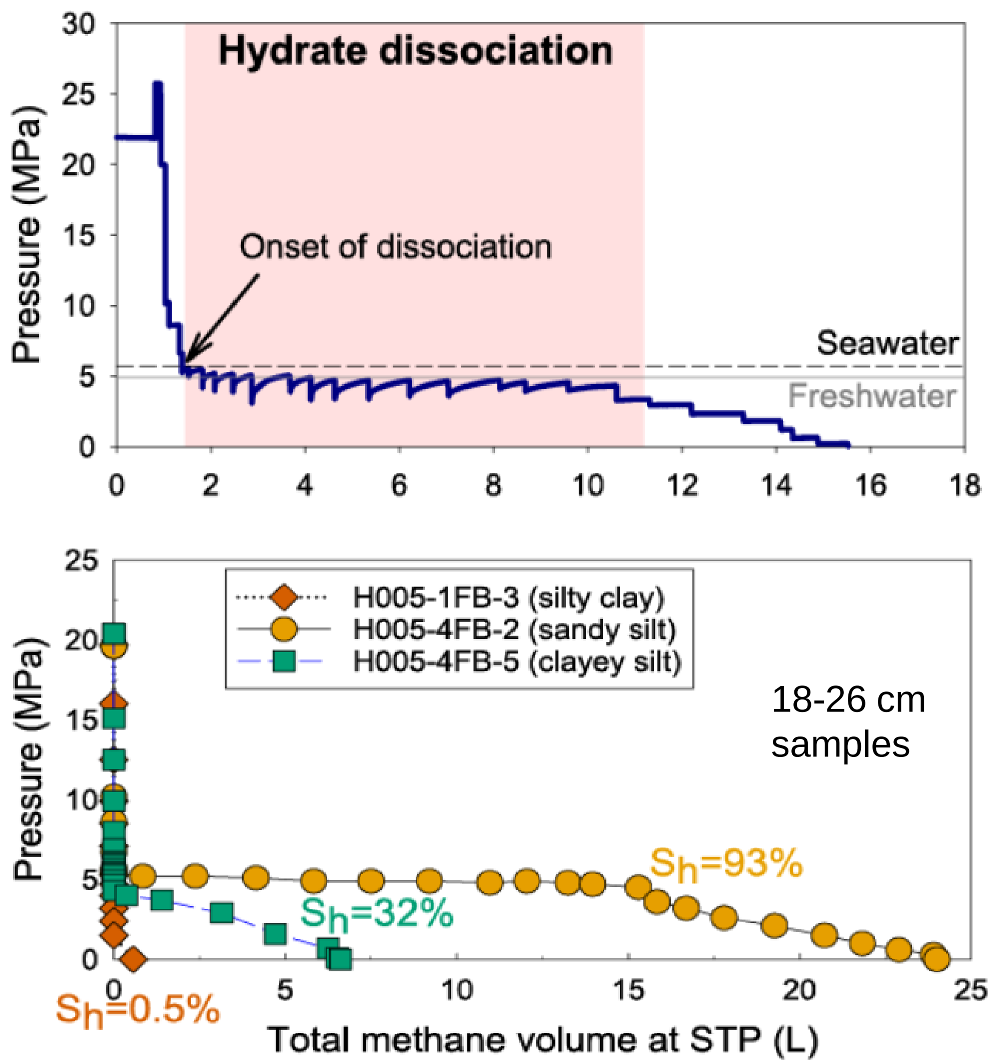


Unit #3



Flemings et al. 2020

Hydrate Concentration (S_h) Detail



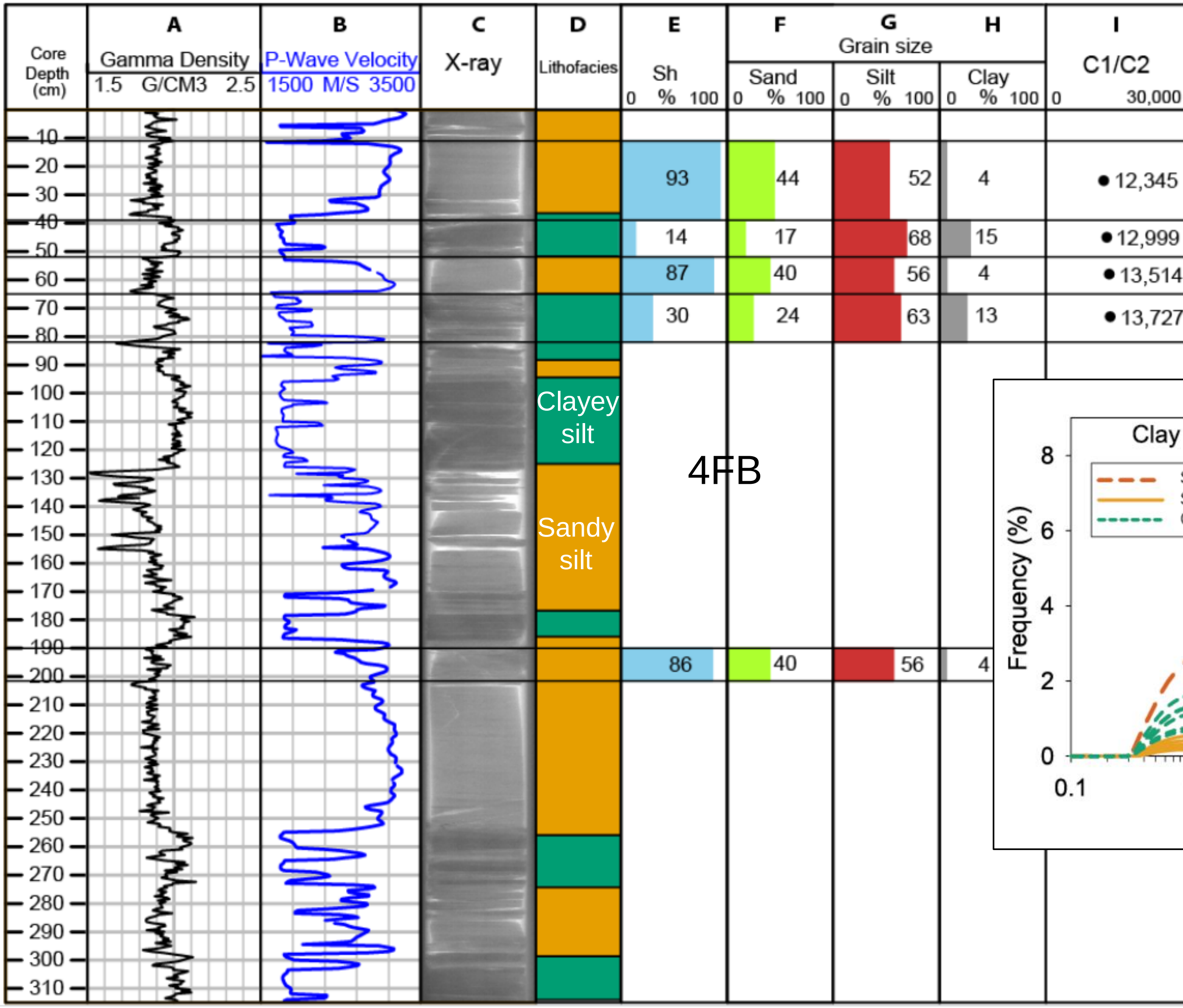
29 total Pressure Core samples tested

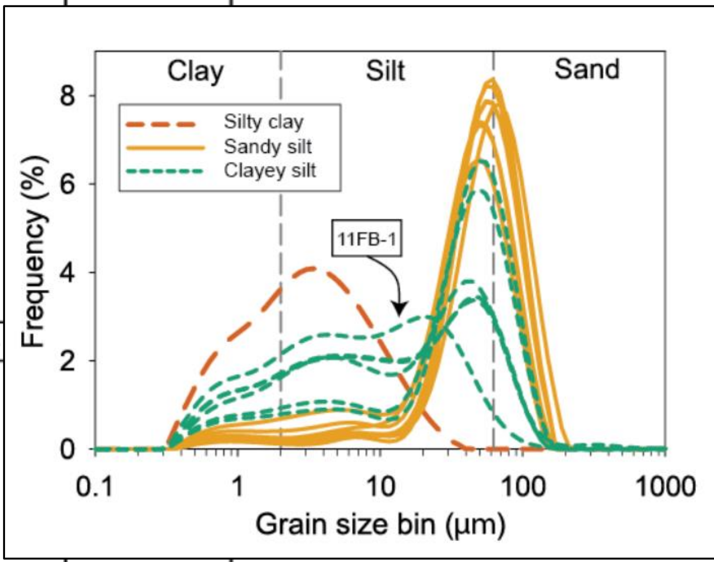
Core-Section	Length (cm)	Lithofacies	Core volume (L)	Porosity	Methane hydrate saturation (% of pore volume)
01FB-3	21	Silty clay	0.42	0.39	0.00
04CS-1	26.8	Sandy silt	0.39	0.40	83
04CS-3	9.5	Sandy silt	0.21	0.38	79
03FB-3	26.5	Sandy silt	0.46	0.35	88
03FB-4	16.5	Multiple	0.26	0.43	27
04FB-2	25.8	Sandy silt	0.41	0.36	93
04FB-3	14.8	Clayey silt	0.28	0.44	14
04FB-4	11.7	Sandy silt	0.19	0.37	87
04FB-5	17.5	Clayey silt	0.31	0.40	30
04FB-7	12	Sandy silt	0.21	0.41	86
06FB-2	10	Compromised	0.18	0.39^	74
06FB-2	7	Compromised	0.14	0.39^	32
06FB-2	20	Compromised	0.41	0.40^	33
06FB-2	8	Compromised	0.16	0.39^	44
06FB-2	32	Compromised	0.65	0.39^	76
07FB-1	18.6	Sandy silt	0.31	0.37	92
07FB-2	44.5	Multiple	0.77	0.31	72
07FB-4	16.6	Multiple	0.32	0.37	59
08FB-2	14.1	Clayey silt	0.29	0.40	13
09FB-2	120	Compromised	2.43	0.43^	71
09FB-4	63	Compromised	1.28	0.42^	44
10FB-2	32	Multiple	0.68	0.42	55
10FB-3	10	Multiple	0.33	0.44	27
11FB-1	27	Clayey silt	0.31	0.36	2

