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International Gas Hydrate Research

March 2014





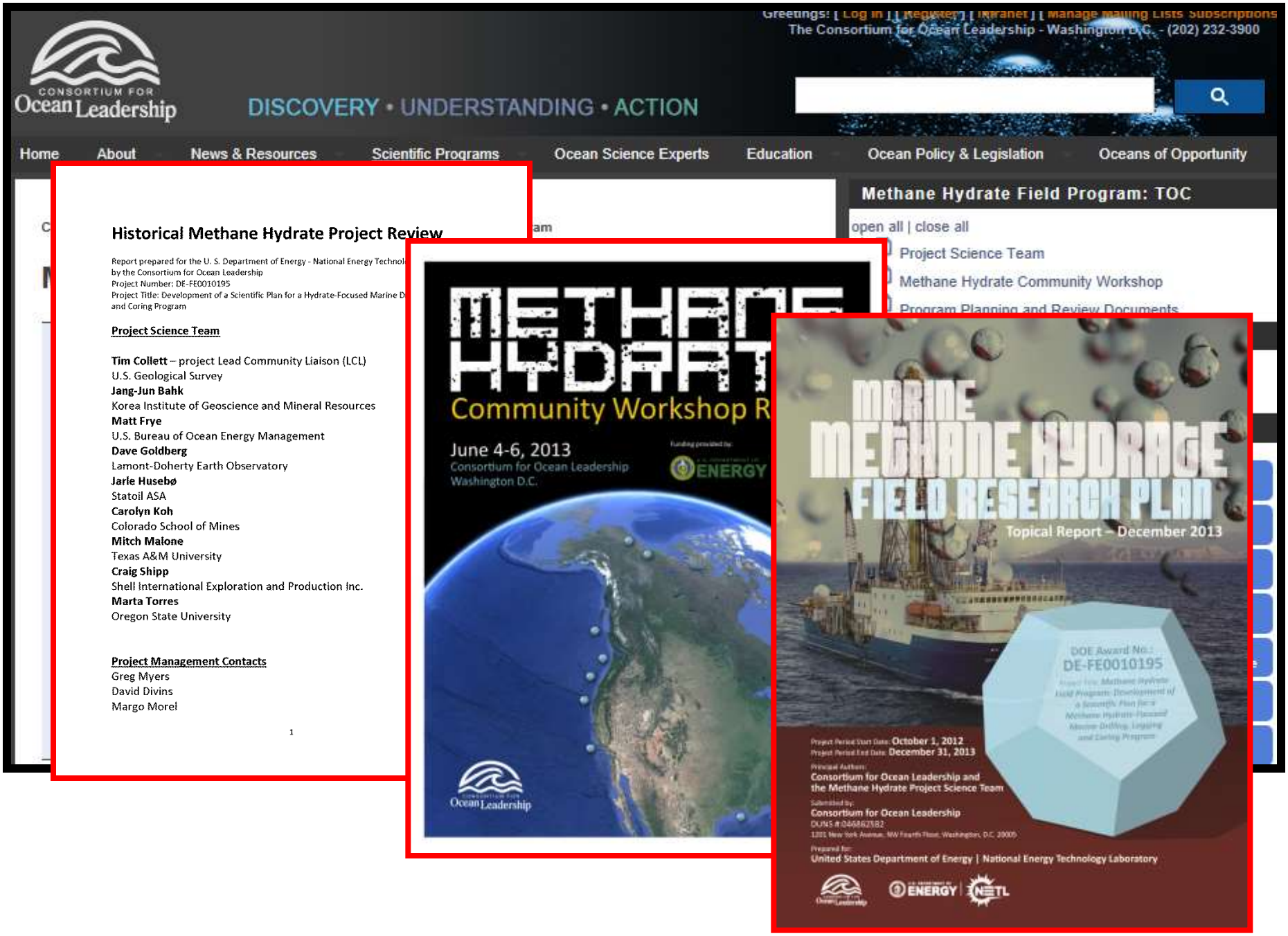
Presentation Outline

International Gas Hydrate Projects – Overview

Gas Hydrate Field Projects

- *MH21 – Japan*
- *UBGH-1 & UBGH-2 – Republic of Korea*
- *GMGS-1 & GMGS-2, Qinghai-Tibet Projects – P.R. China*
- *NGHP01 – India*
- *Arctic Permafrost Gas Hydrate Testing*
  - *-Mallik & Mackenzie Delta – Canada*
  - *-Alaska North Slope (Statoil and JOGMEC interest)*

Summary and Recommendations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The Consortium for Ocean Leadership - Washington D.C. - (202) 232-3900
CONSORTIUM FOR Ocean Leadership
DISCOVERY • UNDERSTANDING • ACTION
Home
About
News & Resources
Scientific Programs
Ocean Science Experts
Education
Ocean Policy & Legislation
Oceans of Opportunity
Methane Hydrate Field Program: TOC
open all | close all
Project Science Team
Methane Hydrate Community Workshop
Historical Methane Hydrate Project Review
Report prepared for the U. S. Department of Energy - National Energy Technol
by the Consortium for Ocean Leadership
Project Number: DE-FE0010195
Project Title: Development of a Scientific Plan for a Hydrate-Focused Marine D
and Coring Program
Project Science Team
Tim Collett – project Lead Community Liaison (LCL)
U.S. Geological Survey
Jang-Jun Bahk
Korea Institute of Geoscience and Mineral Resources
Matt Frye
U.S. Bureau of Ocean Energy Management
Dave Goldberg
Lamont-Doherty Earth Observatory
Jarle Husebø
Statoil ASA
Carolyn Koh
Colorado School of Mines
Mitch Malone
Texas A&M University
Craig Shipp
Shell International Exploration and Production Inc.
Marta Torres
Oregon State University
Project Management Contacts
Greg Myers
David Divins
Margo Morel
1
METHANE HYDRATE
Community Workshop R
June 4-6, 2013
Consortium for Ocean Leadership
Washington D.C.
ENERGY
Ocean Leadership
MARINE
METHANE HYDRATE
FIELD RESEARCH PLAN
Topical Report – December 2013
DOE Award No.:
DE-FE0010195
Project Period Start Date: October 1, 2012
Project Period End Date: December 31, 2013
Principal Author:
Consortium for Ocean Leadership and
the Methane Hydrate Project Science Team
Submitted by:
Consortium for Ocean Leadership
DUNS #:046862582
Prepared for:
United States Department of Energy | National Energy Technology Laboratory
ENERGY
NETL

Historical Methane Hydrate Project Review

Report prepared for the U. S. Department of Energy - National Energy Technology Laboratory, by the Consortium for Ocean Leadership
Project Number: DE-FE0010195
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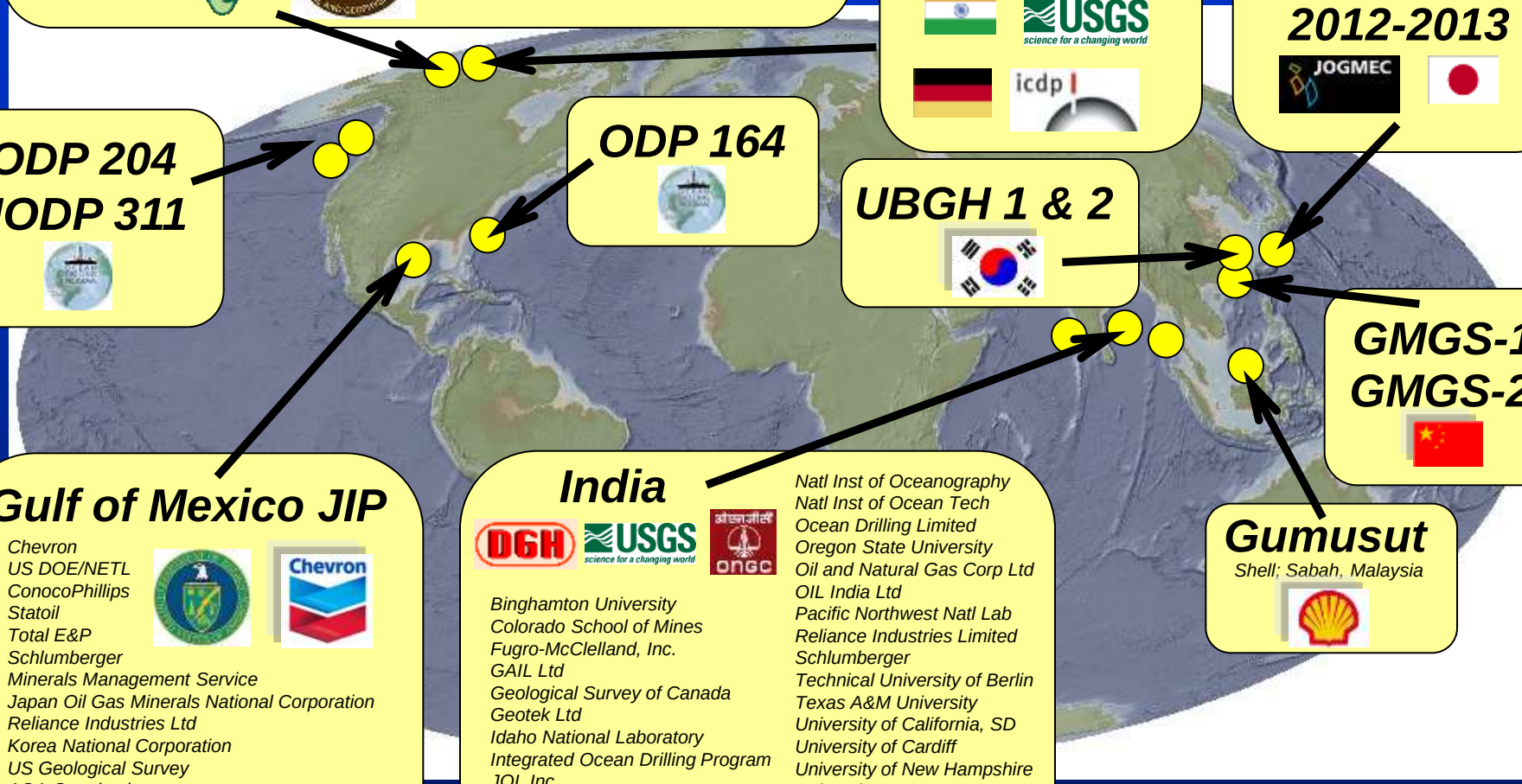


North Slope, Alaska

BP/DOE/USGS
ConocoPhillips/JOGMEC/DOE
North Slope Borough/DOE
BLM/USGS

Mallik 98/02/07/08

Nankai Trough 1999-2000 2004 2012-2013

ODP 204 IODP 311

ODP 164

UBGH 1 & 2

GMGS-1 GMGS-2

Gulf of Mexico JIP

Chevron
US DOE/NETL
ConocoPhillips
Statoil
Total E&P
Schlumberger
Minerals Management Service
Japan Oil Gas Minerals National Corporation
Reliance Industries Ltd
Korea National Corporation
US Geological Survey
AOA Geophysics
Lamont Doherty Earth Observatory
WesternGeco
Naval Research Laboratory
Rice University

India

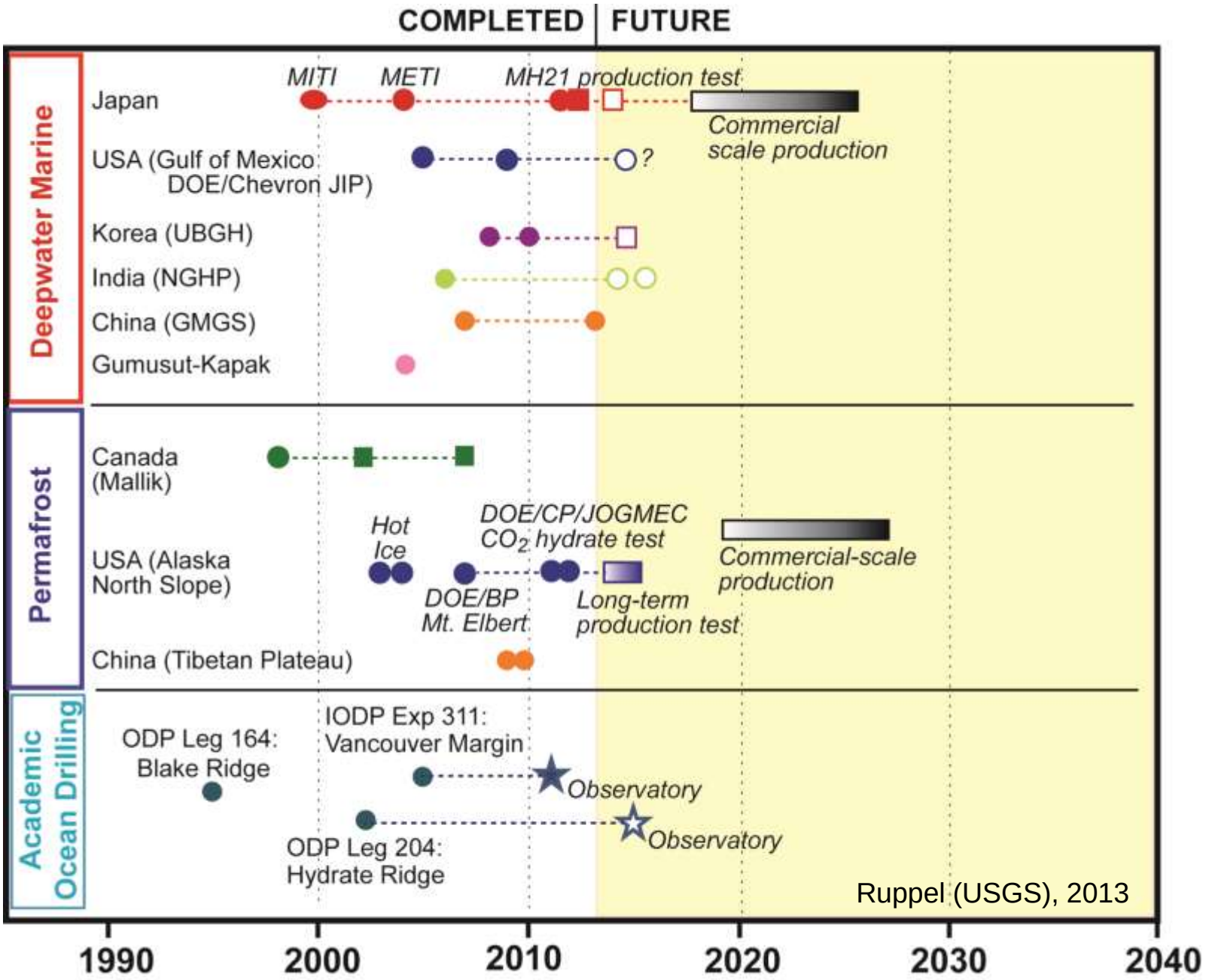
Binghamton University
Colorado School of Mines
Fugro-McClelland, Inc.
GAIL Ltd
Geological Survey of Canada
Geotek Ltd
Idaho National Laboratory
Integrated Ocean Drilling Program
JOI, Inc.
Lamont-Doherty Earth Obs
Ministry of Petrol and Natural Gas
McGill University
DOE-NETL
Natl Inst of Oceanography
Natl Inst of Ocean Tech
Ocean Drilling Limited
Oregon State University
Oil and Natural Gas Corp Ltd
OIL India Ltd
Pacific Northwest Natl Lab
Reliance Industries Limited
Schlumberger
Technical University of Berlin
Texas A&M University
University of California, SD
University of Cardiff
University of New Hampshire
Universität Bremen
University of Rhode Island
U.S. Department of Energy
U.S. Geological Survey
U.S. NSF
Woods Hole Ocean Inst

Gumusut

Shell; Sabah, Malaysia

International Gas Hydrate Research

Gas Hydrate Scientific Drilling



Ruppel (USGS), 2013

International R&D

- **Japan**
  - *2012/13: Collaboration on both Arctic and Marine projects*
  - *2013: One-week marine production test*
  - *2014/15: "Extended" marine production test*
  - *New Japan Sea project*

- **Korea**
  - *2007 & 2010: UBGH-1 & UBGH-2 expeditions*
  - *2015: Marine production test*

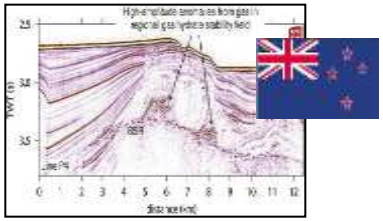
- **China:**
  - *2007 & 2013: GMGS-1 & GMGS-2 expeditions*
  - *2007 through 2011: Onshore "tests"*

- **India**
  - *2006: NGHP-01 expedition*
  - *2009 through 2014: Site review collaboration*
  - *2014: 20-site LWD expedition in Bay of Bengal*
  - *2015: 10-site coring & wireline logging expedition in Bay of Bengal*

International R&D

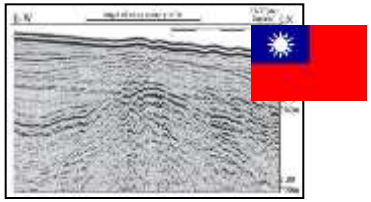
- **Norway (Statoil)**
  - *Onshore long-duration production test*
  - *Gas hydrate global screening*

- **Canada**
  - *Onshore Mallik Project 1998, 2002, 2007-2008*
  - *Beaufort Shelf hazard and climate research*
  - *Pacific and Atlantic marine gas hydrate studies*



- **New Zealand**
  - *Gas hydrates on the Hikurangi Margin, GNS, Univ. of Auckland*
  - *Energy focus, marine surveys, drilling?*

- **Germany**
  - *SUGAR Energy Assessment Project, BGR plus others*
  - *GEOMAR marine gas hydrate research, marine surveys*
  - *MARUM MeBo (sea floor drill rig) drilling research*



- **Taiwan**
  - *Marine gas hydrate research, marine surveys*
  - *Central Geologic Survey and the National Taiwan University*
  - *Energy focus, marine surveys, drilling?*

International R&D

- **Mexico**
  - *Pemex*
  - *Energy focus studies in the Gulf of Mexico*

- **Columbia**
  - *Ecopetrol SA*
  - *Energy focus studies in the Gulf of Mexico*

- **Brazil**
  - *Petrobras*
  - *Geohazard focus studies*

- **Uruguay**
  - *Uruguay's National Oil Company ANCAP*
  - *Energy focus studies*

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Summary and Recommendations

- **METI (JNOC) MH21 (JOGMEC) - Japan**

“Japan’s Methane Hydrate Exploitation Program – MH21”

- Road Map -

- **In July 2001, METI launches the “National R&D Program for Methane Hydrate Resources in Japan” – which followed an inaugural five year study, which drilled gas hydrates in the Nankai Trough for the first time in 1999-2000.**

- **Middle- to long-term R&D program focusing on the commercial production of methane gas from hydrate-bearing sediments in offshore Japan.**

- **MH21 Three phase rolling plan for a period of 16 years focusing on five research areas: (1) Exploration, (2) Modeling, (3) Field Testing, (4) Development Technology, (5) Health-Safety Environmental Assessment.**

glish/

MH21 Research Consortium

Research Consortium for Methane Hydrate Resources in Japan

JOGMEC Japan Oil, Gas and Metals National Corporation

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JOGMEC's Activities | > Oil and Natural Gas | > Metals | > Coal | > Geothermal | > Stockpiling | > Mine Pollution Control

News Releases

HOME > News Releases > 2012 > Gas Production from Methane Hydrate Layers Confirmed

Gas Production from Methane Hydrate Layers Confirmed

Print page

PDF (146 KB)

Like 3 Tweet 0 +1 1

March 12, 2013

Japan Oil, Gas and Metals National Corporation ("JOGMEC"; Headquarter: Minato-ku, Tokyo, President: Hirobumi Kawano), which has been conducting preparation works for the first offshore production test off the coasts of Atsumi and Shima peninsulas, started a flow test applying the depressurization method and confirmed production of methane gas estimated from methane hydrate layers on March 12, 2013.
JOGMEC will start analyzing data while it continues the flow test.
Since this is a flow test of flammables, please do not approach to the site because of the safety reason.

Methane hydrate (*1) receives attention as one of the unconventional gas resources in the future.
During the period from FY2001 to FY2008, which is Phase 1 of the "Japan's Methane Hydrate R&D Program" (*2) (Program), seismic surveys and exploitation drillings were conducted at the eastern Nankai trough, off the coast from Shizuoka-pref. to Wakayama-pref., as the model area, where a considerable amount of methane hydrate deposits is confirmed (*3).

