TEXAS Geosciences
The University of Texas at Austin
Jackson School of Geosciences
Institute for Geophysics

NATIONAL ENERGY TECHNOLOGY LABORATORY

U.S. DEPARTMENT OF ENERGY

Deepwater Methane Hydrate Characterization and Scientific Assessment

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The University of Texas at Austin

Lamont-Doherty Earth Observatory

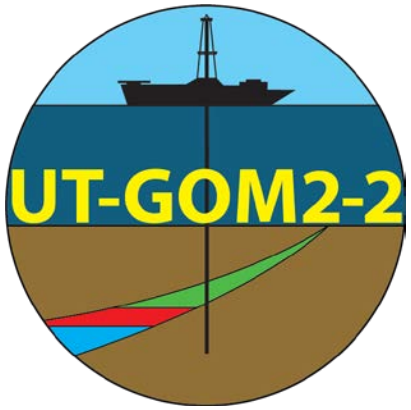
Oregon State University

The Ohio State University

University of New Hampshire

University of Washington

United States Geological Survey



U.S. Department of Energy

National Energy Technology Laboratory

Methane Hydrates Project Review Meeting

October 27, 2020

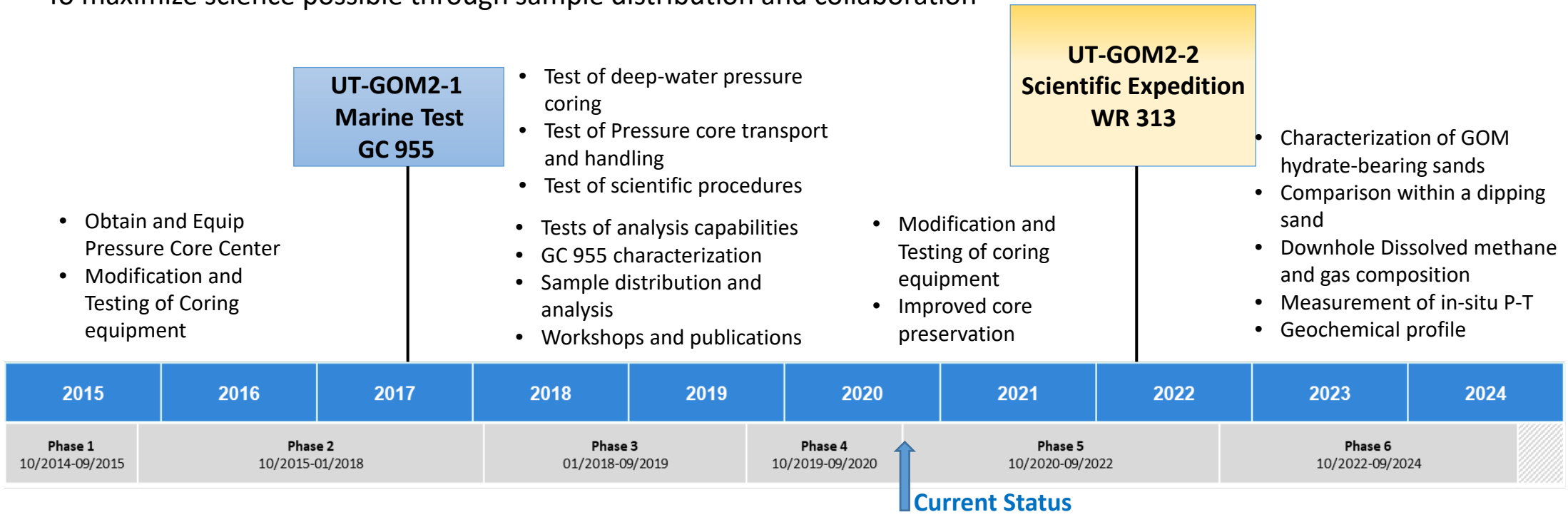
Presentation Outline

1. Introduction
2. UT-GOM2-1 Marine Test
3. Pressure Coring – Core Handling Technology
4. UT-GOM2-2 Science Expedition

Deepwater Methane Hydrate Characterization and Scientific Assessment (DE-FE0023919)

GOM2 Objectives

- 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

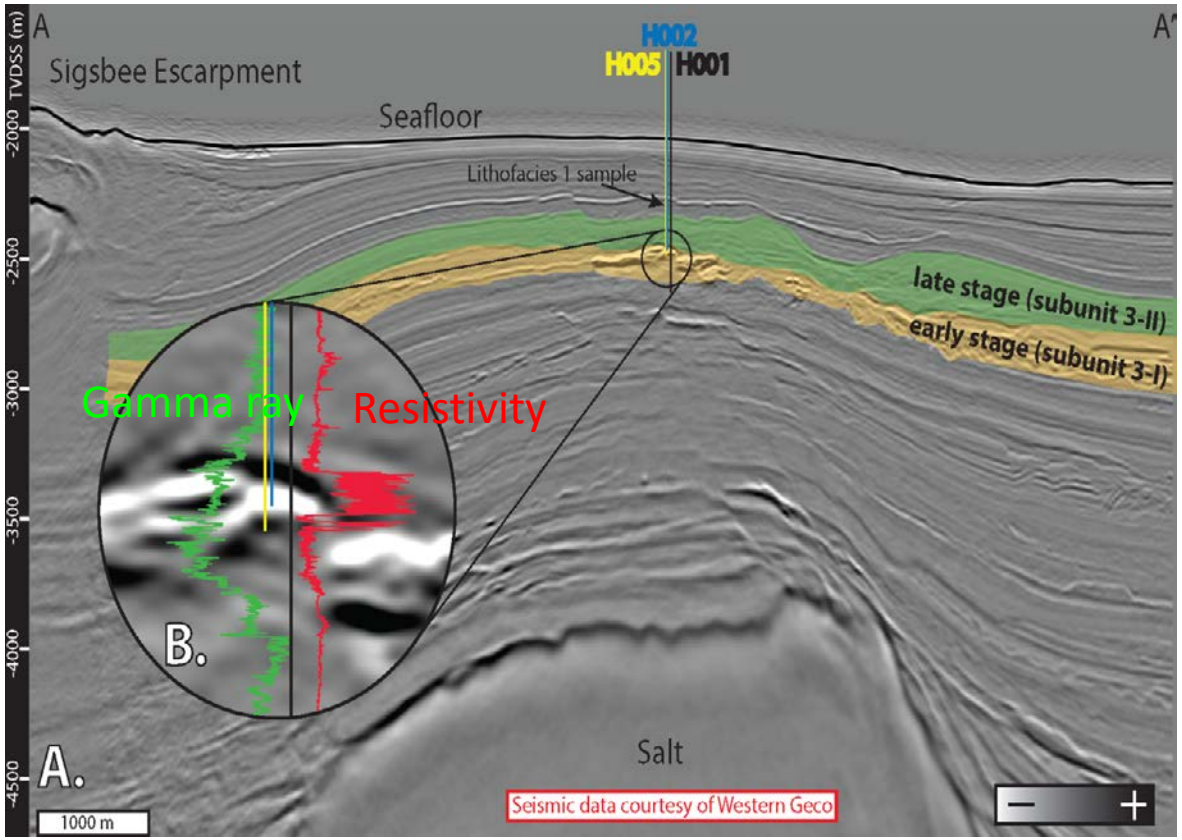


Accomplishments

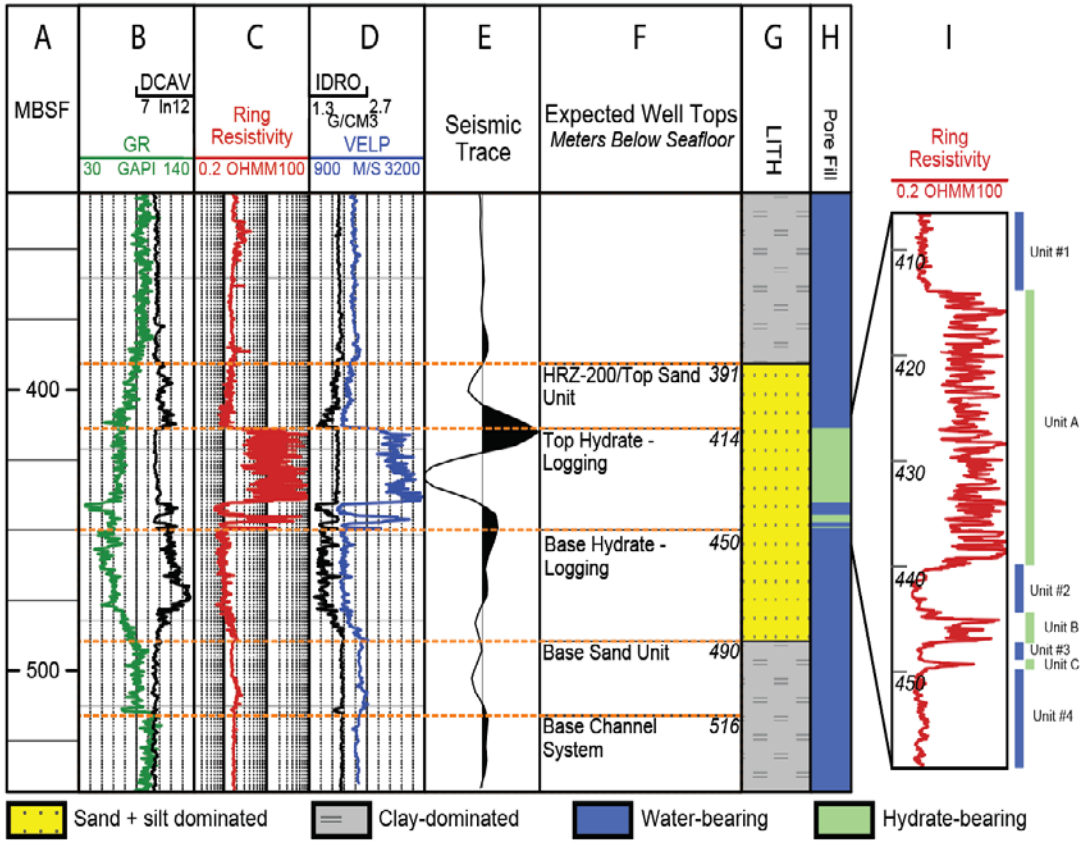
- Successful Field Execution: GOM2-1
- Linked 7 universities, DOE, BOEM, USGS
- Viable, and improving, pressure coring technology
- Fundamental contributions in characterization, laboratory analysis, and modeling
- Dedicated volume summarizing our findings at GC 955
- International research collaboration on analyses of pressure core samples

