UT-GOM2-1: Prospecting, Drilling and Sampling a Coarse-Grained Hydrate Reservoir in Green Canyon 955, the Deepwater Gulf of Mexico

Peter Flemings, Steve Phillips and the GOM^2 Science Party

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

Outline

- The GOM^2 Program
- UT-GOM2-1 Expedition
  - What we knew
  - 7 New Observations
- Future Challenges

GOM^2-'Genesis of Methane Hydrate in Coarse-Grained Systems : Northern Gulf of Mexico Slope'

- Multi-disciplinary and multi-institutional team studies methane hydrates in the Gulf of Mexico supported by DOE.

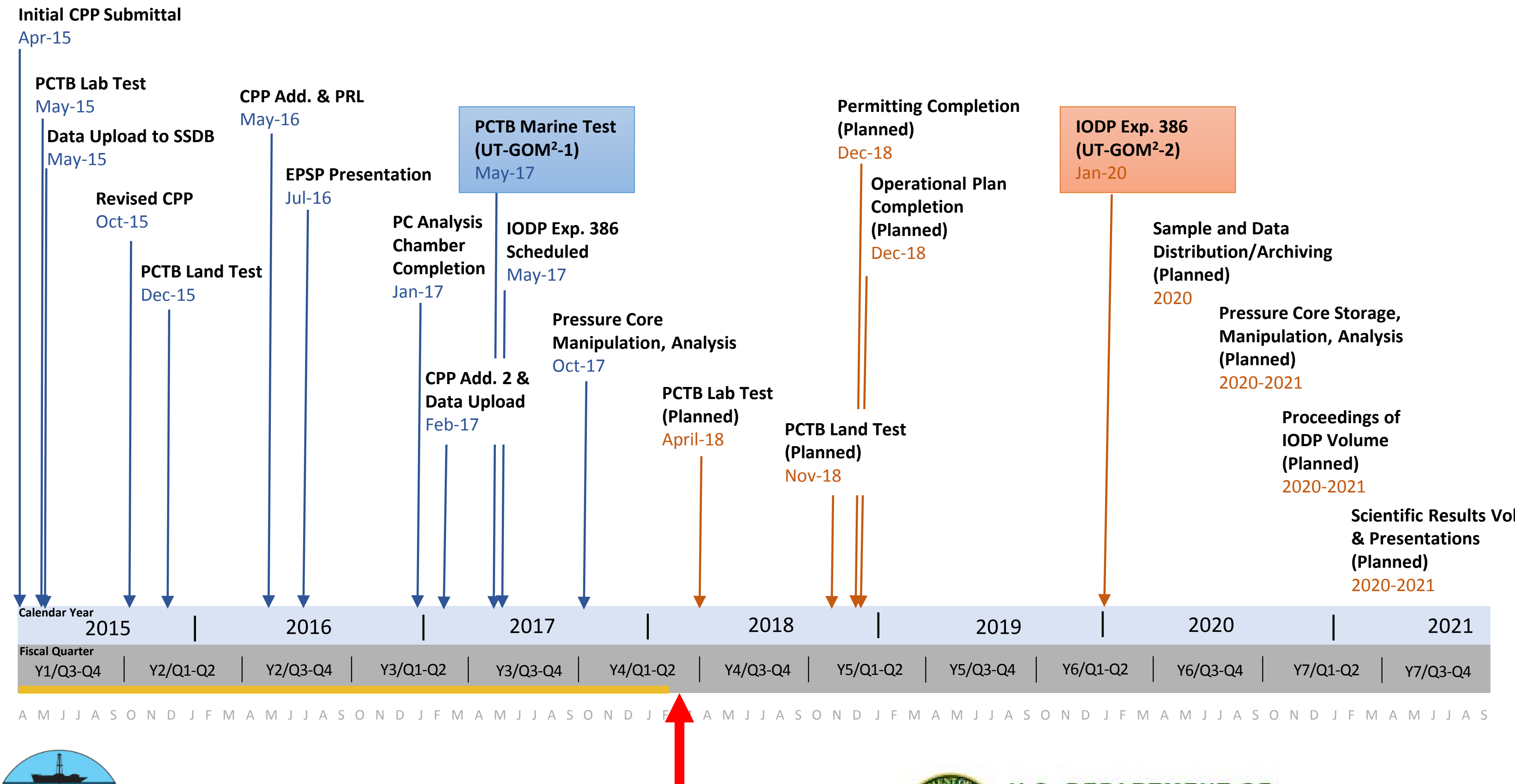
- Two deepwater drilling expeditions will log, sample, and test coarse-grained methane hydrate reservoirs over 6 years
    - ***IODP Expedition 386 scheduled for winter 2020.***

- Illuminate origin, evolution, and producability of hydrate-bearing deepwater sands.

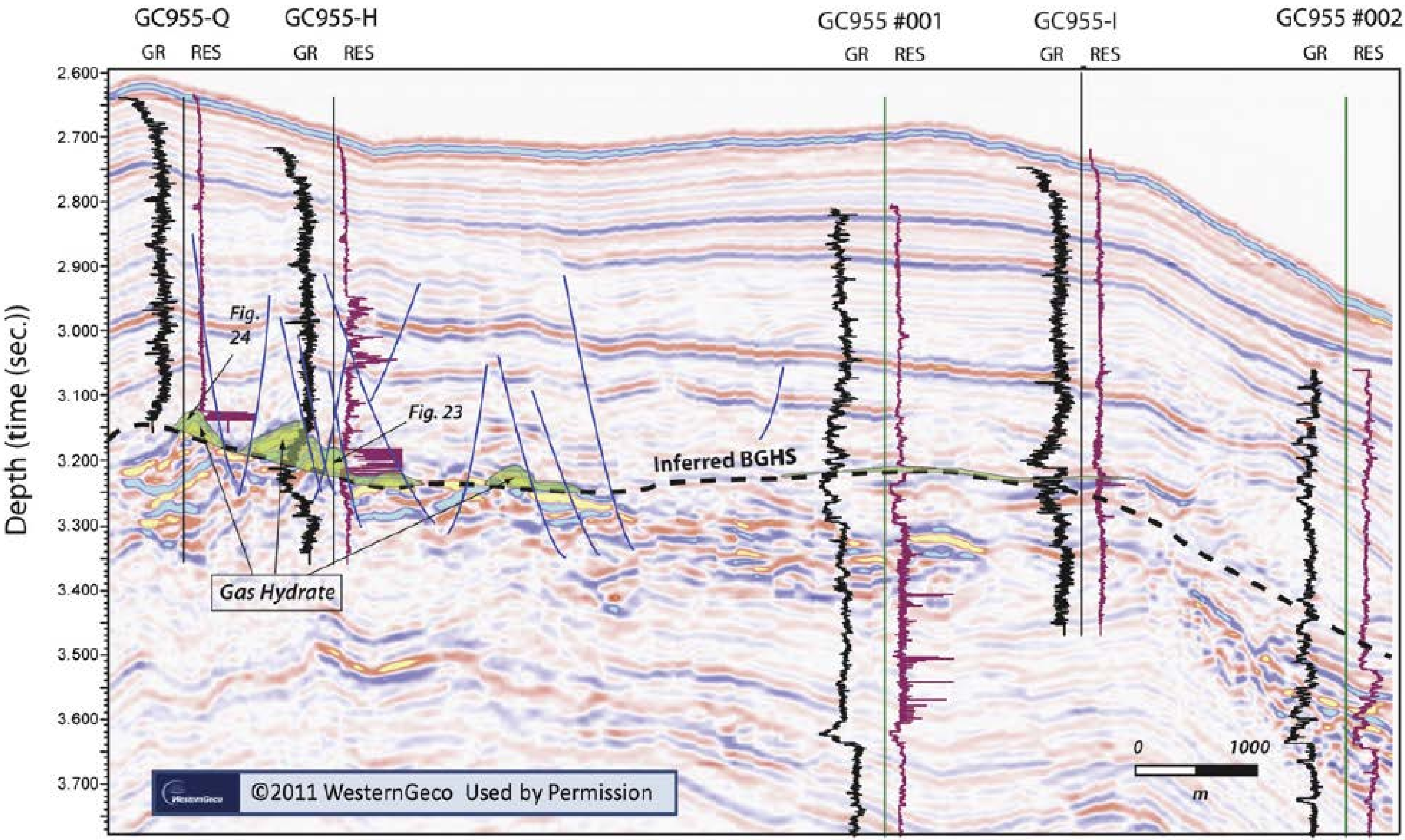
GOM^2 Program

1)PHASE 1: PCTB Development and Expedition Planning
2)PHASE 2: May 2017: Demonstrate Capability- GC-955
3)PHASE 3: Preparation (1/2018-9/2019)
4)PHASE 4: Spring 2020: 60 day expedition (10/2019-9/2021)

GOM^2 Project Timeline

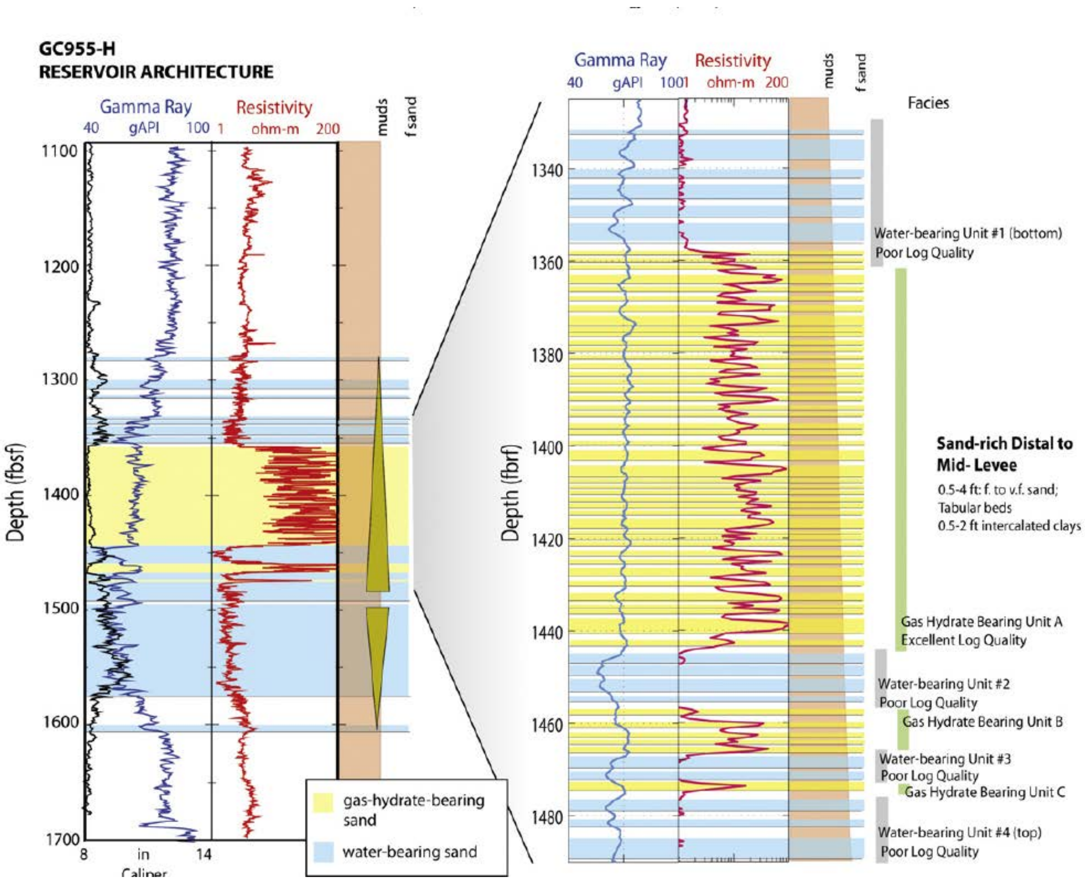


2009 'Chevron JIP' Drilling (DOE, USGS, BOEM)
(Collett, Boswell, Frye, Shedd, McConnell, Shelander, Cook, and more)



