Alaska Natural Gas Hydrate Production Testing, Test Site Selection, Characterization, and Testing Operations

Test Site Selection
Science/Operations Planning

Project Number DE-FE0022898

Alaska Gas Hydrate Production Field Experiment: Reservoir Response Test Planning, Operations, and Results Analysis Support

Field Operations
Results Analysis

Project Number Pending Award

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Presentation Outline

- Program Overview – Goals and Objectives
- Technology Background
- Technical Status/Project Scope
- Accomplishments and Planning
  - Test site review and characterization
  - Field test technical planning support
  - Hydrate-01 Stratigraphic Test Well results
- Production Testing Field Operations and Science Planning
- Project Summary

Project Overview

Alaska Natural Gas Hydrate Production Testing, Test Site Selection, Characterization, and Testing Operations

Test Site Selection

Science/Operations Planning

Funding:

DOE $230,700

USGS $1,890,000 (Cost Share)

Performance Dates:

09/01/2014 – 01/15/2021

Alaska Gas Hydrate Production Field Experiment: Reservoir Response Test Planning, Operations, and Results Analysis Support

Field Operations

Results Analysis

Funding (FY-2021):

DOE $79,430

USGS $318,000 (Cost Share)

Performance Dates:

09/01/2021 – 08/30/2026

USGS Project Participants

Tim Collett (PI), Seth Haines, Rita Zyrianova, Sam Heller, Krissy Lewis, Craig Markey

Project Overview

Goals and Objectives

This project is designed as a cooperative research effort, with USGS providing technical geoscience support in a partnership that includes DOE and the Japan Oil, Gas and Metals National Corporation (JOGMEC). The primary objectives of these two DOE-USGS Interagency Agreements (IA) is to provide geologic and geophysical technical support to identify and characterize gas hydrate production test sites on the Alaska North Slope and to develop plans for an extended gas hydrate production testing program. Within the new pending IA, the USGS will provide direct technical support for the field production testing phase of the project and the analysis of the geologic and production test data as acquired during the field test.

Technology Background

The primary goal of this cooperative project is to conduct a scientific field production test in northern Alaska from one or more gas hydrate bearing sand reservoirs using conventional "depressurization" technology. The project will include the drilling and evaluation of a stratigraphic test well (completed in December 2018), followed by the establishment of a production test site (including a geoscience data well, two production test wells, deployment of well monitoring systems, and surface monitoring), and the testing of reservoir response to pressure reduction over a period of about 12 months or for whatever period the parties find operations at the site to be valuable.

Technical Status/Project Scope

Alaska Natural Gas Hydrate Production Testing, Test Site Selection, Characterization, and Testing Operations

Phase 1-4 (09/01/2014 – 1/15/2021)

Task: Gas Hydrate Production Testing Support

Subtasks 1.1: Geologic occurrences of gas hydrate, analyzing available Eileen geologic and geophysical data

The USGS re-examined the distribution and properties of previously-identified gas hydrate accumulations in the Eileen Gas Hydrate Trend through the collection and incorporation of new well log and seismic data, with the specific goal to further characterize the Milne Point Unit Cascade and Prudhoe Bay Unit Kuparuk 7-11-12 prospects as potential gas hydrate production test sites. The USGS contributed to the acquisition, processing, and analysis of well log data and sidewall cores as acquired from the Hydrate-01 Stratigraphic Test Well.

Subtask 1.2: Gas hydrate field test technical and operational support

The objectives of this subtask included: (1) provided technical leadership and advice for formulation of a research drilling and production testing program designed to assess the production potential of gas hydrates; (2) provided personnel and resources to conduct field and laboratory analyses of recovered pressure cores; and (3) partnered in the synthesis of data from logging, direct sampling, and geophysical characterization studies. The USGS worked as a member of the project "R&D Committee" to review and modify the existing operational plan in support of the "Alaska Gas Hydrate Production Field Experiment" well test plan and incorporate results of the Hydrate-01 Stratigraphic Test Well and other international gas hydrate production testing projects.

Technical Status/Project Scope

Alaska Gas Hydrate Production Field Experiment: Reservoir Response Test Planning, Operations, and Results Analysis Support

Period of Performance: 09/01/2021 – 08/30/2026

Task: Gas Hydrate Production Testing Support

Subtask 1.1: Gas hydrate field test technical planning support

Within this subtask, the USGS shall provide technical guidance in support of the DOE/JOGMEC Extended Gas Hydrate Production Test in the Eileen Gas Hydrate Accumulation on the Alaska North Slope.

Subtask 1.2: Gas hydrate field test technical and operational support

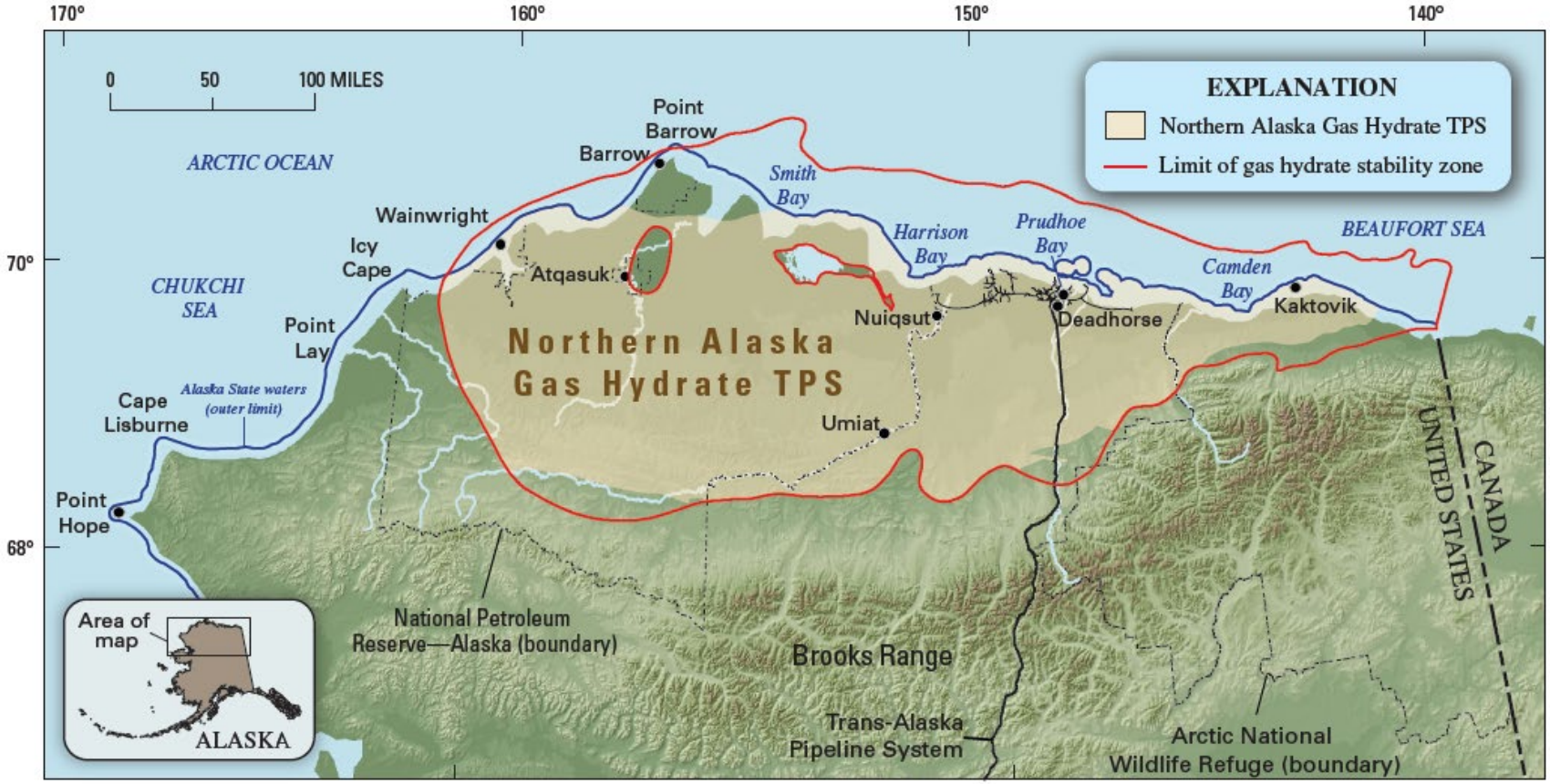
The objectives of this subtask are to: (1) provide technical and scientific leadership and advice for formulation and operation of a research drilling and production testing program designed to assess the nature and production potential of methane hydrates on the Alaska North Slope and (2) provide personnel and resources to enhance field and laboratory analyses of material and data recovered by coring, downhole logging, and geophysical characterization.