AAPG Bulletin, Vol. 104 Number 9, Sept 2020

2. UT-GOM2-1, 2017: ‘Marine Test’



Meazell et al., 2020, AAPG Bulletin 104, 9

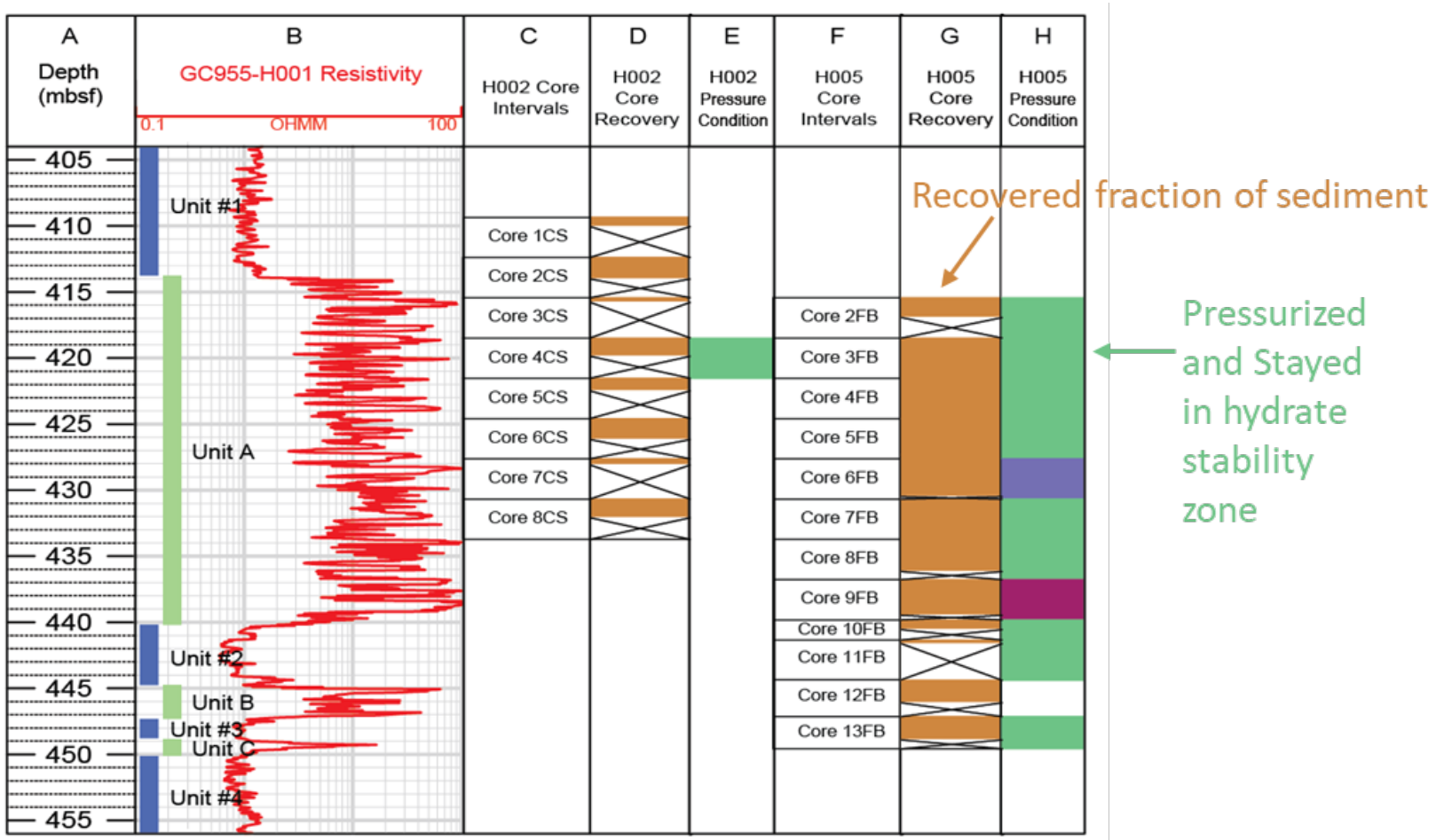


Flemings et al., 2020, AAPG Bulletin 104, 9

UT-GOM2-1 Technical Achievements and Scope

Successes

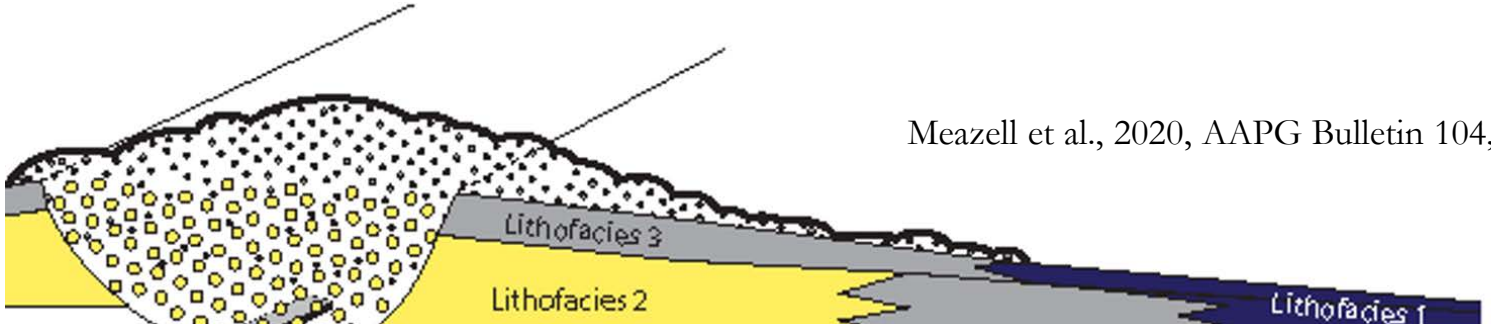
- 12 successful PCTB deployments
- 25.6 m of recovered pressure core
- ~21 m preserved and transported to UT Austin



(Flemings et al., 2020, AAPG)

UT-GOM2-1 Science Achievements

- Characterized the GC 955 hydrate reservoir
- Depositional model (Meazell 2020 et al. ; Santra et al., 2020)