(Boswell et al. 2012a)

2009 ‘JIP Hydrate Drilling’: Low GR, Hi Vel., Hi Res



(Boswell et al. 2012b)

1. **State of Knowledge**
   a. Channel-levee
   b. S_h = ~80% in ‘sands’
   c. ‘sand’ = low GR
   d. Confirmed direct detection, and exploration model

2. **New and Remaining Questions**
   a. Bedding
   b. Concentration
   c. Grain size
   d. Gas origin, composition
   e. In-situ chemistry
   f. Permeability
   g. compressibility

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UT-GOM2-1: Goals

- Drill, log, and pressure core at GC955, site of JIP 'GC955-H' well.
- Demonstrate engineering capability of the pressure-coring tool (PCTB) to capture, collect, and recover hydrate-bearing sand sediment pressure core.
- Demonstrate ability to 1) log and image, 2) subsample and store subsamples 3) obtain geochemical and petrophysical data from pressure cores.
- Advance scientific exploration by providing greater hydrate research community access to depressurized and pressurized cores and logging data

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UT-GOM2-1: A Team Effort

- Peter Flemings, Steve Phillips, Tom Pettigrew, Steve Phillips, Peter Schultheiss, Carla Thomas, Jamie Morrison, Bill Waite, Mike Mimitz, Quentin Huggett, John Roberts, Mel Holland, Skyler Dong, Ann Cook, Kevin Meazell, Aleksei Portnov, Jesse Houghton, Tessa Green, Ethan Petrou, Rick Baker, Ray Boswell, Tim Collett, Matt Frye, Bill Shedd, Patrick Riley, Johanna S., Matt Selman, Josh O'Connell, Manasij Santra, Giles Guerin, Evan Solomon, Rick Colwell, Joel Johnson, Dave Divins

UT, Ohio State, Columbia University, UNH, Oregon State, U. Wash., BOEM, USGS, DOE.
Helix, GeoTek, Schlumberger, Weatherford.

<u>UT Administration, DOE, BOEM, USGS Persistence</u>

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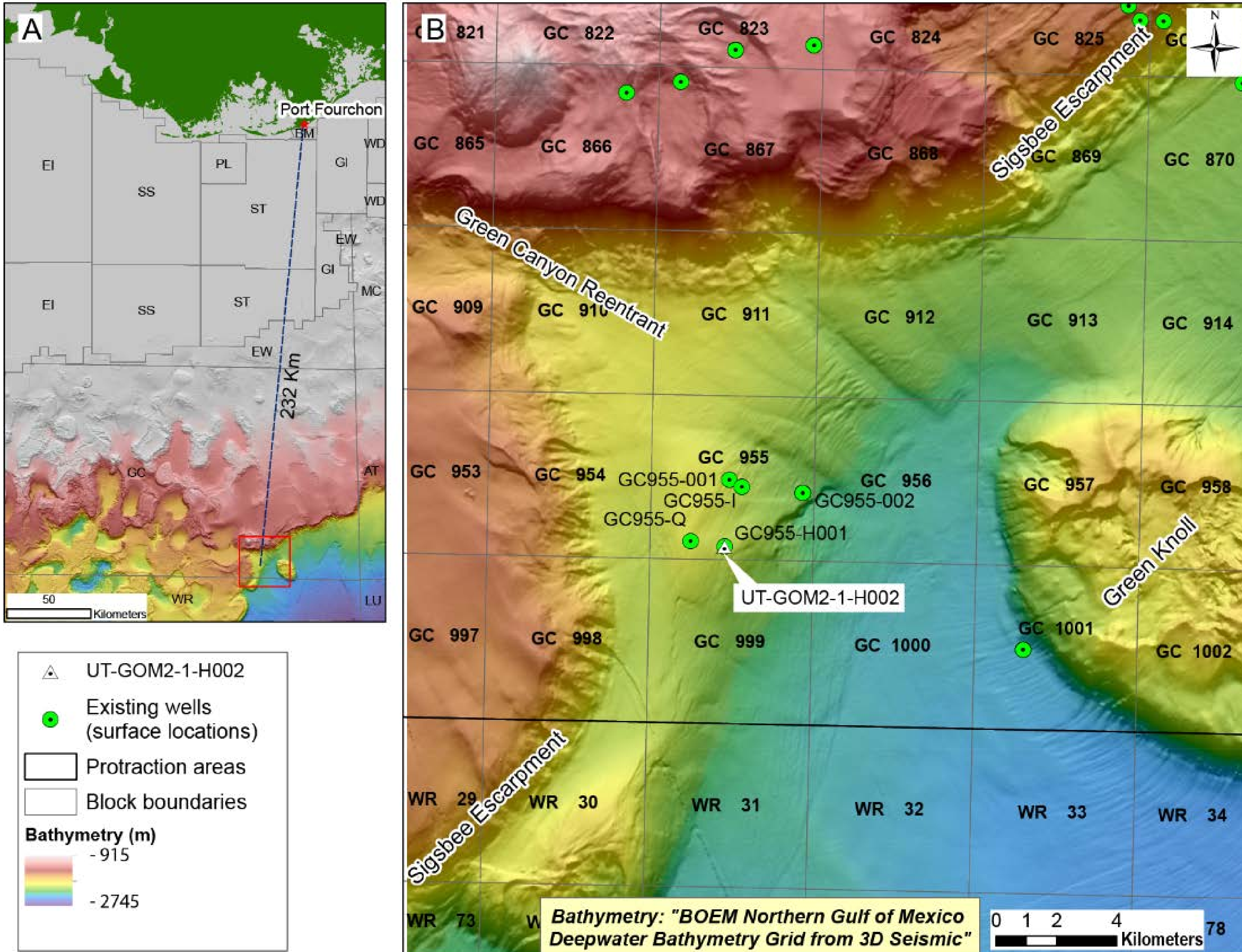

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May 2 Mobilize
May 11 Execute
May 23 Demobilize
May 26 Establish shore-based lab
June 3 Complete Operations