Subtask 1.3: Analysis of gas hydrate field test geologic and production test data

The extensive data acquisition plan associated with the scheduled Alaska gas hydrate production test will yield a large volume of data and technical information. The Project Science-Operational plan will be further developed and refined under this agreement by the USGS and DOE in order to synthesize and analyze the logging, direct sampling, geophysical and geologic data acquired during the testing phase of the Alaska project.

USGS Alaska North Slope Gas Hydrate Research

Gas Hydrate Assessments & Production Studies



1983-2020: USGS Alaska North Slope Gas Hydrate Assessment Project

2007: BPXA Mount Elbert Gas Hydrate Stratigraphic Test

2011-2012: ConocoPhillips CO_2 Displacement Test

2018-2024: Alaska North Slope Extended GH Production Test

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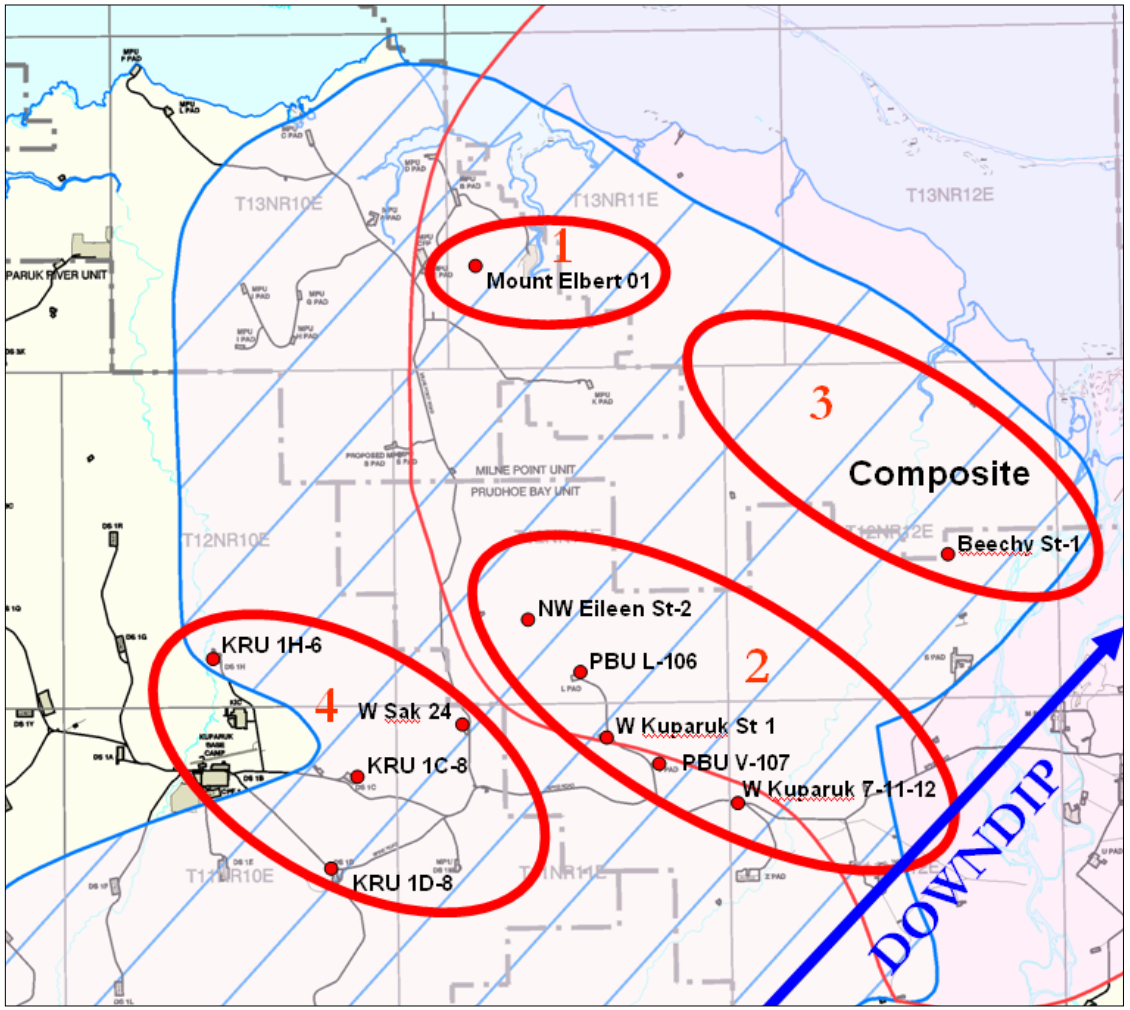
Long-Term Depressurization Testing