In Phase 2 of the Program starting from FY2009, aiming to develop a technology to extract natural gas through dissociation of methane hydrate, this is the first offshore test ever conducted (*4).

The first offshore production test is planned over a span of two years. In February and March last year, the preparatory works including drilling a production well and two monitoring wells were conducted. From June to July, the pressured core samples were acquired from methane hydrate layers. In this operation, a flow test through dissociation of methane hydrate is conducted after the preparatory works including drilling and installing equipments for the flow test.

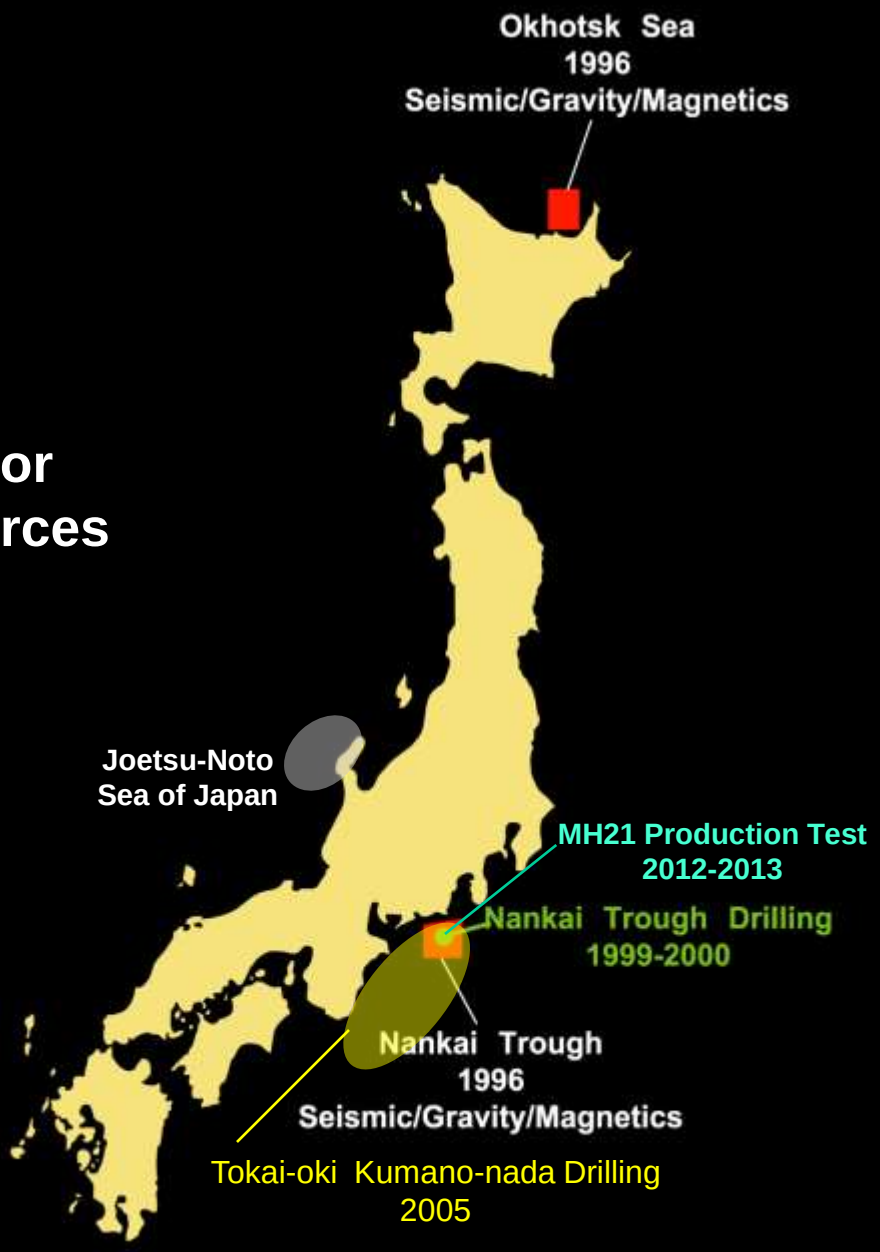
News Releases
- 2013
- 2012
- 2011
- 2010
- 2009
- 2008
- 2007
- 2006
- 2005

http://

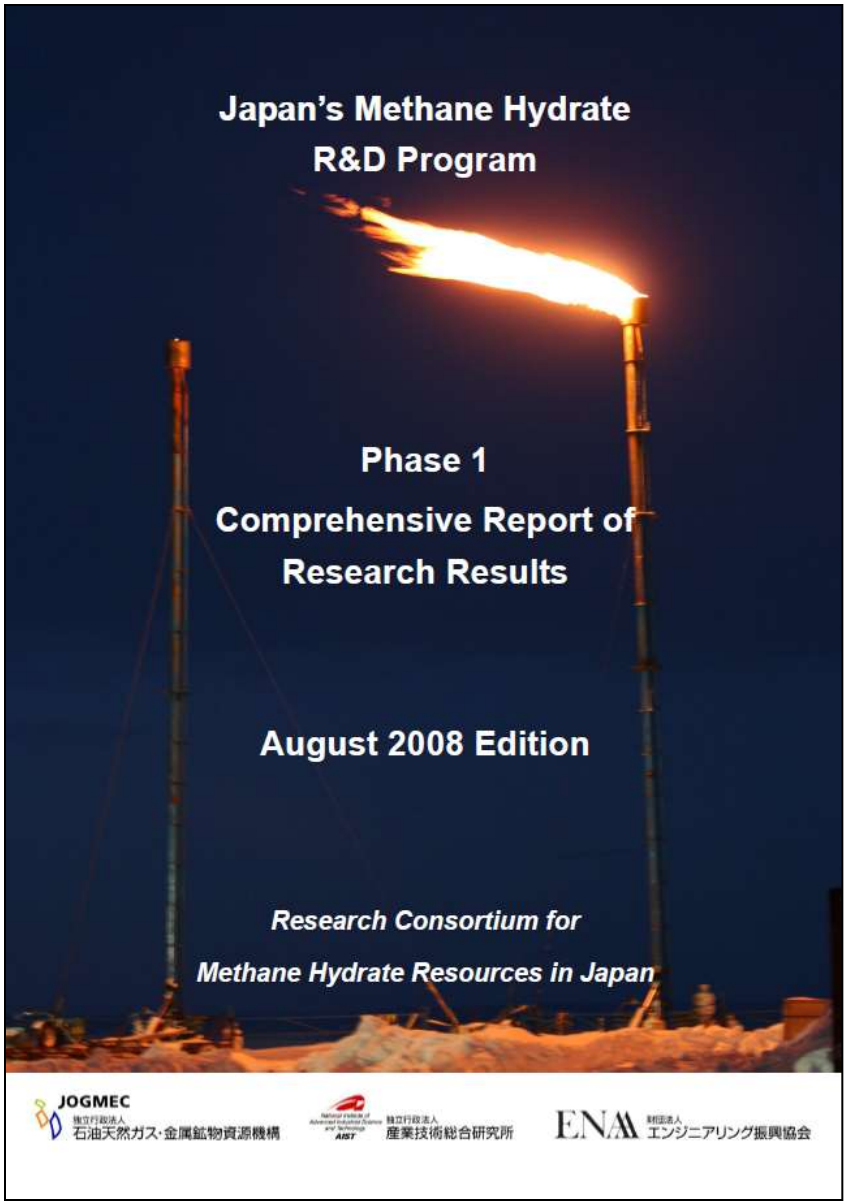
2011/03/11 Japan's Methane Hydrate R&D Program
2011/01/17 Implementation plan for Phase 2
2010/12/01 International Symposium on Methane Hydrate Resources has been concluded successfully

- Process
- Accomplishments and Issues of Phase 1
- Basic Policy and Research System for Phase 2
- Goals and Research Themes for Research Group for Field Development Technology

National R&D Program for Methane Hydrate Resources in Japan



Research Consortium for Methane Hydrate Resources in Japan



Implementation Plan for Phase 2

July 8, 2009

Research Consortium for Methane Hydrate Resources in Japan

Japan's Methane Hydrate R&D Program

Phase 1

FY 2001 2002 2003 2004 2005 2006 2007 2008

FY2001
First Onshore Methane Hydrate Production Test in Canada

FY2003
MITI Exploratory Test Wells in the Eastern Nankai Trough Area

FY2001/2002
2D and 3D Seismic Surveys in the Eastern Nankai Trough Area

Interim appraisal

FY2007/2008
Second Onshore Methane Hydrate Production Test in Canada

Final evaluation for Phase 1

Baseline Researches (Exploration Techniques, Decomposition & Formation Techniques, Production Techniques, Environmental Impact Assessment Techniques)

Phase 2

FY 2009 2010 2011 2012 2013 2014 2015

Preparation for Offshore Methane Hydrate Production Test

Onshore Methane Hydrate Production Test

Interim appraisal

Offshore Methane Hydrate Production Test

Offshore Methane Hydrate Production Test

Final evaluation for Phase 2

(1)Extraction of technical issues through offshore production tests
(2)Recommendation of economical and efficient recovery methods
(3)Evaluation of methane hydrate distribution off the coast of Japan
(4)Recommendation of EIA methods through offshore production tests

Phase 3

FY 2016 2017 2018

Preparations for Commercial Productions

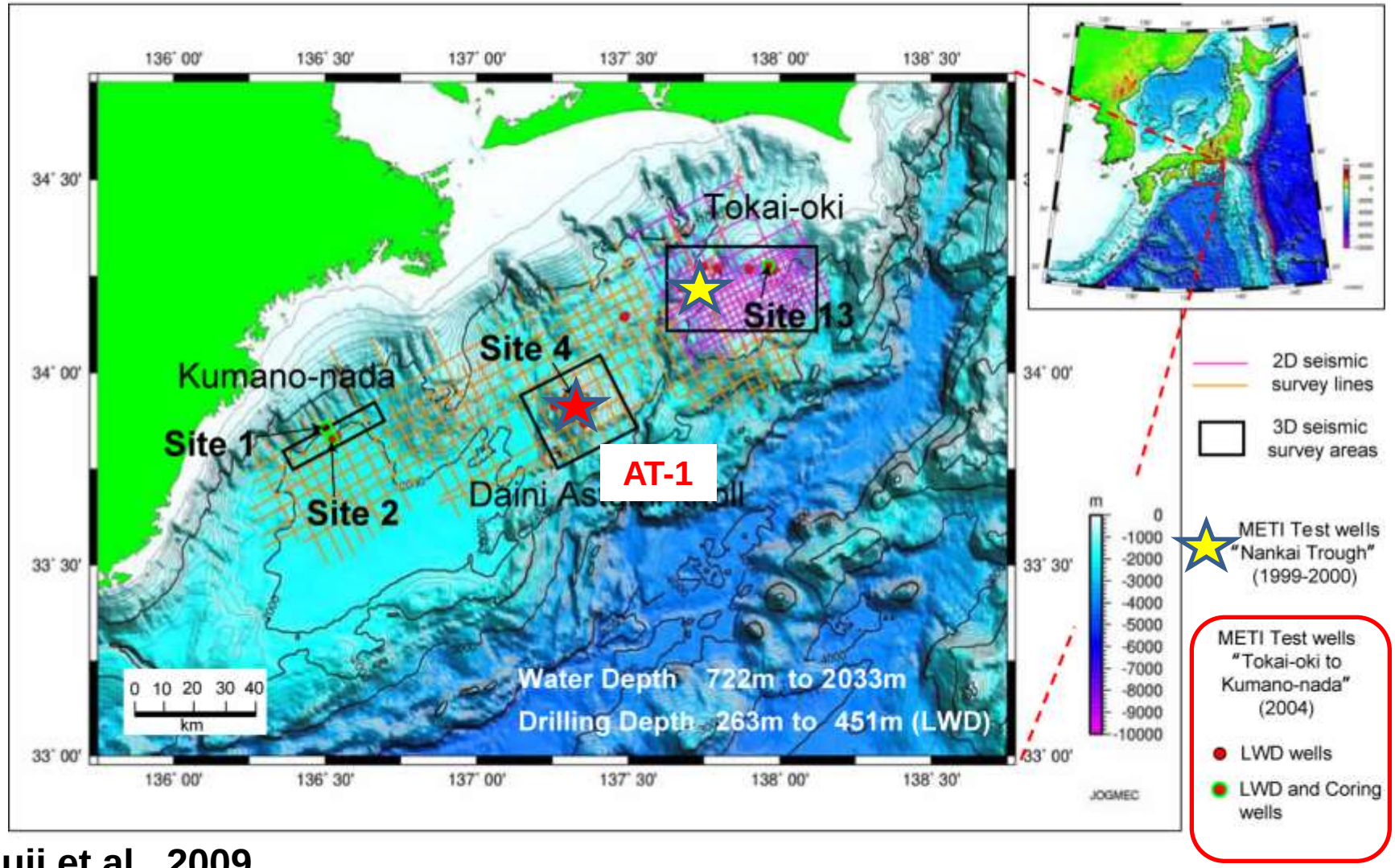
Comprehensive Evaluations (Economic Potential, Environmental Impact Assessment)

Final evaluation

This schedule was revised at the end of Phase 1.

National R&D Program for Methane Hydrate Resources in Japan

-Seismic Research and Drilling-



Tsuji et al., 2009

OTC 20729

Reservoir Characterization of Methane Hydrate Bearing Turbidite Channel in the Eastern Nankai Trough, Japan

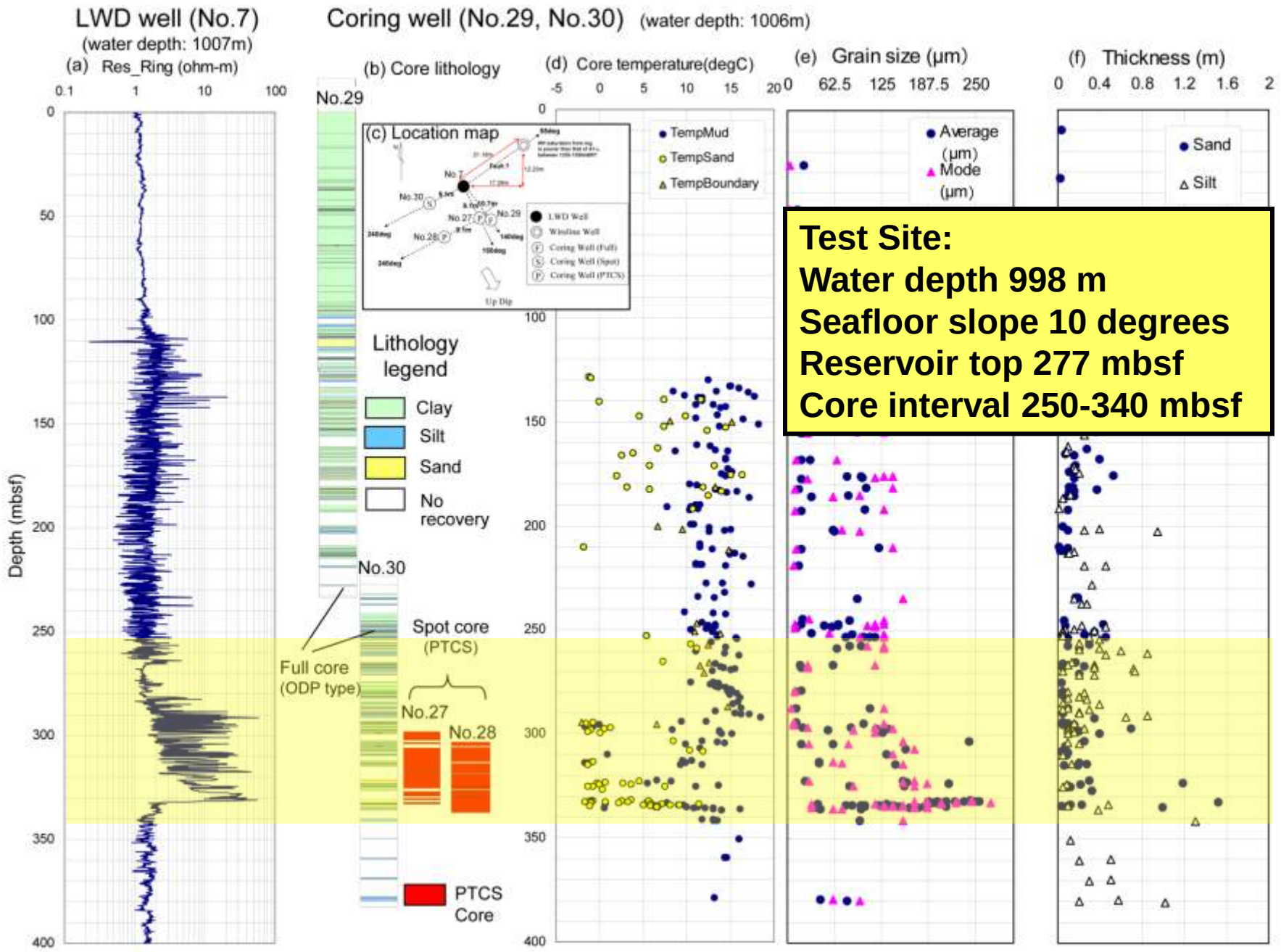
S. Noguchi, N. Shimoda, N. Oikawa, O. Takano, T. Saeki, T. Inamori, T. Fujii, (JOGMEC)

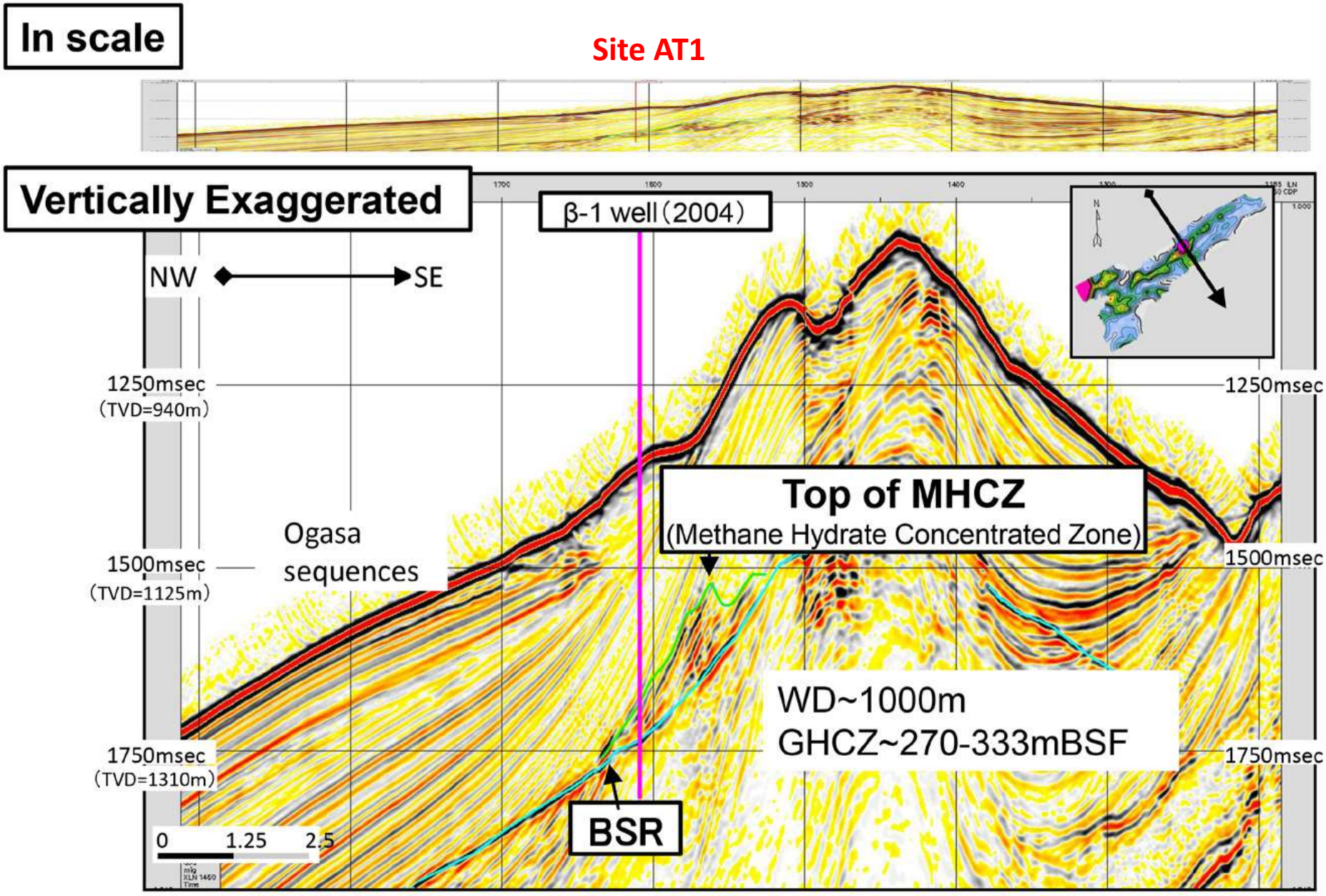
75th EAGE Conference & Exhibition incorporating
SPE EUROPEC 2013
London, UK, 10-13 June 2013