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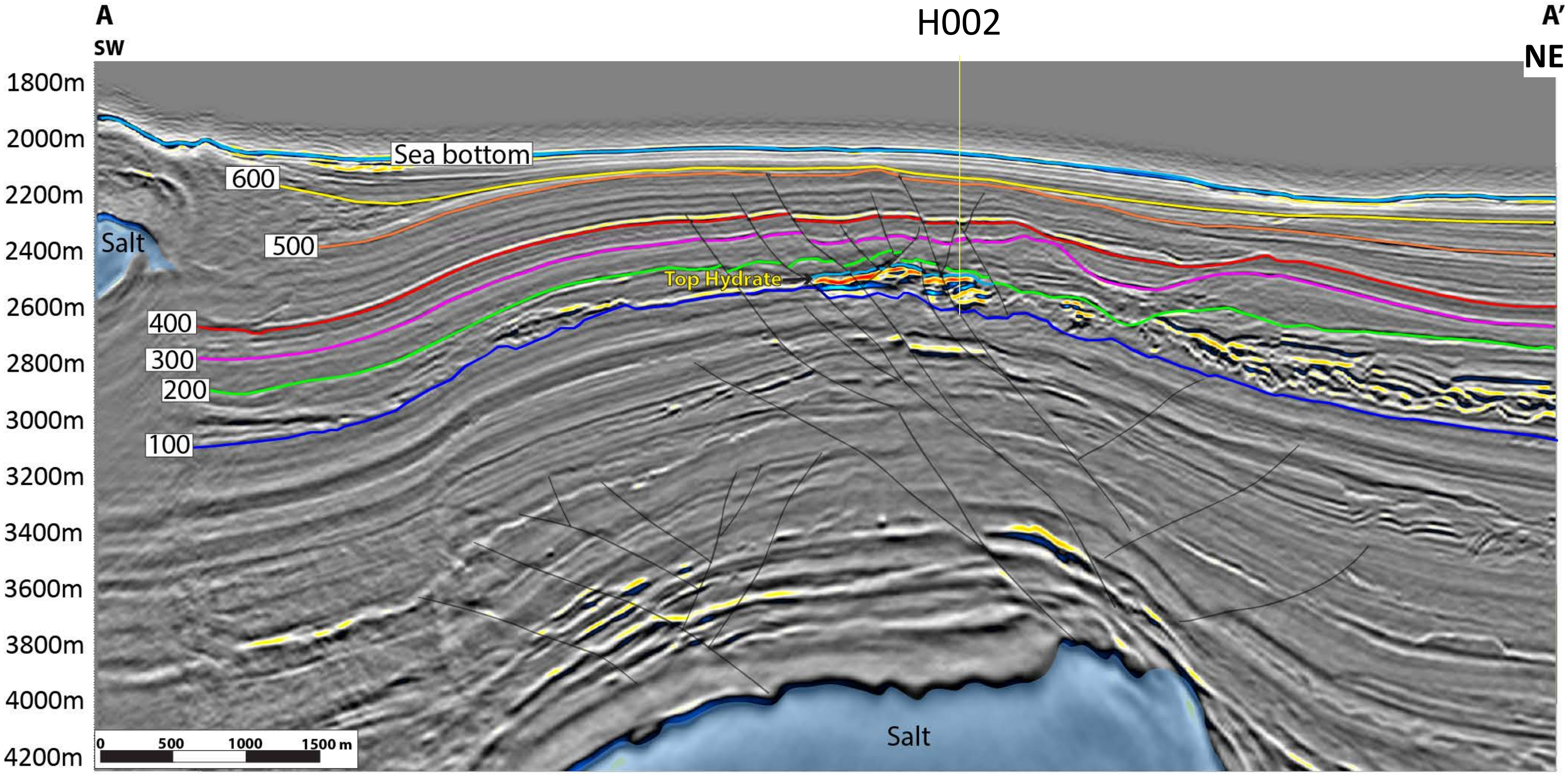
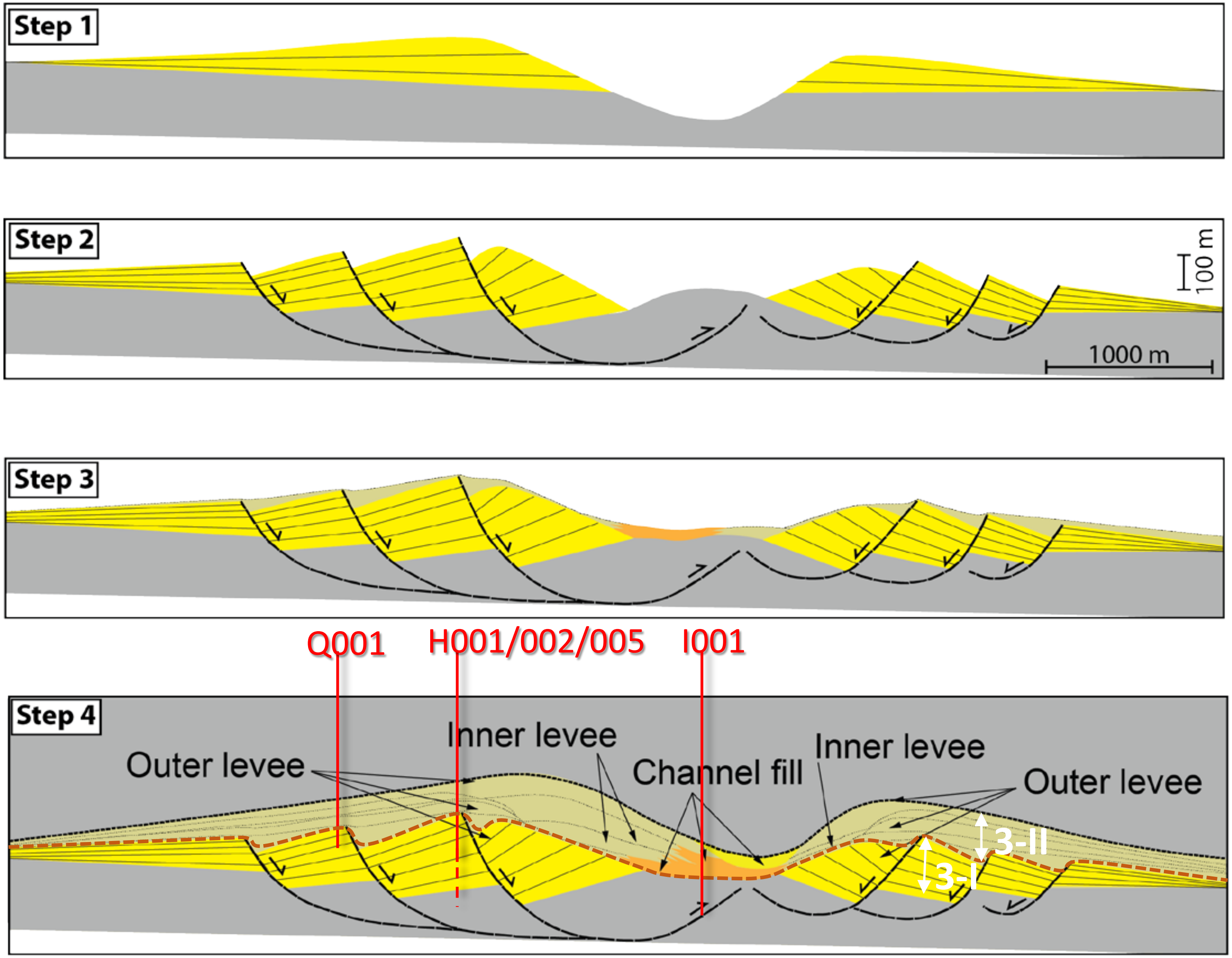


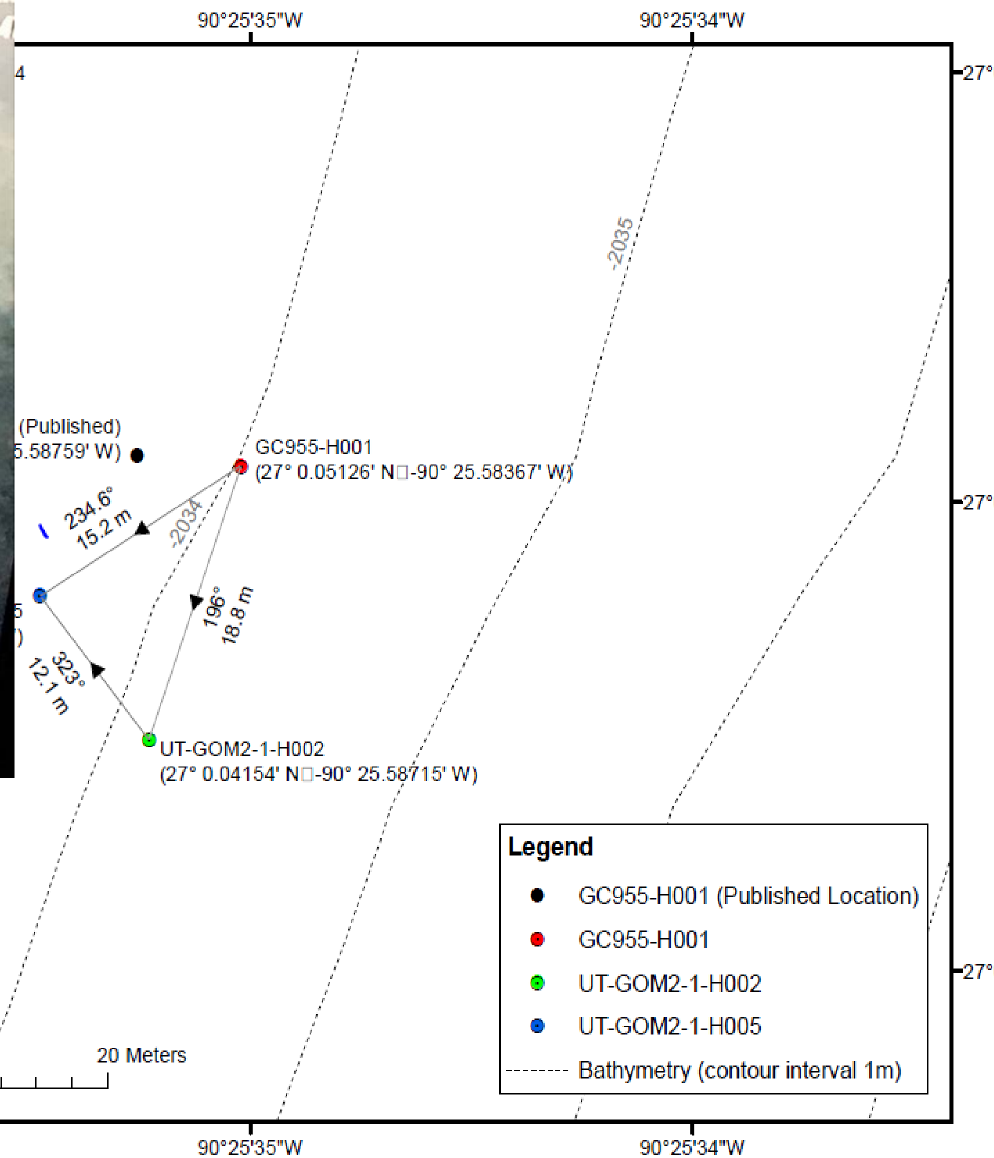
Images courtesy of WesternGeco (Flemings et al., 2017).

OS53B-1209: Santra et al.,

#1: Complex leveed channel deposition



(Santra et al., in prep)



GC 955-H well drilled in 2009

Making up BHA

Spud-in for H002 Well

Recovering pressure core

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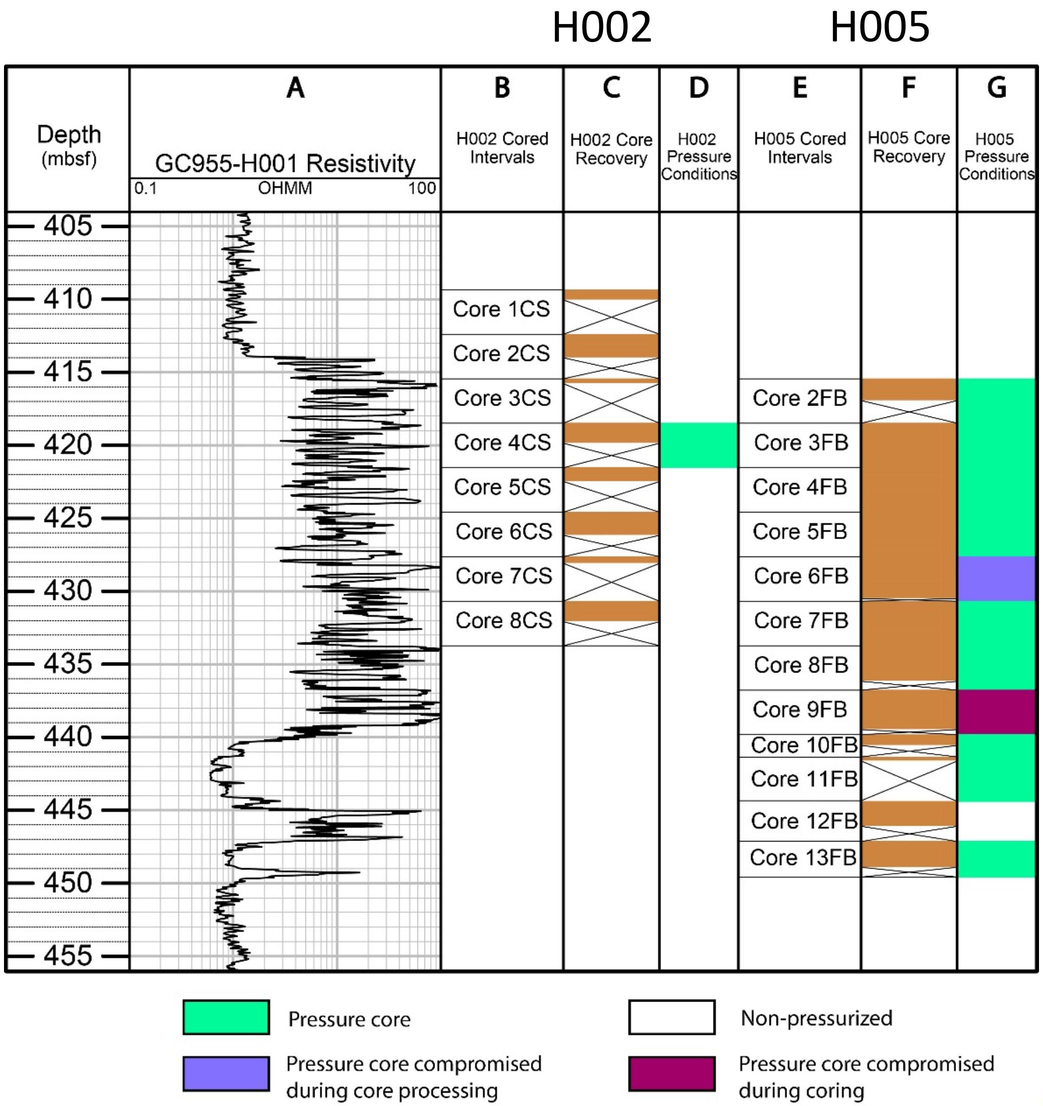
UT-GOM2-1 Expedition - May 2017