Four Areas Were Initially Considered – PBU KRU MPU

Key Criteria

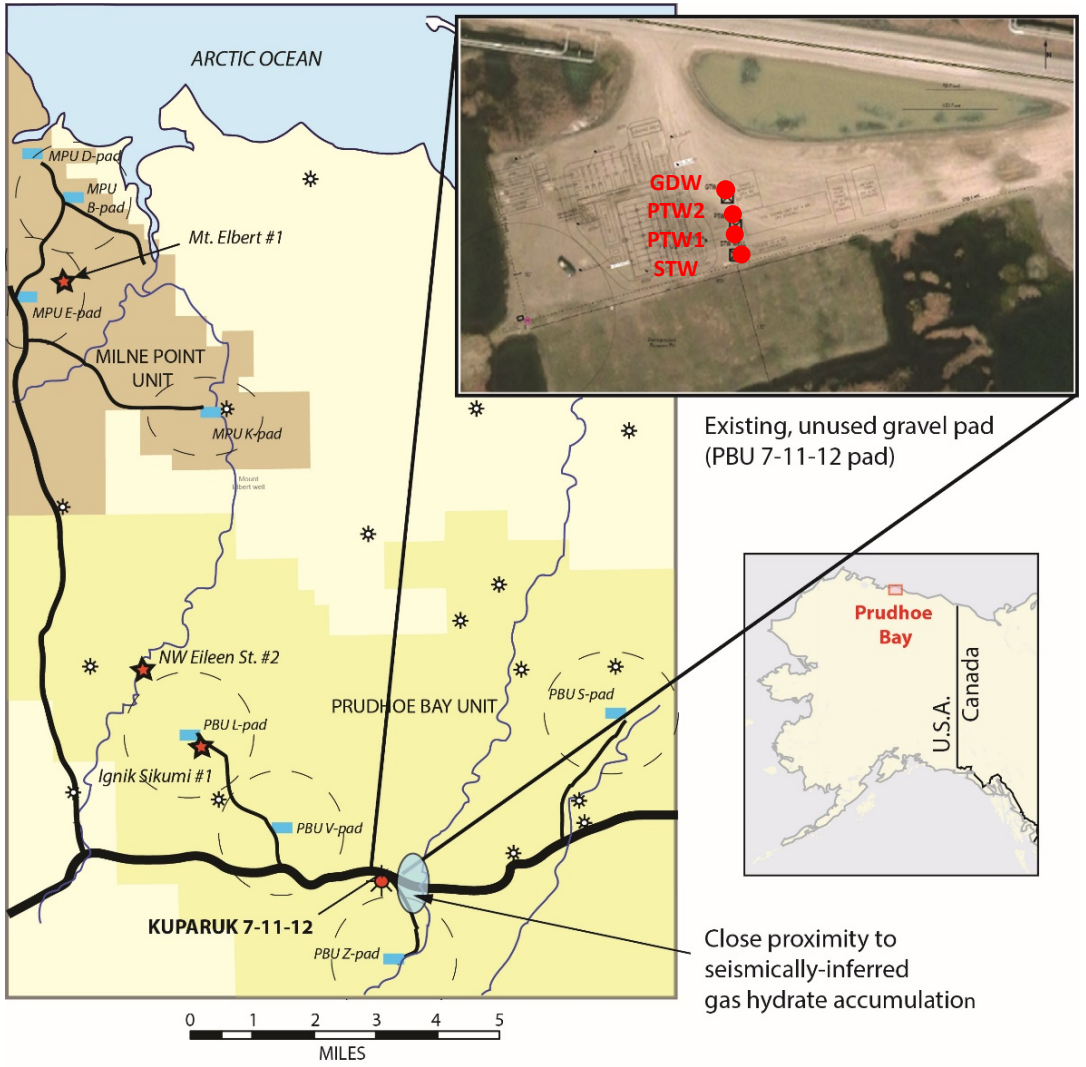
- **Probability for test success**
  - Reservoir presence & quality
  - Temperature
  - Nature of contacting units (pressure support?)
  - Modeling results
  - Operational flexibility (multiple zones)
- **Ease of Access**
- **Logistics/Facilities**
- **Program Complexity**



Alaska North Slope

Extended Gas Hydrate Production Testing – PBU Site Review

- Conduct a long-term test of gas hydrate response to most favorable production technology.
- Leverage known gas hydrate occurrences on the Alaska North Slope that are co-located with required infrastructure (pads, roads, services, EHS).
- Negotiate viable operating structure with ANS industry who are currently unwilling to engage as R&D partners.
- Address common goals as specified in agreements with Alaska Department of Natural Resources and the Government of Japan.
- **Completed initial drilling to confirm a promising site identified in the Westend Prudhoe Bay Unit.**