Phillips et al. 2020

TEXAS Geosciences

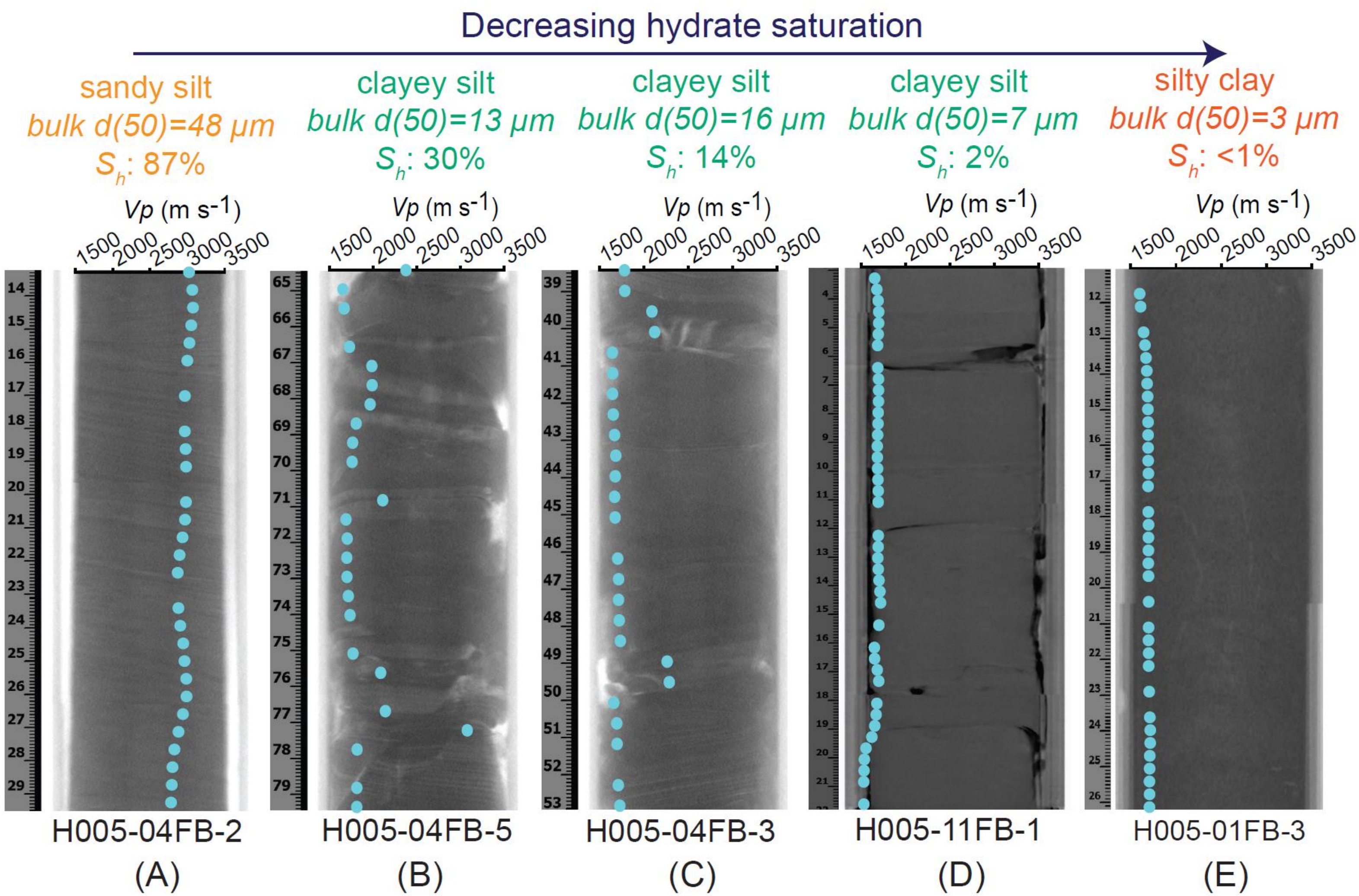
Unit A Lithology and Hydrate Saturation





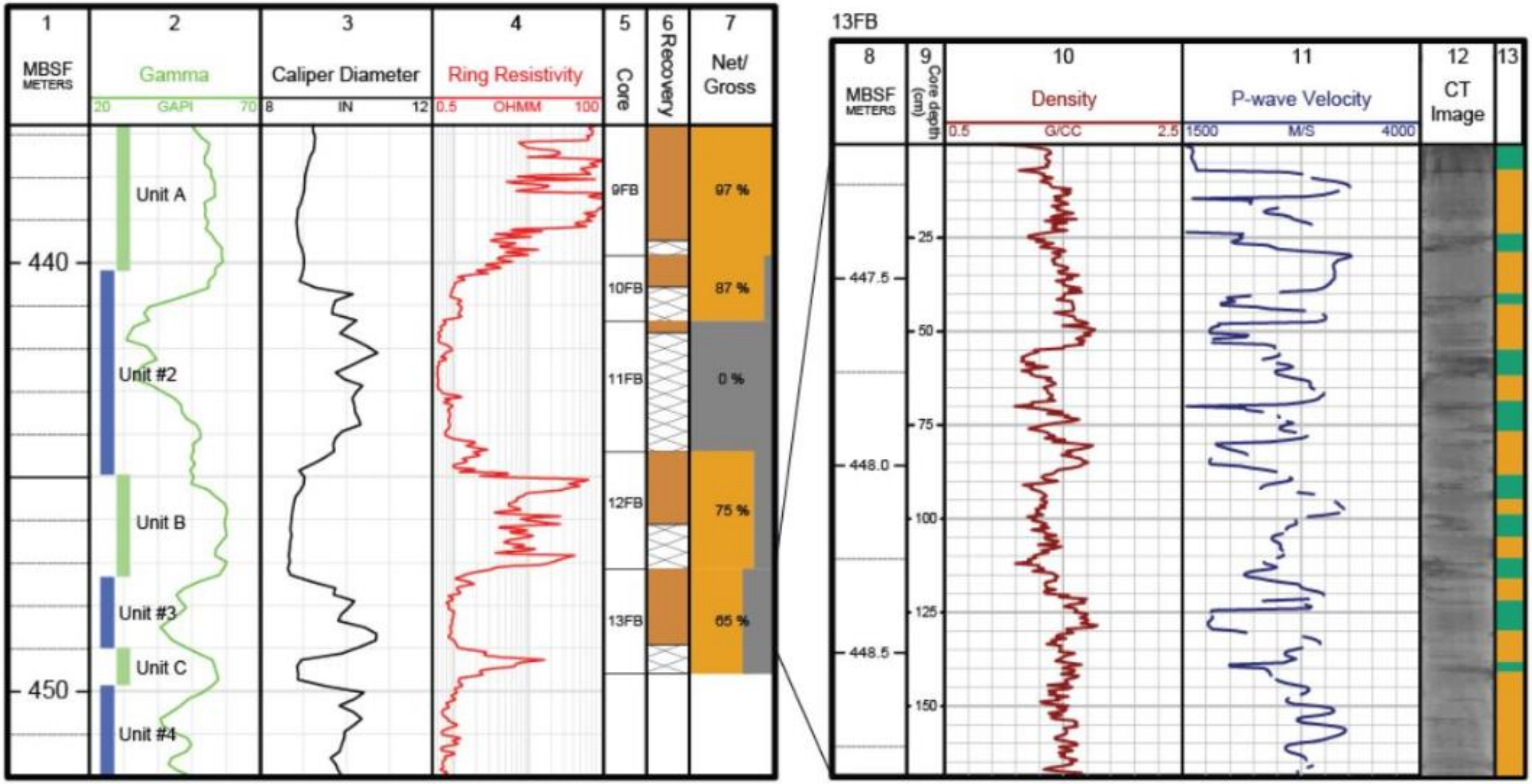
Flemings et al. 2020
Phillips et al. 2020
Meazell et al. 2020