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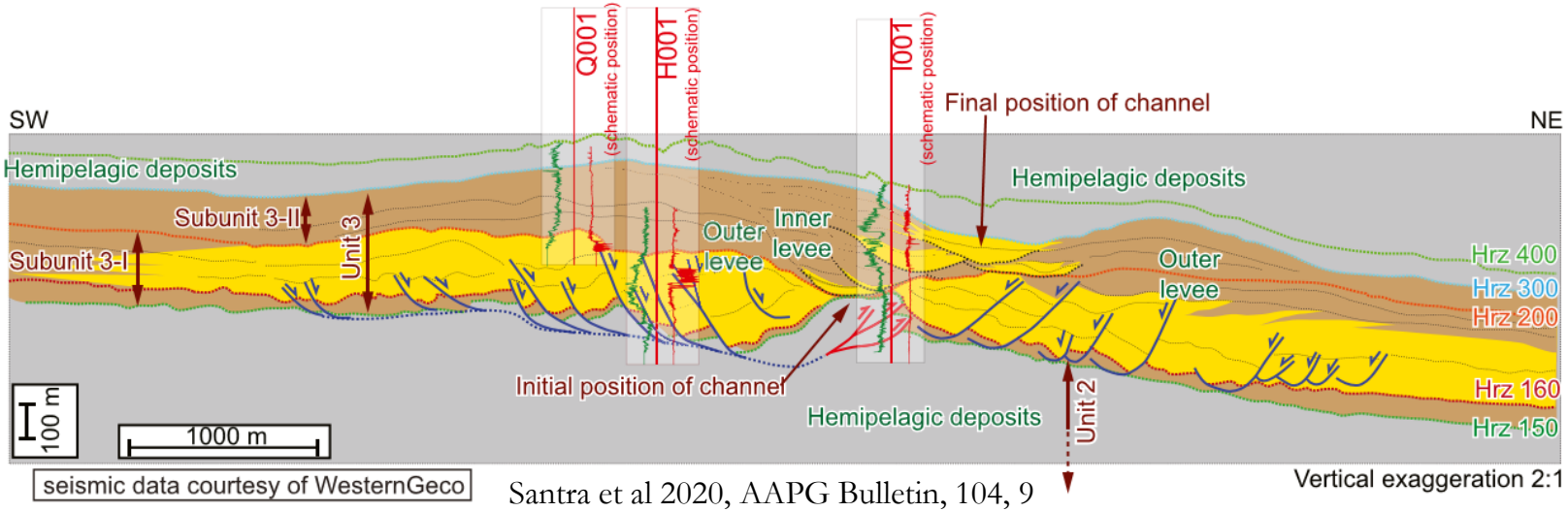
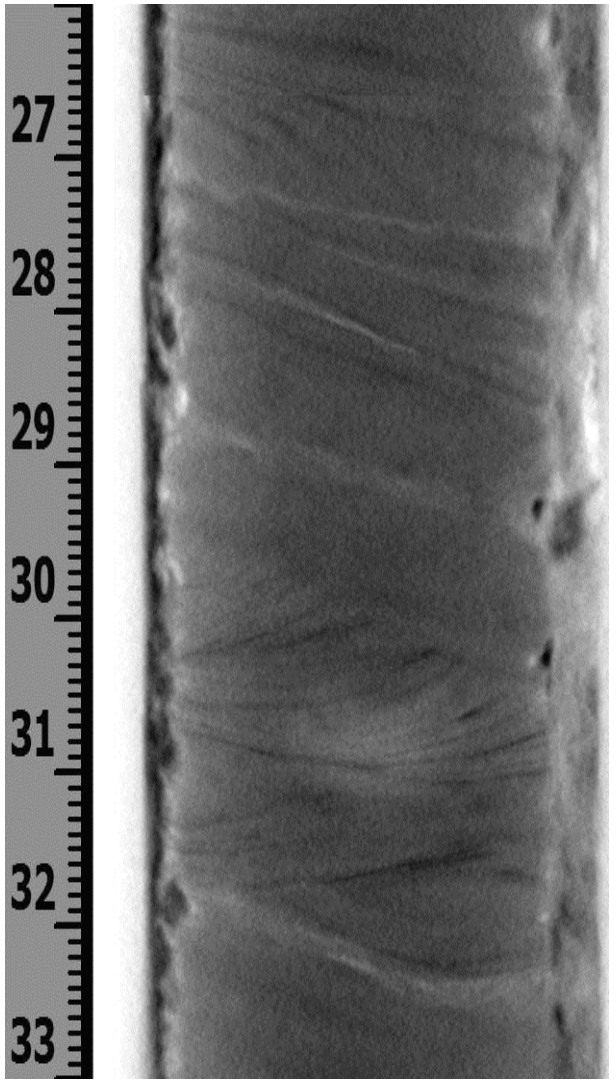
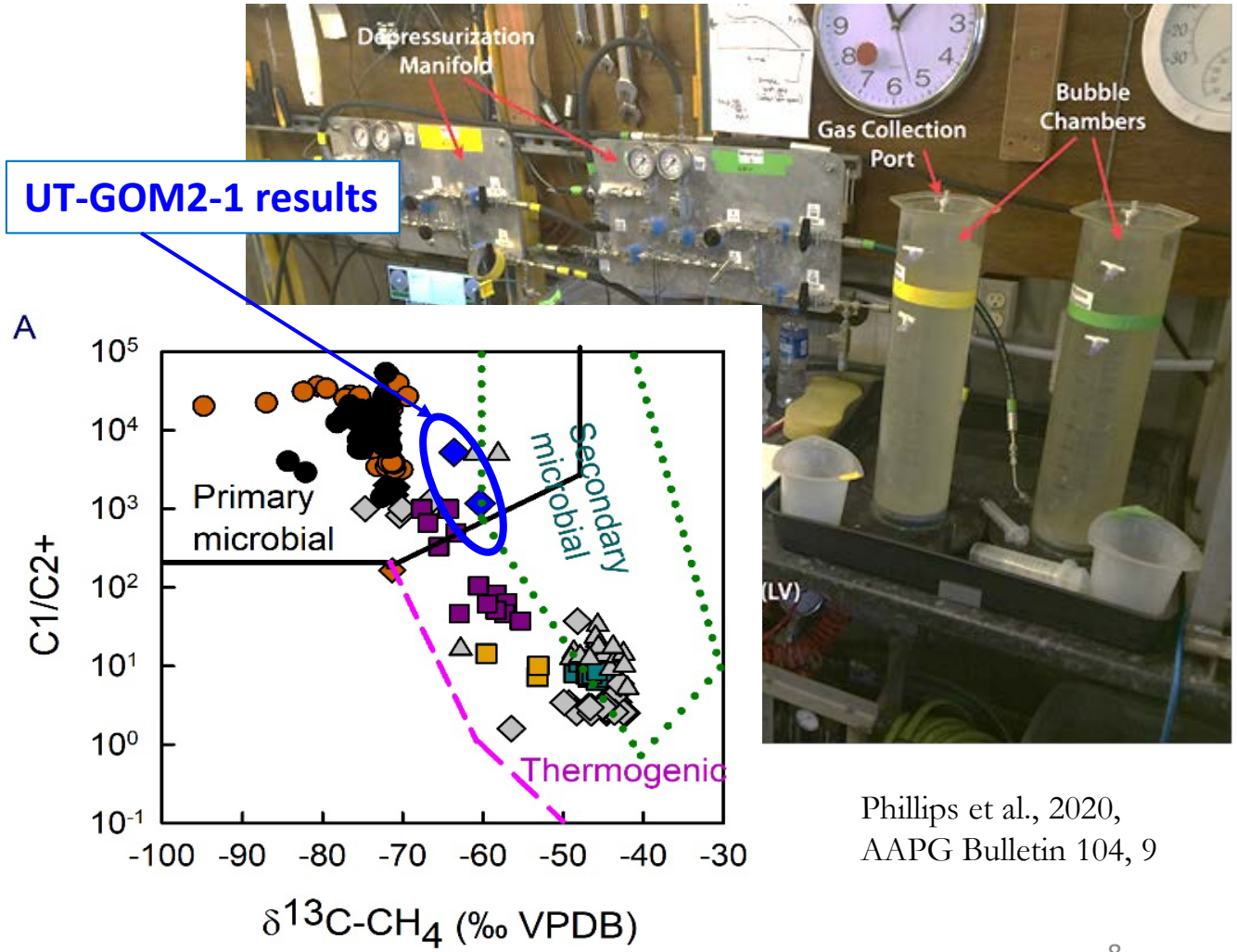


Santra et al 2020, AAPG Bulletin, 104, 9



UT-GOM2-1 Science Achievements

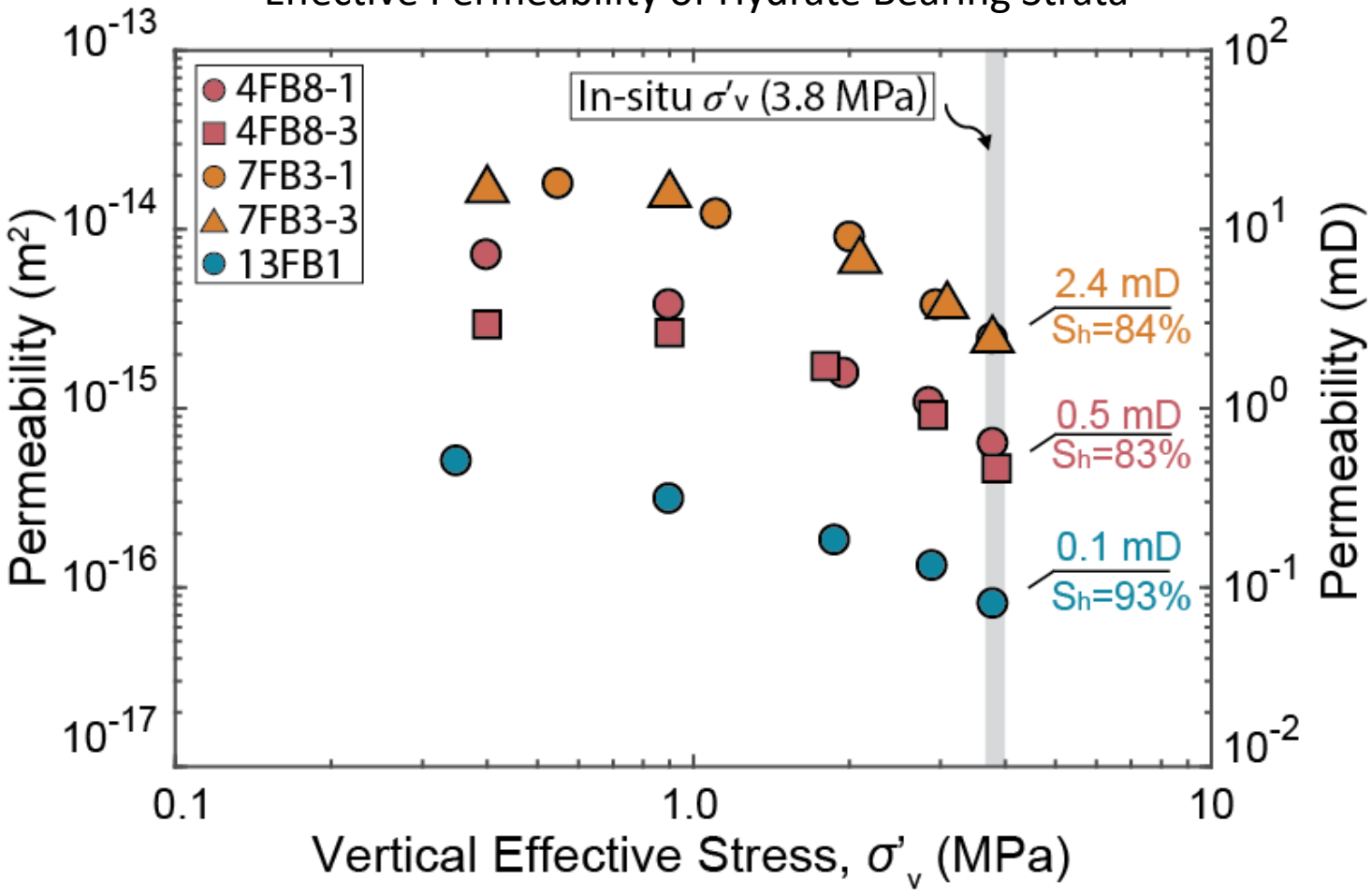
- Characterized Hydrate Concentration
  - 90% of sandy silt pore space is filled with hydrate
  - Water of seawater salinity
- Gas interpreted to be biogenic (microbial) in origin with possible trace thermogenic