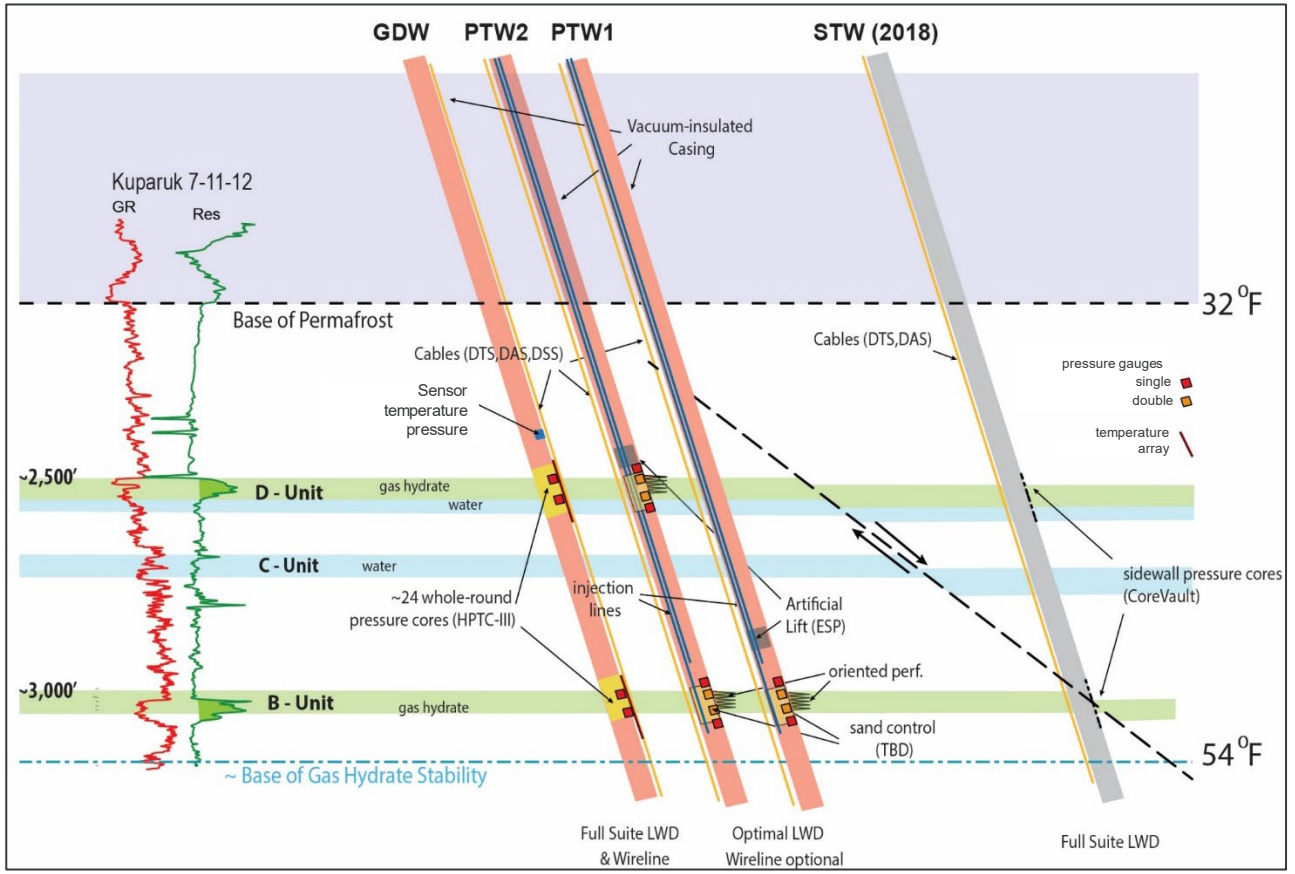


Alaska Gas Hydrate Production Field Experiment

Extended Gas Hydrate Production Testing

Alaska Gas Hydrate R&D

- Cooperative effort to gather necessary G&G and conduct monitored depressurization test
- DOE, JOGMEC, and USGS identified and evaluated potential test sites and designing four well testing program
- Completed Hydrate-01 Stratigraphic Test Well in December 2018
- Drilling of GDW/PTWs 1Q 2022, followed by around 1-year long production test that could be longer



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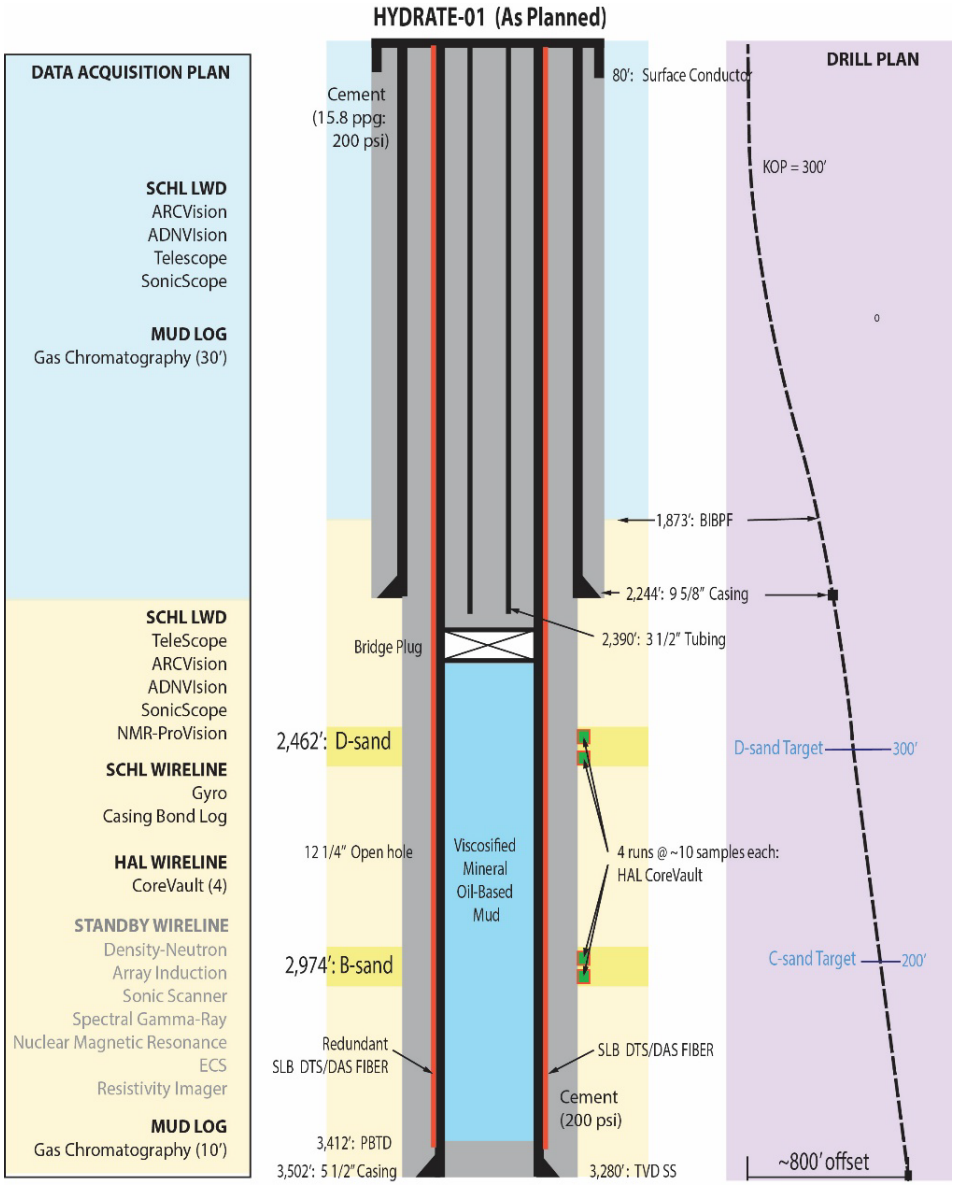
STW = Stratigraphic Test Well
GDW = Geoscience Data Well
PTW1 = Production Test Well 1
PTW2 = Production Test Well 2