Hydrate saturation in Clayey-silt lies in sandy silt silt layers



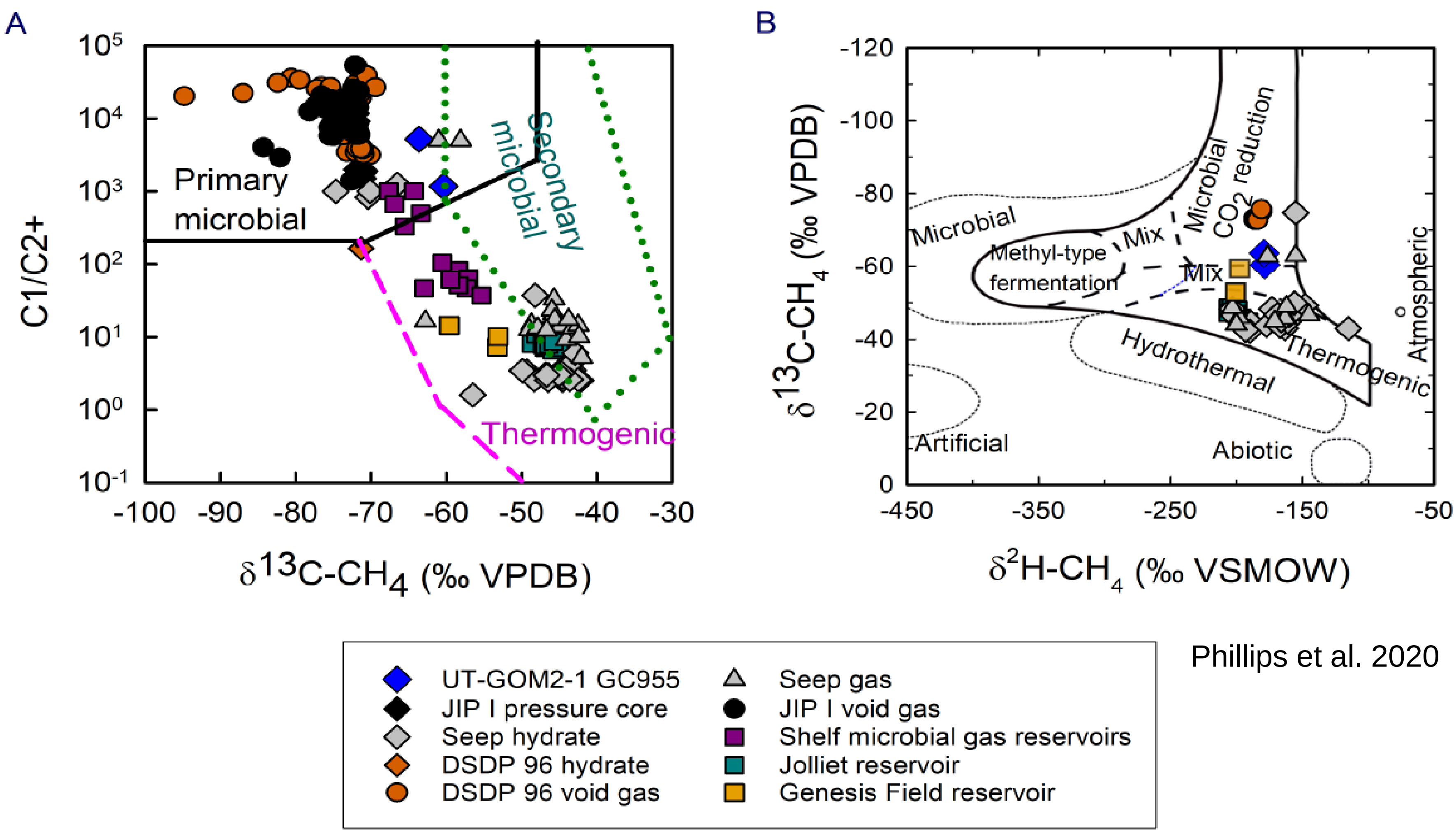
Phillips et al. 2020

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



Flemings et al. 2020

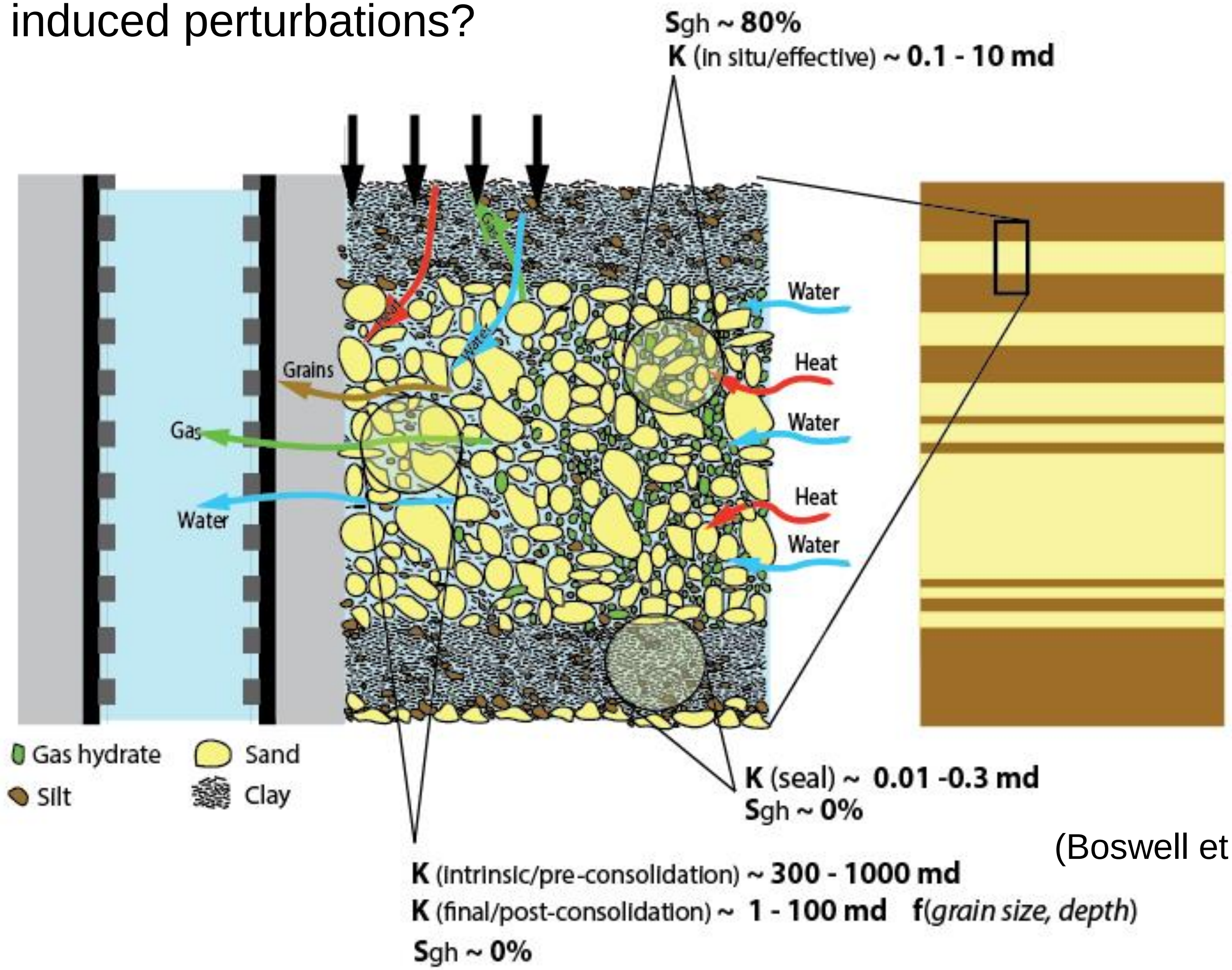
Microbial Source



Phillips et al. 2020

Petrophysics, Geomechanics

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

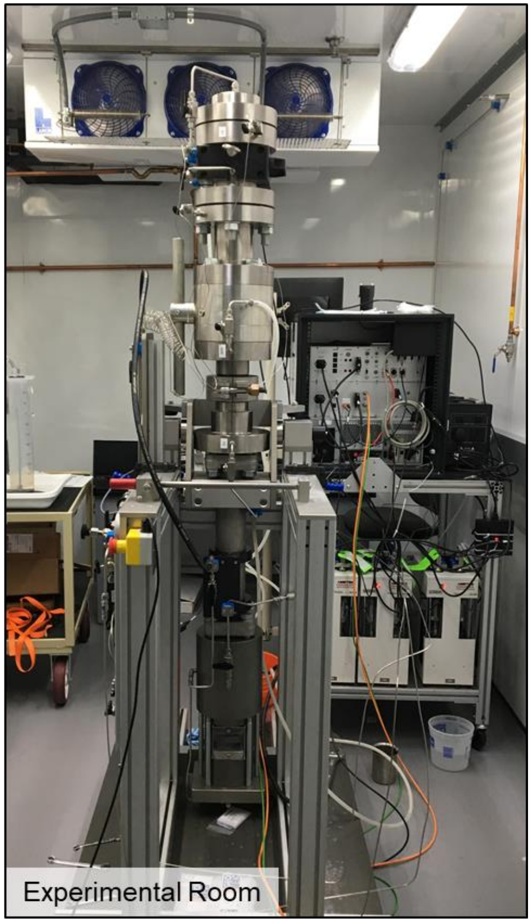


(Boswell et al., 2011)

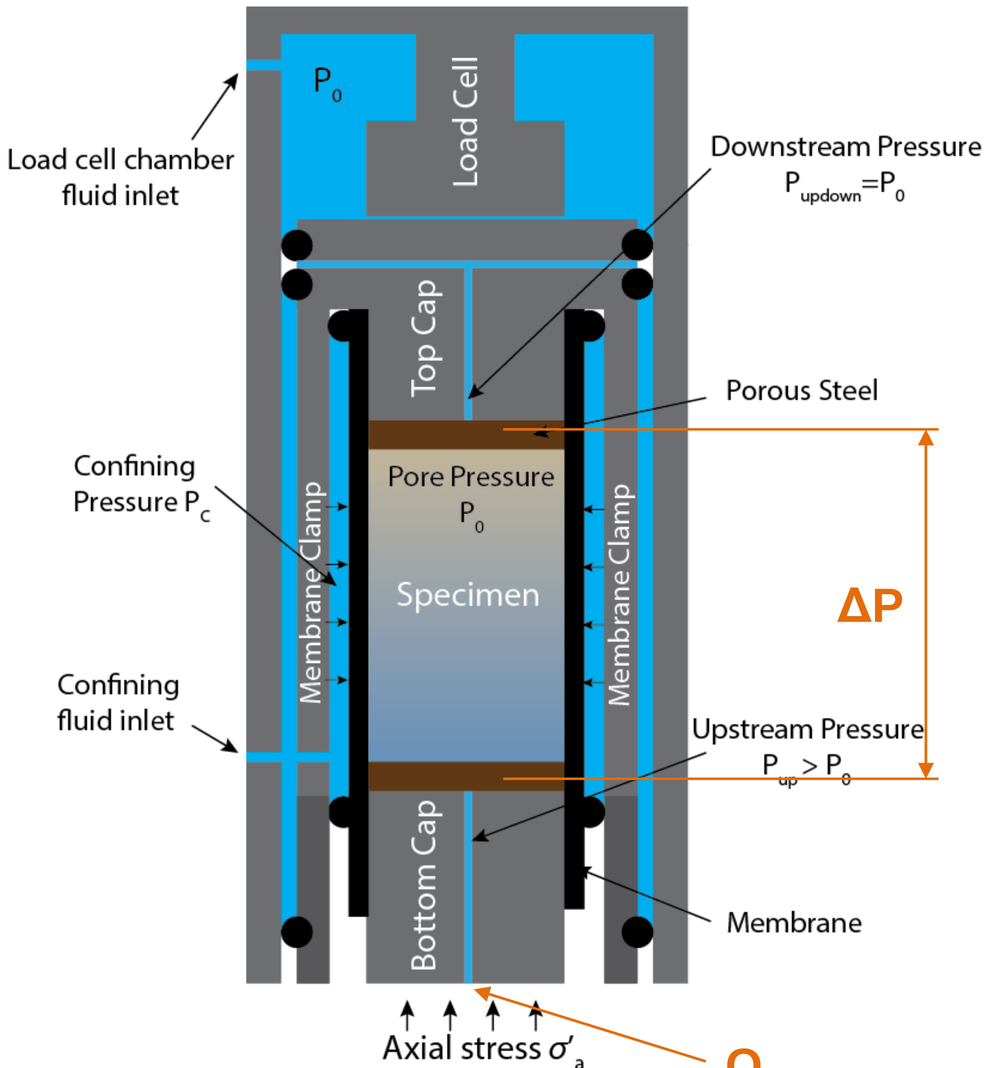
UT-GOM2-1 Experimental Results

(a) Pressure Core Chamber and Mini-PCATS

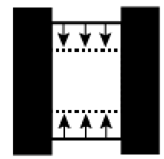
(b) K0 Permeameter



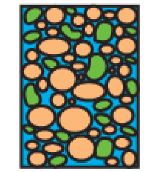
UT K0 Permeability Pressure Core Measurement



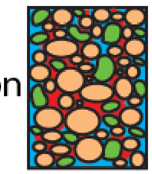
Fang et al. 2020



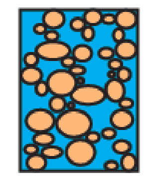
- Sample Extrusion
- Leak Test and Sealing Integrity Test
- Unixial Consolidation (Ko condition)
- Permeability Measurement



- Hydrate Dissociation



- Re-saturation
- Permeability Measurement



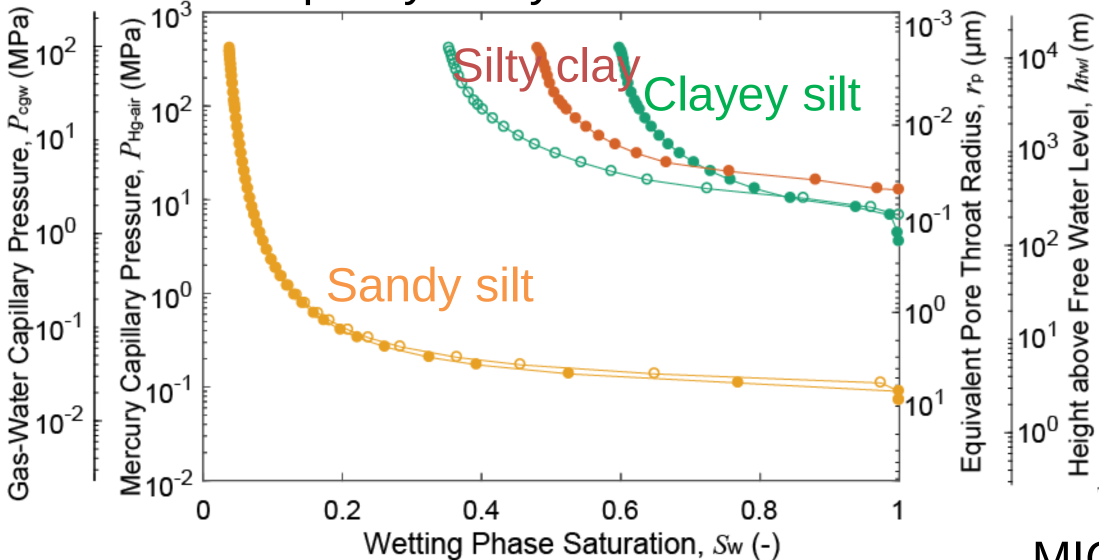
- Sample Characterization

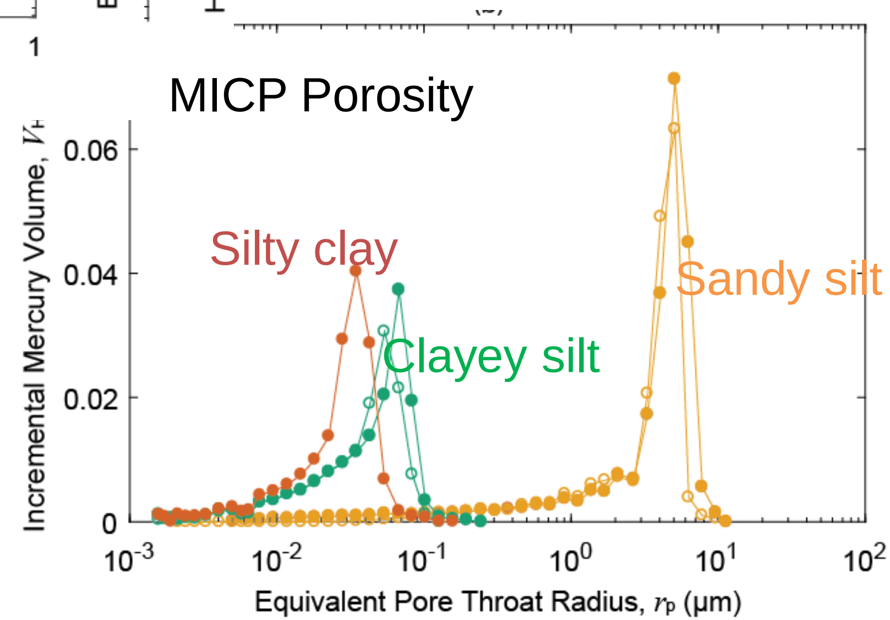
Intrinsic Permeability

$$\text{Intrinsic Permeability: } k_0 = \frac{Q \cdot \mu \cdot L}{A \cdot \Delta P}$$