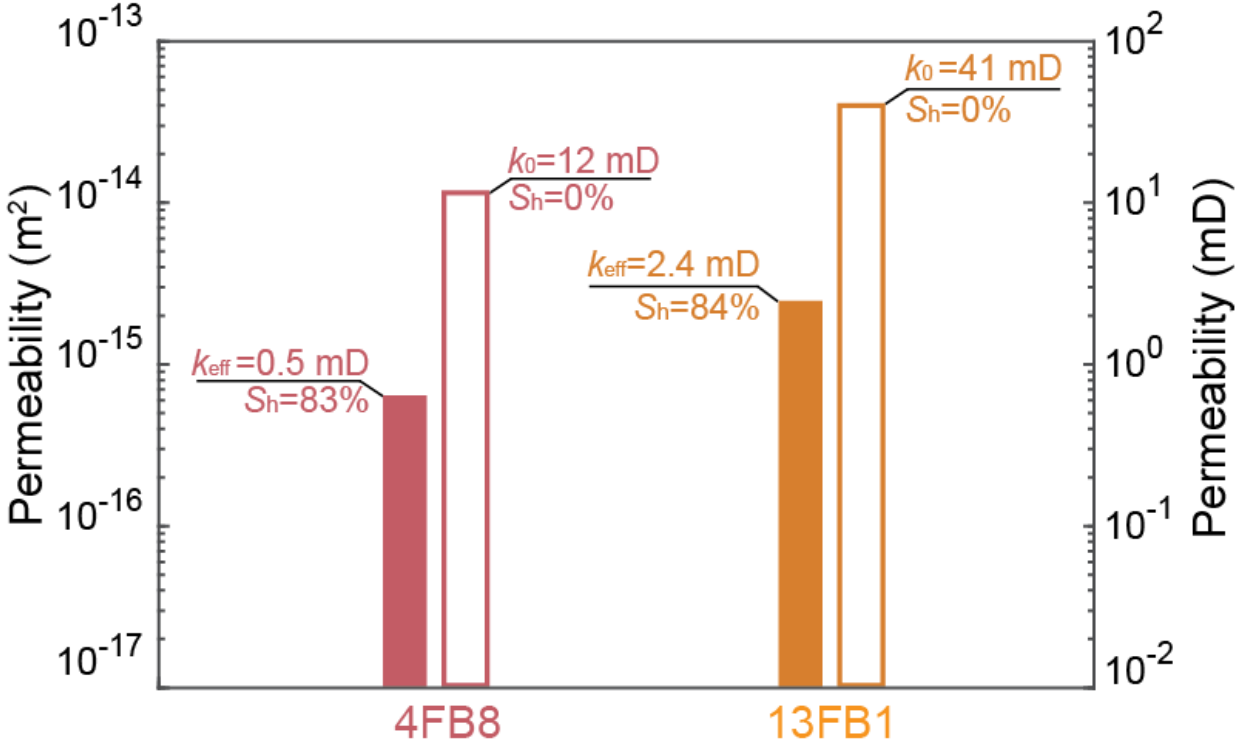
Phillips et al., 2020, AAPG Bulletin 104, 9

UT-GOM2-1 Science Achievements

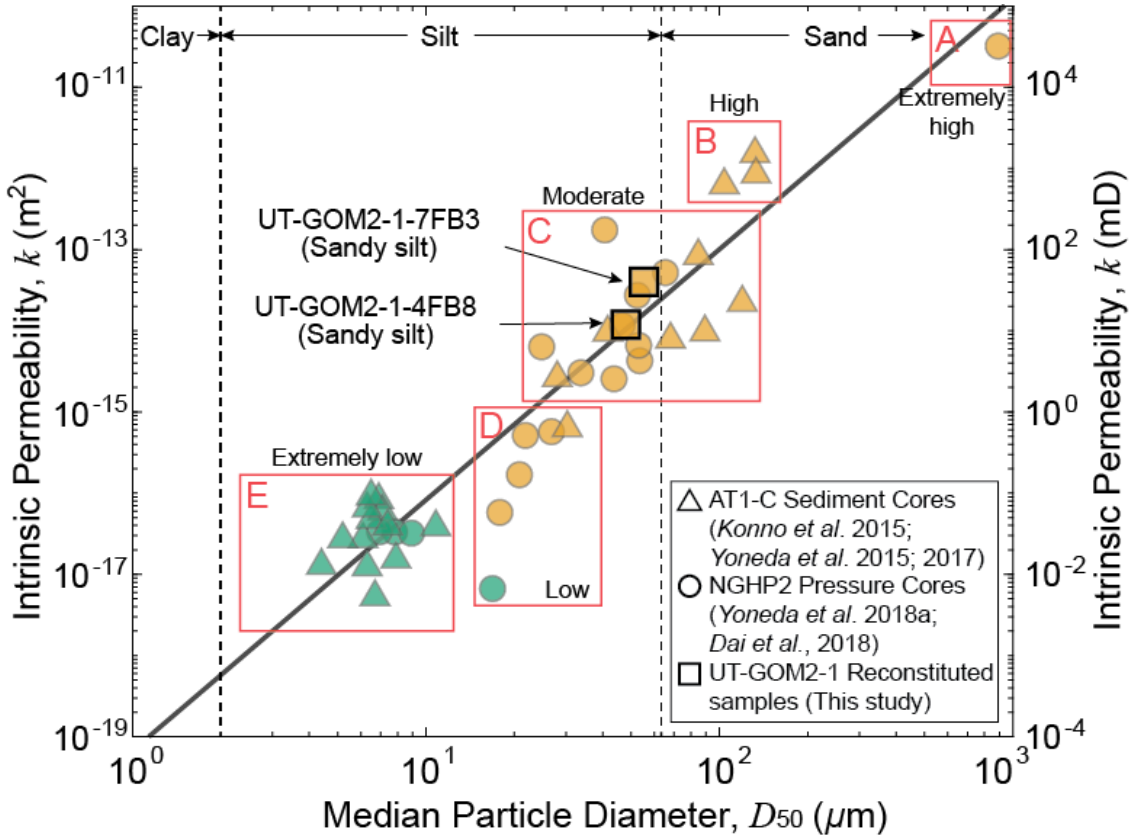
Effective Permeability of Hydrate Bearing Strata



UT-GOM2-1 Science Achievements



Intrinsic permeability is about 20-fold larger than its effective permeability at in-situ effective stress