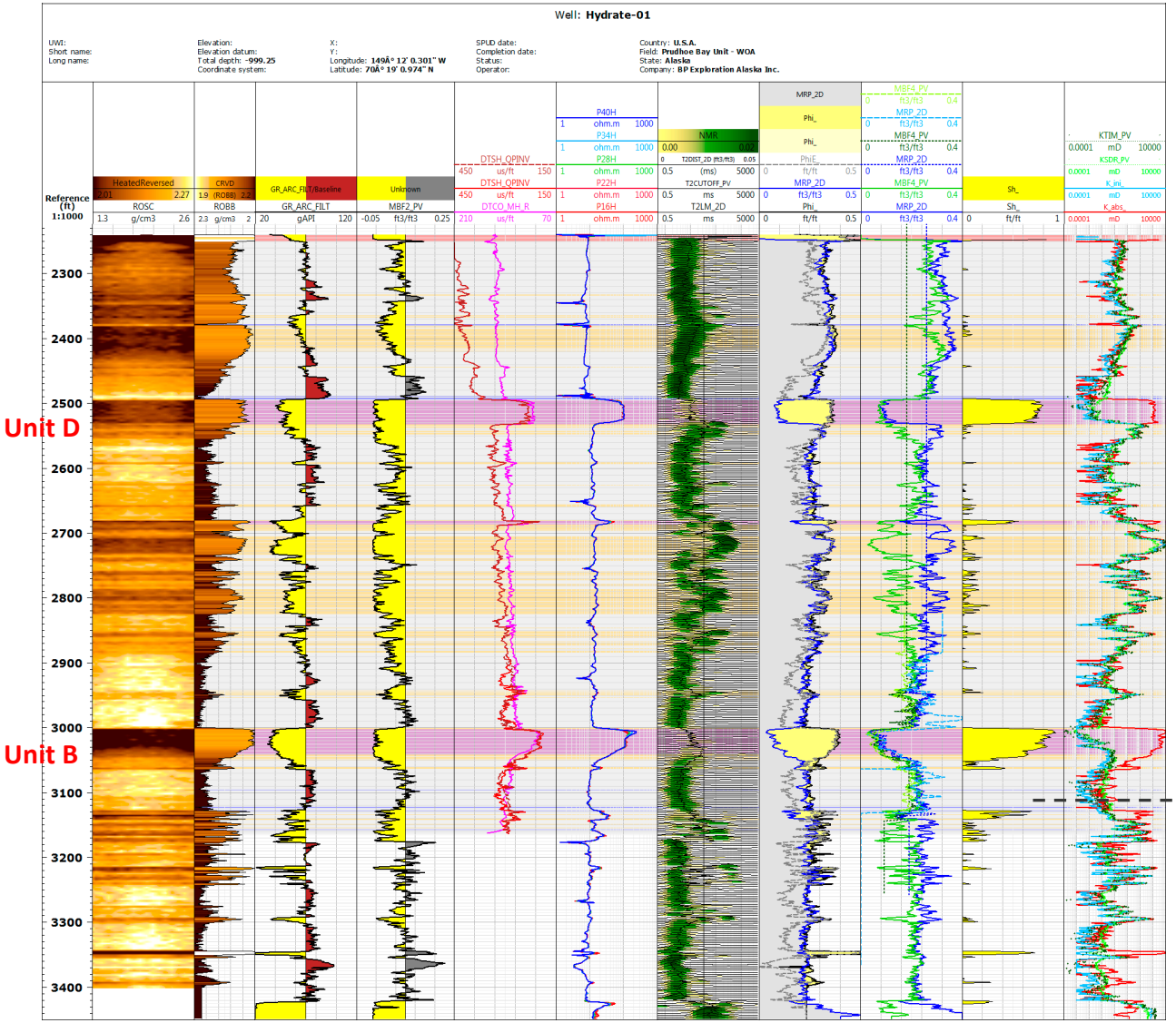
PBU Hydrate-01 Stratigraphic Test Well

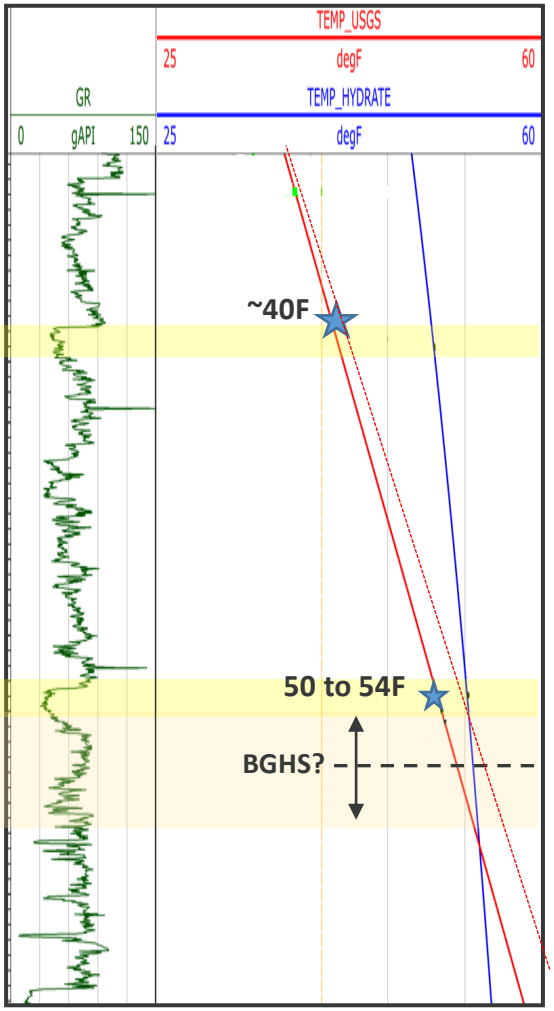
Well Design and Operations

- BPXA gained partner alignment to operate STW (warm up of rig for the impending PBU 2019 drilling season)
- Program was designed to acquire ONLY essential data
  - Full logging suite to confirm reservoir occurrence and characteristic
  - Side wall pressure cores to provide data to support planning of test well completion
  - Installed FO cables to allow STW to support VSP and serve as a monitoring well for future operations