- 12 successful pressure cores in main hydrate reservoir

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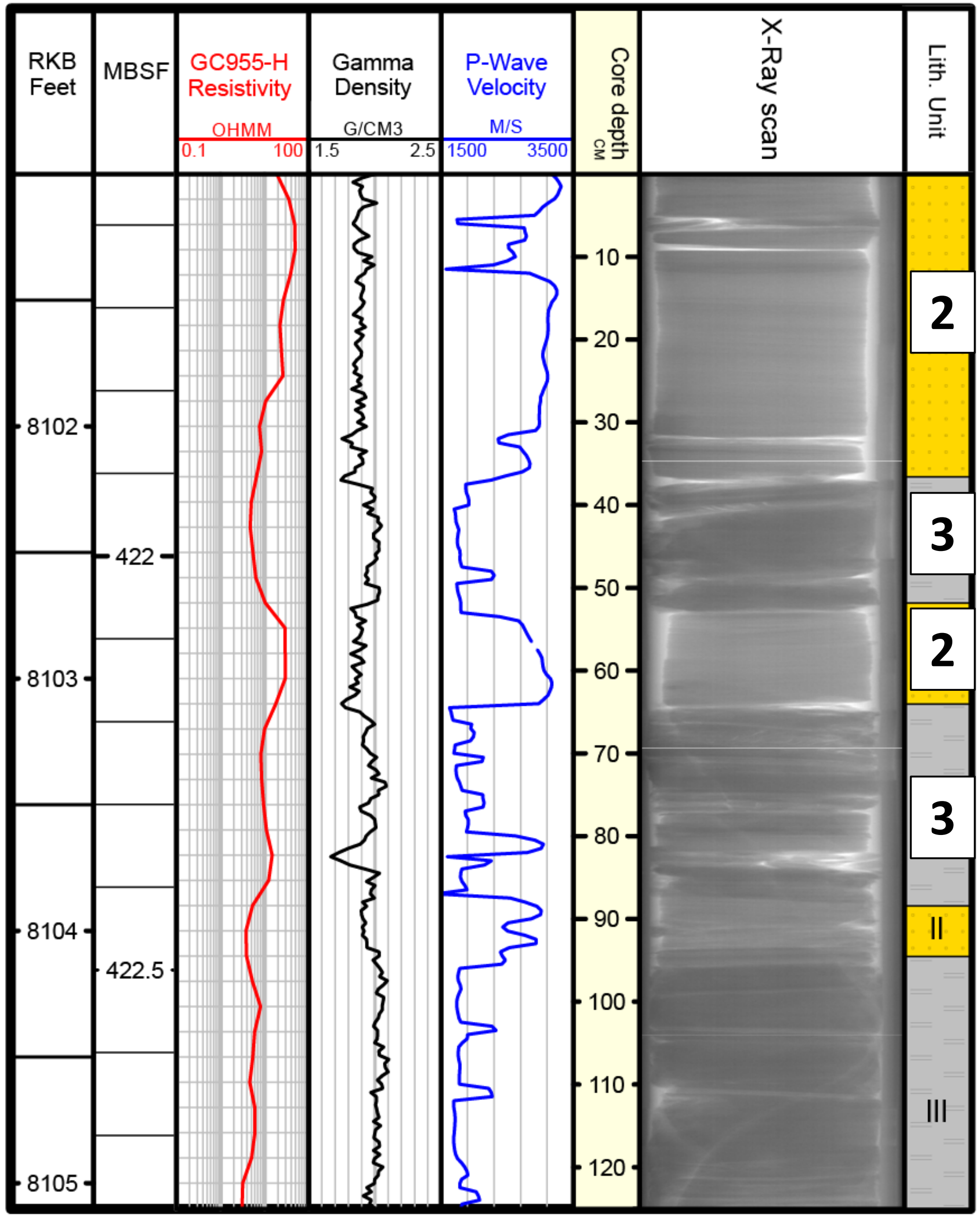
#2) Lithofacies

Lithofacies 2

- **Interbedded with lithofacies 3.**
- **low density (2.05-2.1 g/cc) and high velocity (3000-3250 m/s)**
- **Ripples and/or cross-bedding.**
- **Most continuous underformed samples.**

Lithofacies 3

- **Interbedded with lithofacies 2**
- **High density (~1.9g/cc) and low velocity (~1700 m/s)**
- **Generally massive and more deformed**



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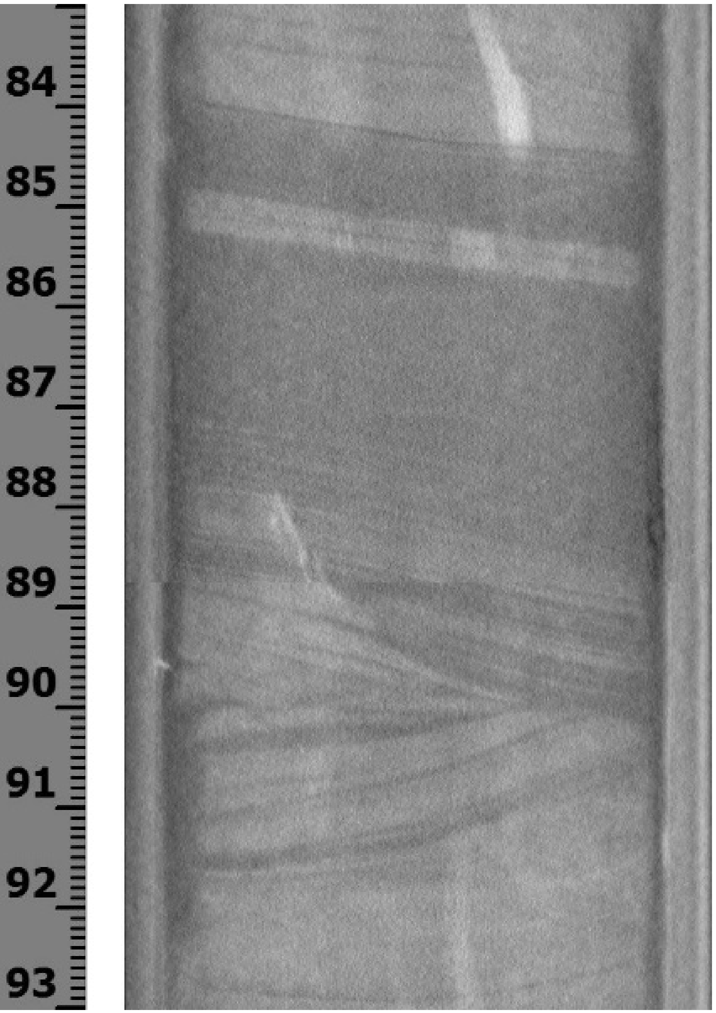
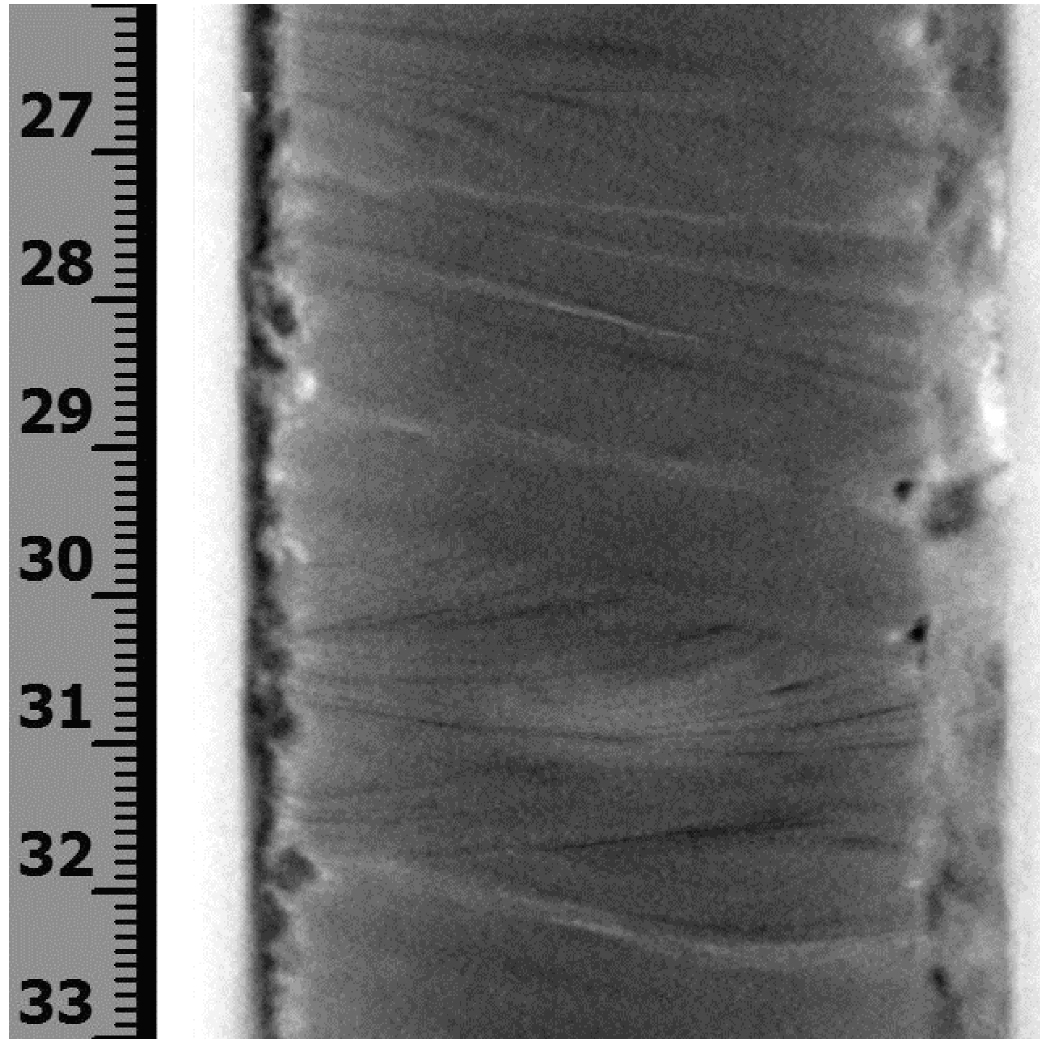
PCATS – X-ray CT