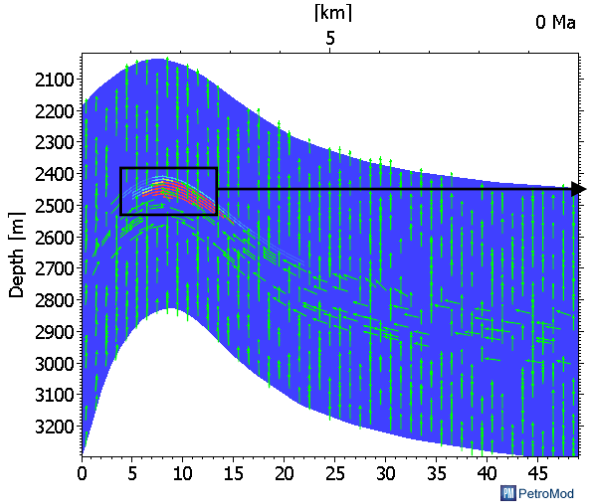


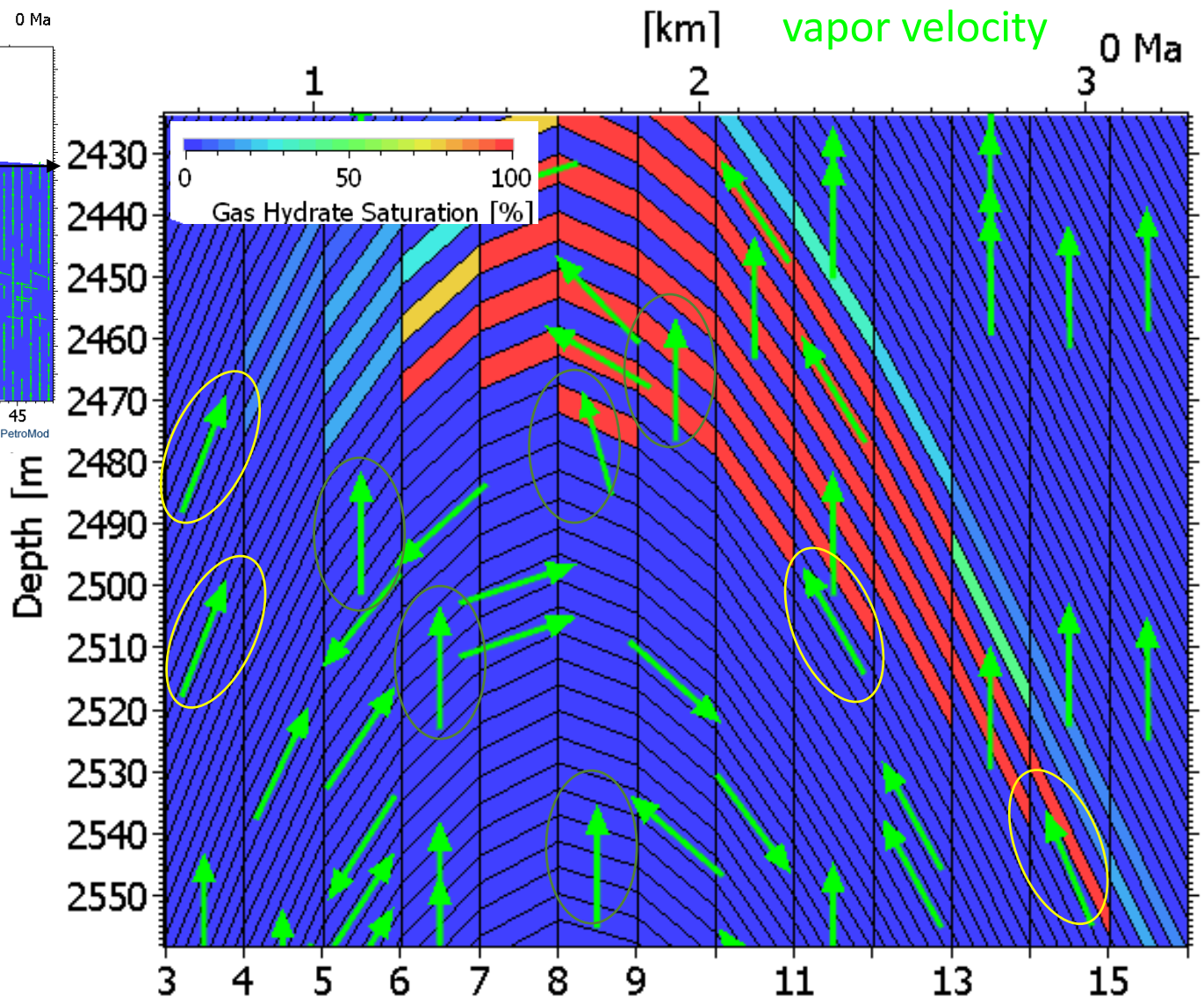
(Fang et al., 2020)

GC 955 Reservoir has 'Moderate' permeability relative to other hydrate reservoirs.

UT-GOM2-1 Science Achievements

Green arrows:
vapor velocity





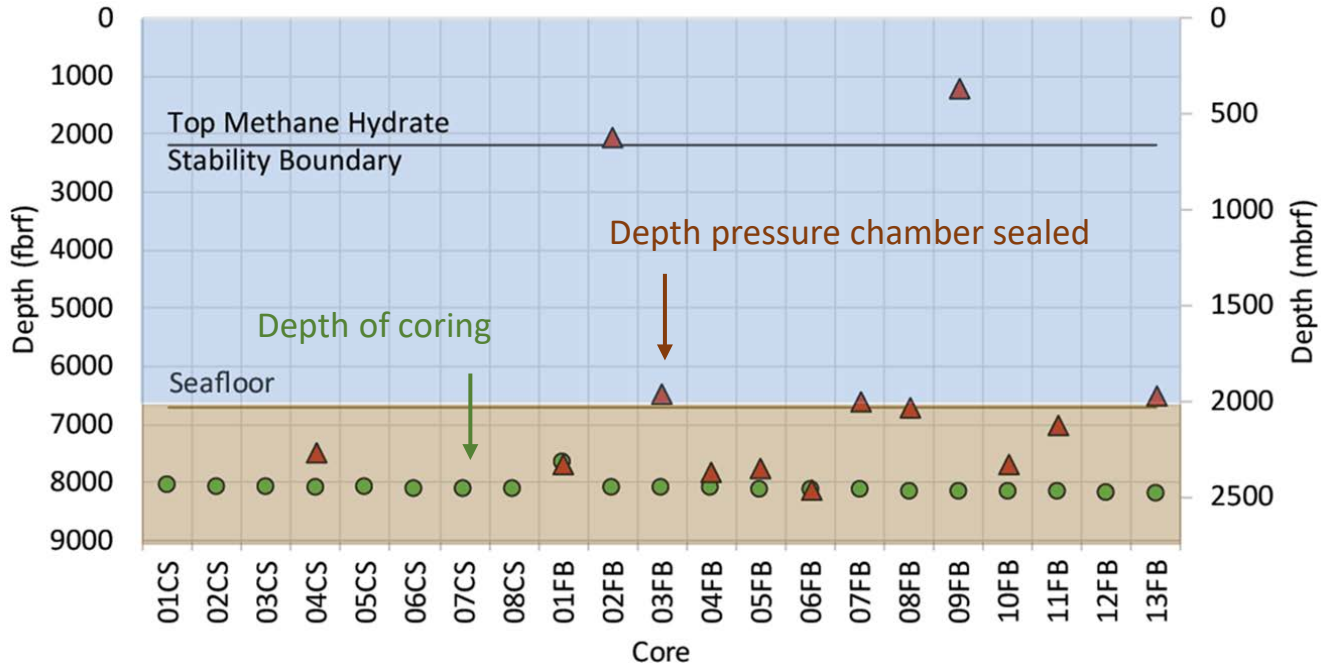
Genesis of
Hydrate Reservoir

- Methane generated microbially by burial of organic rich mud.
- Methane as free gas is transported into structural closures where sandy silt reservoir is present
- Forms concentrated methane hydrate

3. Pressure Coring & Core Handling Technology

- PCTB used in a variety of international programs
- During UT-GOM2-1
  - 7 runs failed
  - 9 runs sealed late
- Fundamental goal:

Improve performance of this tool.



AUMANN & ASSOCIATES

Chevron

GEO TEK CORING

PETTIGREW ENGINEERING

USGS

U.S. DEPARTMENT OF ENERGY

Incremental Improvements to Pressure Coring Technology

- Improved ability to core at higher flow rates (allows better tool performance).
- Improved sealing at top of tool.
- Tested tool at Land Test Site (Spring 2020) and demonstrated ball valve does not seal consistently.
- Developed ability to document failure mechanism in Geotek test facility.
- Now developing solutions to poor sealing.

PCTB Land Test II (March 2020)

<u>7 PCTB tests were performed at Schlumberger CTTF</u>:

- Core recovery in indurated rocks vastly improved
  - ➢ Core recovery and quality were excellent, generally 80% or higher

Core CTTF-02FB contained 8.9 ft of limestone and shale after recovery

PCTB Land Test II (March 2020)

<u>7 PCTB tests were performed at Schlumberger CTTF</u>:

- Sealing still problematic
  - In 6 out of 7 coring tests, the ball valve only partially closed and no increase in pressure was recorded.
  - We interpreted that drilling fluid and entrained cuttings are wedging between the outer housing and the seal carrier jamming the seal carrier which drives the ball.