Capillary Pressure, Porosity

Capillary Entry Pressure





- 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

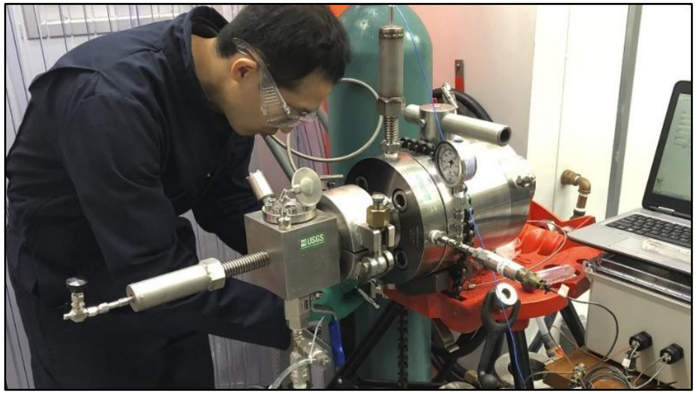
Ongoing Research:
AAPG Publication Collaboration

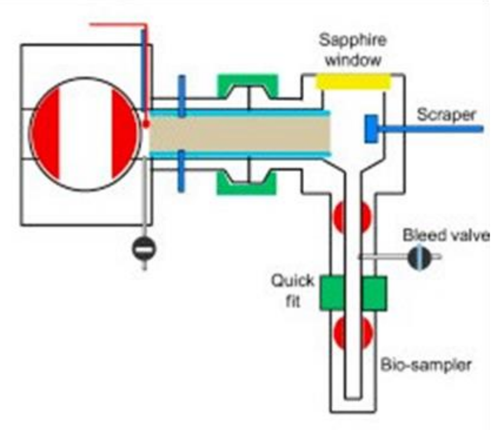
- Editors: Ray Boswell, Ann Cook, Tim Collet, Peter Flemings
- Vol 1 anticipated, now, in April 2020
- Three author workshops to clarify and build synergy for Vol 2 and possible Vol 3

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

Microbiology Team

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

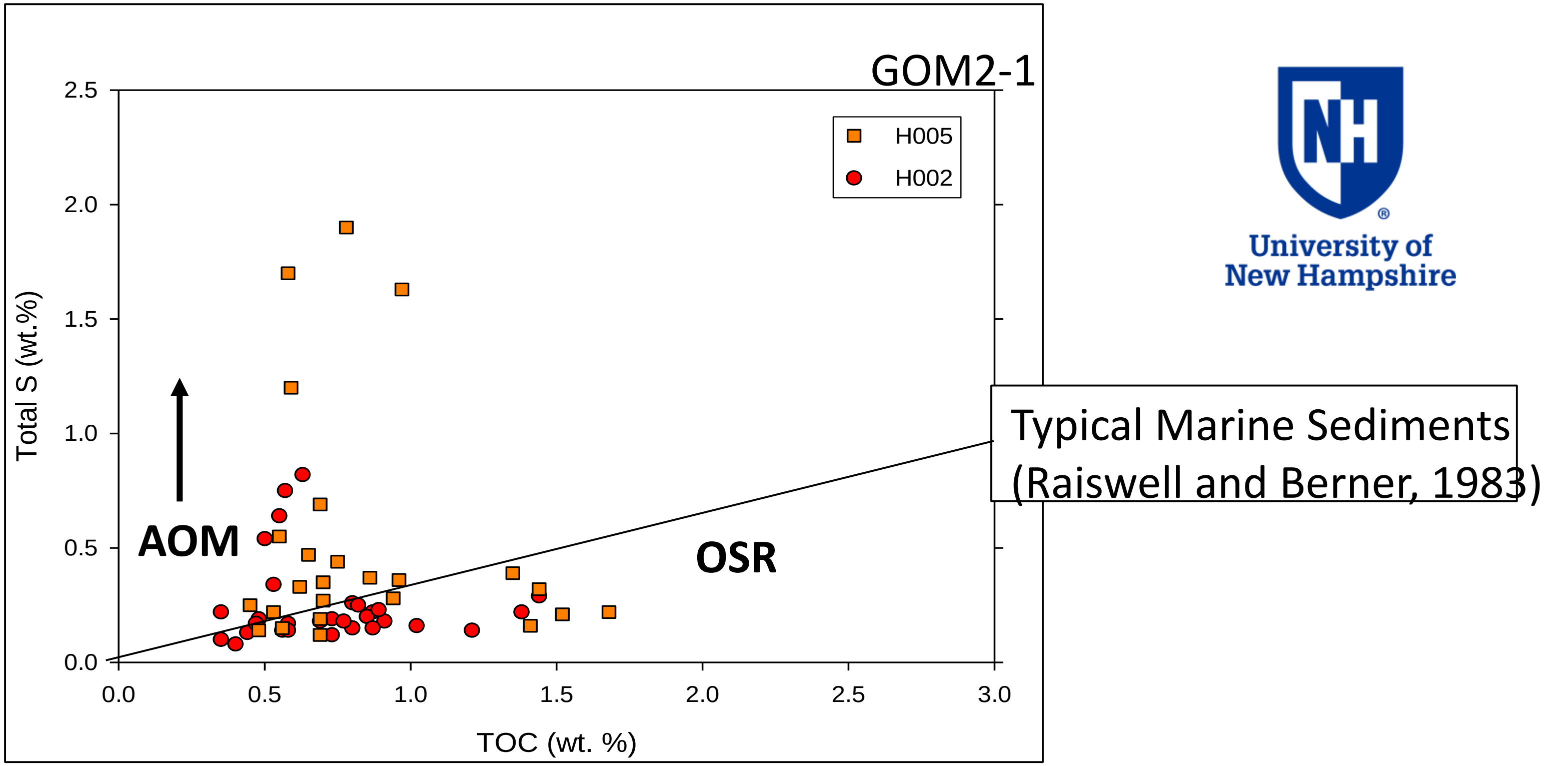




Jang working the BIO chamber in the UT PCC

- Very Low Bioactivity
- High level of contamination
- Initial results show no evidence of methane forming microbes in the GC 955 hydrate-bearing sands

Sedimentology: Total Sulfur, Total Organic Carbon



University of New Hampshire

- 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

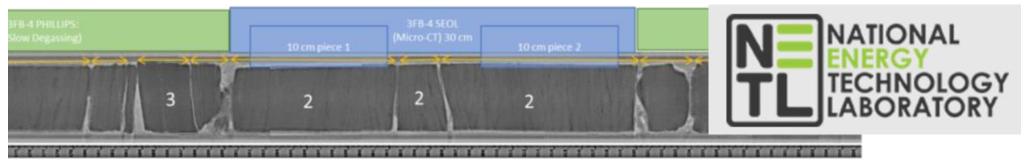
Johnson et al. coming soon

TEXAS Geosciences

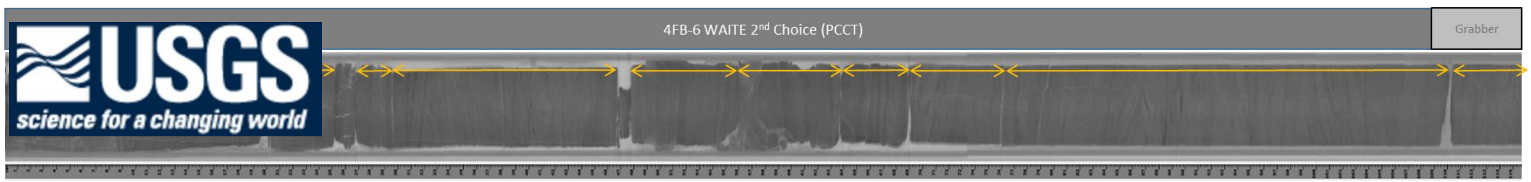
Petrophysics Team

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

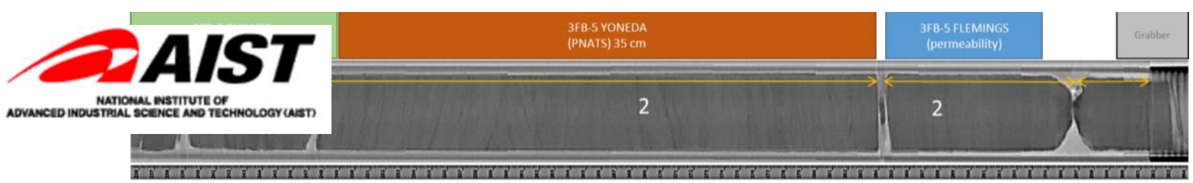
4 - 30 cm pressure core segments transferred to NETL – Y. Soul



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

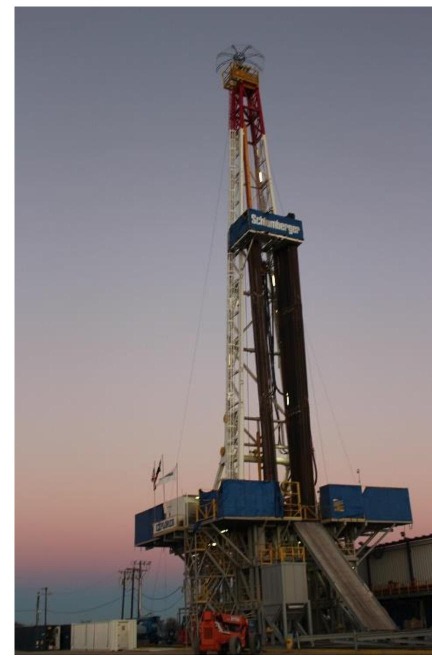
- Project has provided the foundation for widespread advances in analysis of properties of methane hydrate reservoirs.
- 3 U.S. institutions with pressure core analysis capability
  - USGS, DOE-NETL, U.T.
- Through this, we have linked a great number of institutions.
  - Oregon State, University of Washing, Georgia Tech, Texas A&M Corpus Christie, AIST, ExxonMobil,