Lithofacies 2





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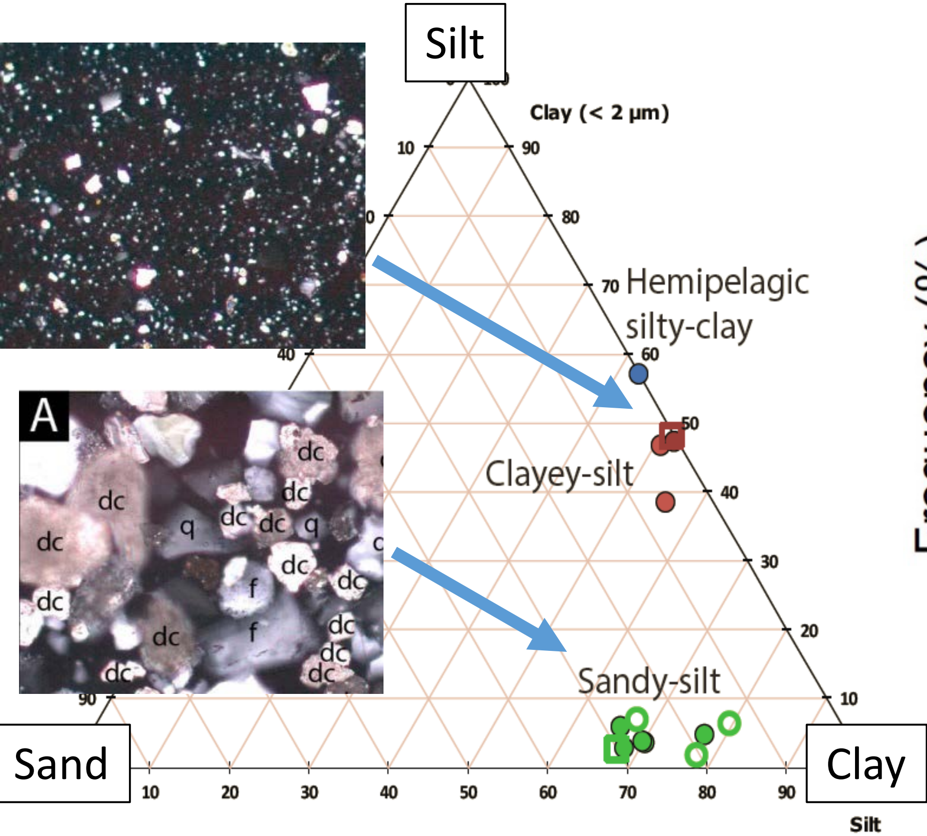
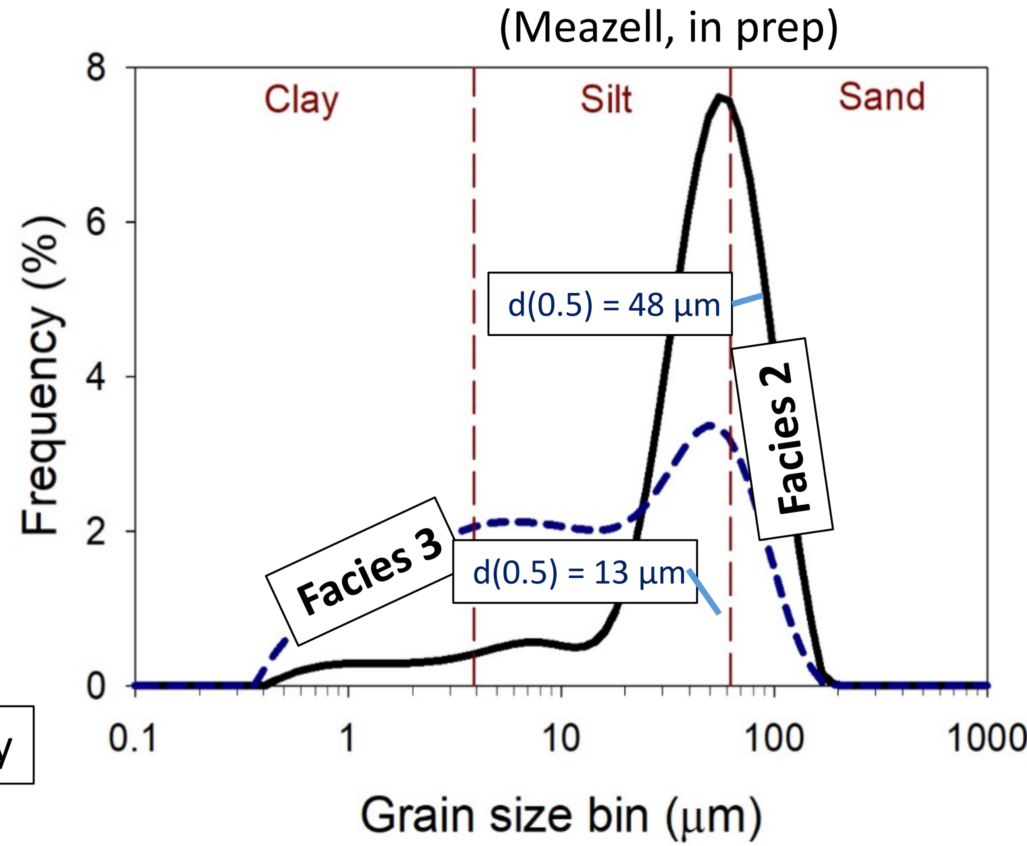
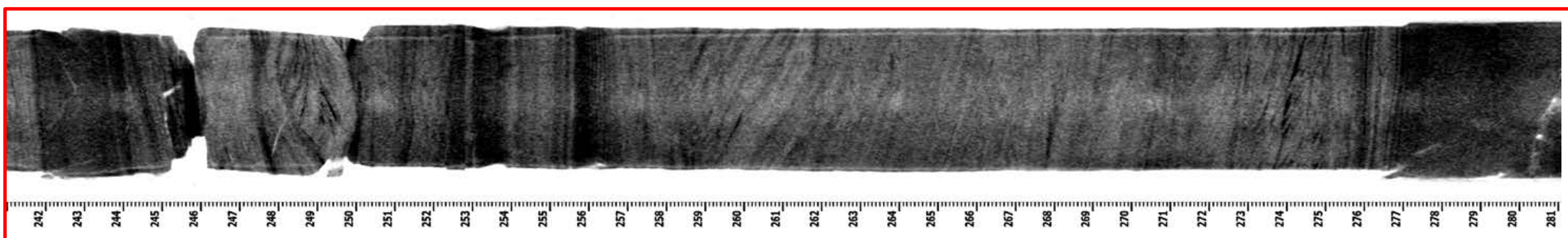
#3) ‘Sand’ is ‘sandy silt’