Workshop paper: B10

Site Selection and Formation Evaluation at the 1st Offshore Methane Hydrate Production Test Site In the Eastern Nankai Trough, Japan

T. Fujii* (Japan Oil, Gas and Metals National Corporation (JOGMEC)), S. Noguchi, T. Takayama, K. Suzuki, K. Yamamoto & T. Saeki

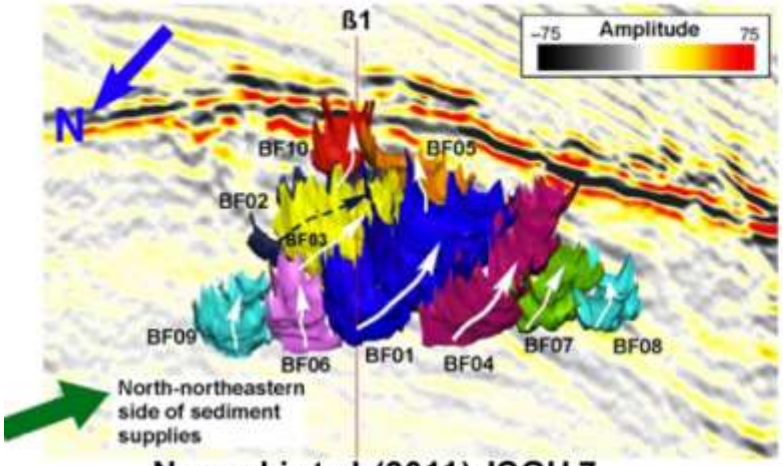

LWD well (No.7)
(water depth: 1007m)
(a) Res_Ring (ohm-m)
0.1
1
10
100
Depth (mbsf)
0
50
100
150
200
250
300
350
400
Coring well (No.29, No.30) (water depth: 1006m)
(b) Core lithology
No.29
No.30
Lithology legend
Clay
Silt
Sand
No recovery
Spot core (PTCS)
Full core (ODP type)
No.27
No.28
PTCS Core
(c) Location map
No.7
No.30
No.27
No.29
No.28
LWD Well
Wireline Well
Coring Well (Full)
Coring Well (Spot)
Coring Well (PTCS)
Up Dip
(d) Core temperature(degC)
-5
0
5
10
15
20
TempMud
TempSand
TempBoundary
(e) Grain size (μm)
0
62.5
125
187.5
250
Average (μm)
Mode (μm)
(f) Thickness (m)
0
0.4
0.8
1.2
1.6
2
Sand
Silt
Test Site:
Water depth 998 m
Seafloor slope 10 degrees
Reservoir top 277 mbsf
Core interval 250-340 mbsf


In scale
Site AT1
Vertically Exaggerated
β-1 well (2004)
NW
SE
1250msec
(TVD=940m)
1500msec
(TVD=1125m)
1750msec
(TVD=1310m)
Ogasa
sequences
Top of MHCZ
(Methane Hydrate Concentrated Zone)
WD~1000m
GHCZ~270-333mBSF
BSR
0
1.25
2.5

Geologic/Geophysics Characterization of the JOGMEC Gas Hydrate Production Test Site

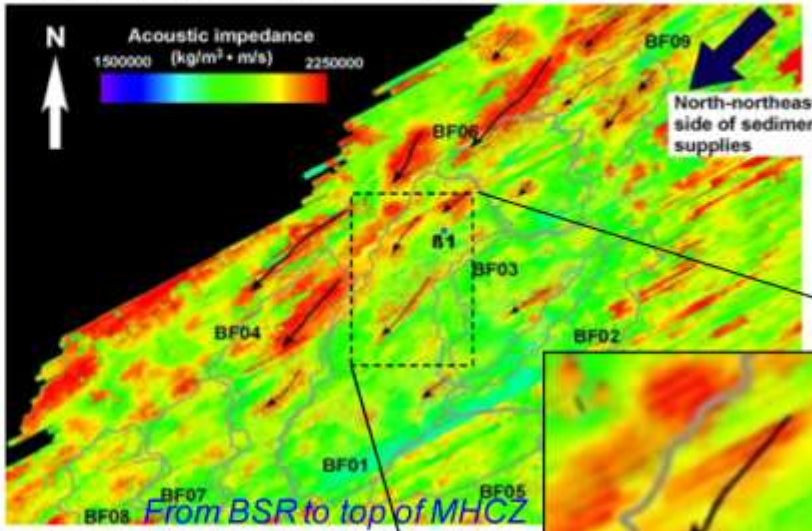
(1) Interpretation of Channel Facies

Identifying bottom frame (BF) of channels

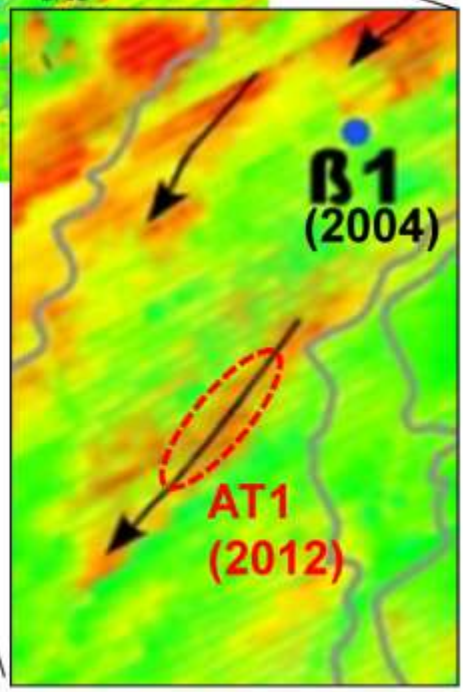


Noguchi et.al. (2011): ICGH 7

(2) P-impedance from seismic inversion



Noguchi et.al. (2011): ICGH 7



Channel Distribution (NE-SW)

Results of Geotechnical holes (2011)

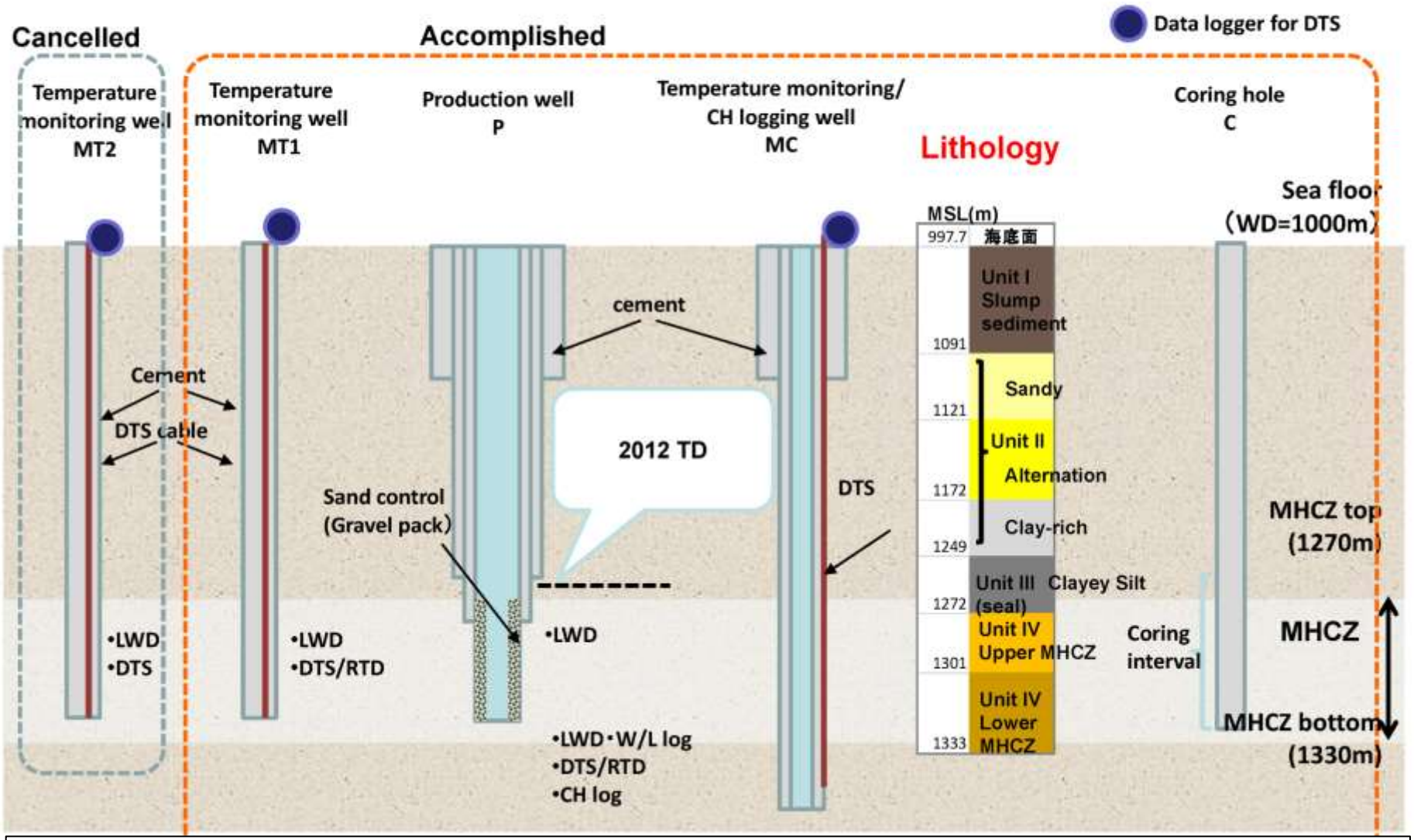
Well to well correlation

Sea floor bathymetry

Location of the Production Test

Wells after the drilling campaign

JOGMEC



One production well (AT1-P), two monitoring wells (AT1-MC and MT1), and one core well (AT1-C) were established.

JOGMEC Gas Hydrate Production Test

Jiji Press (Mar. 20, 2013)
http://www.yomiuri.co.jp/dy/business/T130319003171.htm

The government completed test production of methane gas from seabed methane hydrates off Aichi Prefecture on Tuesday, earlier than initially planned, due to bad weather and equipment problems. The test production, the world's first from seabed methane hydrates, began March 12 for a two-week run. The industry ministry indicated it was difficult to continue as stormy seas were forecast. However, the ministry said the test was fairly successful and the shortened period would not affect future research and development. It will continue to work toward establishing technologies to produce gas from seabed methane hydrates on a commercial basis by fiscal 2018.

Production Period: About six days
Cumulative Gas Production: ~120,000 cubic meters (4,200,000 cubic feet)
Mean daily gas Production: ~20,000 cubic meters (700,000 cubic feet)

NEWS RELEASE www.jogmec.go.jp

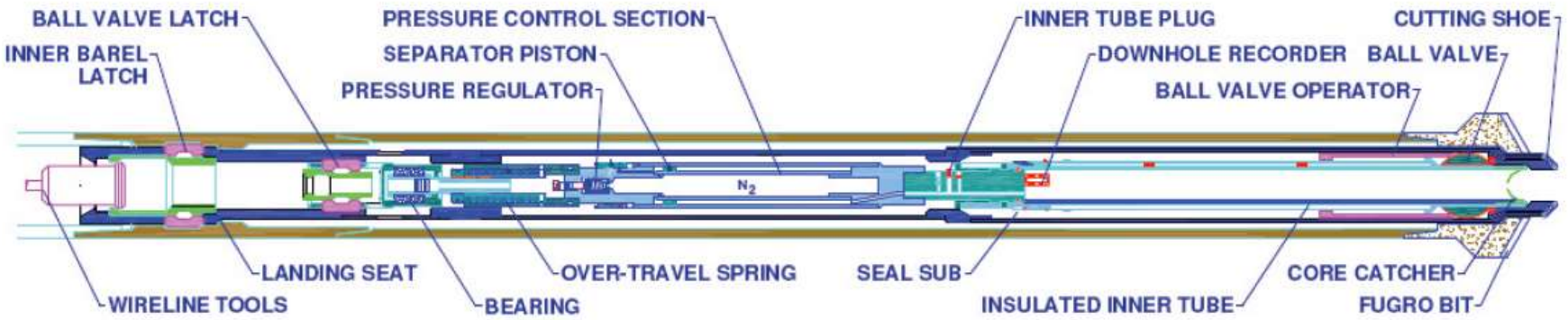
JOGMEC

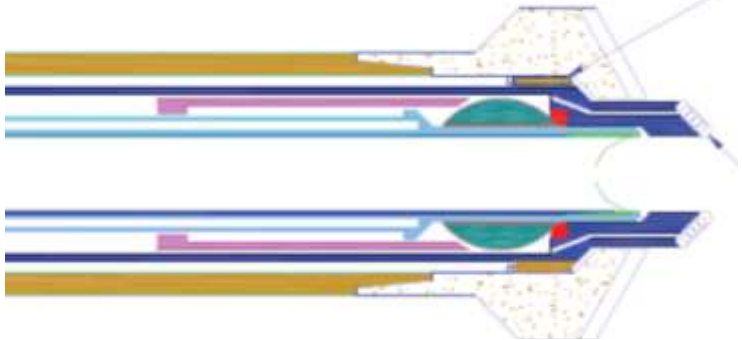
Japan Oil, Gas and Metals National Corporation

Methane Hydrate R&D Division, Technical Department
Fax:+81-43-276-4062 mh21info@jogmec.go.jp
Public Relations Division, General Coordination Department
UEMATSU Fax:+81-3-6758-8008

Gulf of Mexico JIP Project

Hybrid-PCS Tool Development and Testing





- ***Modified from the design of the successful PTCS which was designed and developed for JOGMEC from 1997-2003, and successfully used to collect gas hydrate-bearing sand.***
- ***Deployed on a wireline that locks into the BHA.***
- ***Corer/drill pipe assembly is driven from the top drive, cutting a 3.5m long 54mm diameter core.***
- ***Upon completion of the coring process a running tool connects with the corer for retrieval.***

Aumann & Associates

GEO TEK

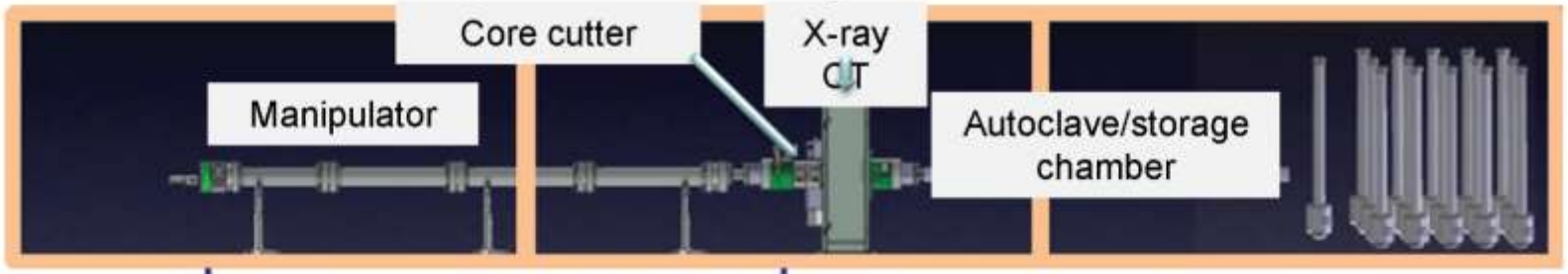
Georgia Tech

USGS science for a changing world

Hybrid PCS/PCTB – JAMSTEC (CEDEX) and JOGMEC: Industry standard pipe of 5.5 inch ID and core strings on the Chikyu and the Resolution – deployed by JOGMEC June 2012 in the Nankai Trough.

PCATS

- Pressure core is transferred to the device, X-ray and MSCL (sonic, density) scanned, cut, and stored in storage chamber.
- Loaded on the back deck of Chikyu, and used on board



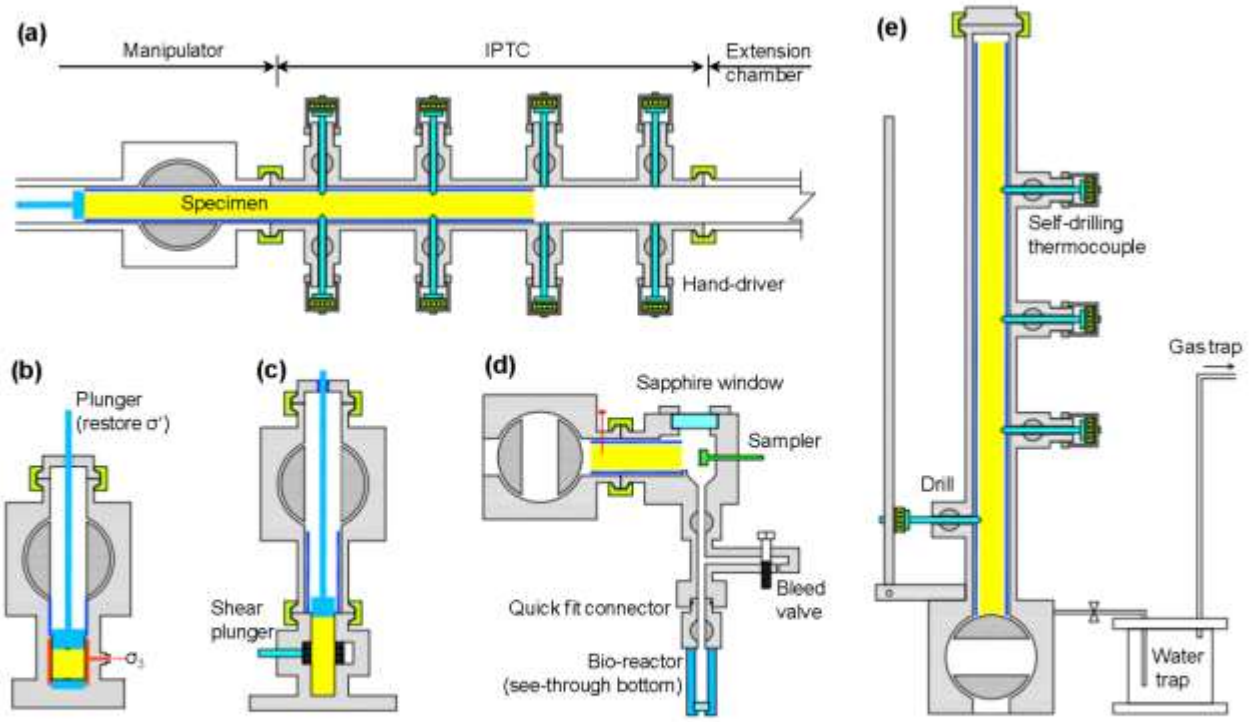
Lab Pressure Equipment and Storage Vessels

IPTC – USGS/Georgia Tech

Vp-Vs, thermal & electrical conductivity, strength, water/gas sampling
IPTC manipulator
IPTC cutting tool