Tool Development

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



2015 Land Test – SLB Drill Rig

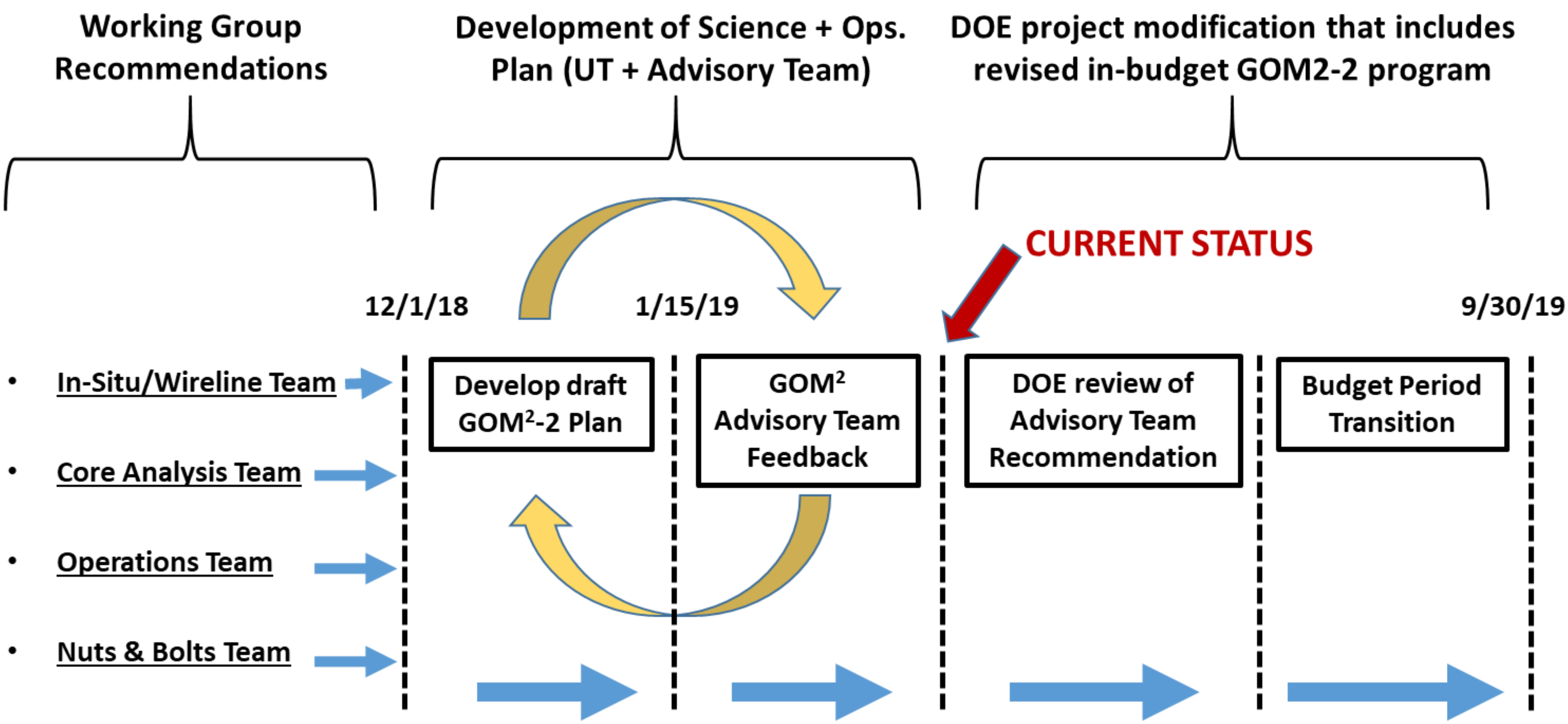
PCTB Development

Land Test

- Draft Schedule

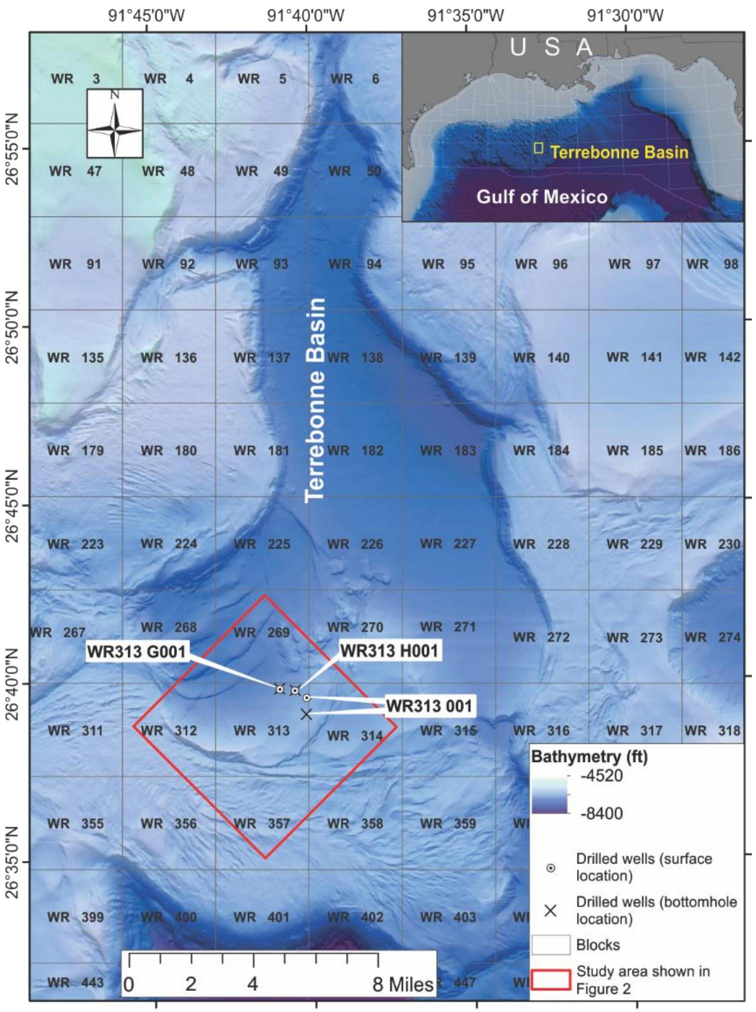
Day	Date	Activity
1	Mon, March 16	Mobilization, Shipping
2	Tue, March 17	Staging, Spotting, Rig-Up
3	***Wed, March 18, 2020***	***FB Test 1, FB Test 2***
4	***Thu, March 19, 2020***	***FB Test 3, BHA change***
5	***Fri, March 20, 2020***	***CS Test 2, CS Test 2, CS Test 3***
6	Sat, March 21, 2020	Possible additional test, Rig down
7	Sun, March 22, 2020	Rig-down, Demobilization
8	Mon, March 23, 2020	Demobilization

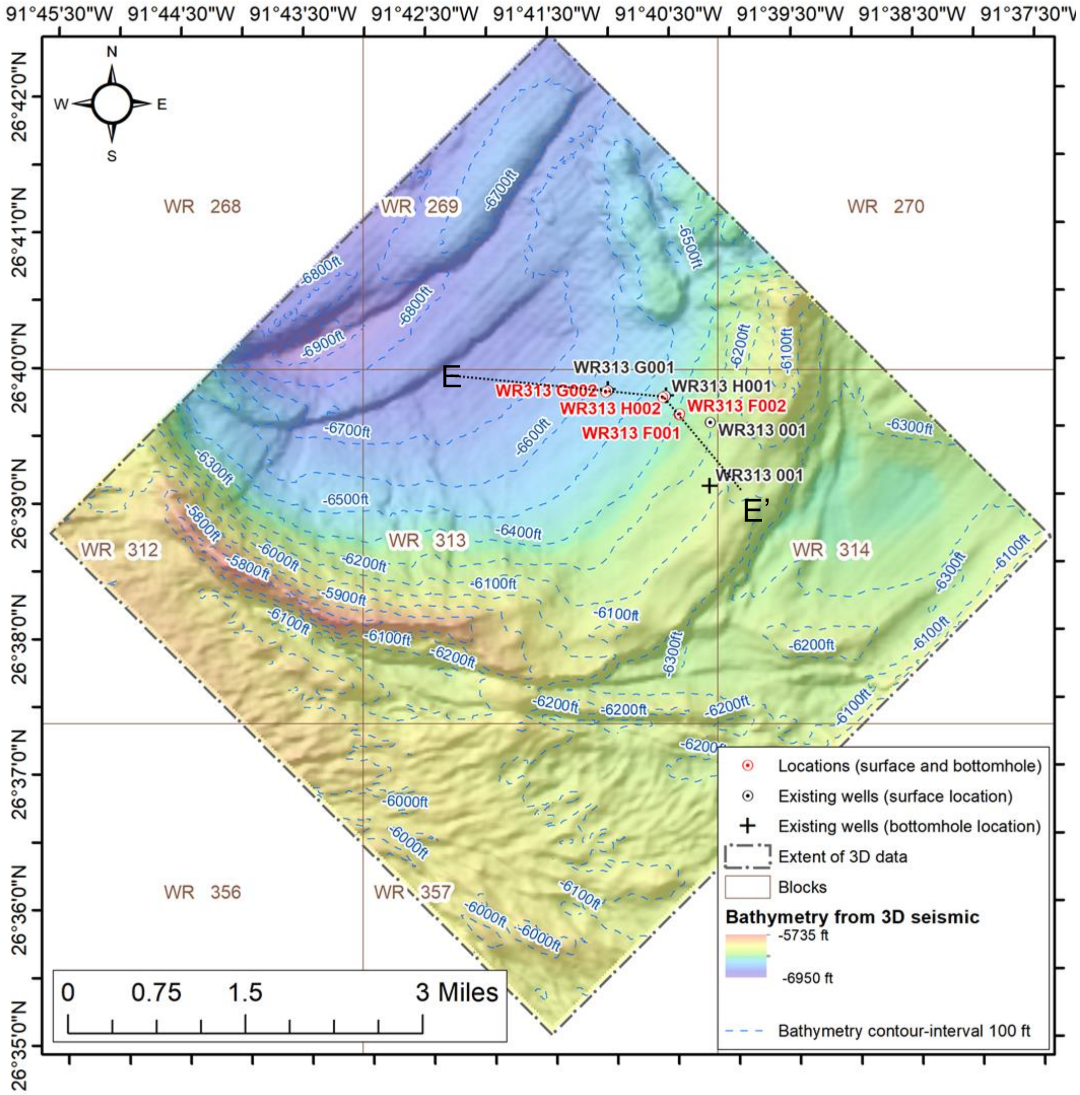
1. GOM^2-2 Planning



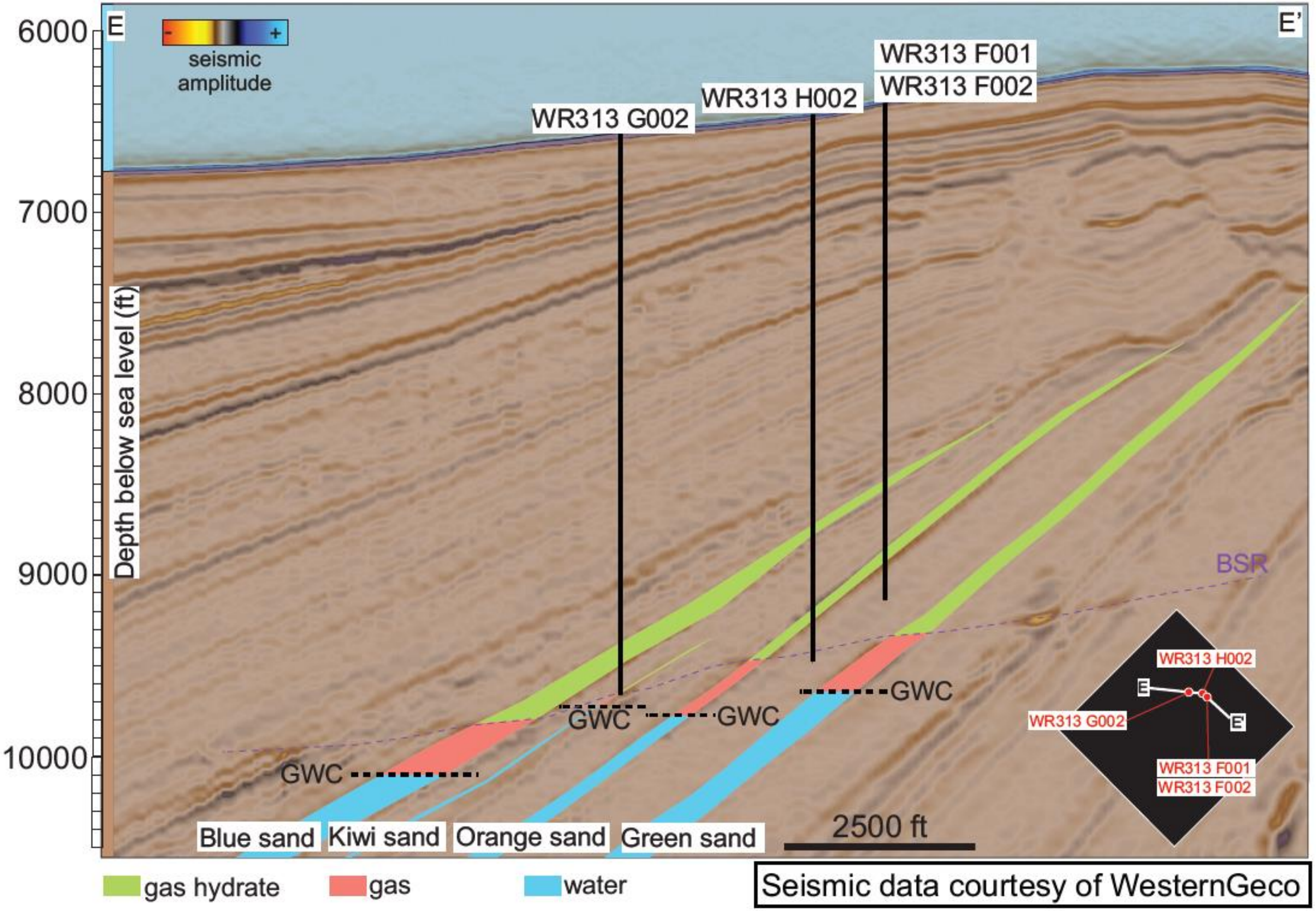
- UT-GOM^2-1 was a ‘technology test’.
  - True science in terms of developing a systems understanding of the hydrate reservoir will be from the second expedition (UT-GOM^2-2).
    - Coring of a second coarse-grained system with laterally extensive sandstone more characteristic of high-volume hydrocarbon reservoirs;
    - Acquiring pressure cores from marine mud to reservoir to understand the biogenic factory, seal rock, and system evolution; and