PBU Hydrate-01 Stratigraphic Test Well

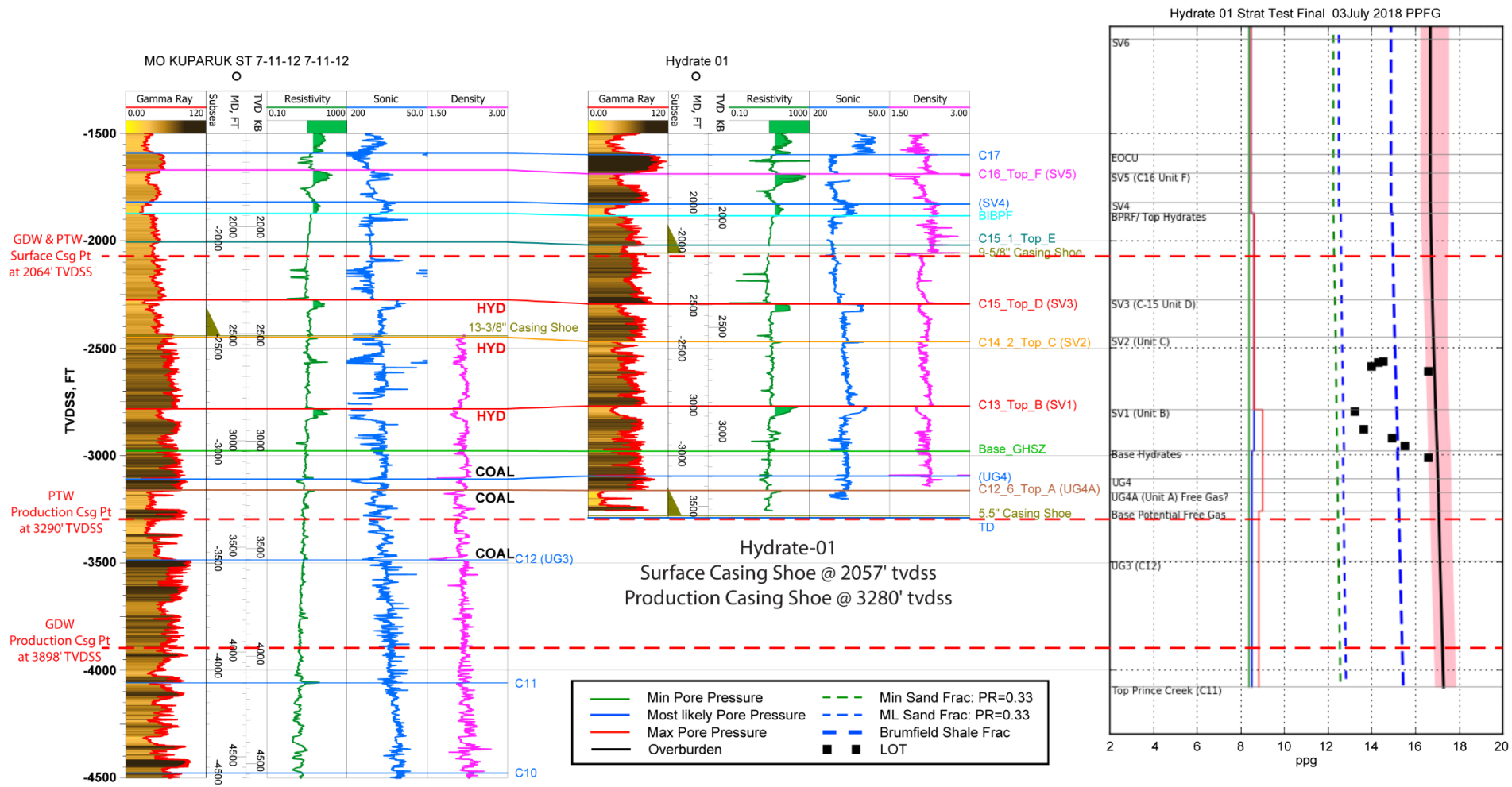




Modified from Boswell et al., 2020 - ICGH10

Alaska Gas Hydrate Production Test Site

Lithostratigraphic/Geomechanical Framework



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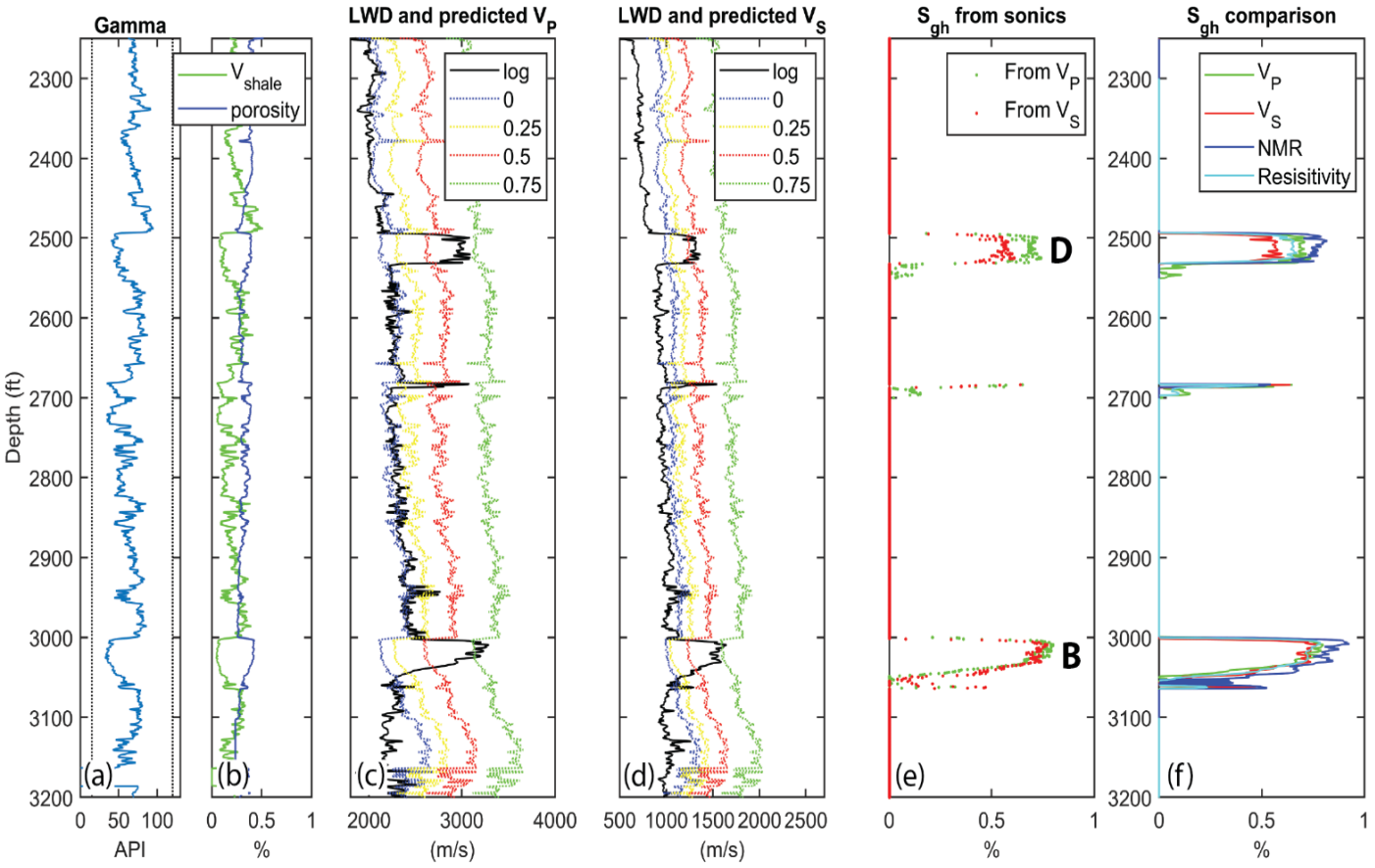
PBU Hydrate-01 Stratigraphic Test Well