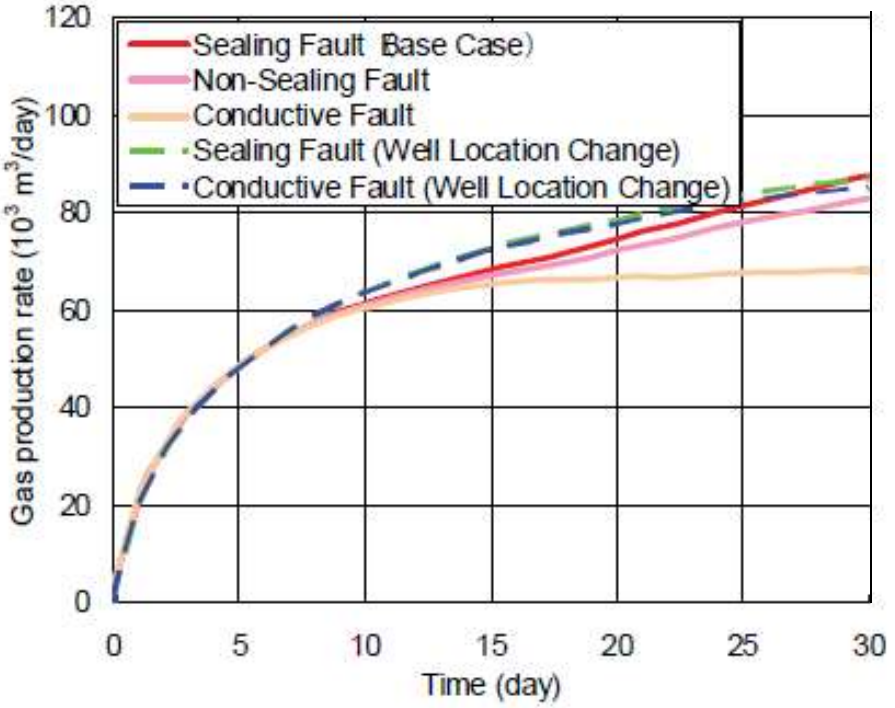
Effective stress cell – Georgia Tech

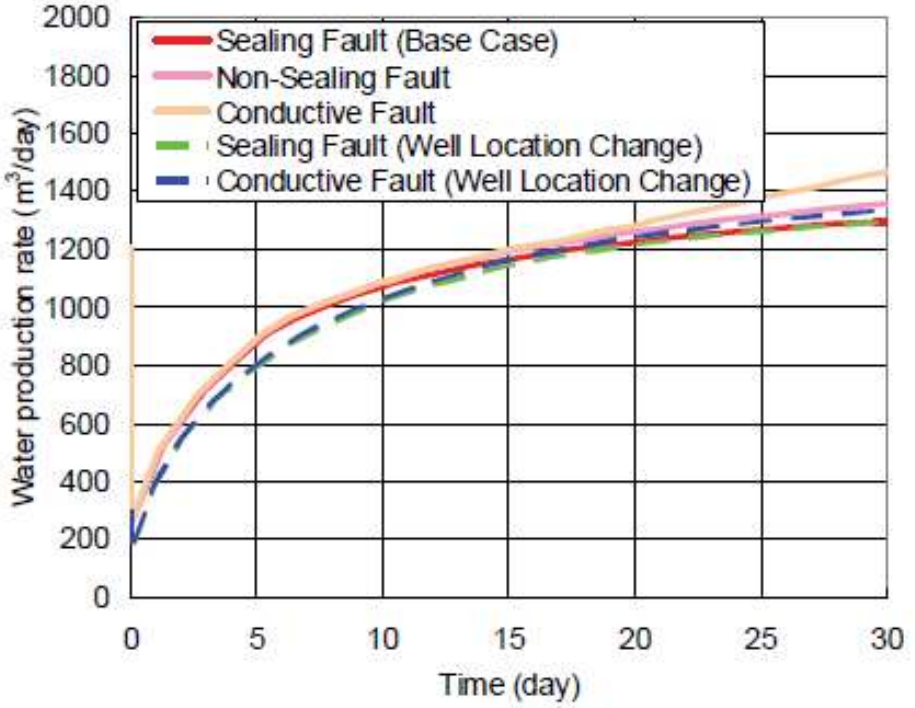
Vp-Vs, thermal & electrical conductivity
Shear strength device
Water/gas sampling
Mass-transfer
Microbio-reactor

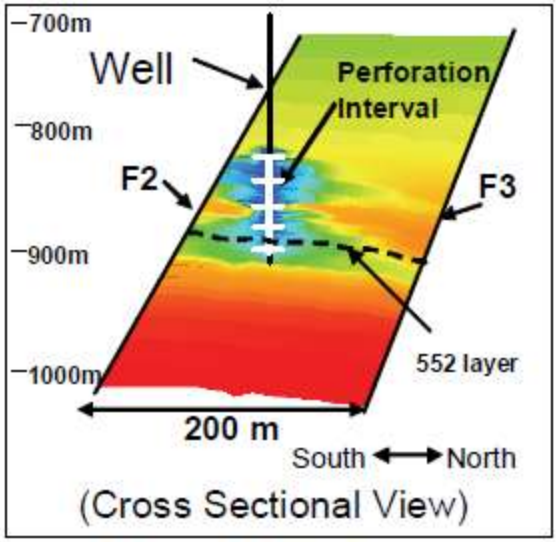


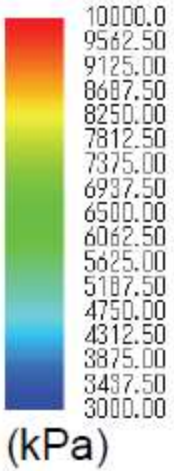
(a) IPTC, (b) ESC effective stress chamber, (c) DSC direct shear chamber, (d) BIO sampler, (e) CDP depressurization chamber

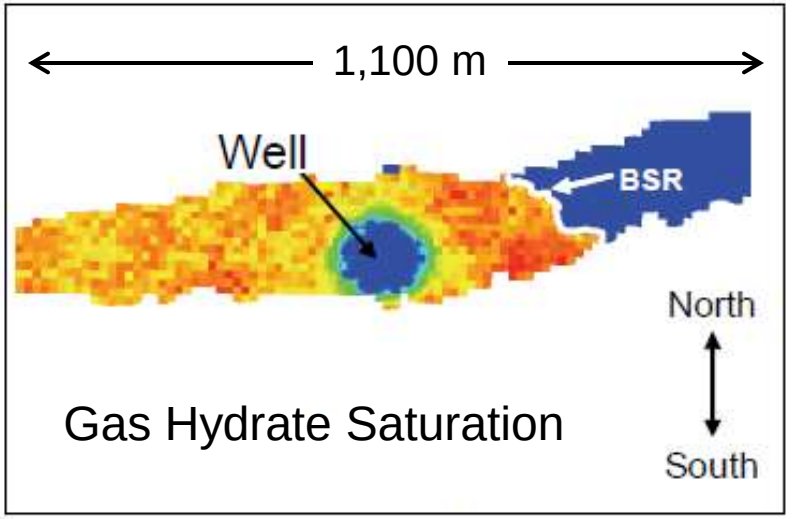
Reservoir Production Modeling – α1 Site







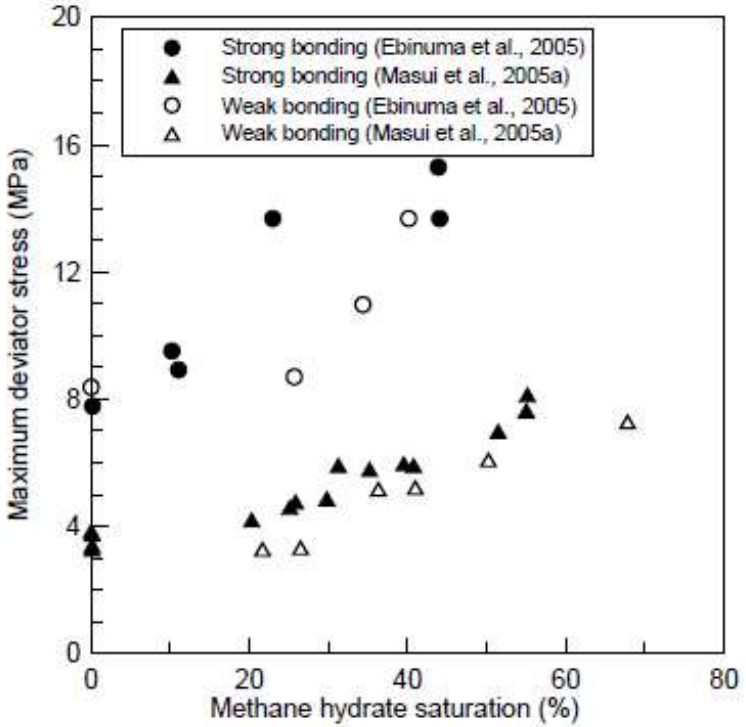


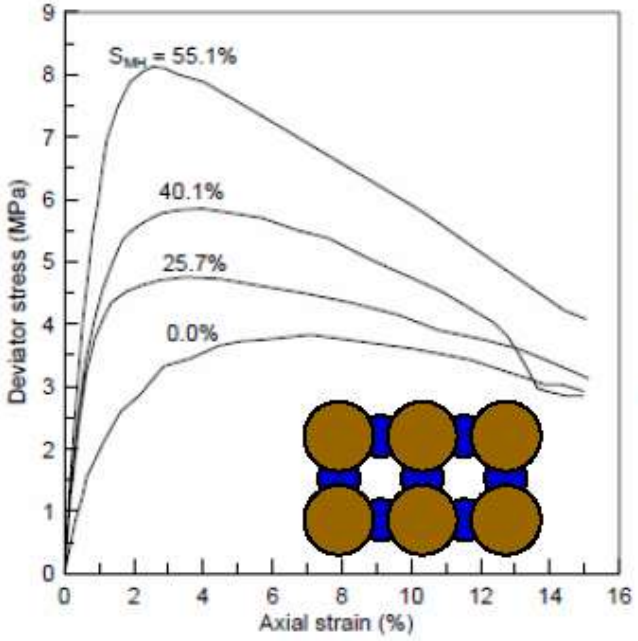


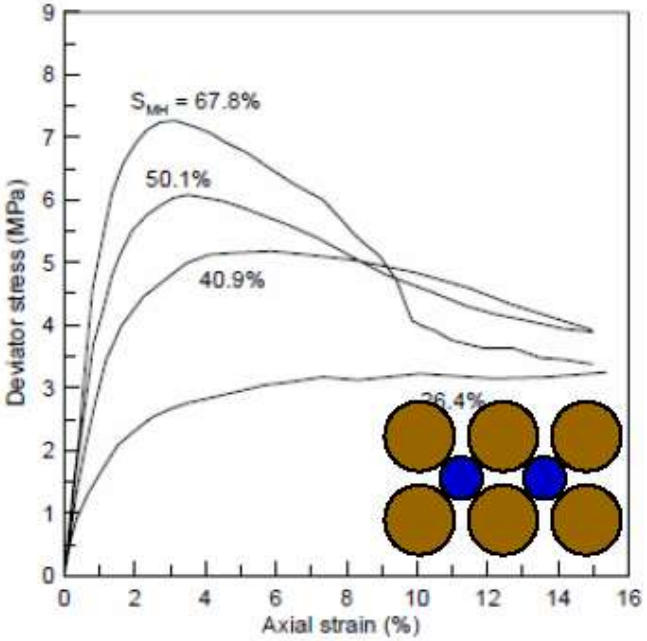
Kurihara et al., (2010), OTC 20737

Methane Hydrate Geomechanical Studies

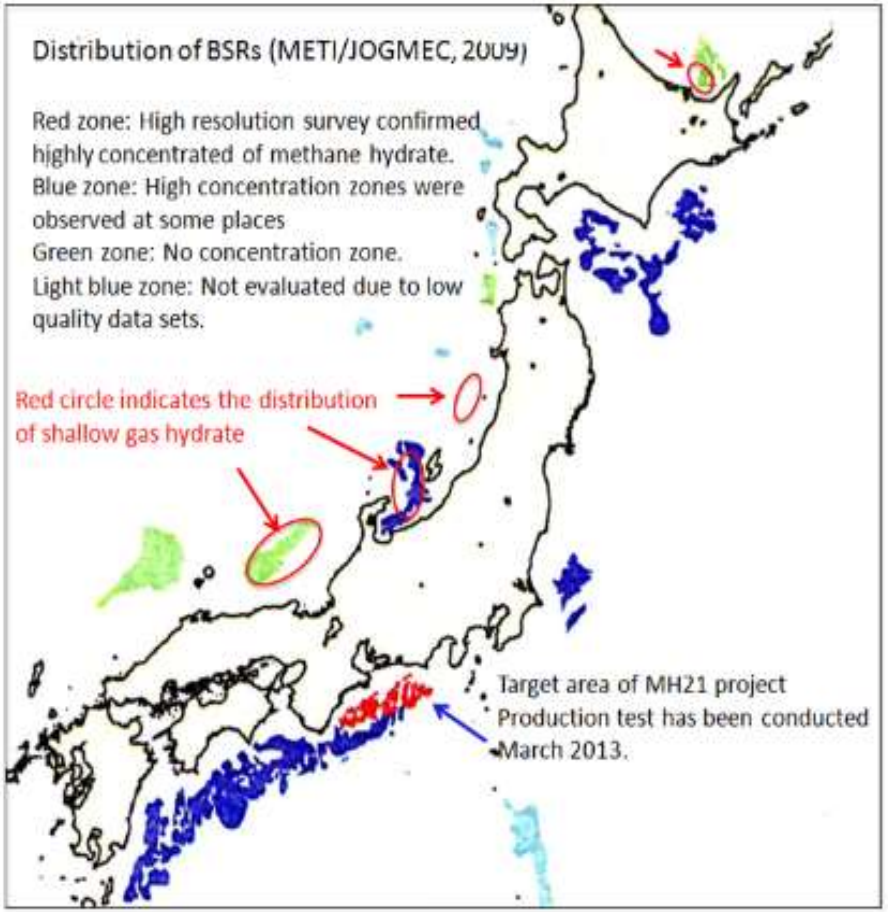
Koji Yamamoto (2008) IACMAG
Synthetic hydrate laboratory studies

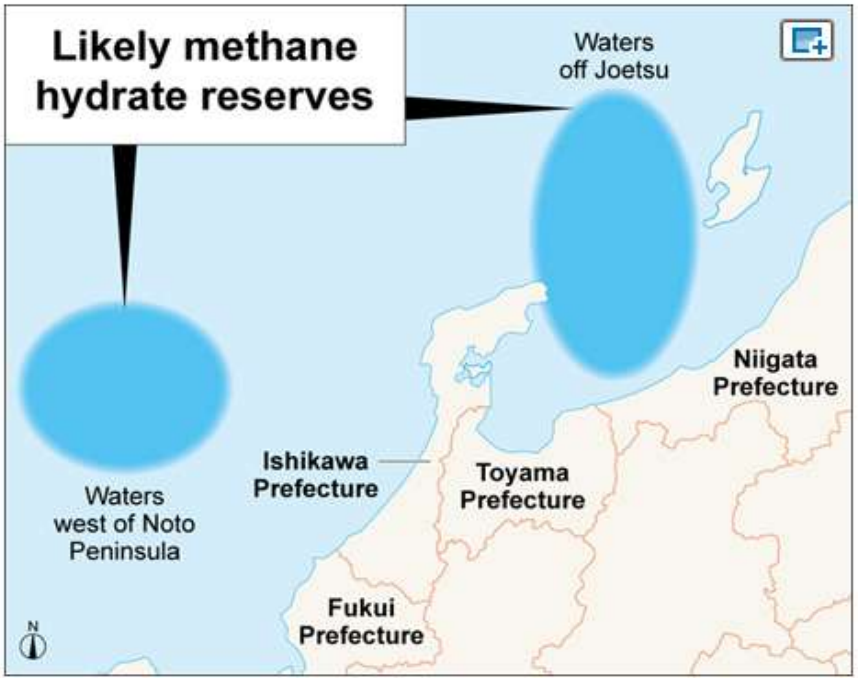






Joetsu-Noto Methane Hydrate, Sea of Japan



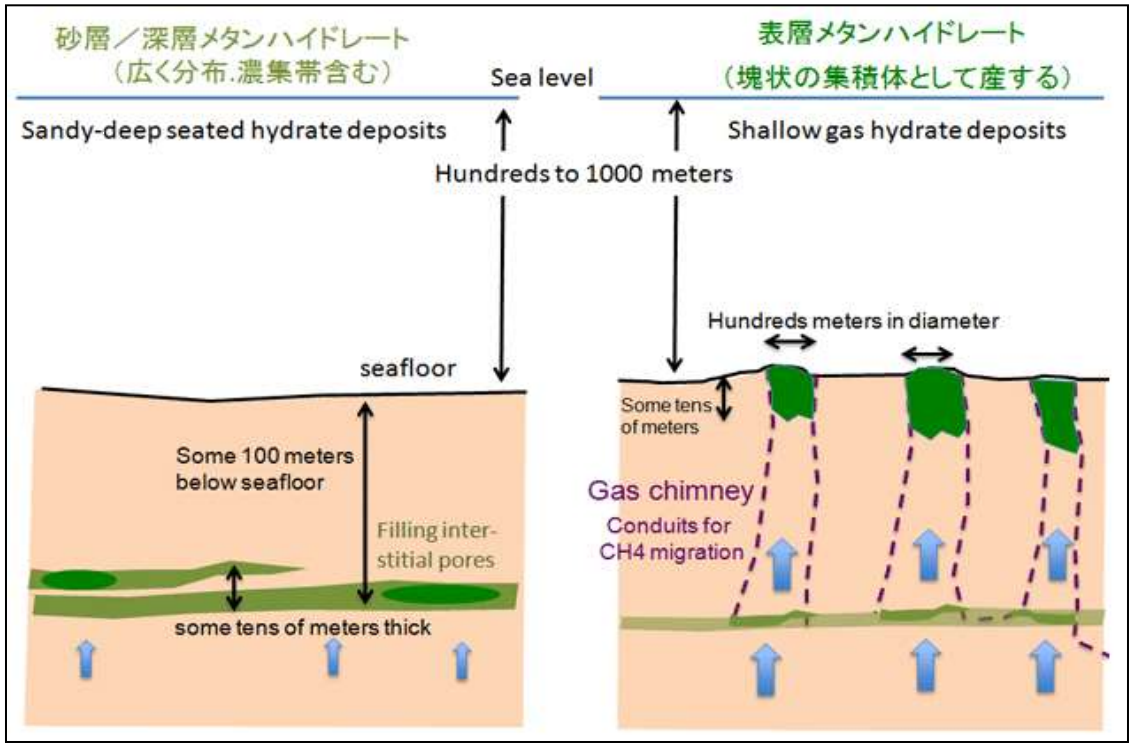


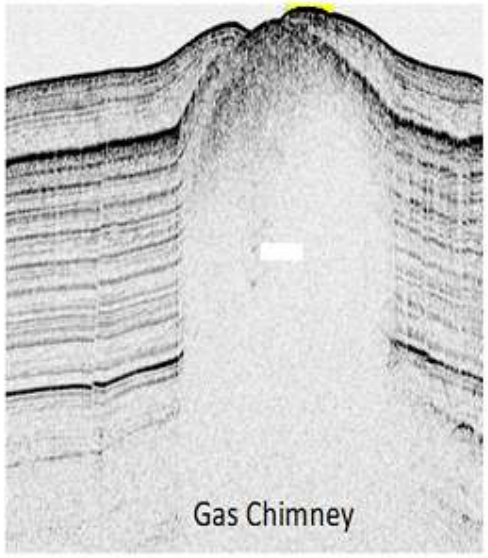
Agency for Natural Resources and Energy (ANRE)
Funded by the Ministry of Economy, Trade and Industry

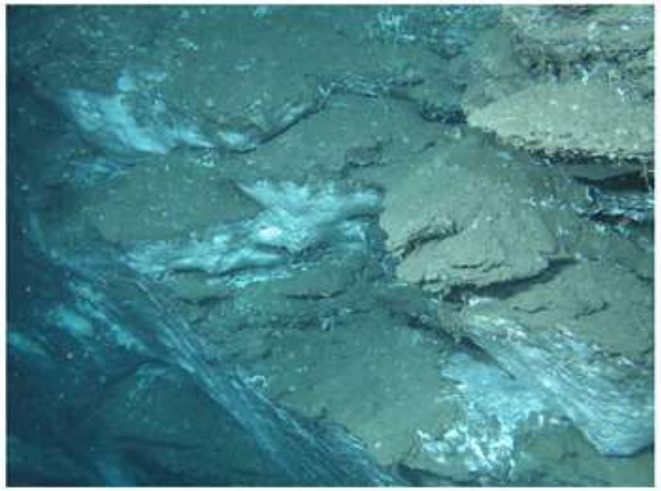
" Survey of Shallow Subsurface Methane Hydrate Resources with 225 sites with geographical features suggesting reserves of methane hydrate in waters off Joetsu, Niigata Prefecture, as well as the Noto Peninsula"