PROJECT LOCATION





PROJECT LOCATION



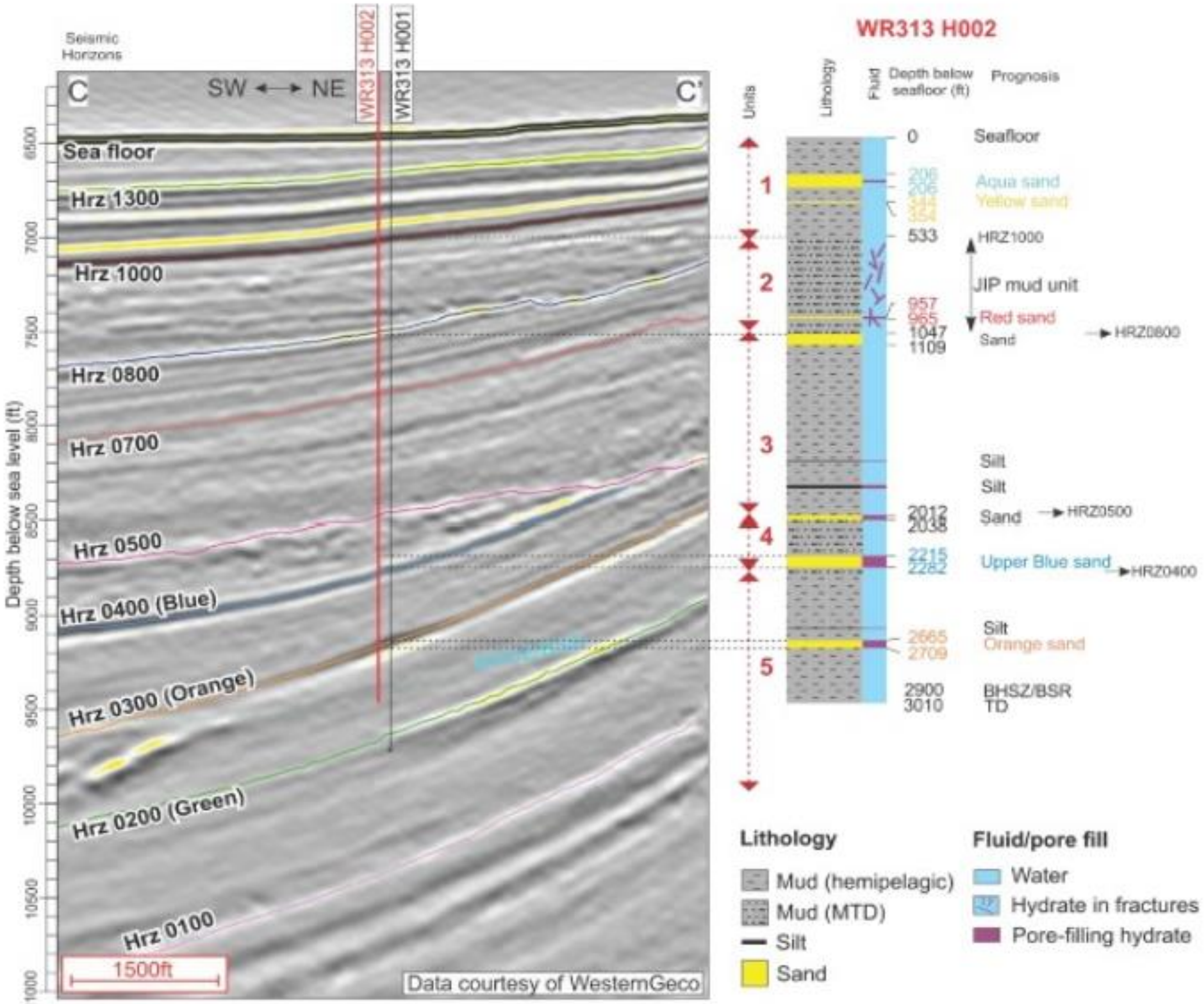
SCIENCE OBJECTIVES

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

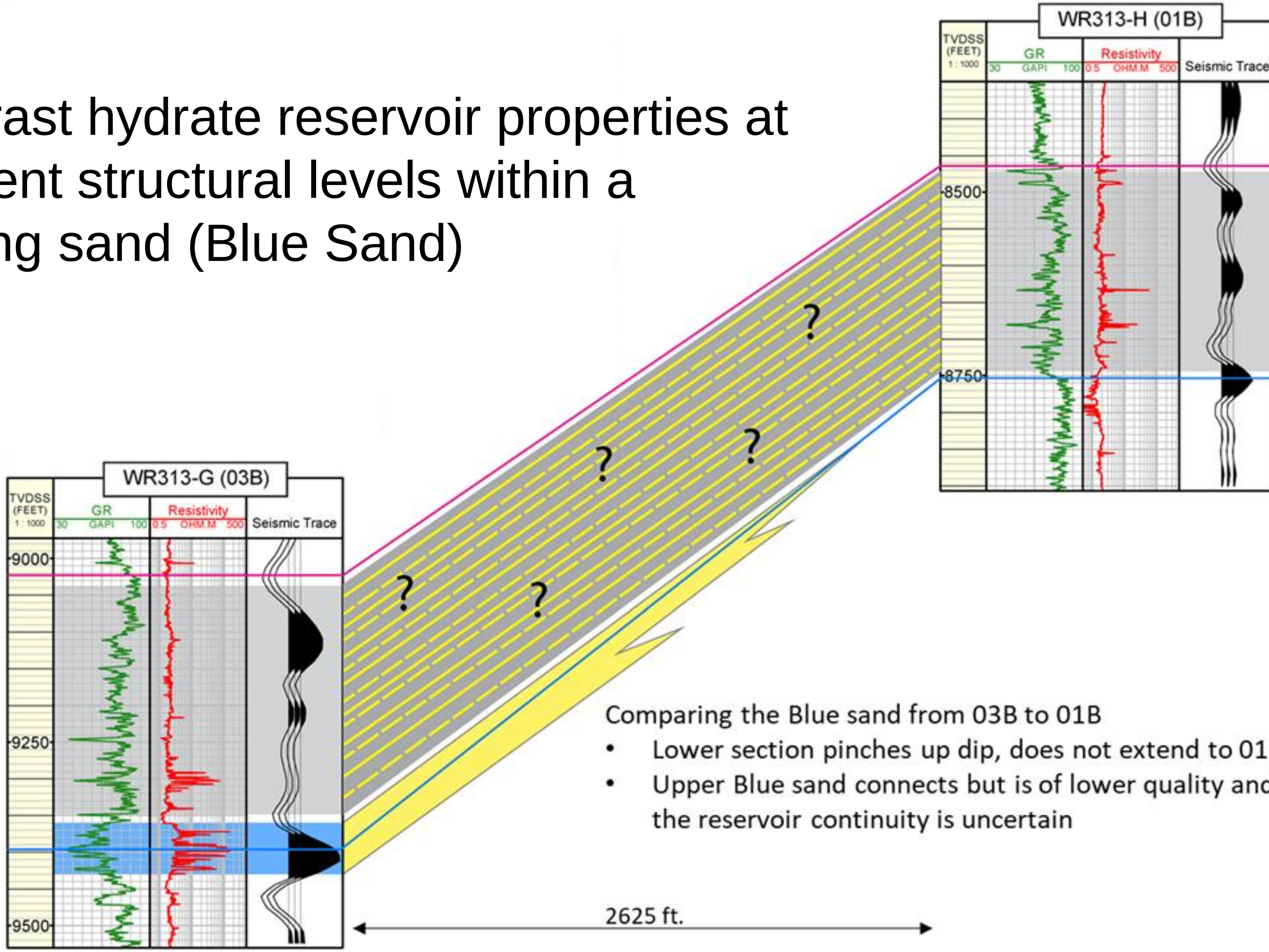
Characterize the Orange and Upper Blue sand

- 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)

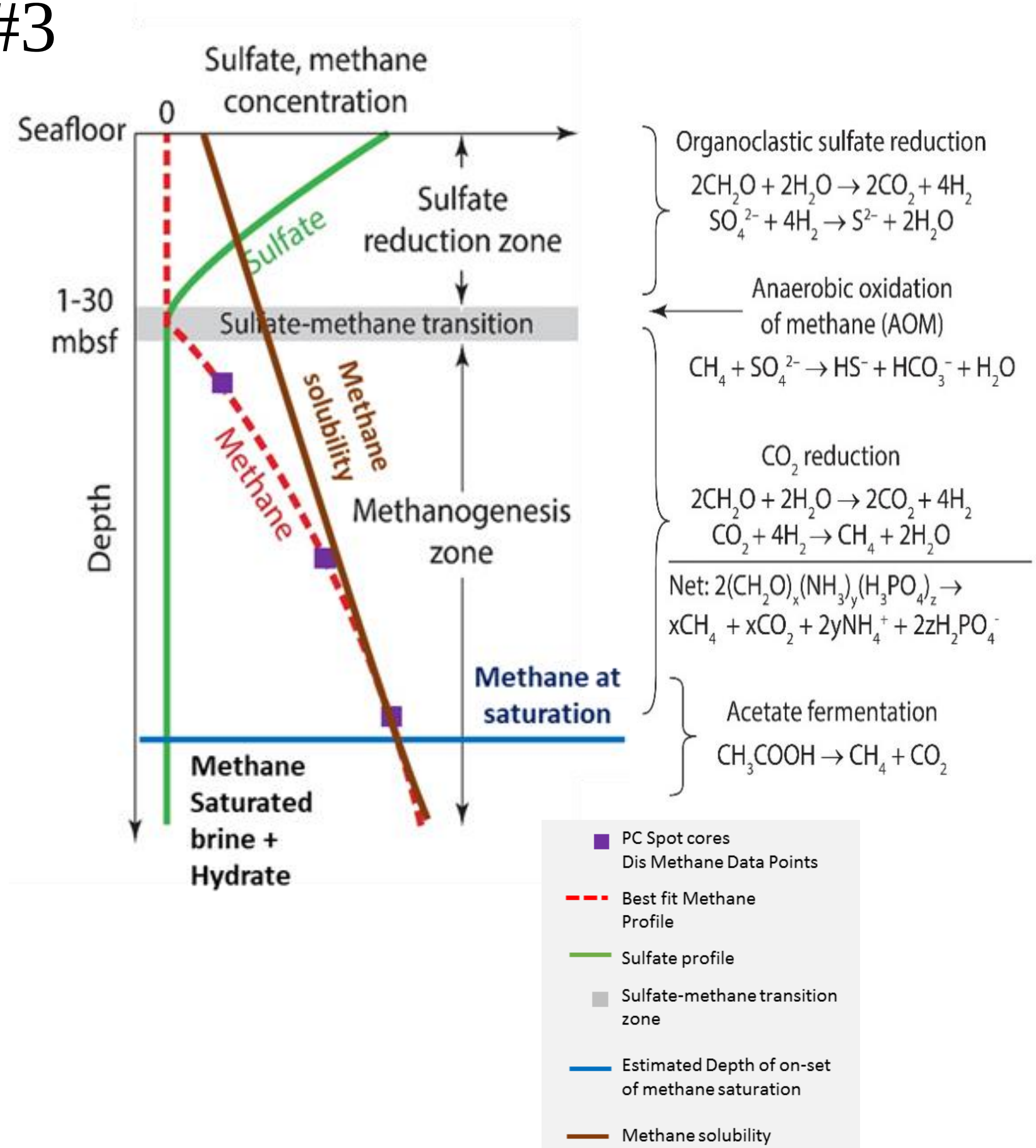


Science Objective #3

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.