Well Log Analysis



Gas hydrate saturations (S_{gh}) from sonic and other log data.

a. Gamma ray log data

b. LWD derived shale volume (V_{sh}) and porosity logs

c. LWD-measured V_P (black line) and model predicted V_P for S_{gh} values

d. LWD-measured V_S (black line) and model predicted V_s for S_{gh} values

e. Predicted V_S and V_P Gas hydrate saturations (S_{gh})

f. Comparison of S_{gh} estimated from V_P and V_S, NMR-DEN porosity, and resistivity LWD-measurements

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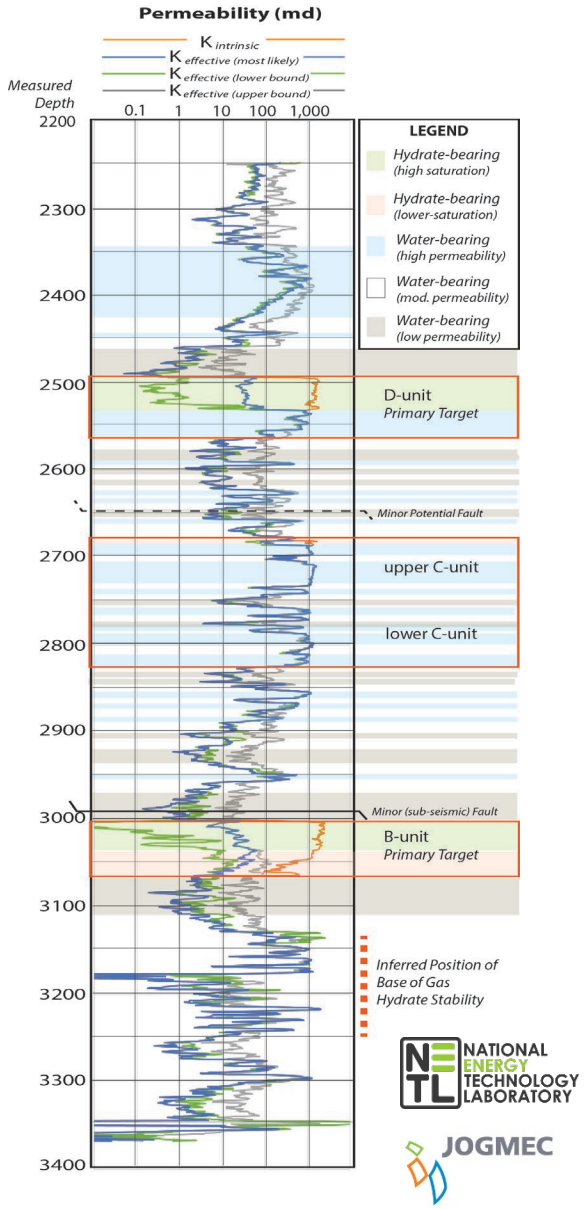
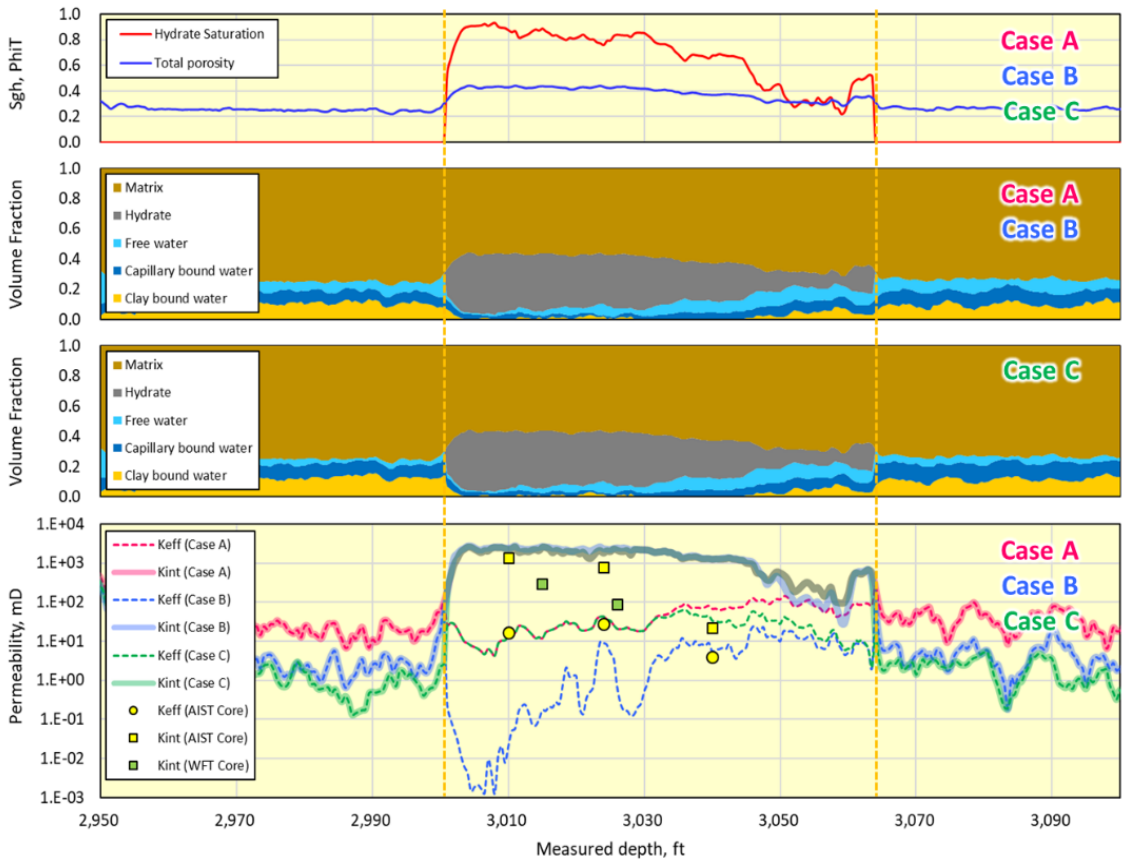
Gas Hydrate Production Modeling

Reservoir Properties

Boswell et al., 2020 - ICGH10
Myshakin et al., 2020 - ICGH10





Three modeling cases to constrain gas and water rates

- Conservative case (CASE B) based on NMR- Ks
- Aggressive case (CASE A) core-corrected (entire section)
- Most Likely case (CASE C) core-corrected (main reservoir)

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PBU Hydrate-01 Stratigraphic Test Well
Data Acquisition Results

Drilling/wellbore quality (to allow reliable data collection)

- FULLY ACHIEVED: both targets penetrated within provided target. Mud temperature maintained within set limits (as modified). No incidents of induced GH dissociation; hole in gauge.