Joetsu-Noto Methane Hydrate, Sea of Japan

"Most of the methane hydrate deposits in the Sea of Japan are concentrated near the seafloor's surface, while the reserves in Pacific waters off the Atsumi Peninsula are contained in sandy sediment layers beneath the ocean floor. That means reserves in the Sea of Japan are likely more accessible"







- **UBGH1 and UBGH2 - Korea**

Korea

Korea: “Gas Hydrate Research and Development Organization - GHDO”

Ministry of Commerce, Industry and Energy (MOCIE now MKE)
Korea Institute of Geoscience and Mineral Resources (KIGAM)
Korea National Oil Corporation (KNOC)
Korean Gas Corporation (KOGAS)

- **Conduct marine geophysical surveys in the East Sea (2000-2004).**

- **This project has included the acquisition of >7,000 km of 2D MCS profiles and >5,000 km of single channel seismic profiles; and a total of 38 shallow core holes <10 mbsf.**

- **Basic and applied gas hydrate laboratory studies dealing with gas hydrate physical properties and reservoir simulation.**

- **Conducted gas hydrate research coring and logging in the Ulleung Basin in 2007 (UBGH1).**

- **Second gas hydrate research coring and logging expedition conducted July-September 2010 in the Ulleung Basin (UBGH2). Plus new 2D and 3D seismic data acquisition.**

- **Gas hydrate production testing in the Ulleung Basin in 2015.**

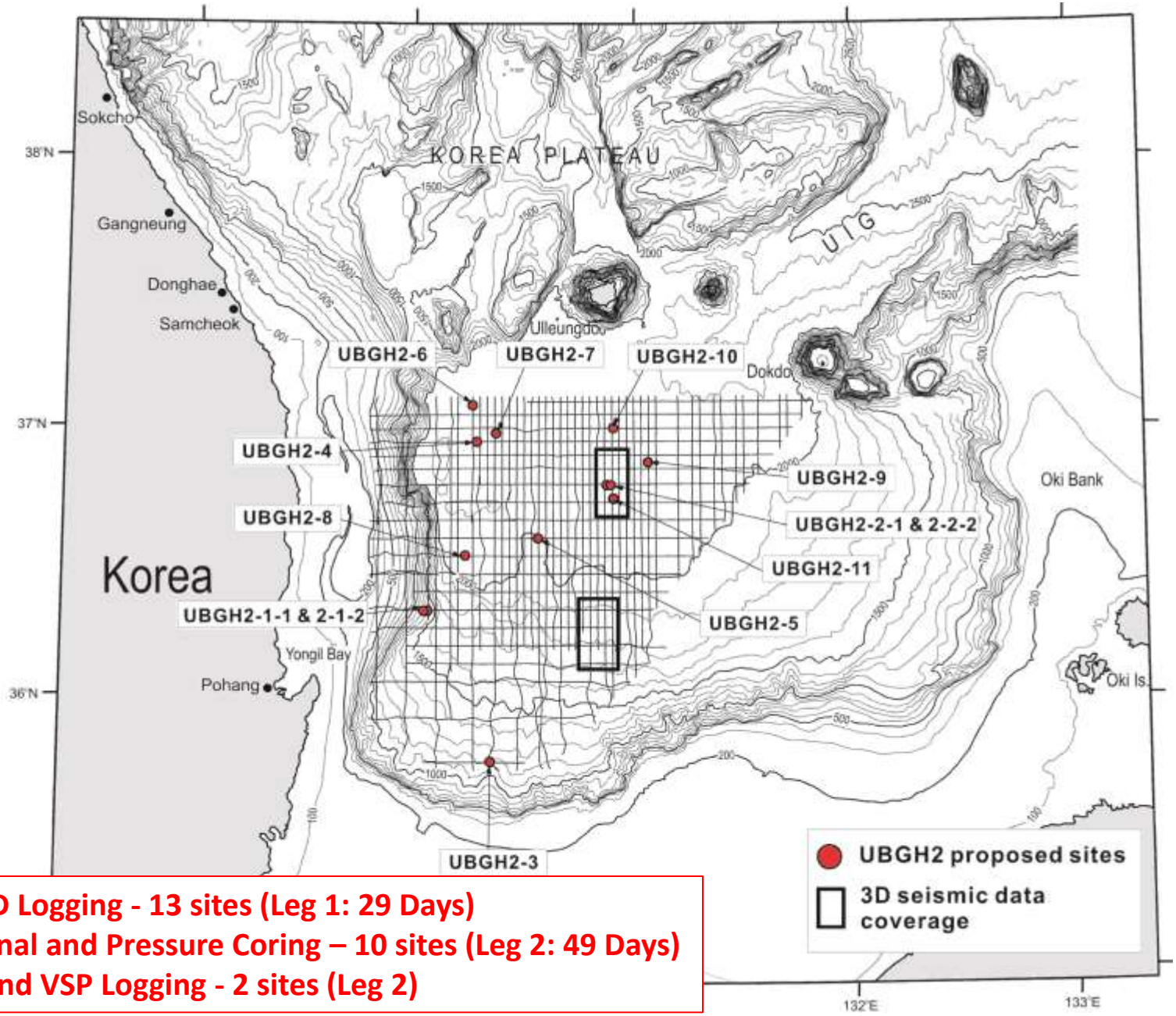
Long Term Plan for Gas Hydrate in Korea

Execution of the project by phase with the target of commercial production in 2015

Field	preliminary step (2000 ~ 2004)	1st phase (2005 ~ 2007)	2nd phase (2008 ~ 2011)	3rd phase (2012 ~ 2014)
1. Regional Seismic Survey & Basic R&D				
2. Prospect I Survey & Drilling (Component research)		UBGH1 2007		
3. Prospect II Survey & Drilling (Base technology for production)			UBGH2 2010	
4. Test Production & Confirmation of production method				UBGH3 2014

Korea: "Gas Hydrate Research and Development Organization"
Korea Institute of Geoscience and Mineral Resources (KIGAM)
Korea National Oil Corporation (KNOC)

Ulleung Basin Gas Hydrate Drilling Expedition (UBGH2) 2010



LWD-MWD Logging - 13 sites (Leg 1: 29 Days)
Conventional and Pressure Coring – 10 sites (Leg 2: 49 Days)
Wireline and VSP Logging - 2 sites (Leg 2)

Ulleung Basin Gas Hydrate Prospects

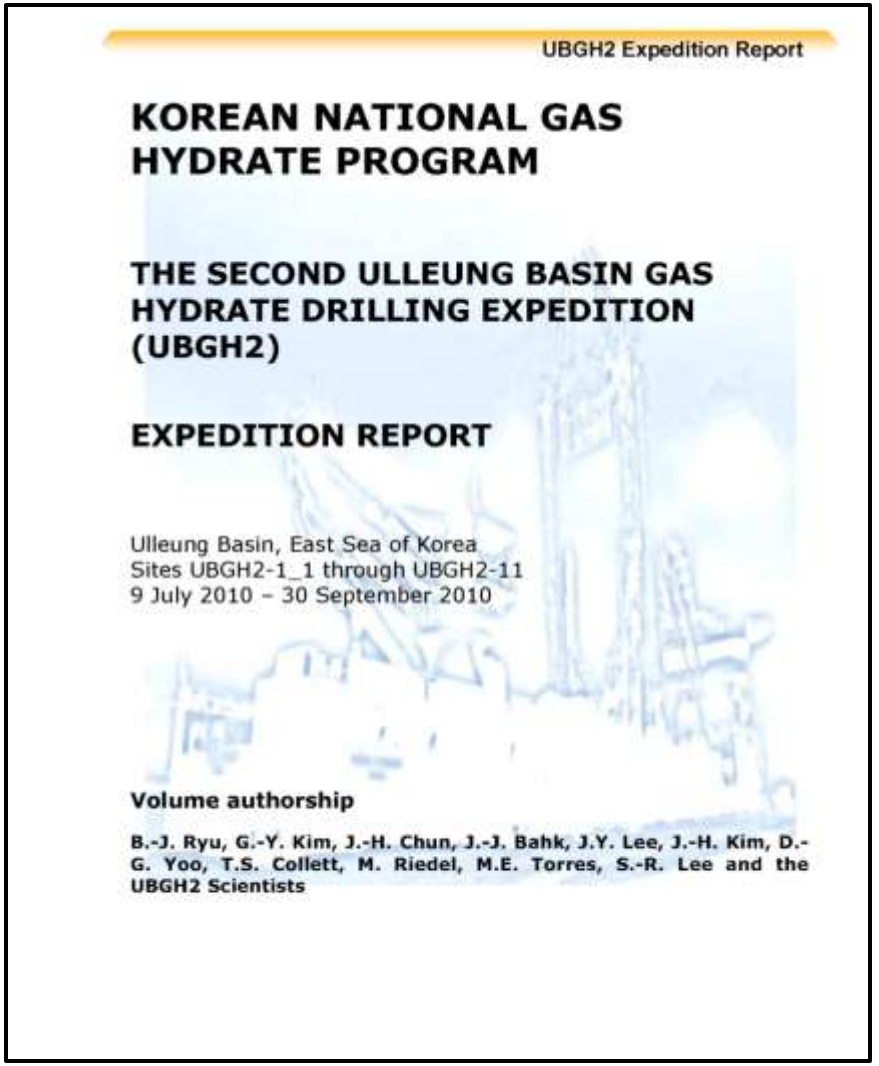
-Chimney structures (vents, etc.)

-Diatom-rich hemipelagic fracture-dominated reservoirs

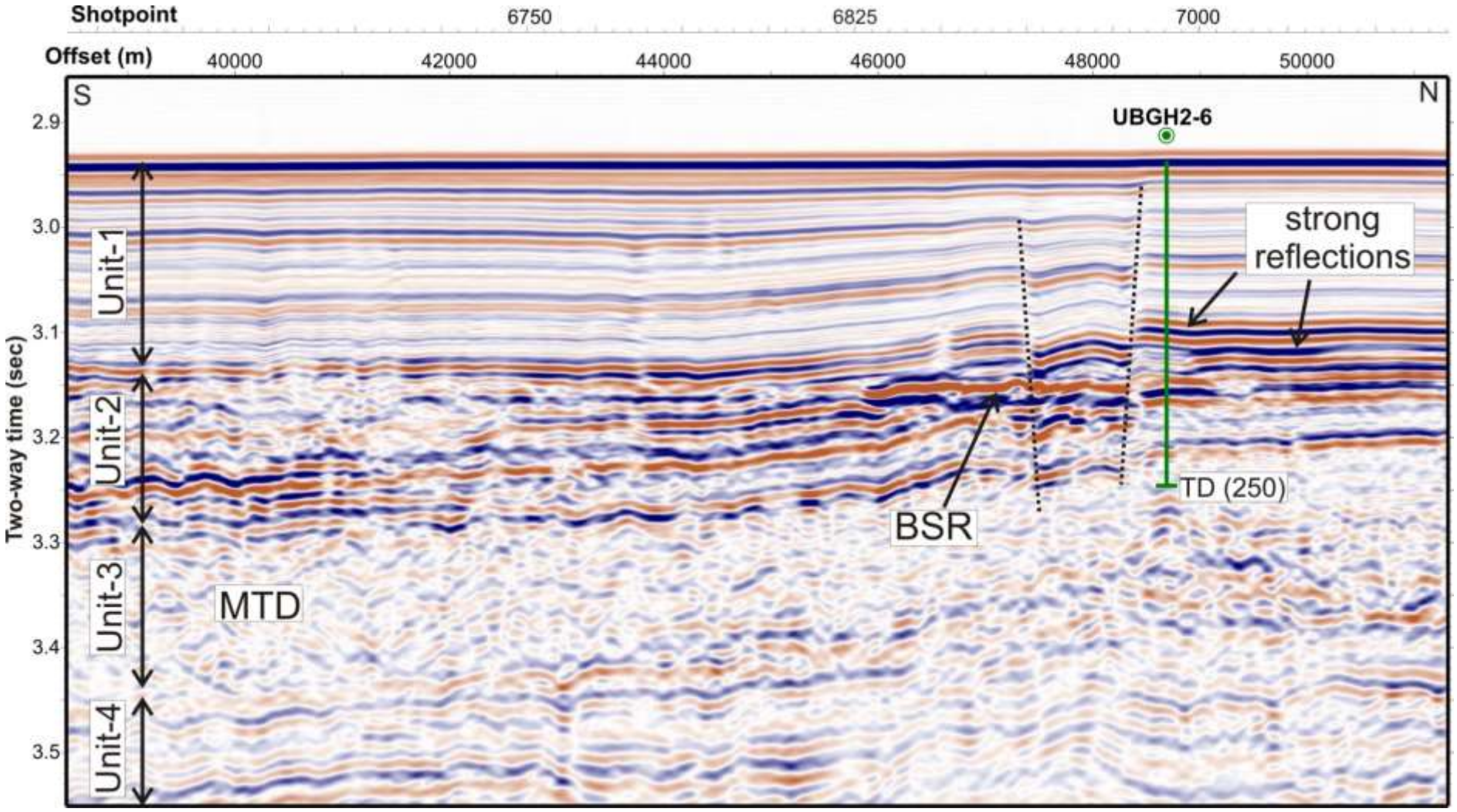
-Sandy debris flows

-Turbidite sands

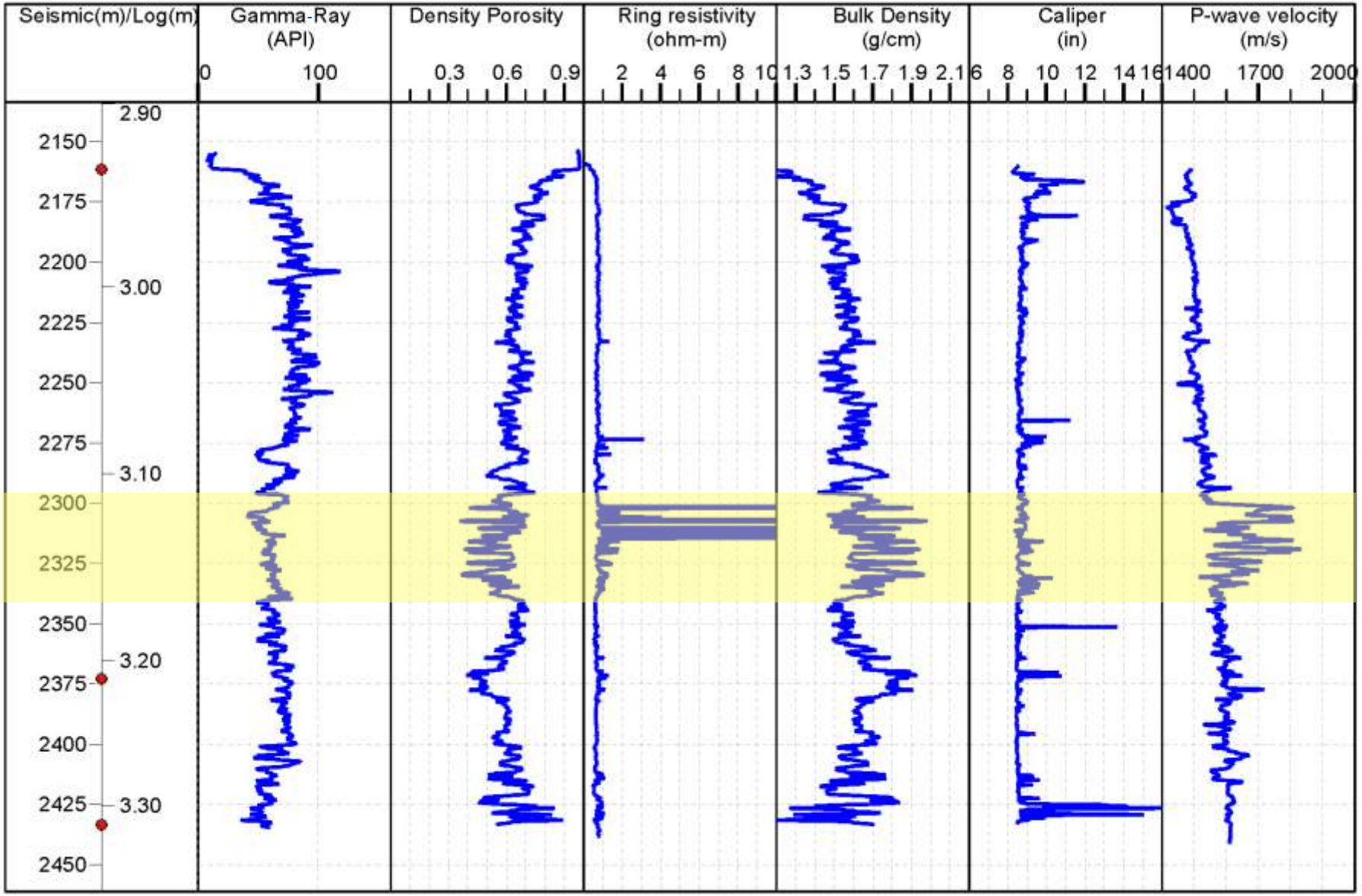
LWD-MWD Logging - 13 sites (Leg 1)
Conventional and Pressure Coring – 10 sites (Leg 2)
Wireline and VSP Logging - 2 sites (Leg 2)



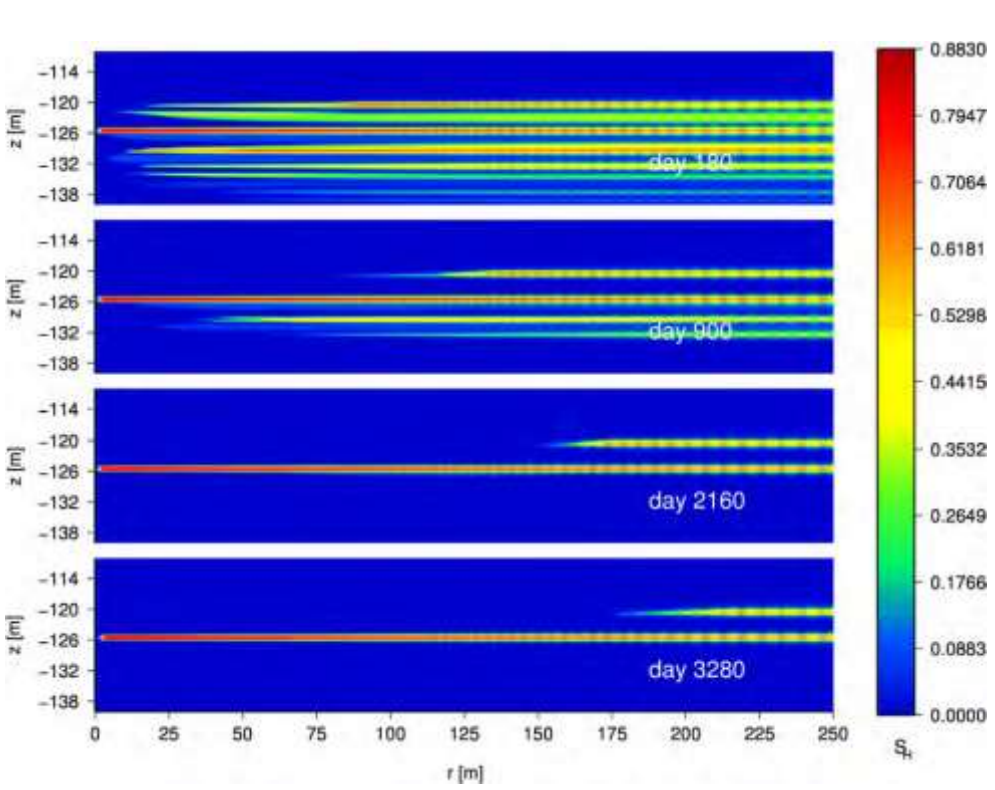
Ulleung Basin Gas Hydrate Drilling Expedition: UBGH2-6

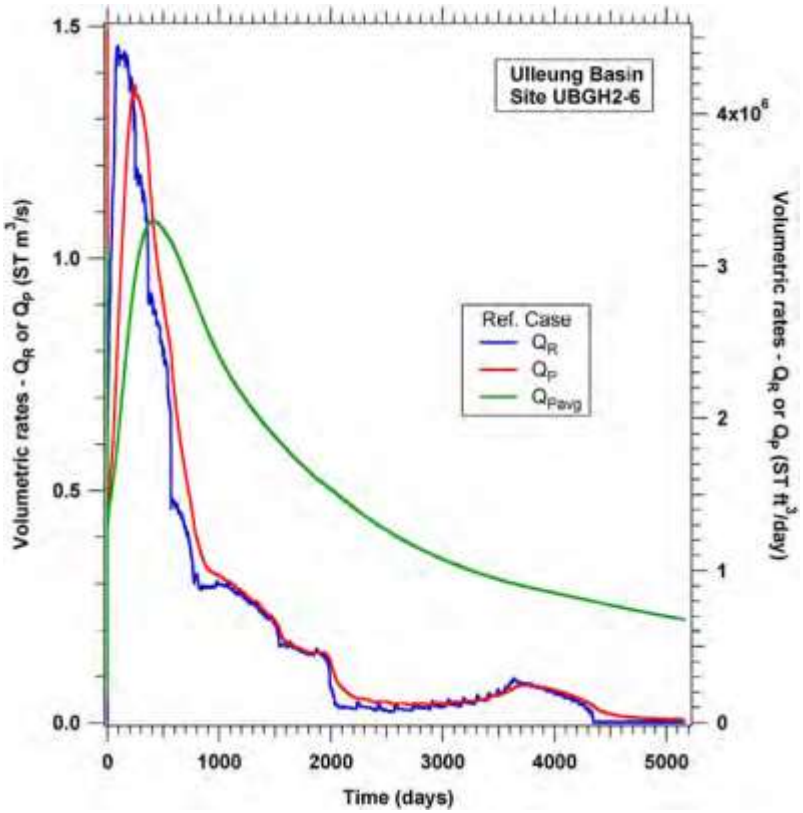


Ulleung Basin Gas Hydrate Drilling Expedition: UBGH2-6



Site UBGH2-6 Gas Hydrate Production Modeling





Production rate of 1.5 ST m^3 per sec ($4.5x10^6$ ST ft^3 per day).