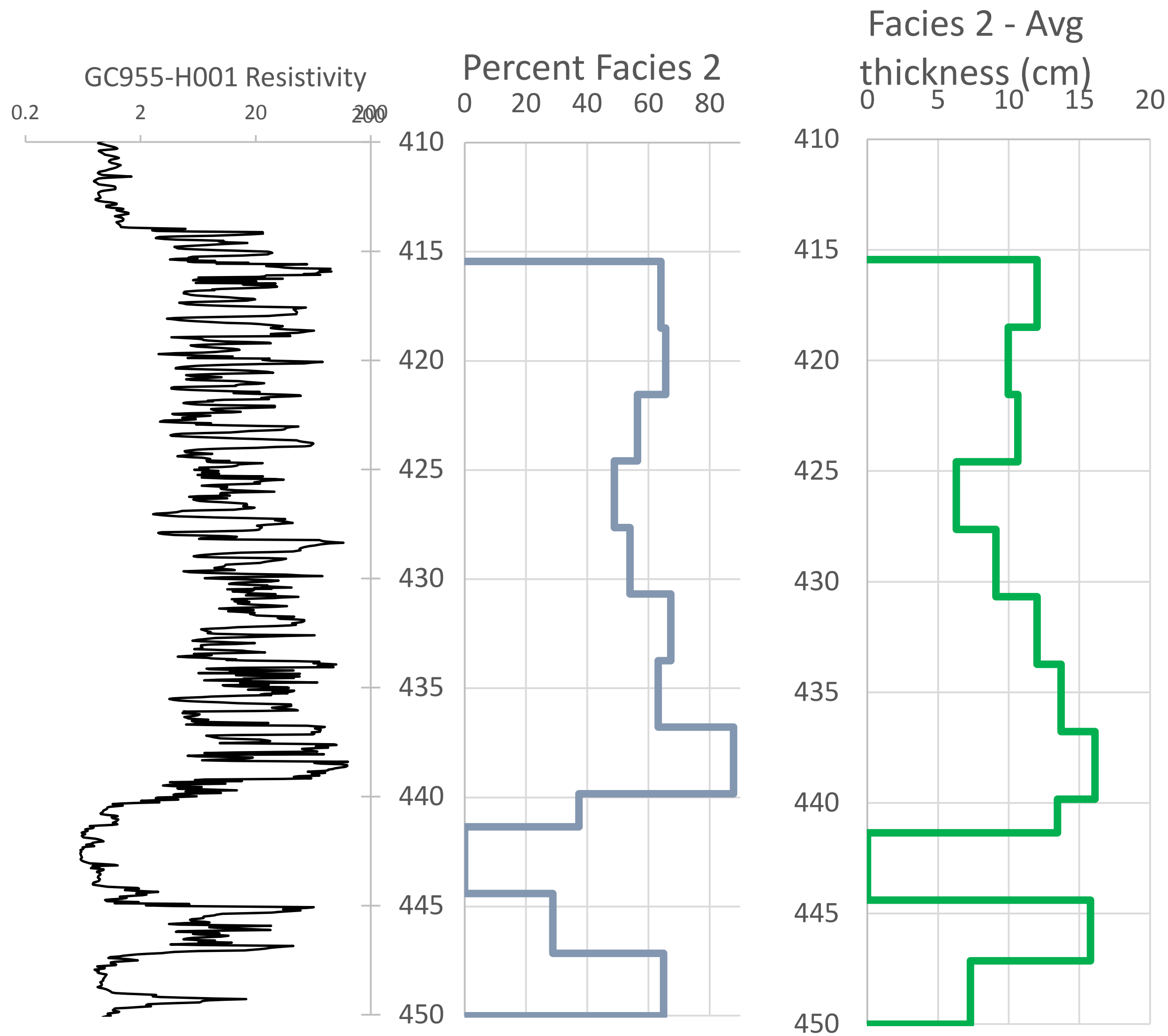






#3) Lithofacies Distribution

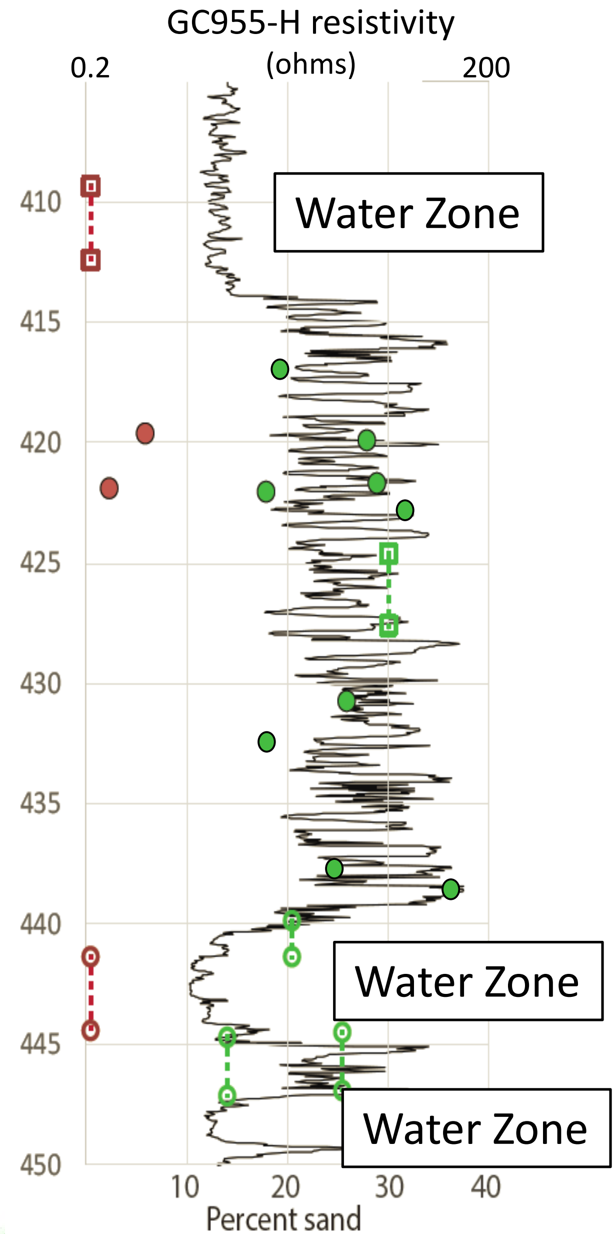
- Lithofacies 2 is dominant
- Thickness and percent of Lithofacies 2 increases downward



1/30/2018

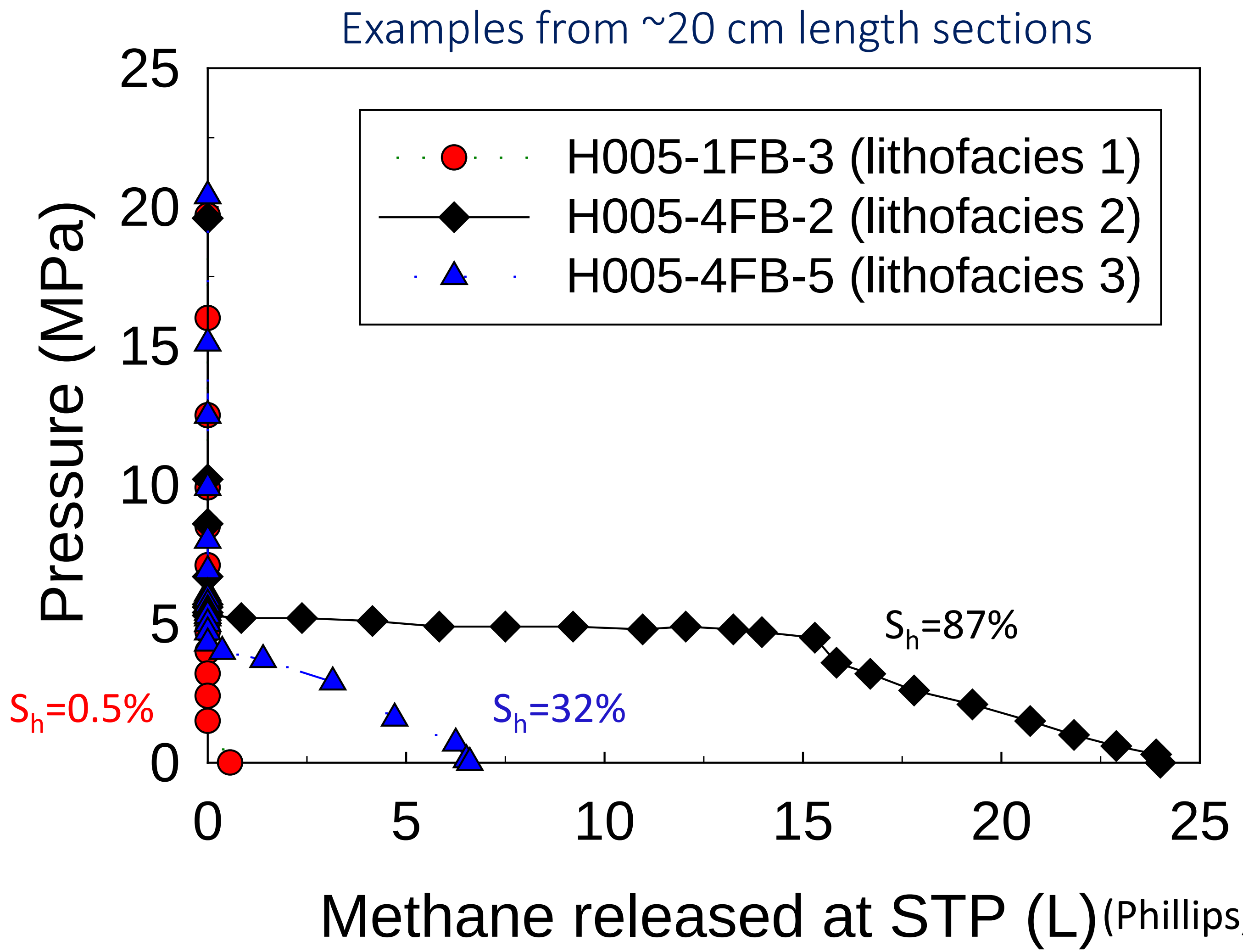
#4) Water Zones

- Slightly finer grained (<10% sand)
- Suggests lithologic control on hydrate distribution
- Alternative Interpretation:
    - o Sands washed away?



(Boswell et al. 2012)

#5) Hydrate Concentration (S_h)



(Phillips, GRC Poster)

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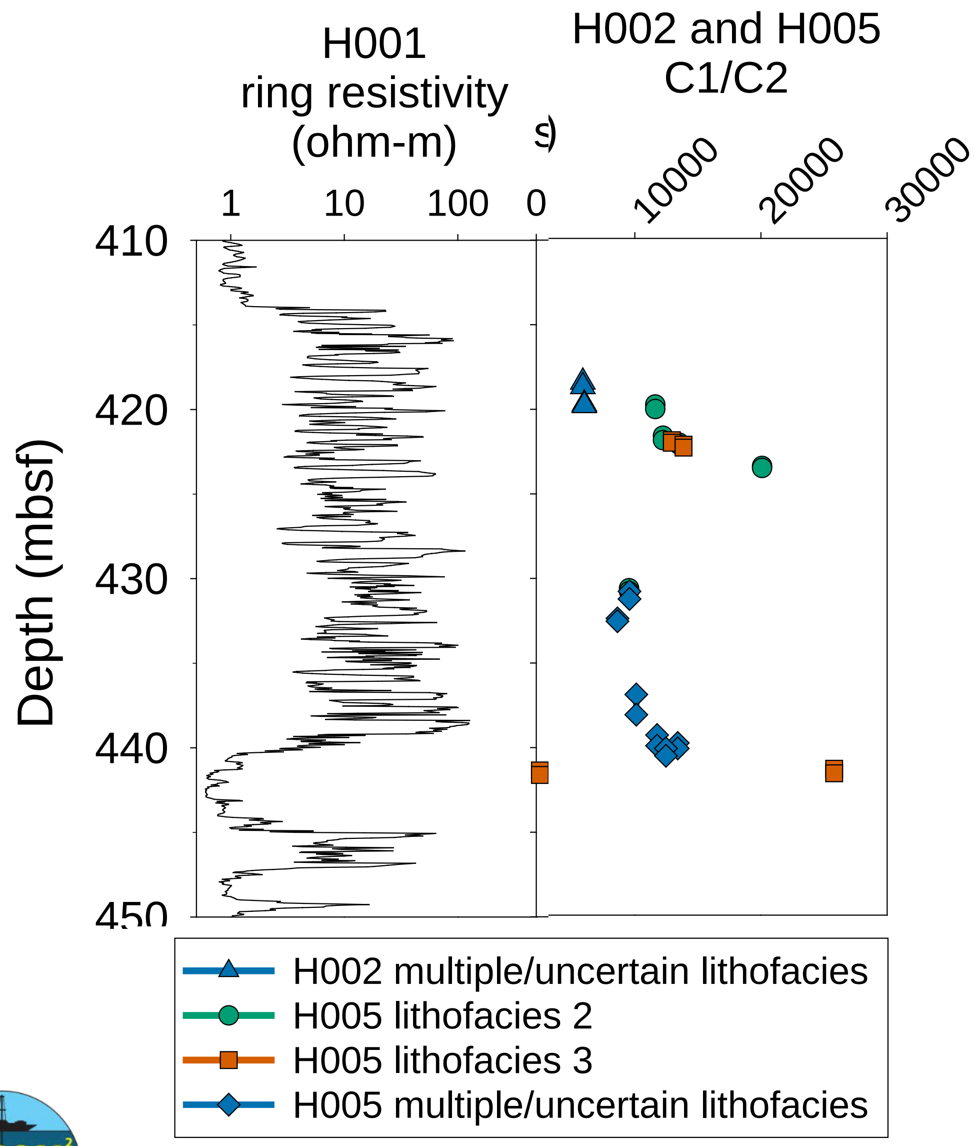
#5) Hydrate Concentration (S_h)