Logging-while-drilling (data to confirm/characterize reservoir condition)

- FULLY ACHIEVED: outstanding quality data with all tools!
- **NOTE**: Sonic data – muted reservoir response in lower portion of B target. Verified proper tool response through two additional MAD passes across the reservoir.

Contingency Wireline data

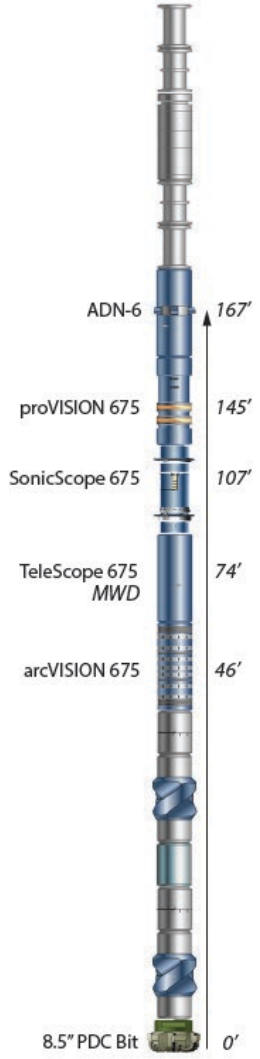
- DEFERRED PER PLAN: Not required due to high quality of LWD data.

Sidewall pressure cores (grain size analyses & test well completion design)

- FULLY ACHIEVED: 34 samples recovered spanning full extent of both reservoirs.
- **NOTE**: Obtained additional petrophysical data from the highest quality cores.

Fiber Optic cable installation (to enable use of STW as monitoring well)

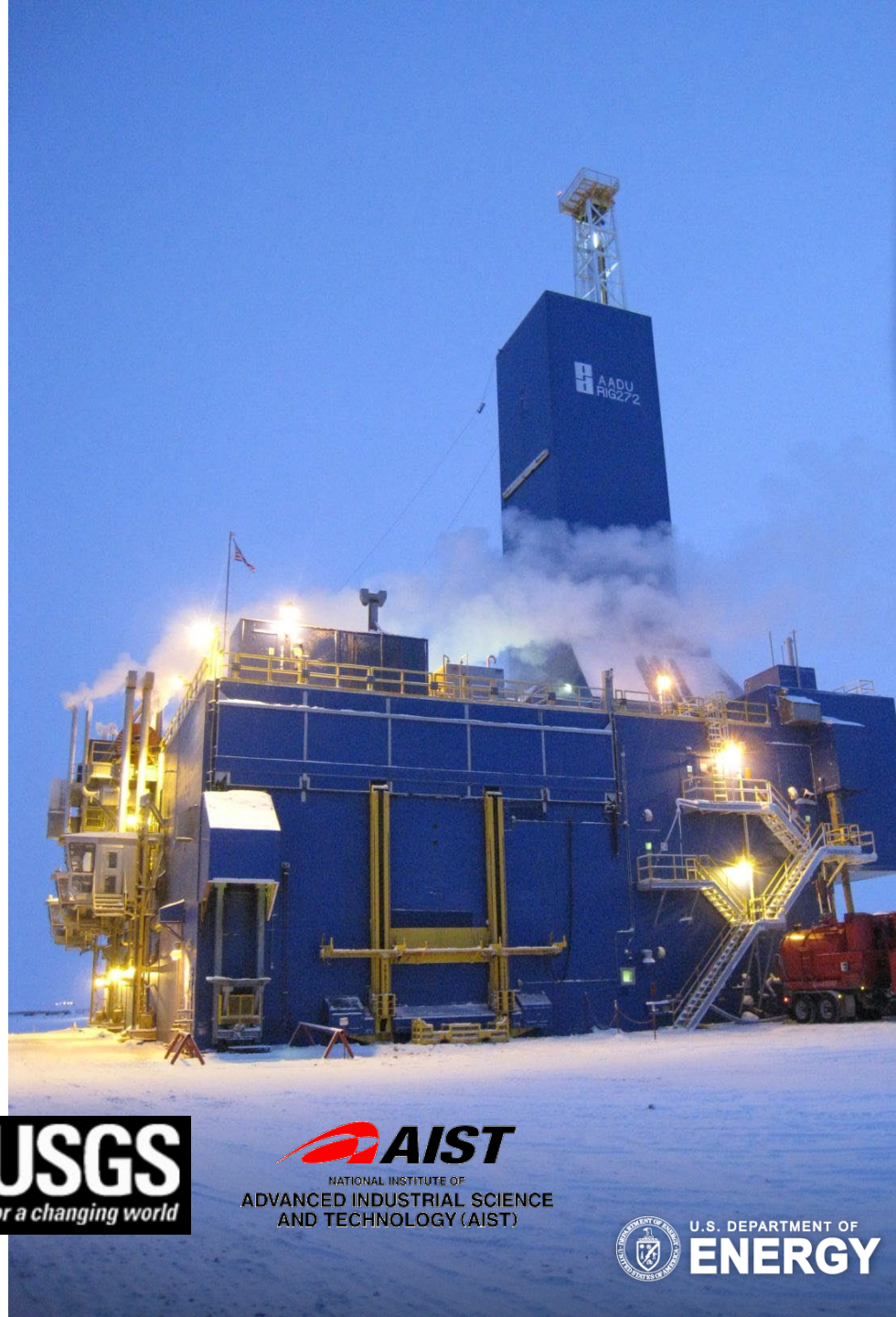
- FULLY ACHIEVED: Two (one as backup) distributed temperature/acoustic sensor cable packages were installed on outside of casing and successfully tested.



Bottom-hole assembly for main hole (from Schlumberger)

Alaska Gas Hydrate Production Field Experiment

Operations and Science Planning



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Plans for Future Testing

Alaska Gas Hydrate Production Field Experiment: GDW/PWTs Science and Operational Plan

1. Well Delivery: Engineering Planning and Operations

2. PTWs Completion and Production Testing Program

- -PTWs Completions
- -Surface Facilities
- -Production Testing Planning and Design
- -Testing Operations
- -Testing Results Analysis

3. Well-Based Data Acquisition and Analysis

- -Mud Logging Program
- -Downhole LWD/Wireline Logging Program
- -Pressure Coring Operations
- -Coring Plan
- -Well Site Core Flow and Analysis
- -Post Well Site Core Shipping, Processing and Analysis

4. GDW and PTWs Monitoring Program

- -DTS/DAS/DSS and Gauge Based P&T Systems and Surface Monitoring Systems
- -4D VSP/CWT Geophysical Data Acquisition: Test Site Characterization and Production Monitoring