CTTF-O3CS: Ball-valve visibly jammed open upon recovery of tool

CTTF-O1FB: Ball-valve closed upon recovery of tool

Developed Testing Facility with GeoTek at Salt Lake

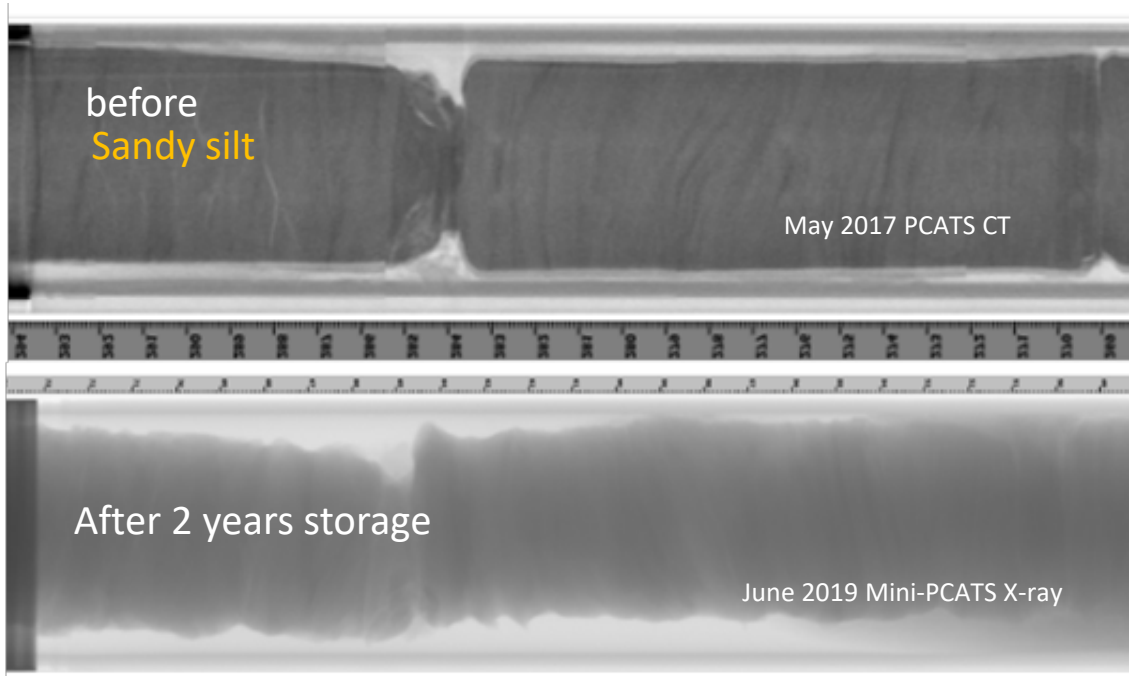
PCTB Mk 4

*Successfully reproduced failure mechanism using a range of grain sizes of sediment.

- Now implementing incremental technology improvements to overcome failure mechanism.
- We have gone from 100% failure to roughly 75% success in the bench test.
- Goal is to further improve performance and then return to field test.

Developing Better Core Storage

- Hydrate-bearing pressure cores must be preserved for years for experimental programs.
- Significant core degradation is occurring in storage
- Degradation roughly equal to the amount of methane that can be dissolved into storage fluid
- Developing mechanisms to keep bulk of storage fluid away from the cores
- Determining if and how we can replace or dope storage fluid to prevent hydrate loss.

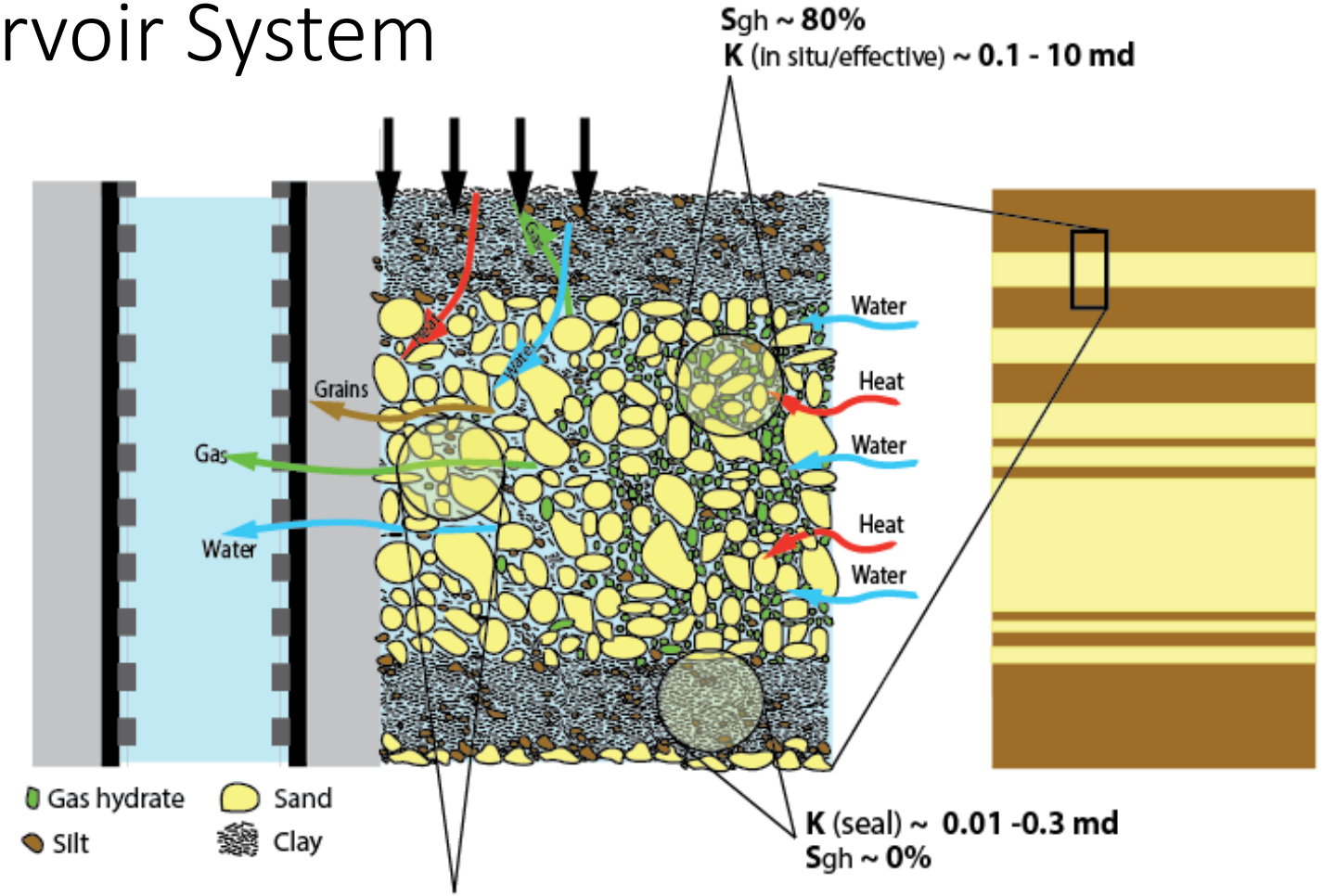


4. UT-GOM2-2 Science Expedition SCIENCE OBJECTIVES

6 Specific objectives all contribute to reservoir and basin systems understanding of WR313

1. Characterize the primary and secondary hydrate reservoirs and their bounding units (**Orange Sand**, and **Upper Blue Sand**, respectively).
2. Contrast hydrate reservoir properties at different structural levels within a dipping sand (**Upper 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

UT-GOM2-2 Science Objectives
Reservoir System

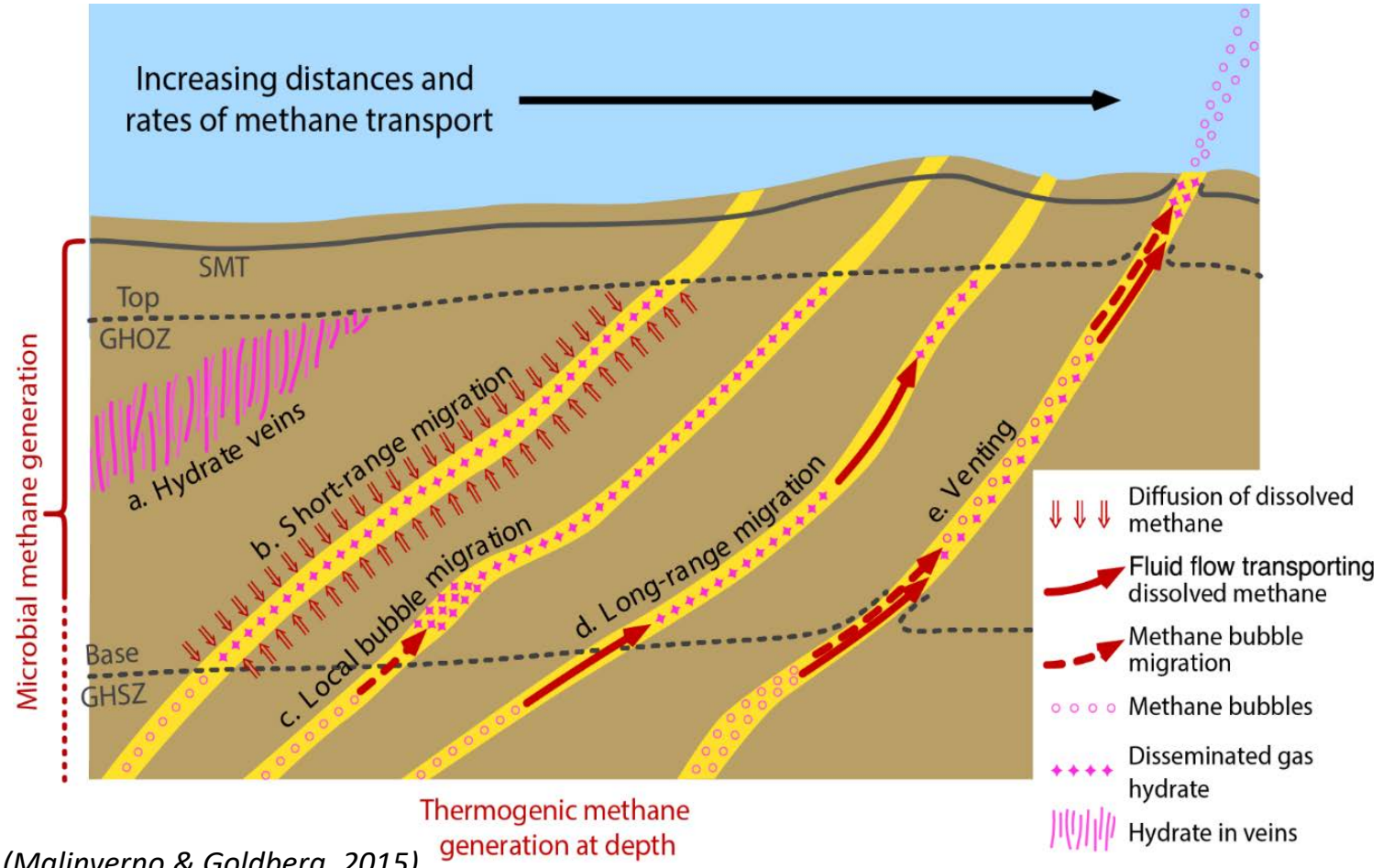


Modified from Boswell and Collet 2016

Steps:

- Obtain pressure core
- Determine hydrate concentration, gas composition, age, sediment texture, pore water chemistry
- Determine permeability, compression, capillary behavior, strength
- Elucidate reservoir production behavior to inform reservoir simulation

UT-GOM2-2 Science Objectives
Basin System

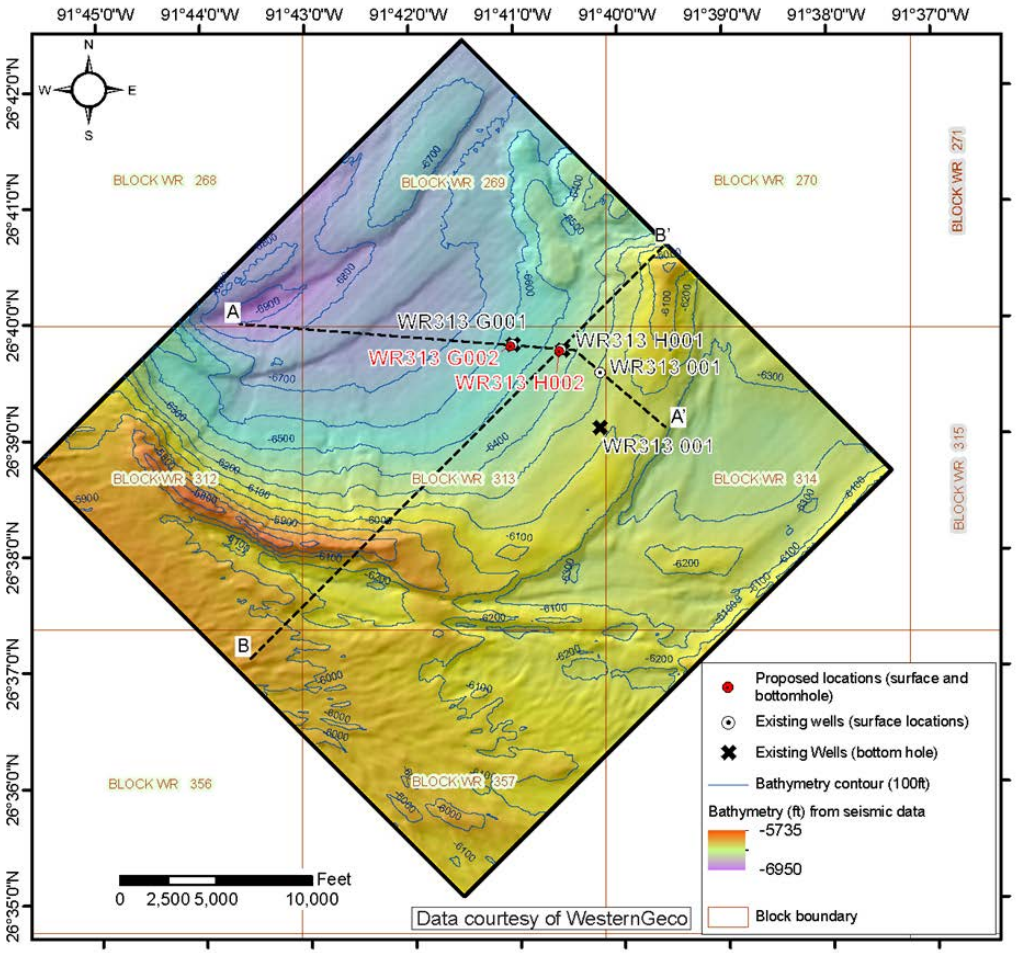


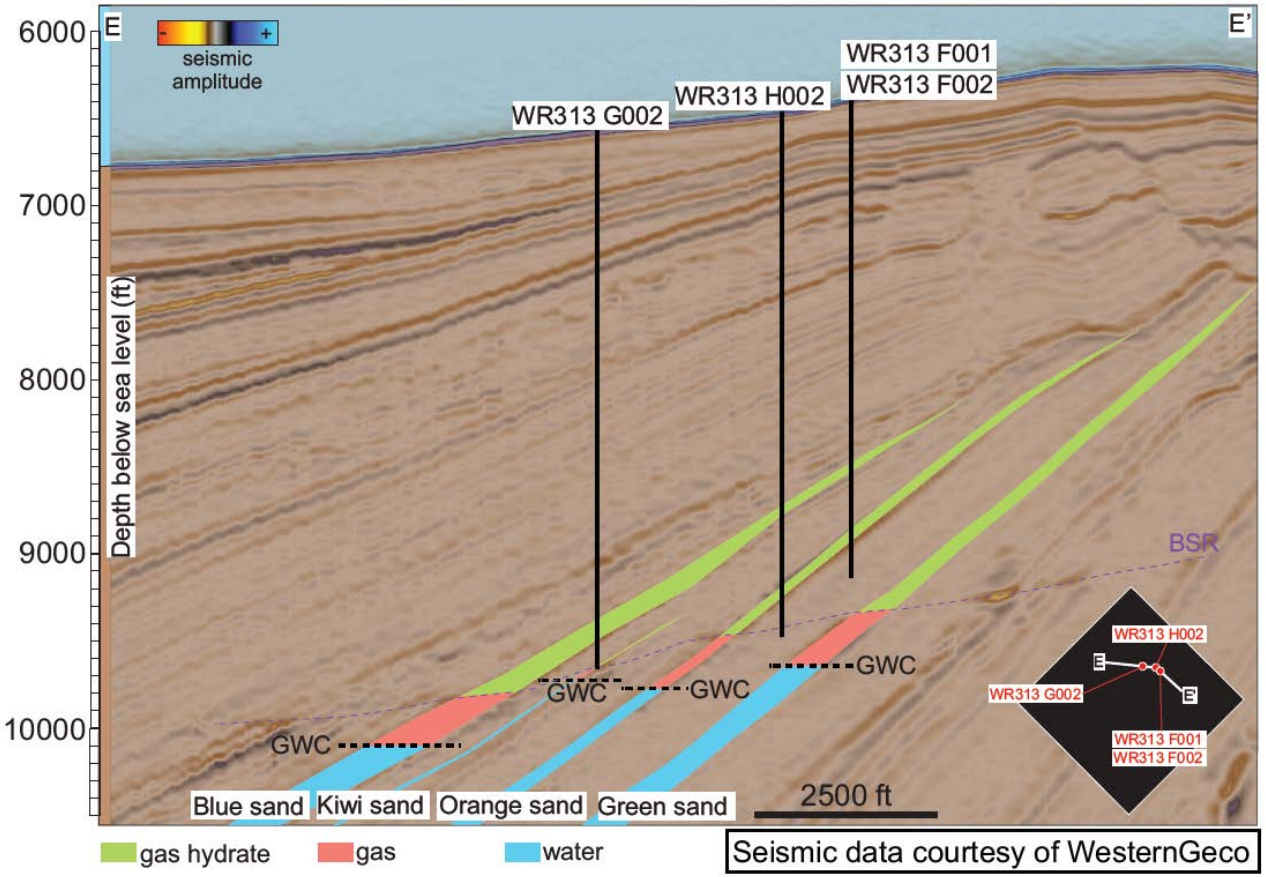
(Malinverno & Goldberg, 2015)

Steps:

- Collect sediment (some at in situ conditions), gas, and pore water samples, pressure and temperature with depth
- Characterize dissolved methane/hydrate concentration, gas molecular composition (microbial source), pore water geochemistry and sedimentology, variation in organic carbon with depth, age of sediments.
- Interpret:
  - how the microbial factory works (shallow vs deep methane generation)
  - How are the products transported to the deposit
- Elucidate basin origin and evolution