Core H005-04FB

Lithofacies 2 Lithofacies 3

Multiple posters this GRC on the stratigraphy and sedimentology of GC955

#6: Really Dry Gas

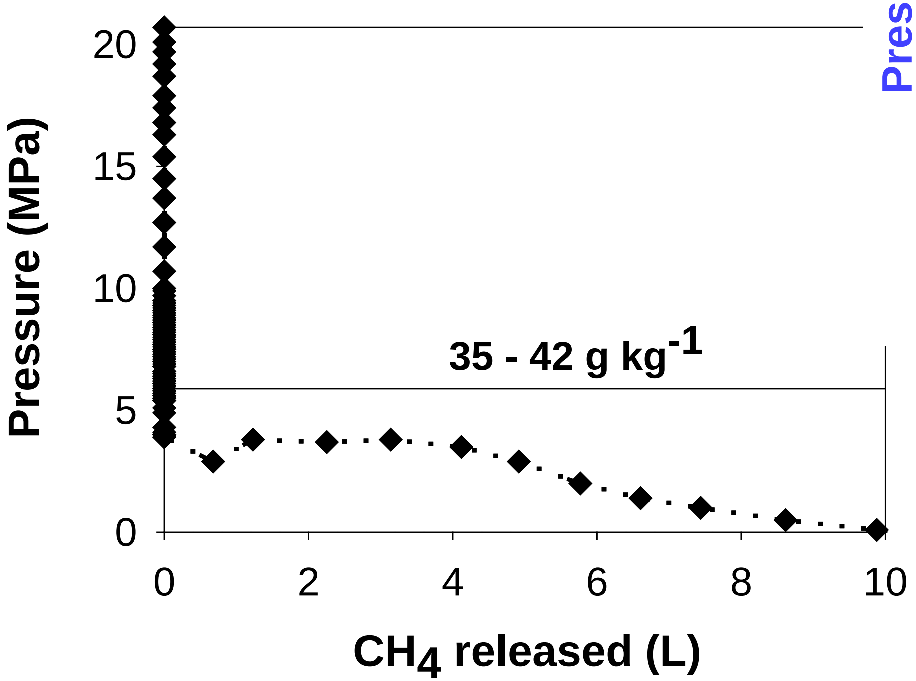


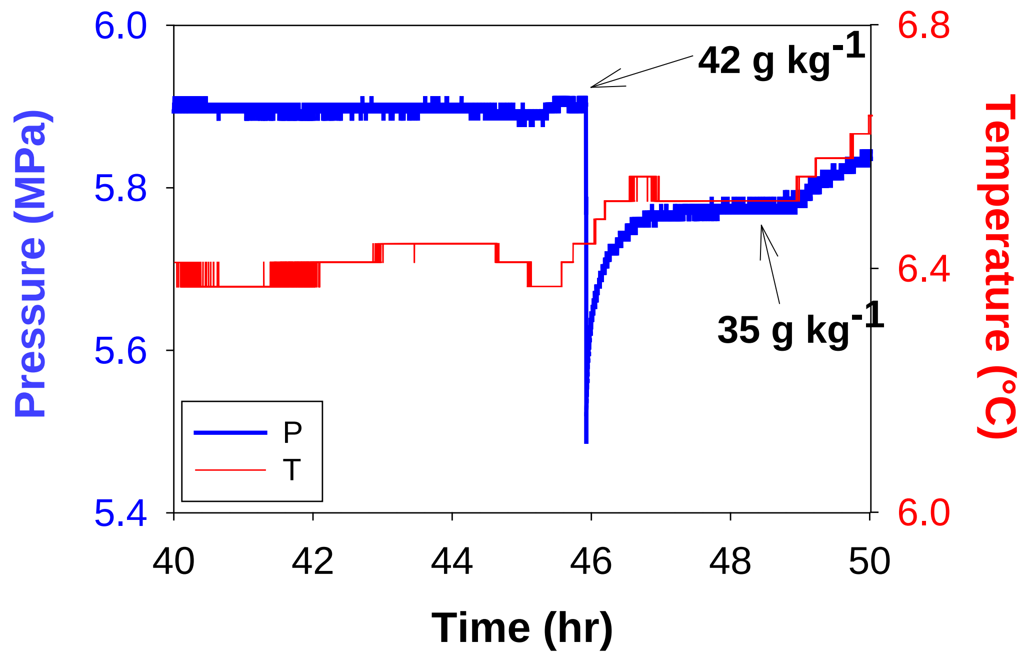
- Nearly pure methane
- Ethane < 200 ppm

Ongoing gas analyses

- Methane $\delta^{13}C$ and δD
- Noble gases
- Clumped methane isotopes $\Delta 18$

#7) In situ salinity is near seawater





Section H005-04FB-4
lithofacies 2

7 Insights

1. **Complex leveed channel deposition & deformation**
2. **Interbedded clayey silt and silty sand at cm to m scale.**
3. **‘Sand’ is ‘sandy silt’**
4. **Water Zones are finer-grained**
5. **90% hydrate saturation in silty sand; lithology controlled.**
6. **Really dry gas**
7. **In situ salinity is near seawater**

Highlights:

1. The U.S. is poised to make fundamental advances in understanding hydrate systems
2. We have spectacular cores in sand-rich hydrate reservoirs.
   a) Interbedded silty sand (~80% Sh) and clayey silt (~20% Sh)
   b) Gas composition virtually all methane
3. ~21 m pressure core subsampled and transferred at pressure to UT Austin
   a) The foundation of petrophysical and geochemical research across UT, the nation, and the globe.
4. UT GOM2-2 (IODP Exp. 387) scheduled for 2020

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Expedition Website – *Completed*

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

Content includes:

- Home Page with Executive Summary
- Participants
- Prospectus
- Expedition Report
- Protected Data Directory
- Sample Request Form and Instructions

Expedition Report Structure:

- Structured after the IODP Expedition Reports
- On-line Report includes
  - Preliminary Pages
  - Expedition Summary (Chapter 1)
  - Methods Chapter (Chapter 2)
  - Chapter on each hole (Chapter 3 &4)
    - Background and Objectives
    - Operations
    - Pressure Coring
    - Physical Properties and Core Transfer
    - Quantitative Degassing
    - Lithostratigraphy
    - Geochemistry
    - Wireline Logging

Released

To be Released in Oct

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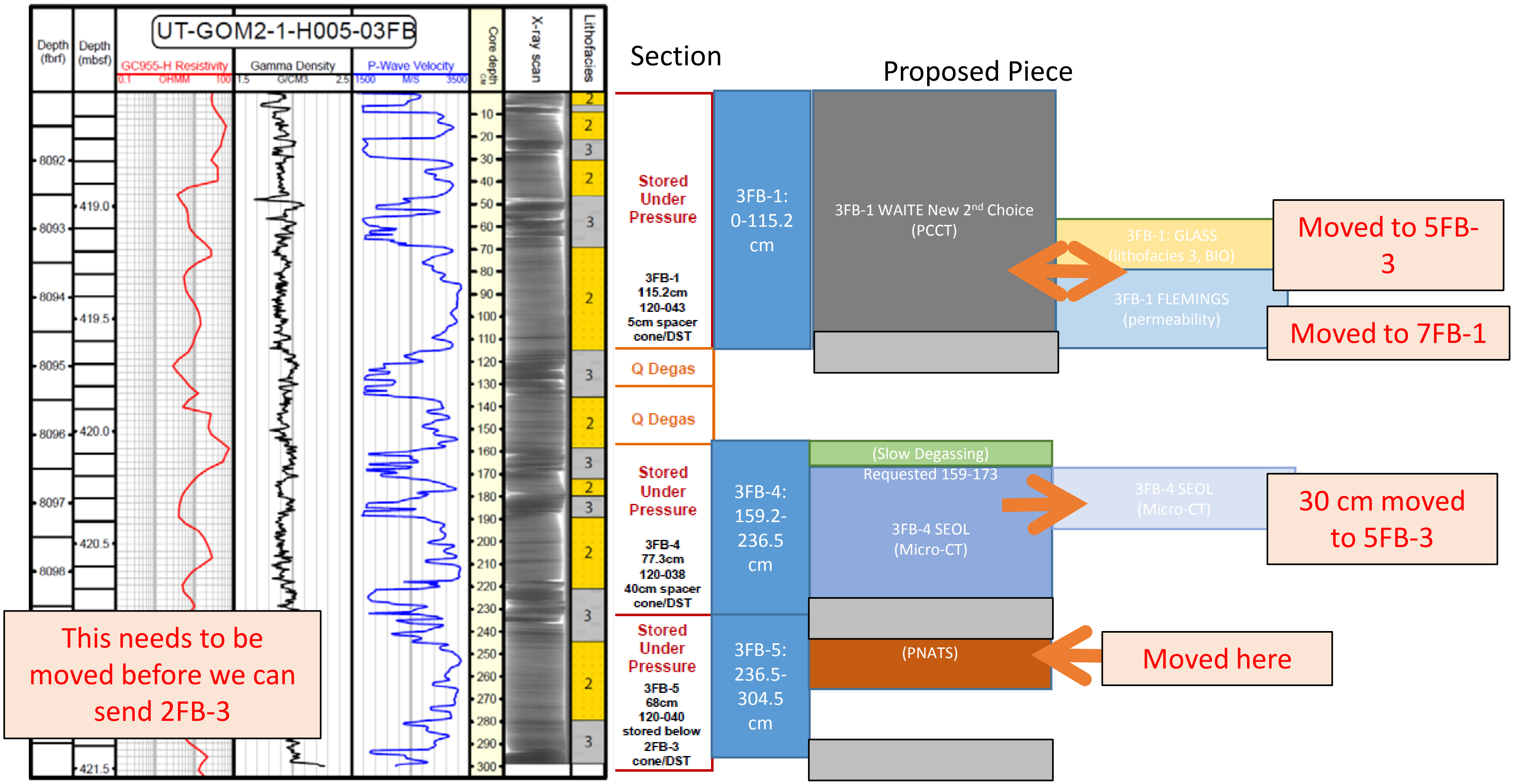
Next Steps:

1. Range of Experimental Work
    1. Permeability, compressibility, relative permeability
    2. Imaging at the microscale
    3. Chemical analysis
        1. Microbial vs. thermogenic source
        2. Fluid composition
2. Manage Sample distribution to other laboratories (NETL, USGS, AIST)
3. Publication Volumes
4. UT GOM2-2 (IODP Exp. 387) scheduled for 2020