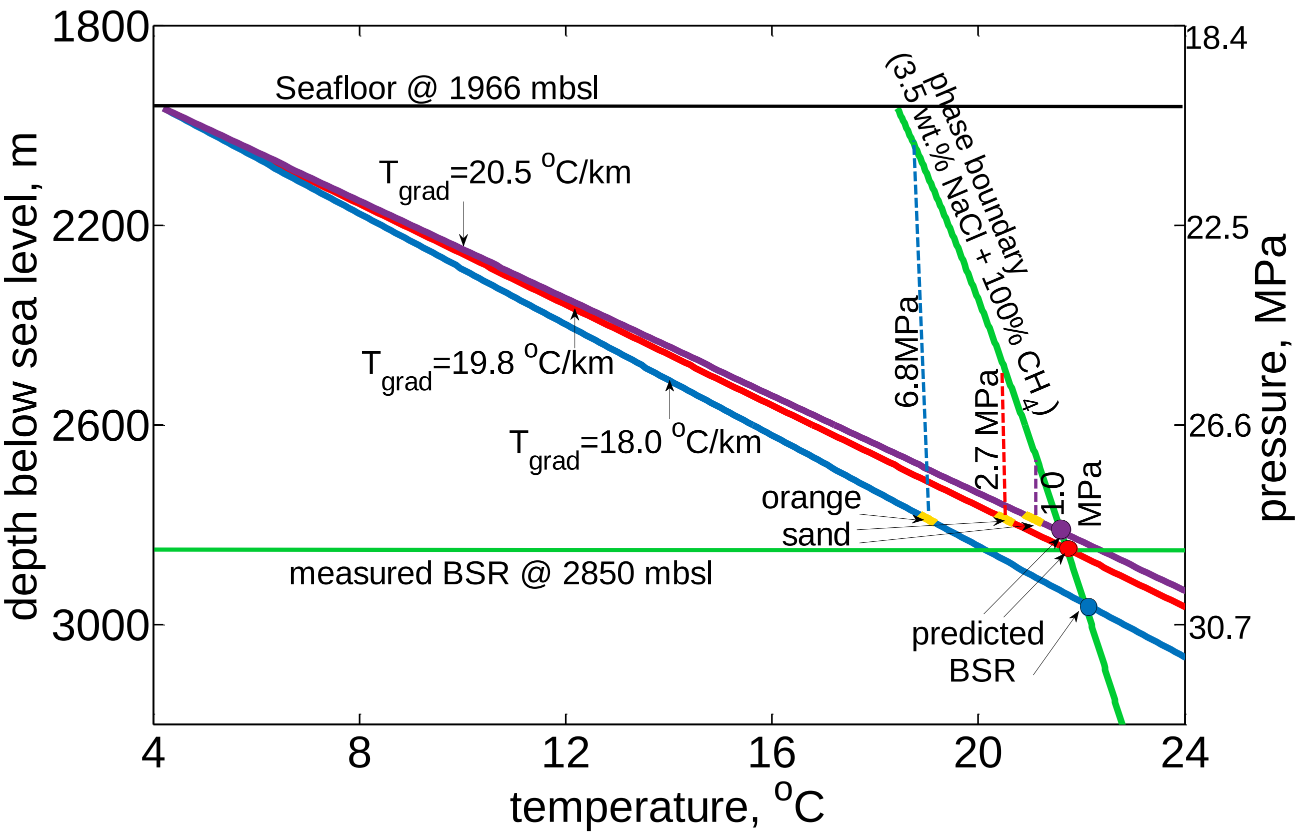


TEXAS Geosciences

Science Objective #4

- Measure pressure and temperature with a penetrometer to at least1640 feet below seafloor (fbsf)

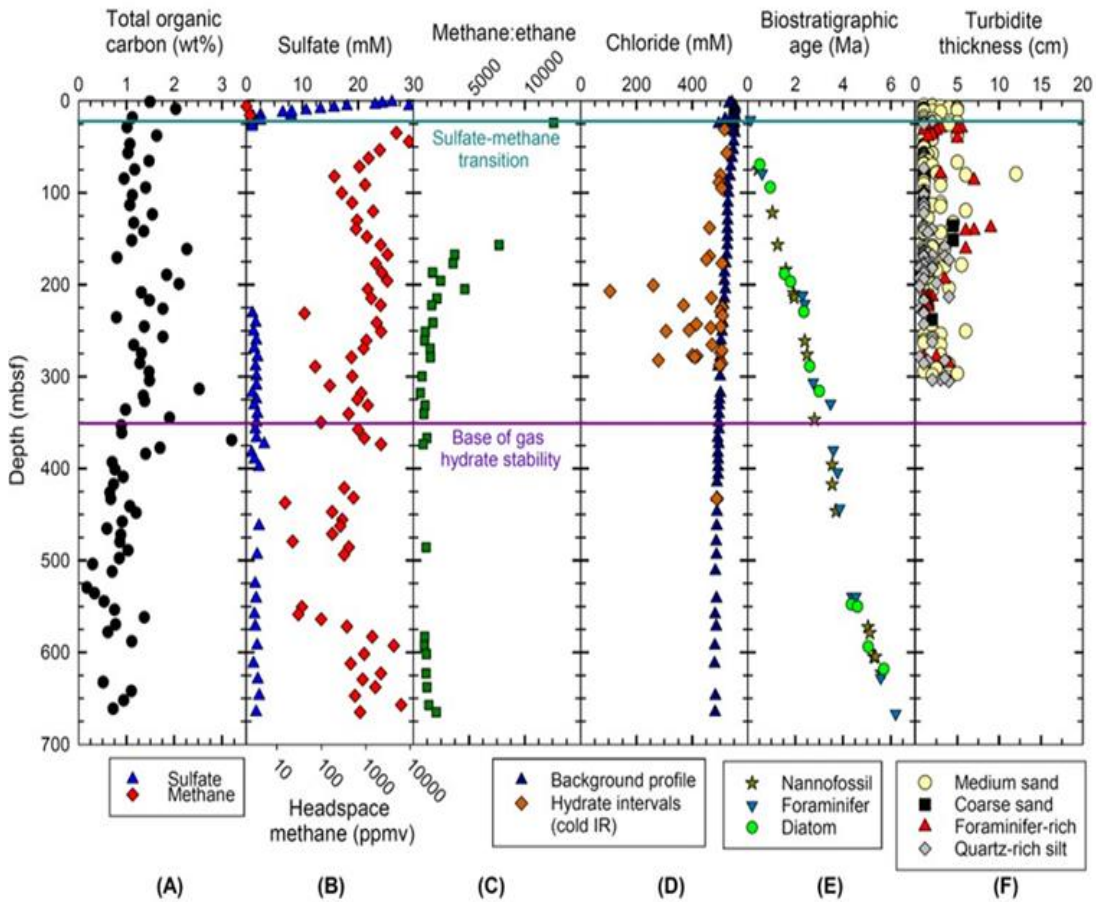
Is base of the hydrate stability zone is at the three-phase boundary (methane hydrate-seawater-methane vapor) ?



Science Objective #5

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

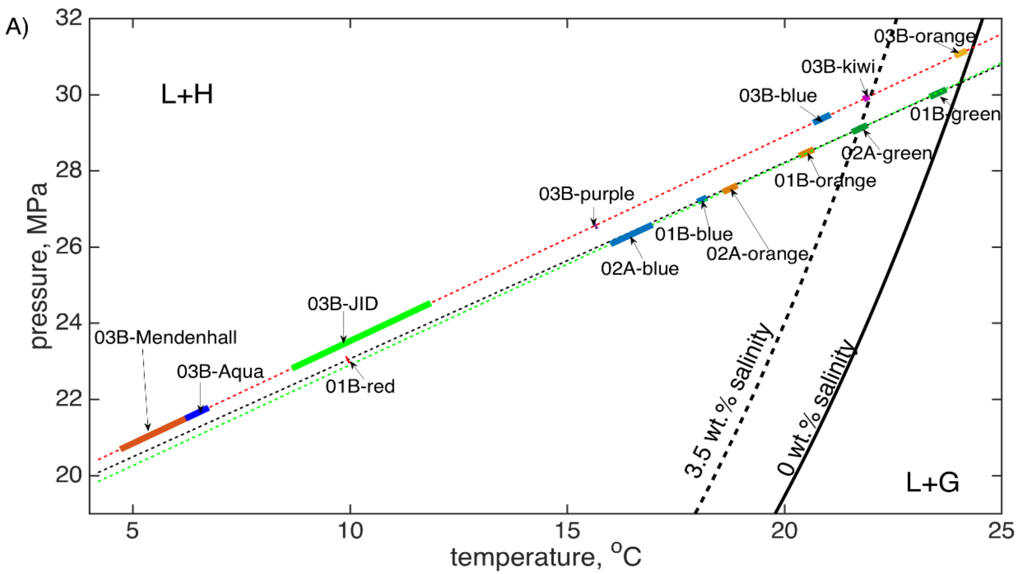
- Measure organic carbon with depth to constrain degree of microbial biogenesis
- Observe transitions in the first 250 fbsf and general behavior to total depth of the pore water composition to infer fluid flow, hydrate formation/dissociation, diagenesis.
- Develop age model.
- Continuous record of lithologic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