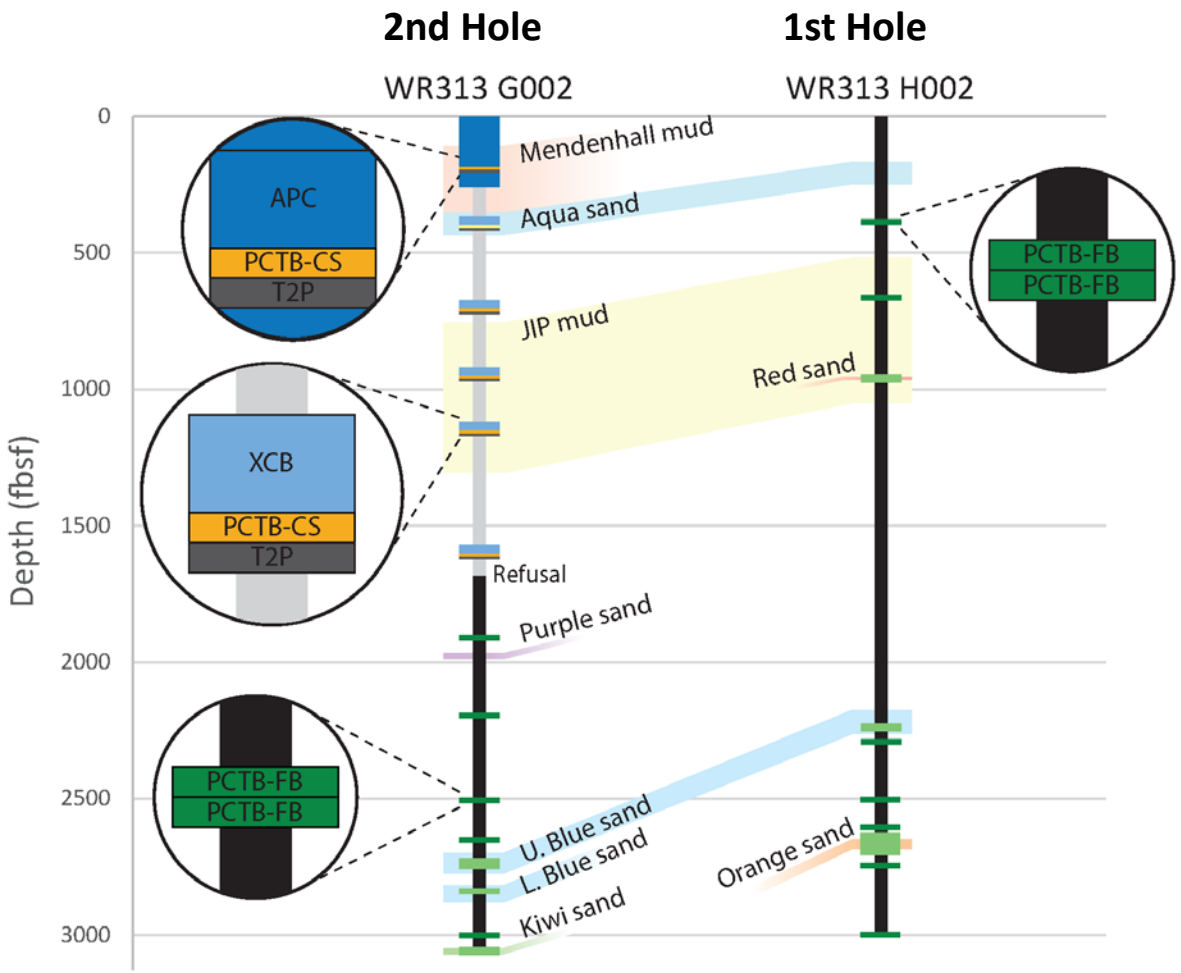
UT-GOM2-2 Location: Walker Ridge 313





UT-GOM2-2 Drilling Program

- 53 Pressure coring runs (up to 60)
- 13 Conventional cores
- 100% Pressure coring in the 1st Hole to meet Objective #1: Characterize the **Orange sand**
- In situ temperature and pressure measurements
- Spot coring pairs ensure we obtain 1 clean core at each depth



UT-GOM2-2: 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

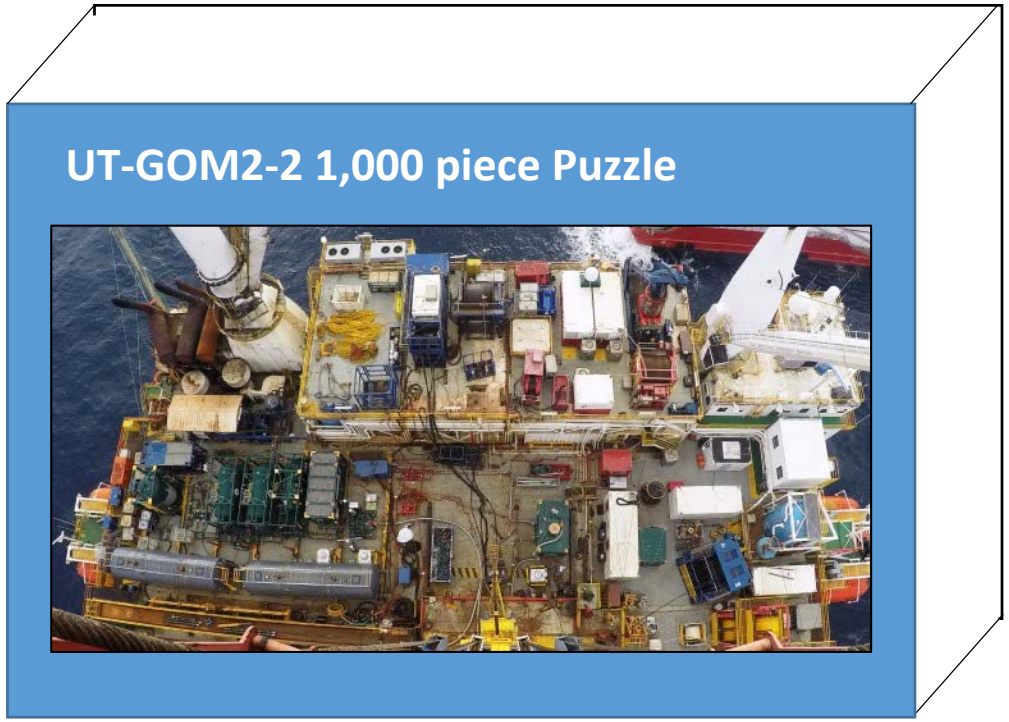
Comparing GOM2-1 and GOM2-2

	UT-GOM2-1	UT-GOM2-2	
Purpose	Technical Test	Research Expedition	
Schedule	22 days off-shore 14 days dockside	39 days off-shore 30 days dockside	x2
Downhole operations	21 PCs	53 PCs 13 APC/XCBs In situ probe	x3
Objectives	Test capability of UT, PCTB, and pressure core transport	6 Major Scientific Objectives	x6
Outcomes	Characterization of GC 955 Hydrate-bearing sand	Reservoir and Basin - Systems understanding of WR 313	

Detailed planning is critical to success

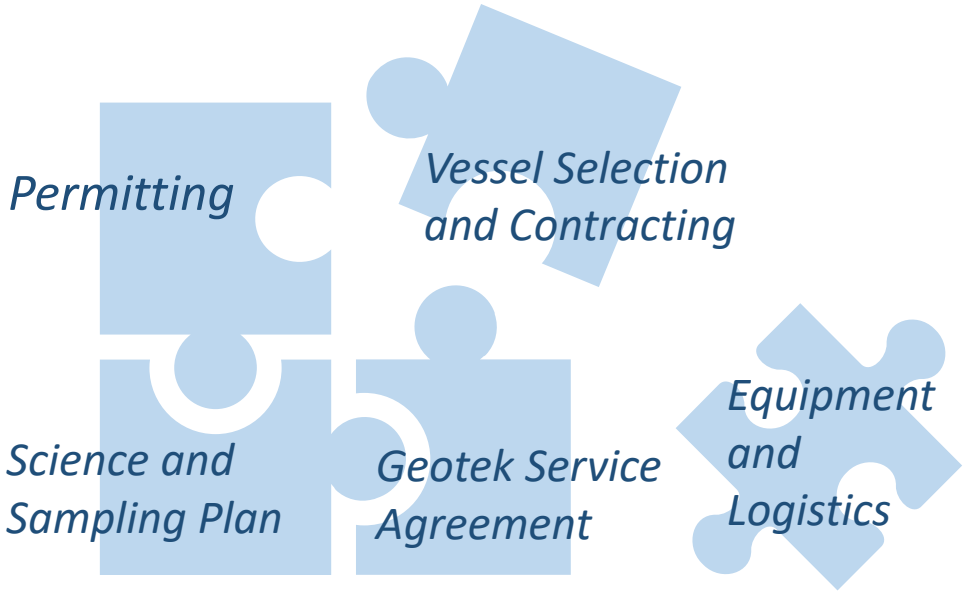
UT-GOM2-2 Status: Planning

- All the planning pieces..



High level Operation Summary (Ops Plan)

Detailed Overlapping Teams/Documents



Summary: GOM2 Project Evolution

1. UT-GOM2-1 Marine Test (2015-present)
   - Do science, develop and test approach, define shortcomings
2. Technology Development (2017-2021)
   - Incremental advances to achieve better science.
3. UT-GOM2-2 Science Expedition (2019-2024)
   - A prepared, focused, integrated effort to illuminate hydrate system.