Sample Distribution – 3FB

Allocation



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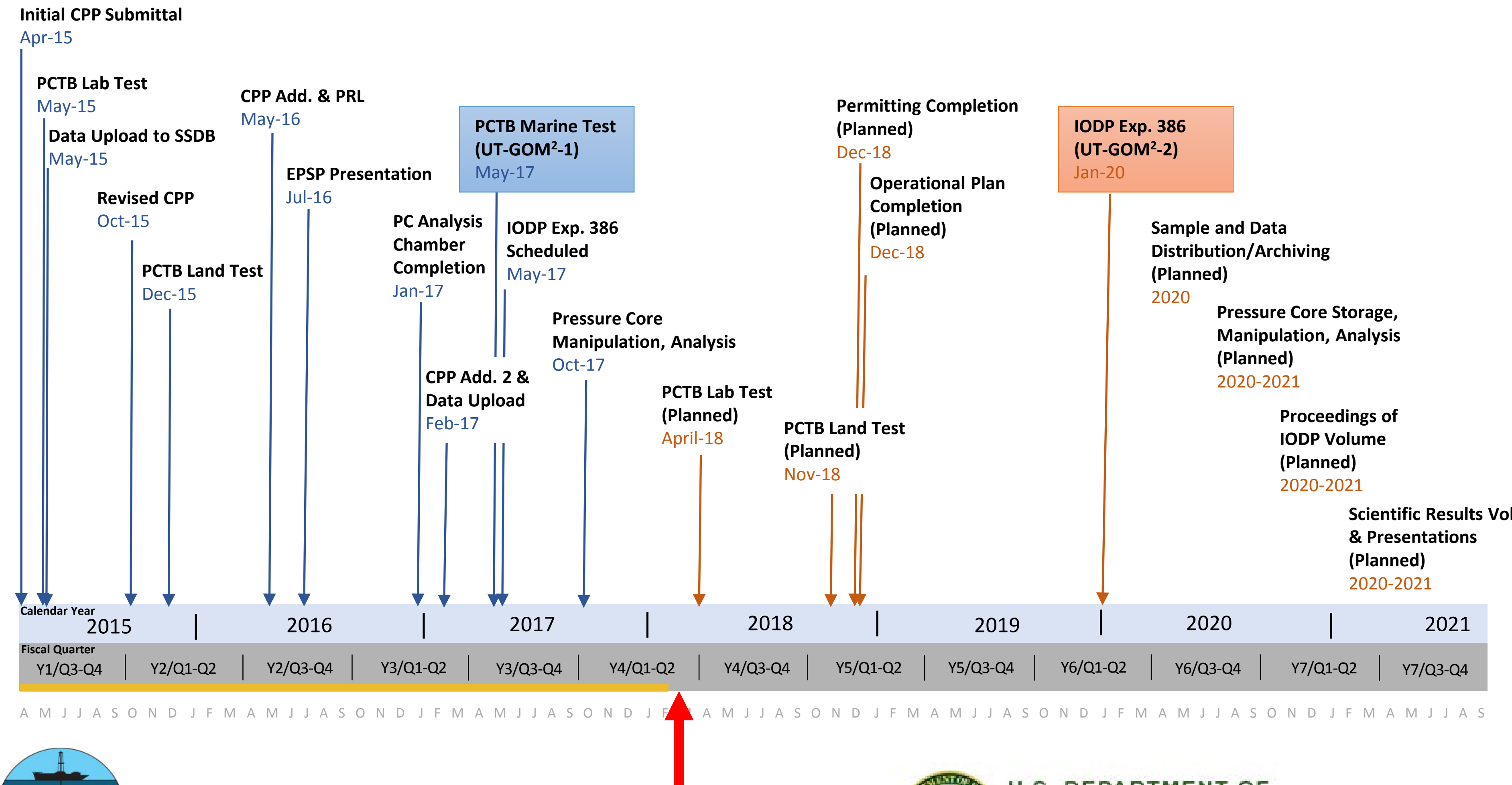
GOM^2 Project Timeline



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IODP Expedition 386: UT GOM^2-2

3 year effort thus far:

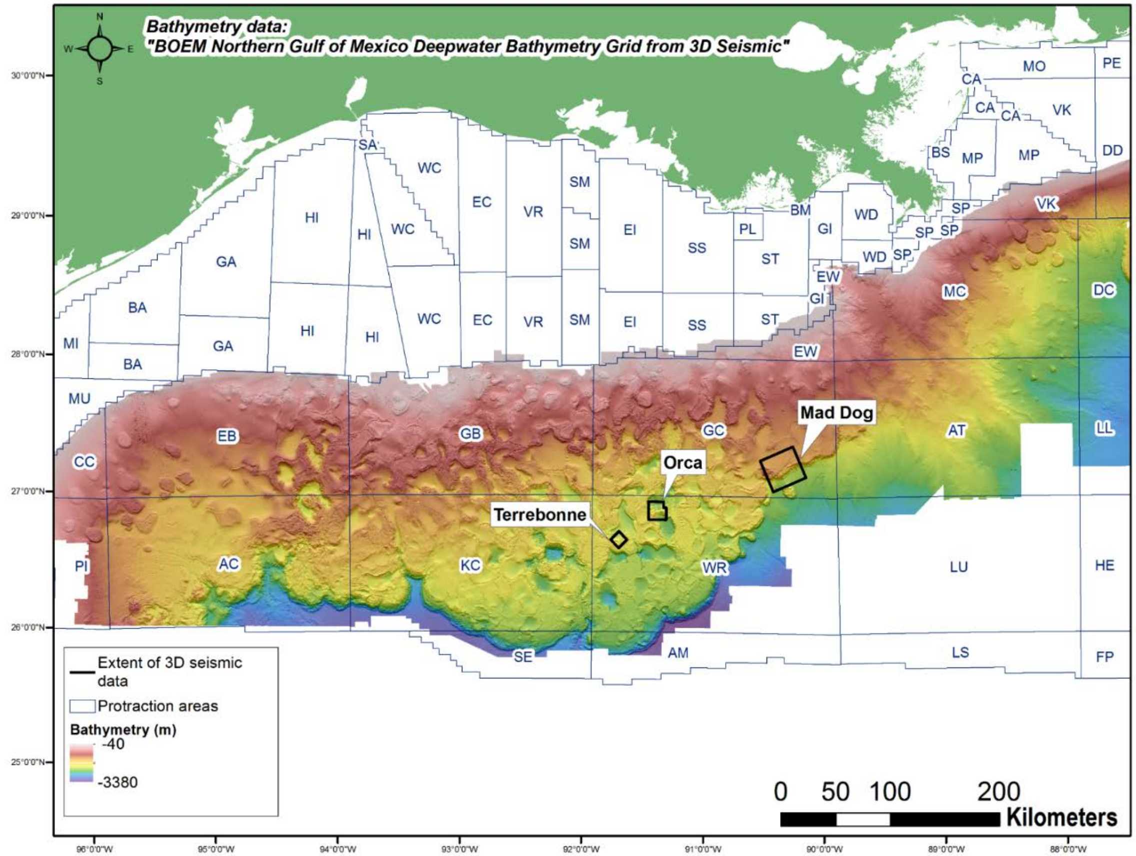
Phase 1 (~5 days): LWD Orca & Terrebone

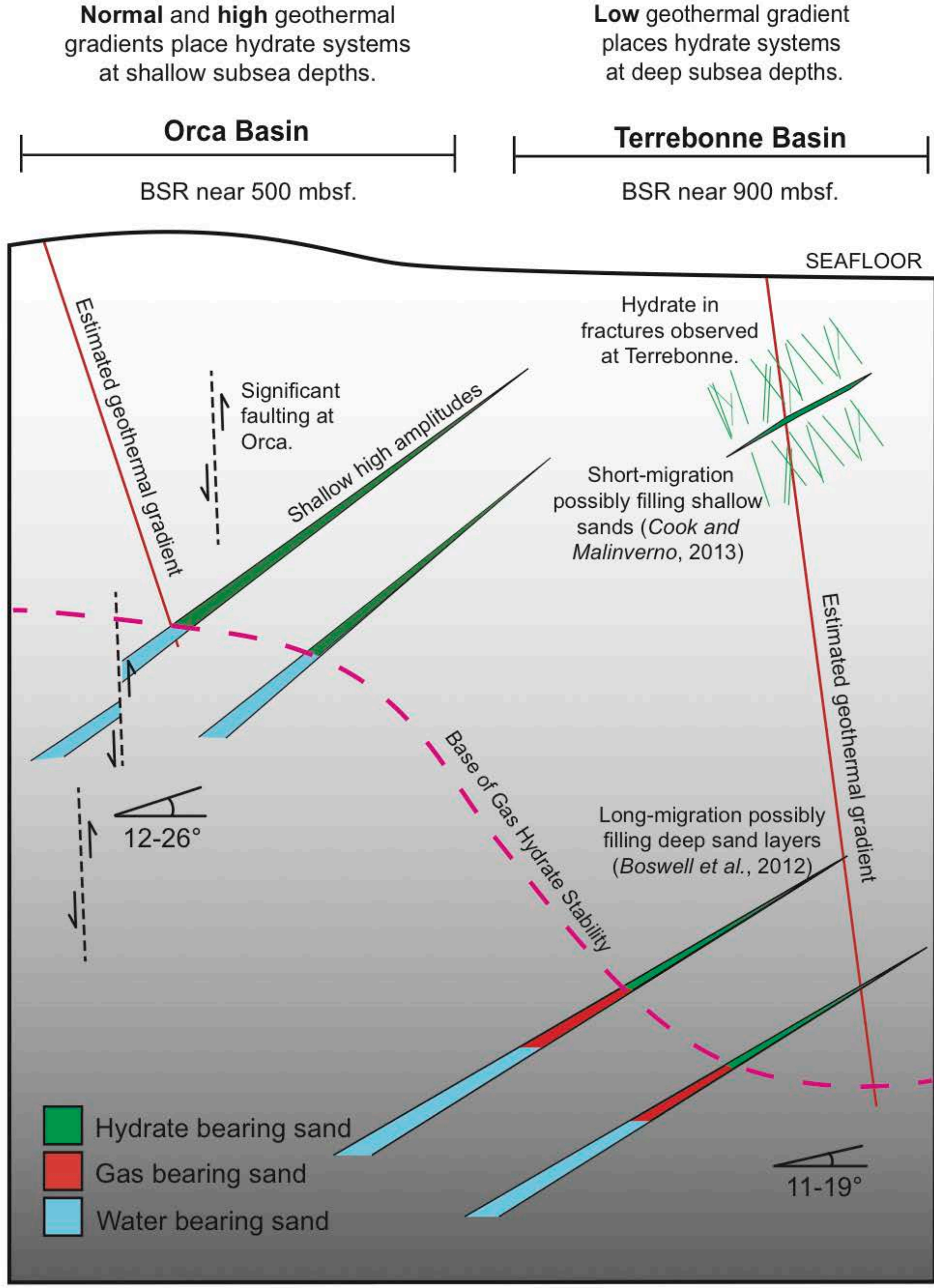
Phase 2 (~50 Days): Coring and Testing, Terrebonne

- Pressure coring
- Packer tests
- Conventional JR. Operations

21 January to 22 March 2020 (3 days "port call", 58 days at sea).
~10 day port call before this period for expedition load-out

http://iodp.tamu.edu/scienceops/index.html





SHALLOW REGIME

- Density of water-filled sands > marine muds
- Wet sands have positive acoustic impedance.
- Shallow microbial activity and diffusion may fill gas hydrate sand layers
- Lower pressure.
- Lower effective stress.
- Less competent seal.

DEEP REGIME

- Density of water-filled sands < marine muds.
- Wet sands have negative acoustic impedance.
- Thermogenic gas or biogenically recycled gas could fill gas hydrate sand layers
- Higher pressure.
- Higher effective stress.

Project Risks

- Vessel certification and permitting
- PCTB Performance