Total production of 10^8 ST m^3 ($3.5x10^9$ ST ft^3) in 5200 days (about 14 years)

The low production rate is caused by the relatively low amount of the resource (10 m of hydrate-bearing strata) and the low overall permeability of the system with clay interlayers.

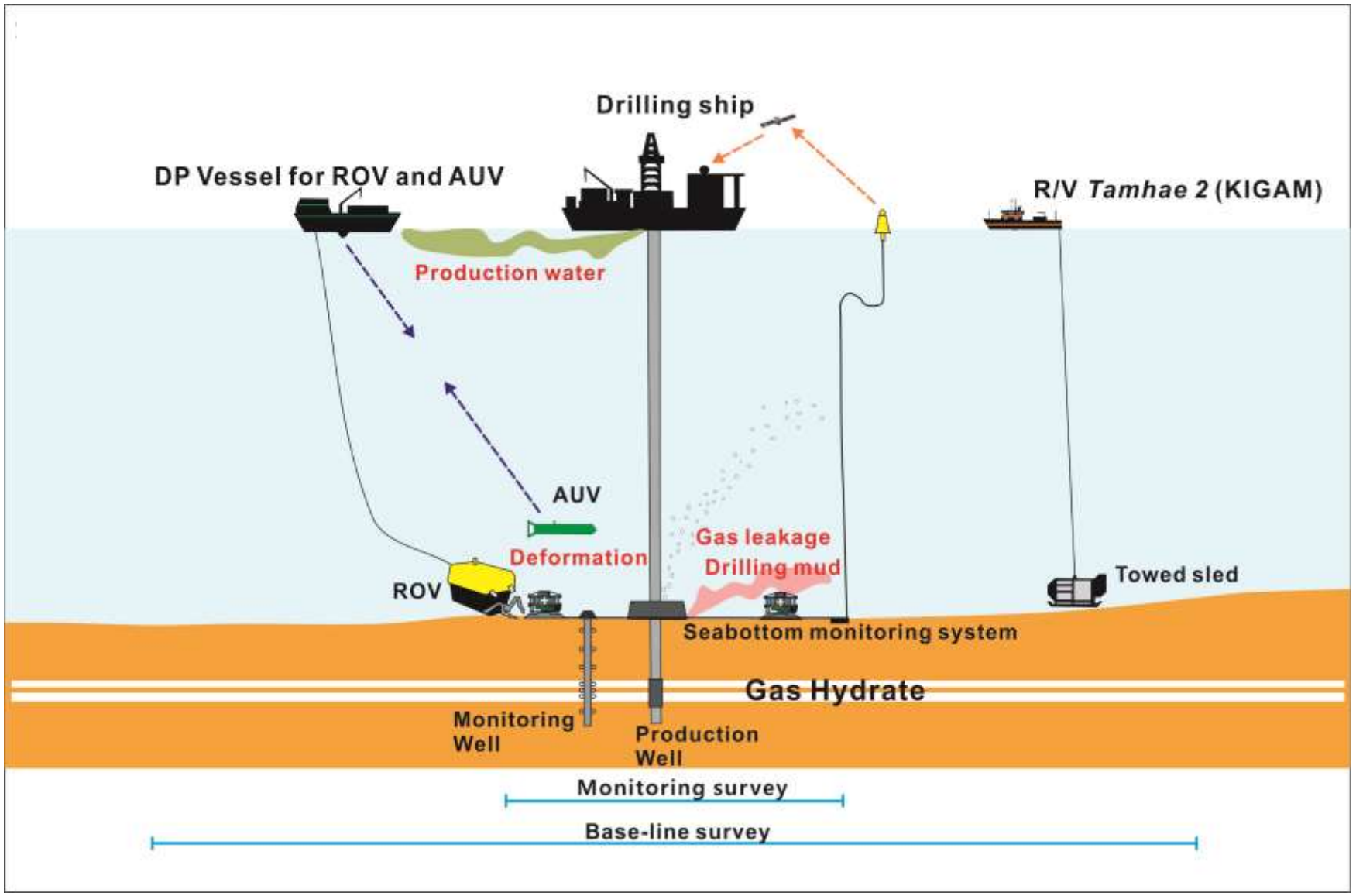
Moridis et al., 2013

Ulleung Basin Gas Hydrate Production Test Plan

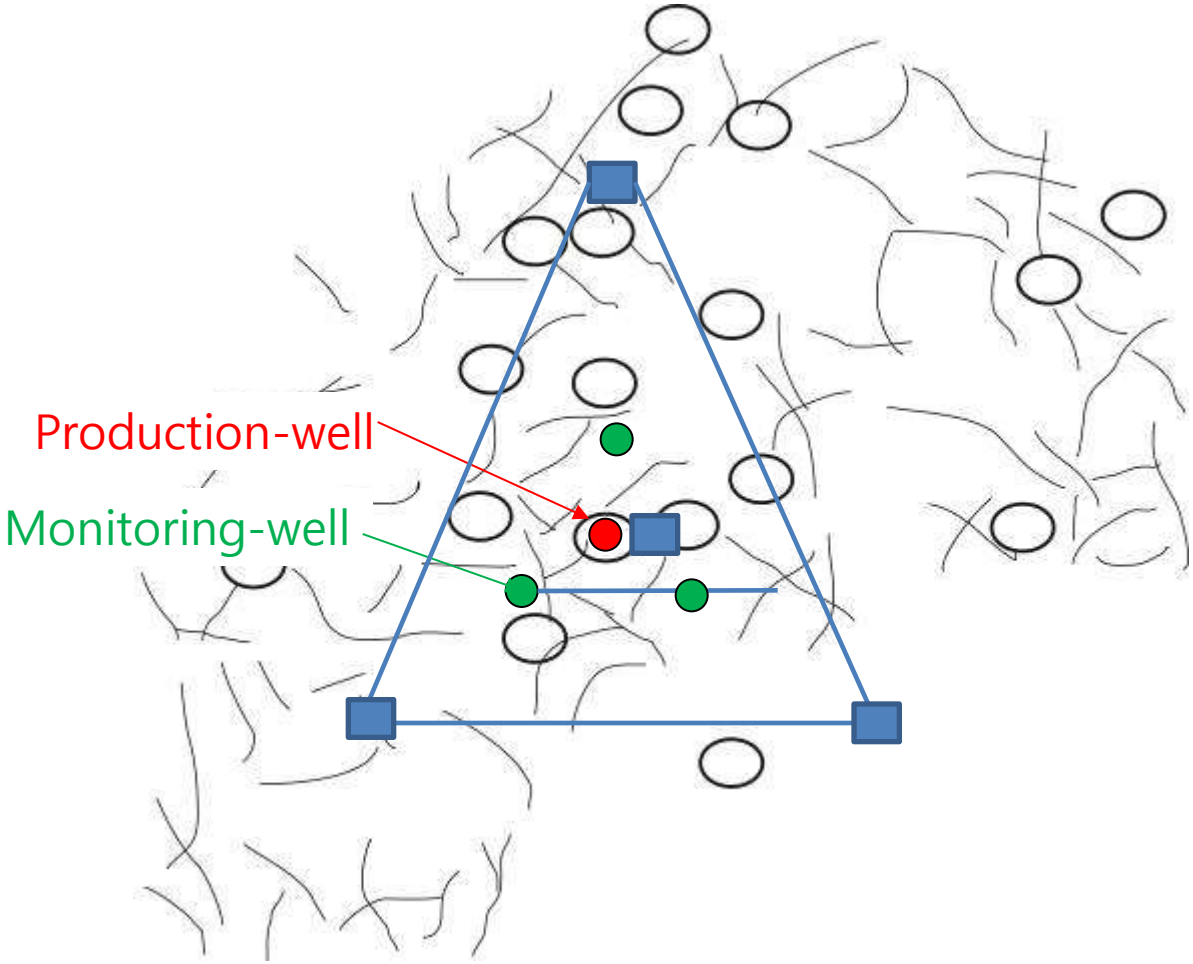
GHDO Gas Hydrate Production Test Plan

September, 2012 : Determination of budgets
September, 2013 : Determination of test production sites
September, 2014 : Development of test plan
April-June, 2015 : Performance of production test

2015 Environmental Impact Study



2015 Monitoring Study



- Interpretation of seafloor deformation
- Connection of four observation platforms and monitoring well
- Acquisition and broadcast of real-time monitoring data

- **NGHP-01 India**

India

India: “National Gas Hydrate Program”

-The National Gas Hydrate Program (NGHP) was initiated by the Ministry of Petroleum and Natural Gas (MOP&NG) in 1997.

-In 2000, the National Gas Hydrate Program (NGHP) was reconstituted by MOP&NG with the direction of the Directorate General of Hydrocarbons (DGH)

A. Steering Committee – PN&G, as directed by MOP&NG

B. Technical Committee – MOP&NG, DGH, ONGC, GAIL, OIL, NGHI, CSIR, NIO, NIOT, DOD

C. Operational Subgroups – Drilling (ONGC), Production (ONGC), Geoscience (ONGC), Environment (ONGC), Transportation (GAIL)

-In 2006 research drilling, coring and logging under NGHP Expedition 01

-In 2014/2015 research LWD, coring, and wireline logging under Expedition 02

India: “National Gas Hydrate Program”
NGHP R&D Activities

-Journal of Marine and Petroleum Geology – NGHP 01 Scientific Results Vol

-NGHP02 Drill Site Review and Selection – Gas Hydrate Prospecting

-NGHP02 Operations – Project Scope and Planning

-Gas Hydrate Production Modeling with Laboratory Support

-India National Gas Hydrate Assessment

-NGHP03 Gas Hydrate Production Testing

-Development of Domestic R&D Capabilities

NGHP Expedition 01

- Expedition began in Mumbai, India (April 28, 2006) and ended in Chennai, India (August 19, 2006).
- 21 sites were established during NGHP Expedition 1, Total of 39 holes, 12 LWD-MWD holes were drilled; 27 core holes; 13 wireline logged holes and six VSP surveys.
- Examined 9,250 m sedimentary section; 2,850 m of recovered core.

Kerala-Konkan:

One Site

Krishna-Godavari:

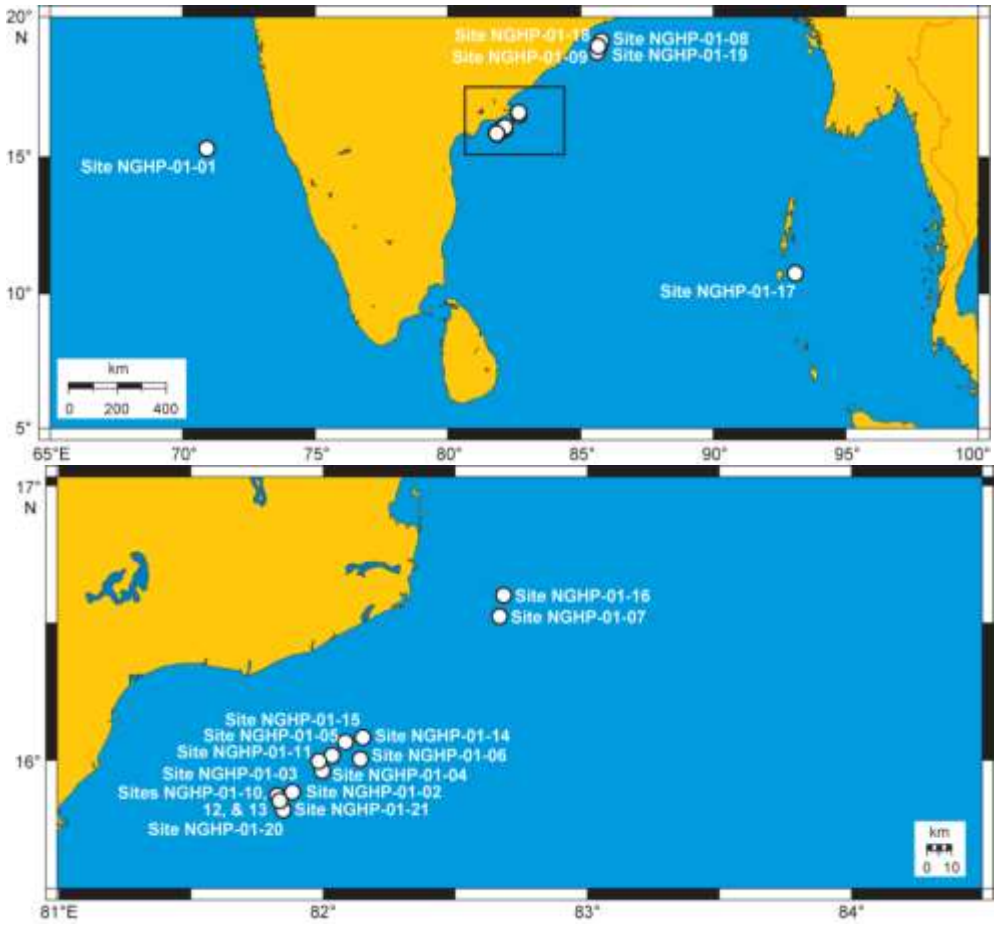
Fifteen Sites

Mahanadi:

Four Sites

Andaman Islands:

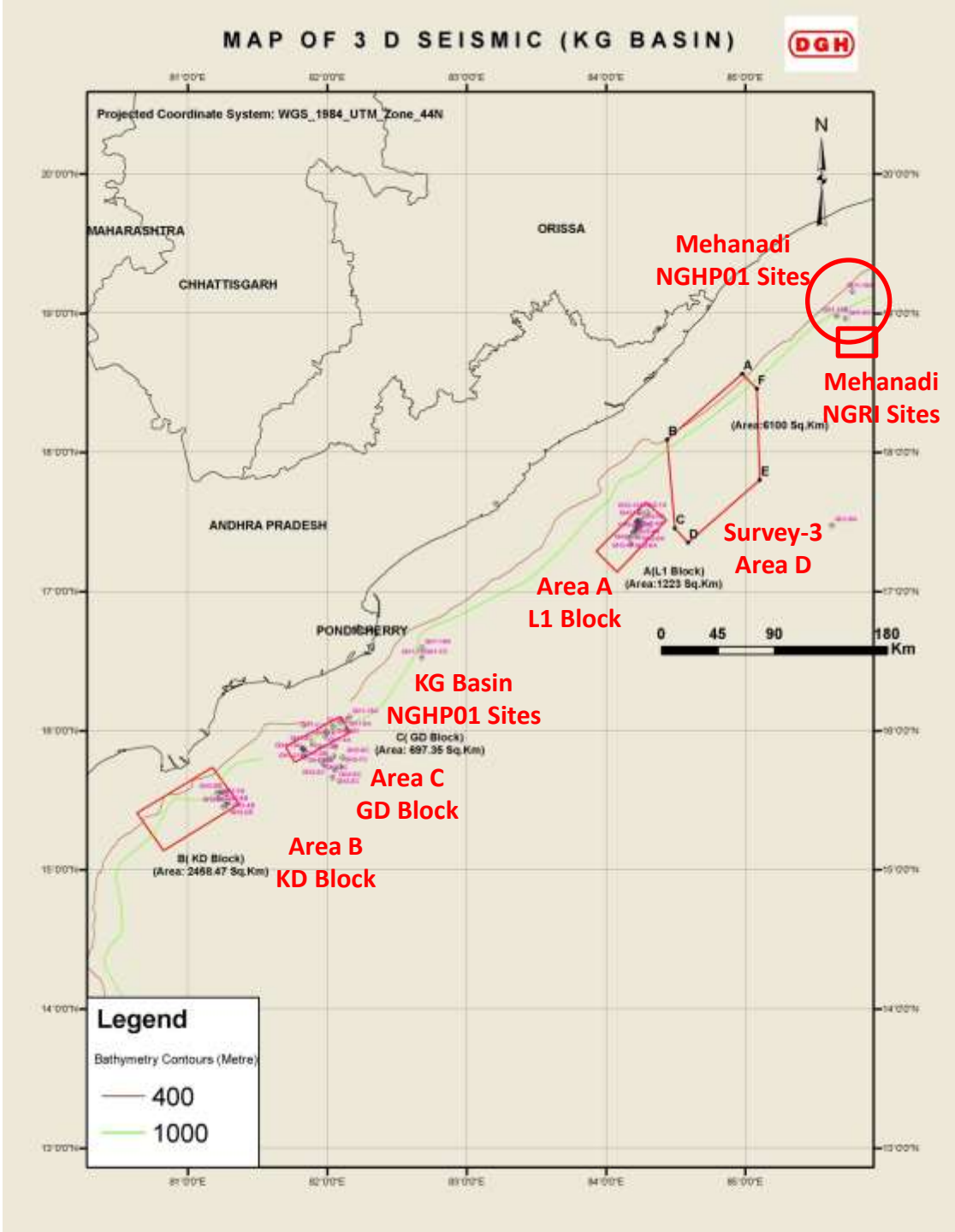
One Site

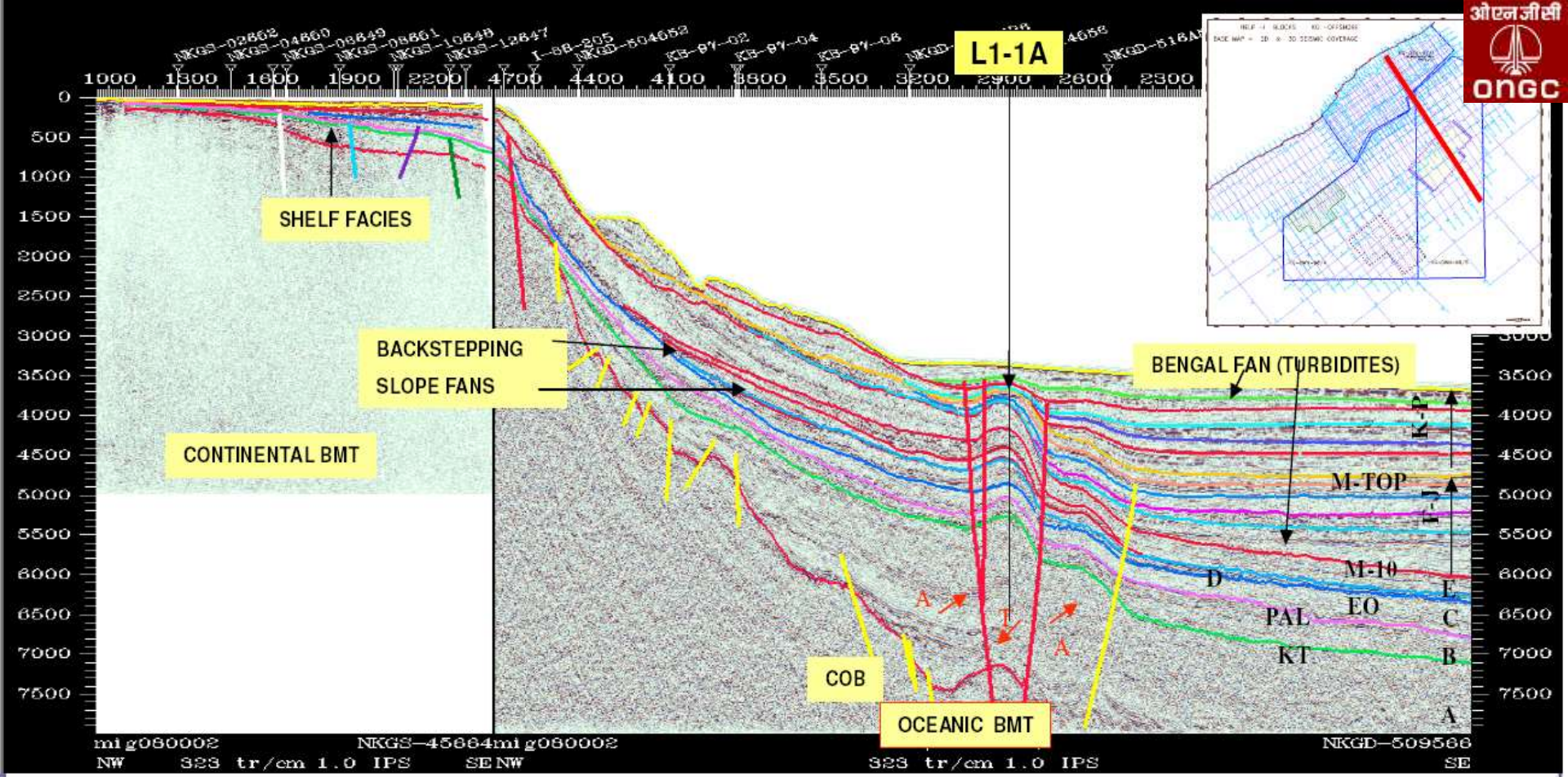


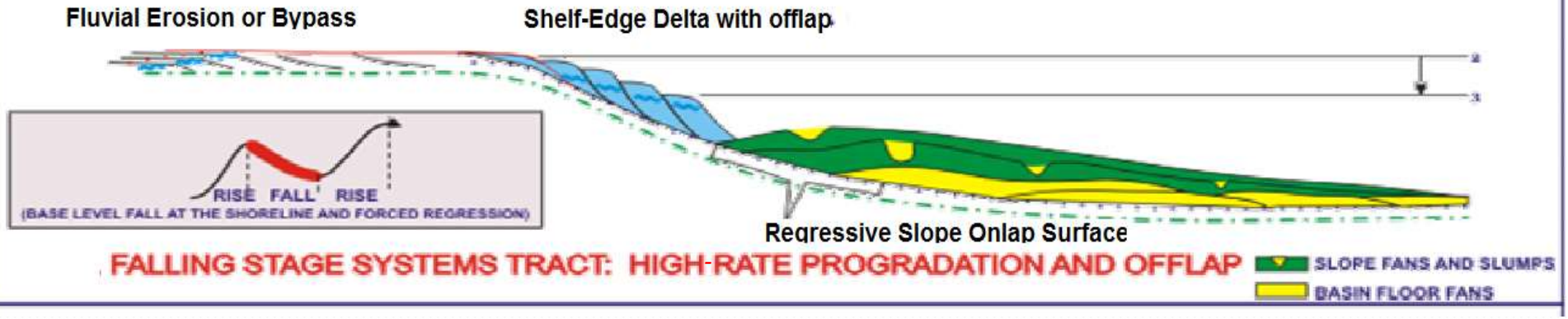
National Gas Hydrate Program

NGHP Expedition 02

Gas Hydrate Prospecting

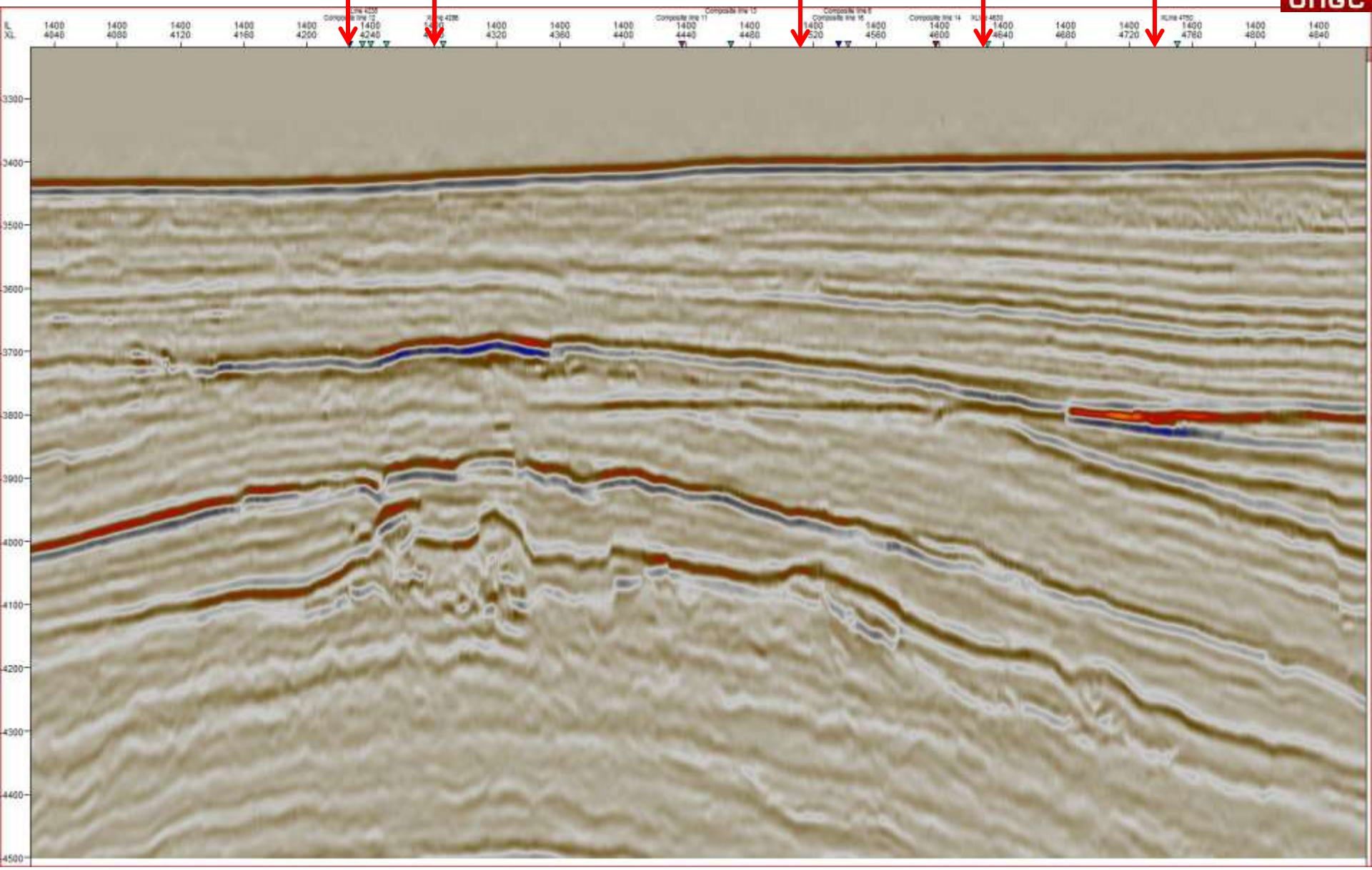






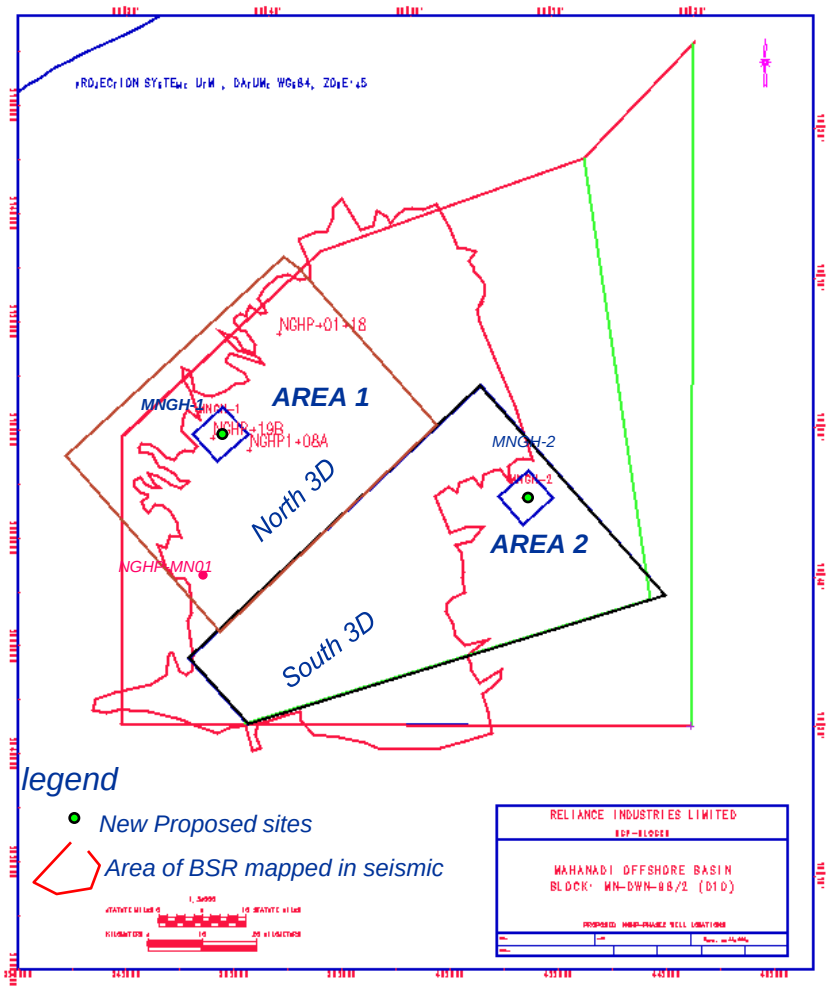
Source: WOB, Mumbai

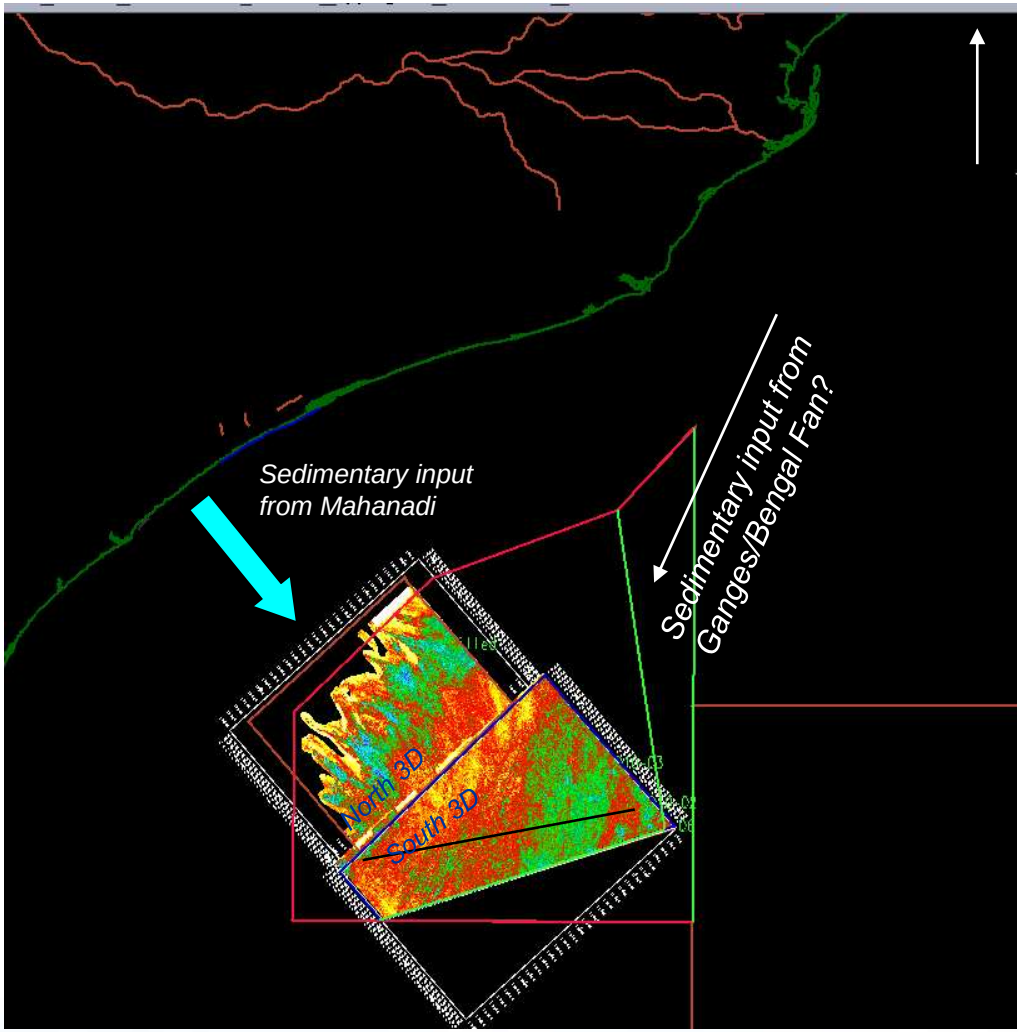
WGHSZ-1 Inline1400



KDMIPE

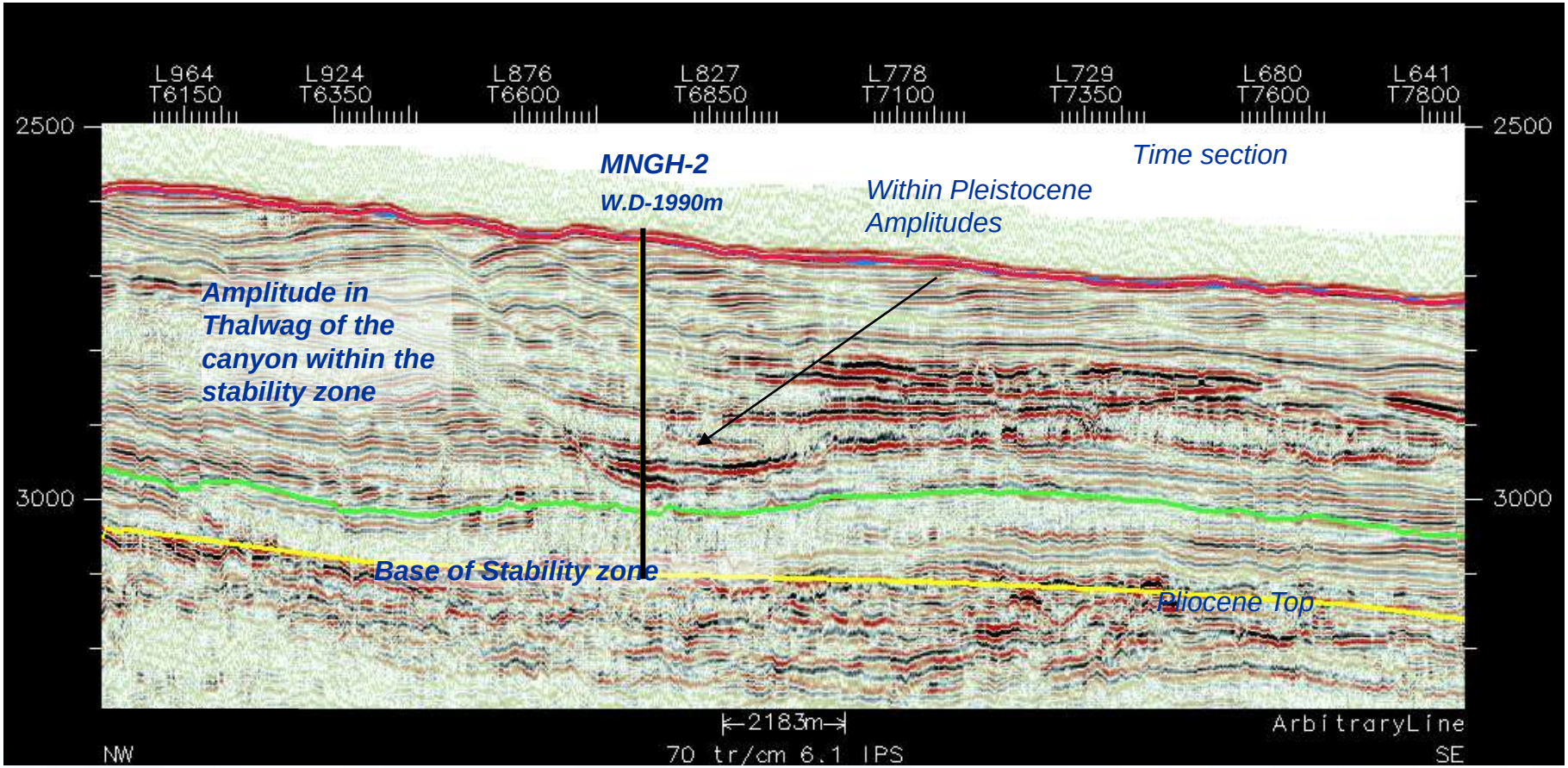
Block MN-DWN-98/2 (MND-10)





Pliocene Depositional fairways from 3D Seismic. The Northern 3D where 4 sites were drilled during NGHP 01 is more oriented in the NW direction

BlockMND10: Site MNGH-2



- GMGS-1 and GMGS-2
- Muli Spot, Qinghai-Tibet
- Mohe Basin, Heilongjiang

China

China: “China National Gas Hydrate Program”

Guangzhou Marine Geological Survey (GMGS)
China Geological Survey (CGS)
The Ministry of Land and Resources of P. R. China

-Examine the geologic occurrence of gas hydrates in the South China Sea

-Assess the resource potential of gas hydrates in the offshore of China

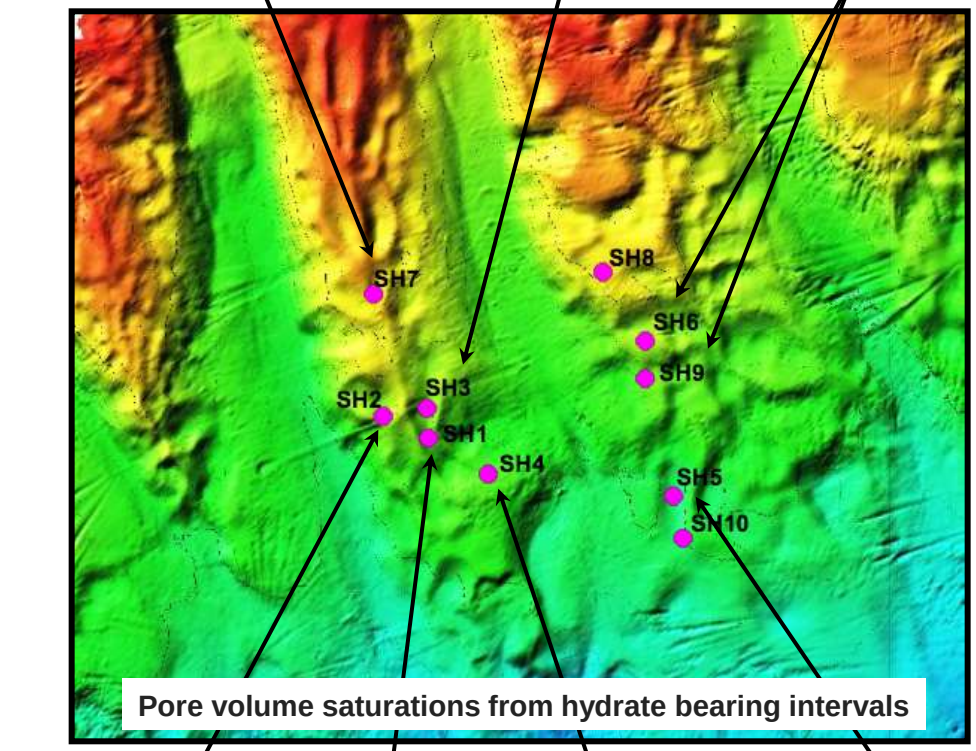
-Expedition GMGS-1 (2007): Shenhu area of the South China Sea