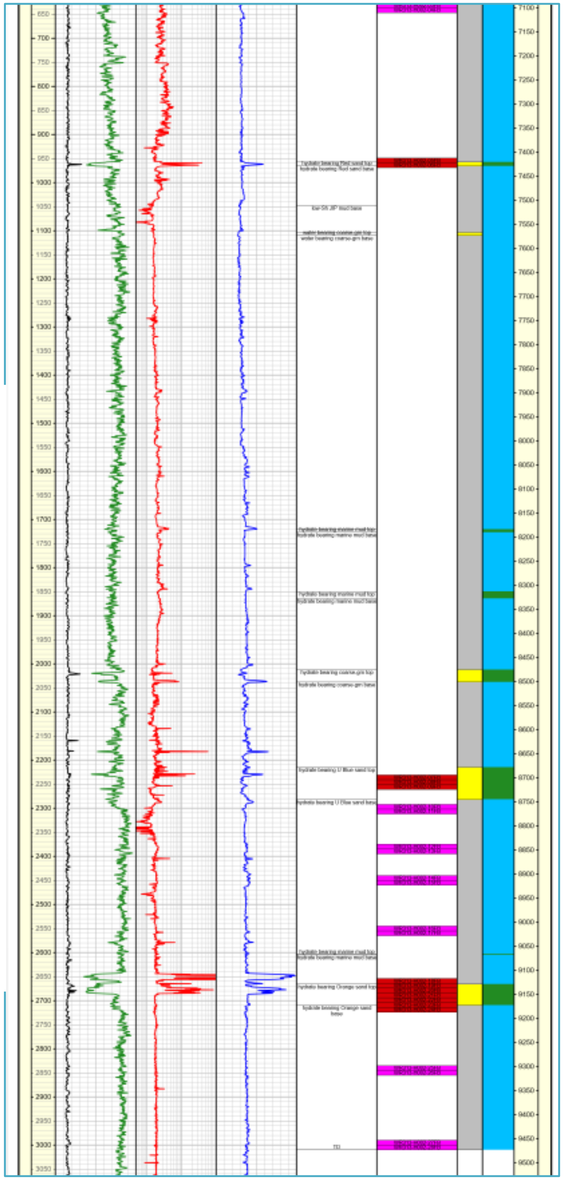


Example geochemical data from IODP Site U1445 in the Mahanadi Basin, northern Bay of Bengal

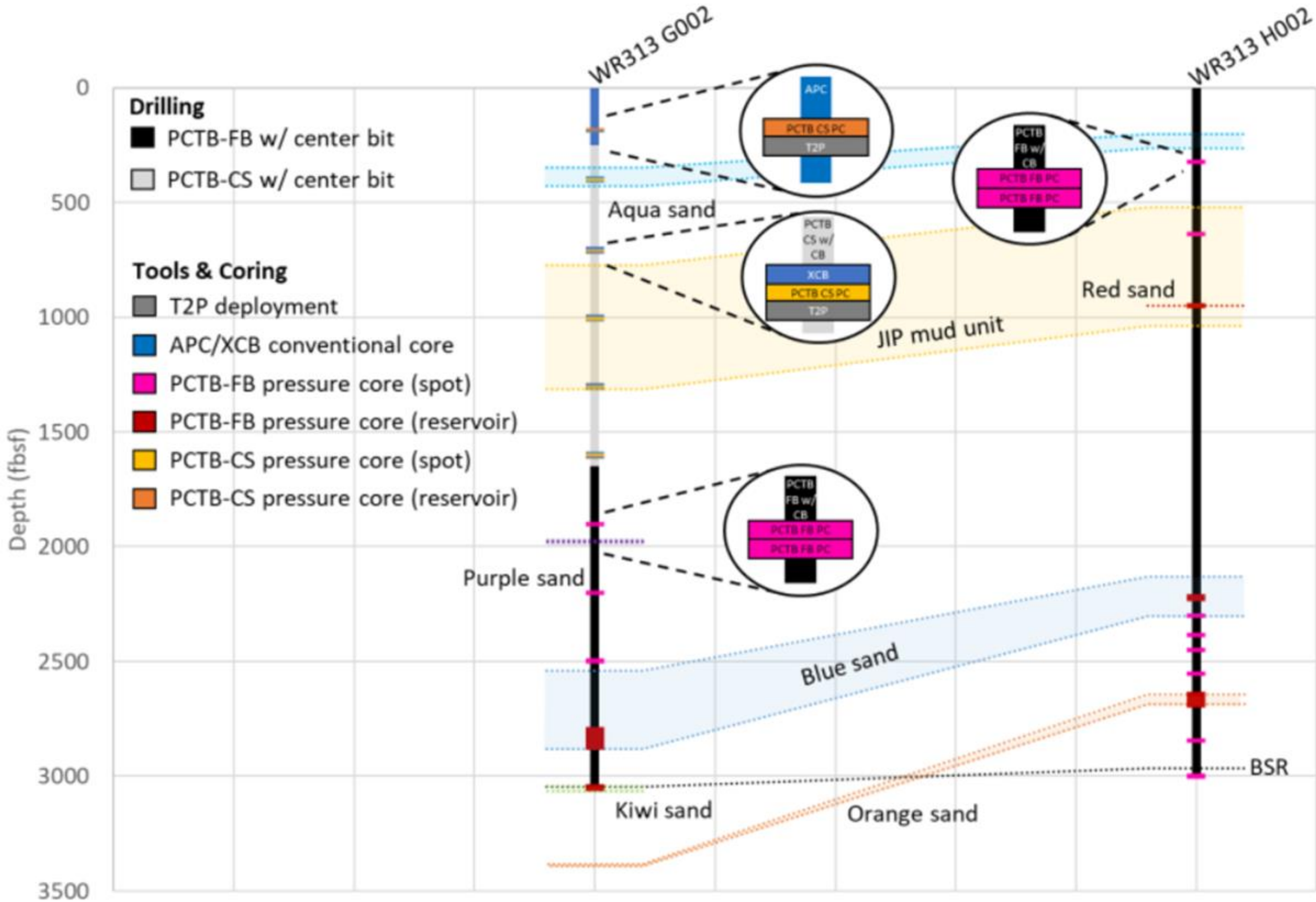
Science Objective #6

Characterize other sands of interest





UT-GOM2-2 DRILLING PROGRAM



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.

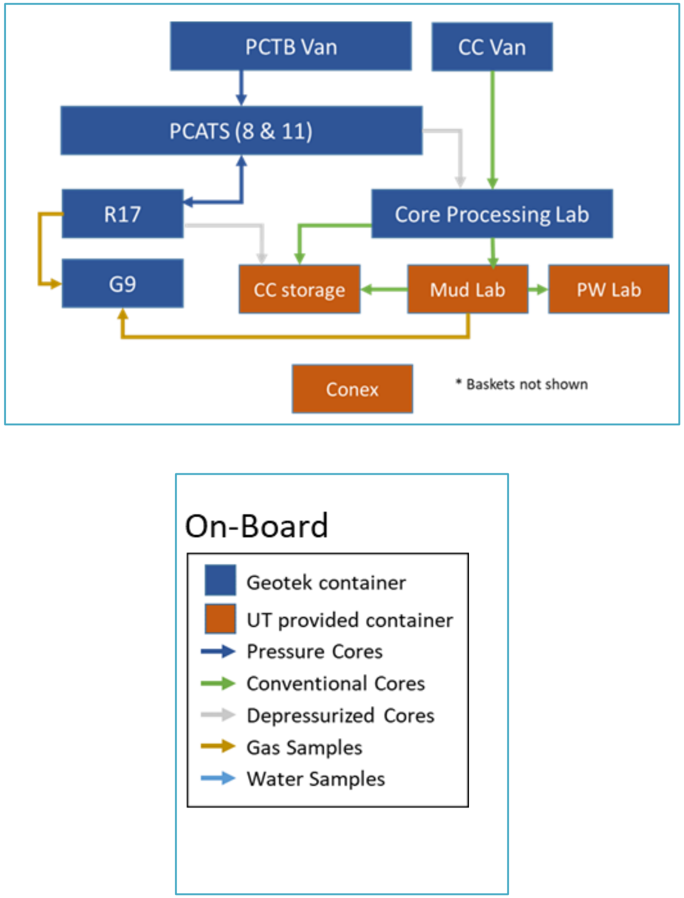
SCHEDULE

- 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

No.	TASK	LOCATION	ESTIMATED DURATION (DAYS)	CUMULATIVE DURATION (DAYS)
1	Premobilization Staging	Port of Embarkation	7.0	7.0
2	Mobilization	Port of Embarkation	3.7	10.7
3	H002 Coring Program	Walker Ridge 313	15.2	25.9
4	G002 Coring Program	Walker Ridge 313	16.6	42.5
5	Stage 1 Demobilization	Walker Ridge 313	2.9	45.4
6	Dockside Core Processing	Port Fourchon, LA	30.0	75.4
7	Stage 2 Demobilization	Port Fourchon, LA	3.0	78.4

On-board Core Analysis

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



Dockside Core Analysis

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

GOM^2-2 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>
<tr><th rowspan="2"></th><th colspan="2">Objective 1 & 5</th><th colspan="2">Objective 8 & 3</th><th colspan="2">Objective 6 & 4</th><th>Objective 2</th><th>Objective 7</th></tr>
<tr><th>Characterization of the Orange Sand through pressure coring</th><th>Characterization of the dissolved methane concentration and the hydrocarbon composition depth profile</th><th>Characterizing hydrate reservoirs at different thermodynamic states within a dipping sand (up-dip, down-dip)</th><th>Reservoir characterization and in situ measurements through LWD in 02A</th><th>High resolution geochemical and sedimentary profiles – moving towards an exploration model</th><th>Measurement of the thermal gradient – Temperature profile (500 mbsf)</th><th>Reservoir characterization through in situ testing and wireline logging across the Orange Sand at 01B</th><th>Reservoir characterization: Other Targets</th></tr>
<tr><td>C-6</td><td colspan="2" rowspan="5">Yes</td><td>Yes</td><td>Yes</td><td>Limited</td><td>No</td><td rowspan="2">No</td><td rowspan="2">Limited</td></tr>
<tr><td>C-7</td><td>Limited</td><td rowspan="4">No</td><td colspan="2" rowspan="2">Yes</td></tr>
<tr><td>C-5</td><td>No</td><td>Yes</td><td>Very limited</td></tr>
<tr><td>C-1</td><td rowspan="2">Limited</td><td rowspan="2">Limited</td><td>No</td><td rowspan="2">No</td><td rowspan="2">Limited</td></tr>
<tr><td>Recommended Plan (C-8)</td><td>Yes</td></tr>
</table>

CURRENT EFFORTS: PROJECT TIMELINE

Current/Future Project Periods

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

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

Complete Preliminary Expedition Summary
2022

Initiate Scientific Results Volume and Presentations
Jun 2023-

2020	2021	2022	2023	2024

Phase 4 10/19-09/20	**Phase 5** 10/20-09/22	**Phase 6** 10/22-09/24

CURRENT STATUS

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

- Boswell, R., and T. Collett, 2016, Emerging Issues in the Development of Geologic Models for Gas Hydrate Numerical Simulation, Fire in the Ice, p. 18-21.
- Fang, Y., P. B. Flemings, H. Daigle, S. C. Phillips, P. K. Meazell, and K. You, in press, Petrophysical properties of the Green Canyon block 955 hydrate reservoir inferred from reconstituted sediments: Implications for hydrate formation and production: AAPG Bulletin.
- Flemings, P. B., S. C. Phillips, R. Boswell, T. S. Collett, A. E. Cook, T. Dong, M. Frye, G. Guerin, D. S. Goldberg, M. E. Holland, J. Jang, K. Meazell, J. Morrison, J. O'Connell, T. Pettigrew, E. Petrou, P. J. Polito, A. Portnov, M. Santra, P. J. Schultheiss, Y. Seol, W. Shedd, E. A. Solomon, C. Thomas, W. F. Waite, and K. You, In press, Concentrated hydrate in a deepwater Gulf of Mexico turbidite reservoir: initial results from the UT-GOM2-1 Hydrate Pressure Coring Expedition: American Association of Petroleum Geologist Bulletin.
- Phillips, S. C., P. B. Flemings, M. E. Holland, P. J. Schulthiss, W. F. Waite, J. Jang, E. G. Petrou, and H. H., in press, High concentration methane hydrate in a silt reservoir from the deep-water Gulf of Mexico: American Association of Petroleum Geologist Bulletin.

END OF PRESENTATION

Thank you