-Expedition GMGS-1 (2013): Pearl River Mouth Basin of the South China Sea

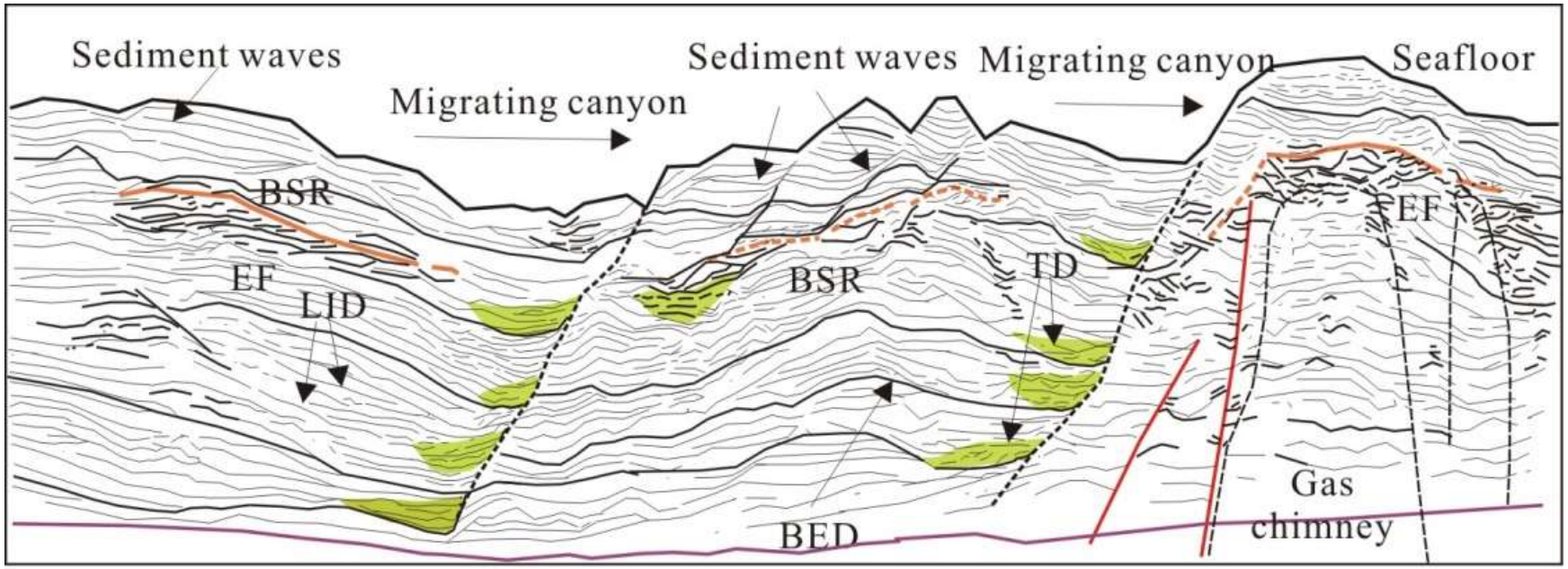
-USGS cooperative gas hydrate research with the Institute of Oceanology, Chinese Academy of Sciences (Dr. Xiujuan Wang)

GMGS-1 Results

- 8 sites were drilled, 5 sites were extensively sampled
- Water depths of up to 1500 m
- Coring & drilling up to 250 mbsf
- Presence of hydrate confirmed at three locations (plus one sand-rich reservoir)
  - Layer above GHSZ, 10 to 25+ m thick
  - Disseminated in fine grained, foram-bearing to rich clay interval
  - Saturations of 20 to 40% of the pore volume
  - Gas composition was 99% methane
- Post-cruise analyses
  - Interpretation/review of datasets collected at sea
  - Analysis of samples, such as frozen gas hydrate-bearing sediment, pressure cores, etc.



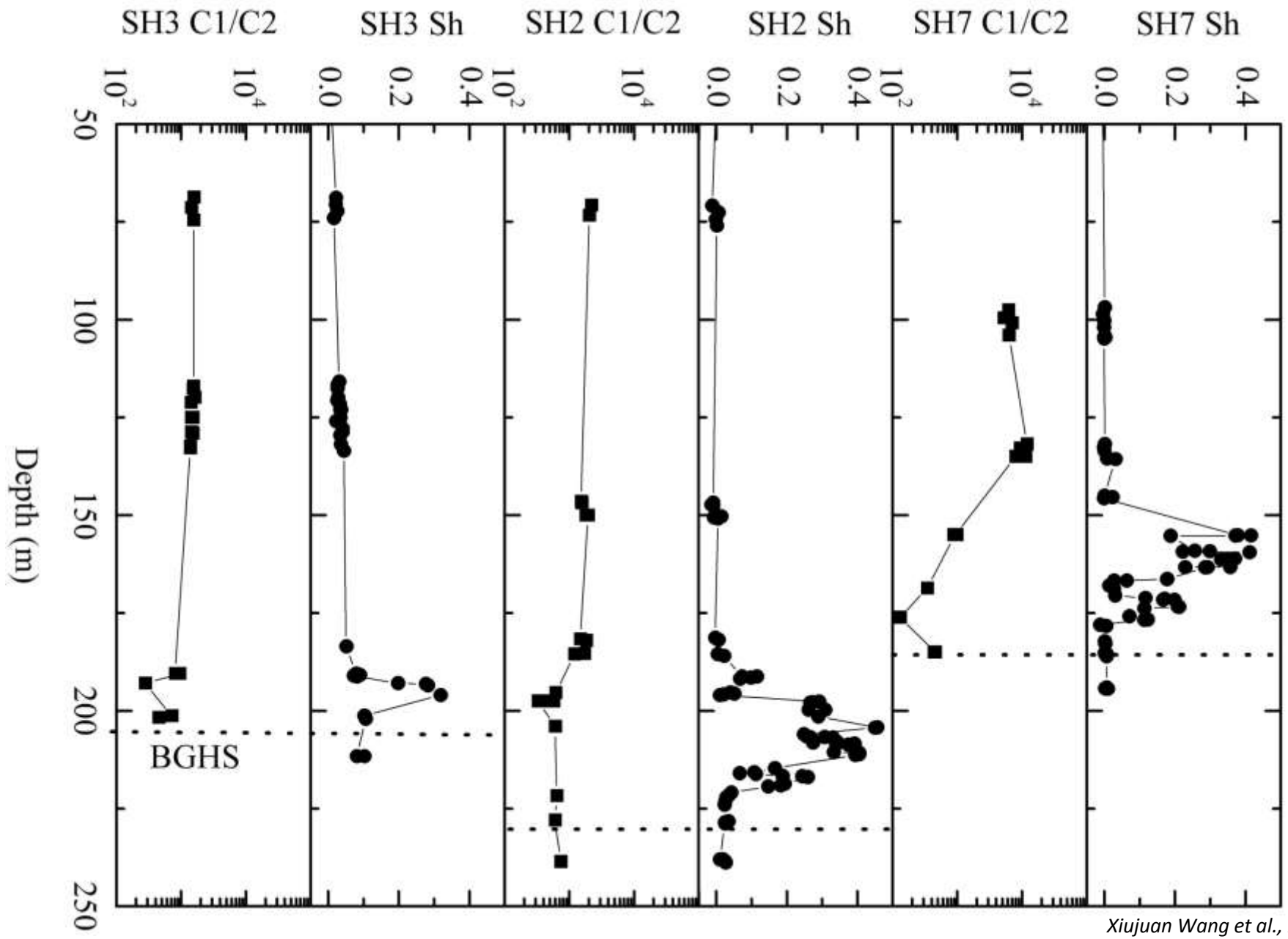
Shenhu Area Depositional System



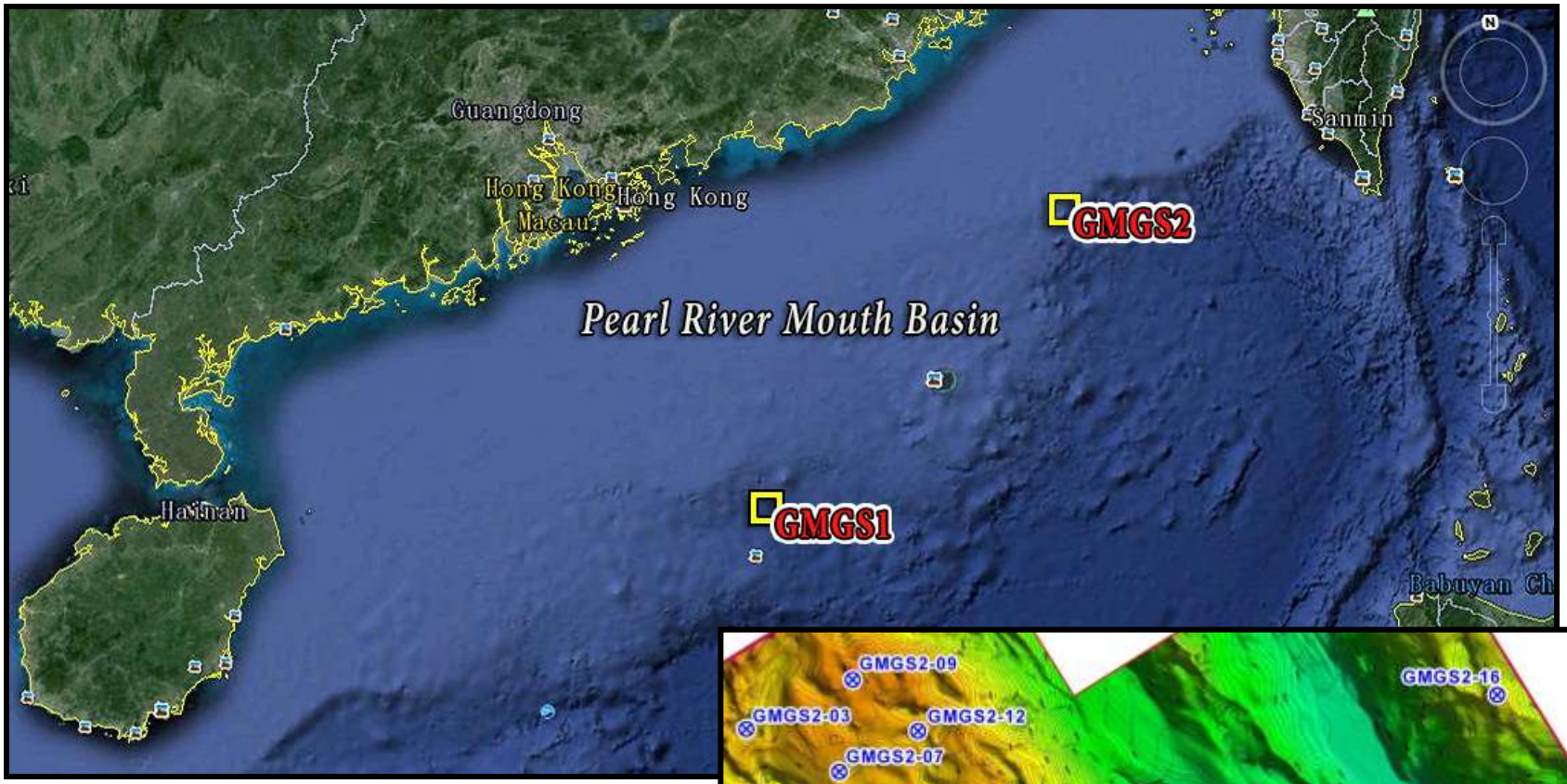
EF: Enhanced reflections BSR: Bottom simulating reflector TD: Thalweg deposit
LID: Lateral inclined deposit BED: Basal erosional discontinuities

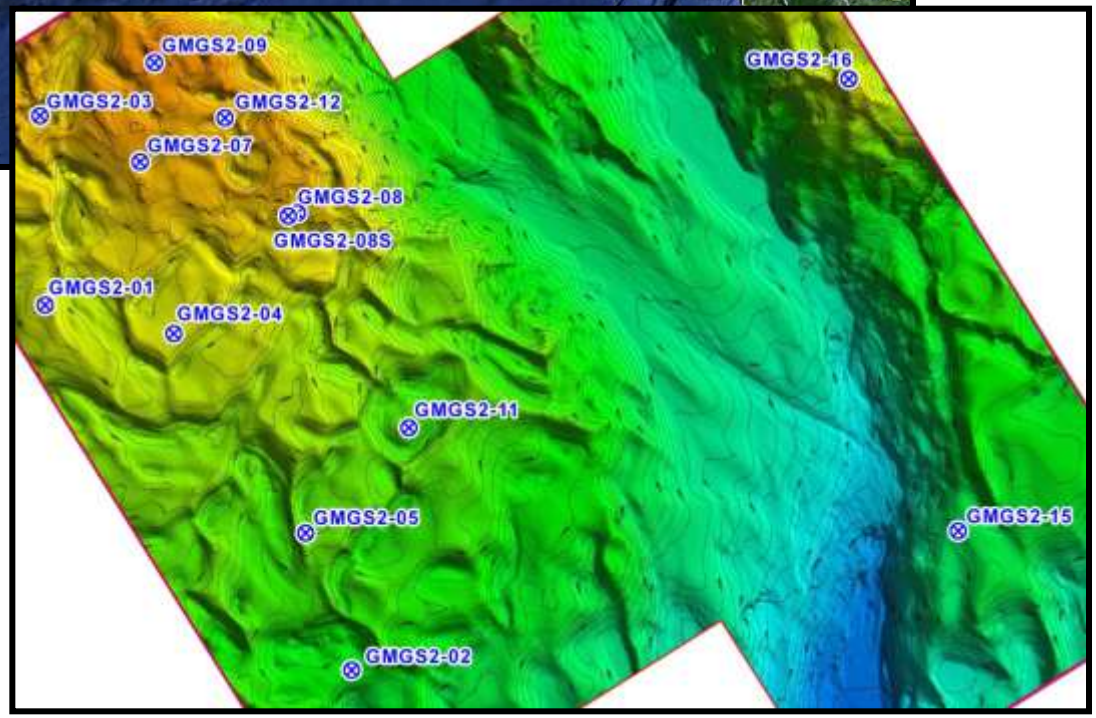
Xiujuan Wang et al., 2014

GMGS-1 Gas Chemistry and Hydrate Saturation



Xiujuan Wang et al., 2014





GMGS-2 Gas Hydrate Expedition

Zhang et al., 2014, FITI

GMGS-2-08 LWD Data

GMGS-2-08F Pressure Core

Zhang et al., 2014, FITI

China Permafrost Gas Hydrate Drilling and Testing

China Permafrost Gas Hydrate Drilling and Testing

2007: First scientific drilling for gas hydrate at the *Muli Spot, Qinghai-Tibet*.

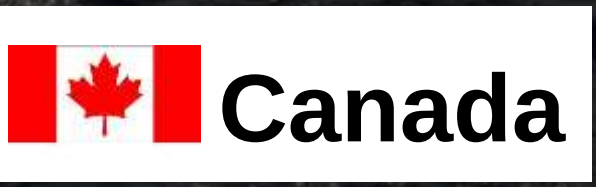
2009: Additional drilling/coring at the *Muli Spot, Qinghai-Tibet*. New drilling in the *Mohe Basin* in northeast China (Heilongjiang).

2011: Additional drilling at the *Mohe Basin* and new drilling at a third site in the Qiangtang Basin on the Qinghai-Tibet Plateau. Production testing at the *Muli Spot*.

Ministry of Land and Resources China – China Geological Survey

Arctic Permafrost Gas Hydrate Testing Mackenzie Delta, Canada

- Mallik 1998, 2002, 2007/2008



Canada: Gas Hydrate Research Interest

NRCan – Geological Survey of Canada

- Current Objectives & Status -

-Mallik gas hydrate production testing projects 1998, 2002, 2007/2008

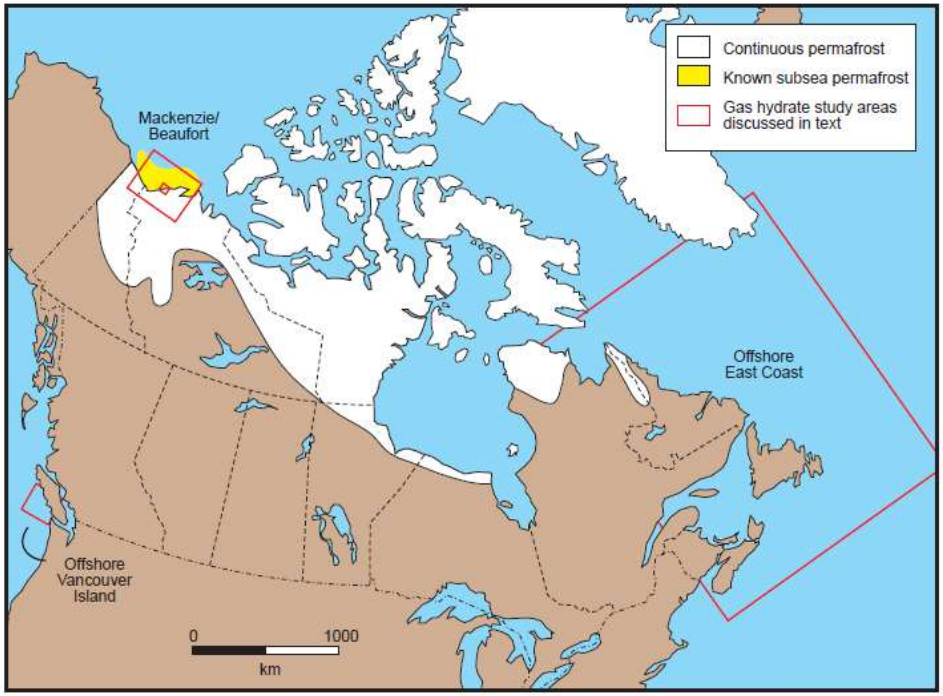
-Marine (offshore Pacific and Atlantic margin) and Arctic focus (Mackenzie Delta – Beaufort Shelf)

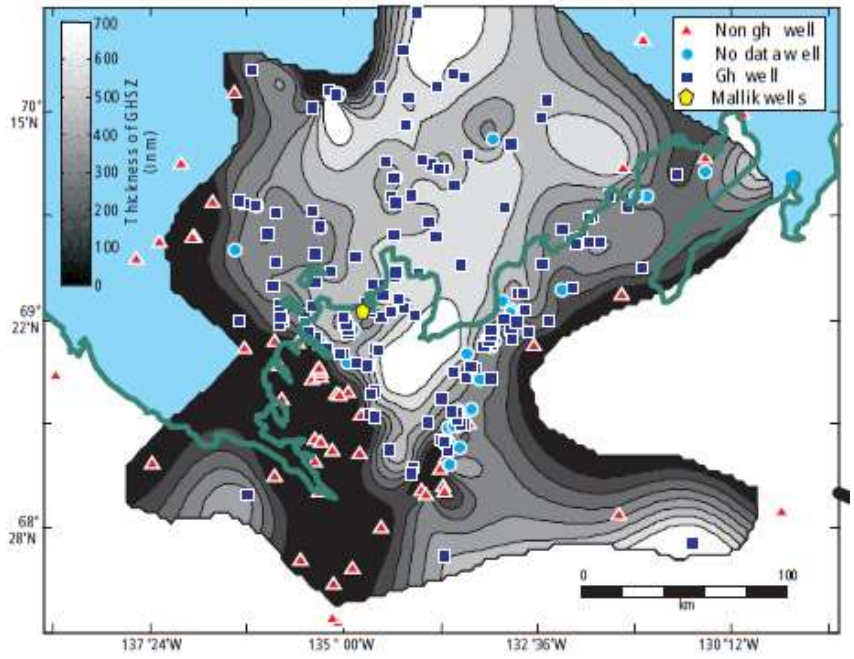
-Research Focus: (1) Constrain exploration models, (2) Quantify the physical properties of gas hydrate, (3) Develop appropriate production methods

-Focus on gas hydrates as an "environmentally friendly" source of energy for North America

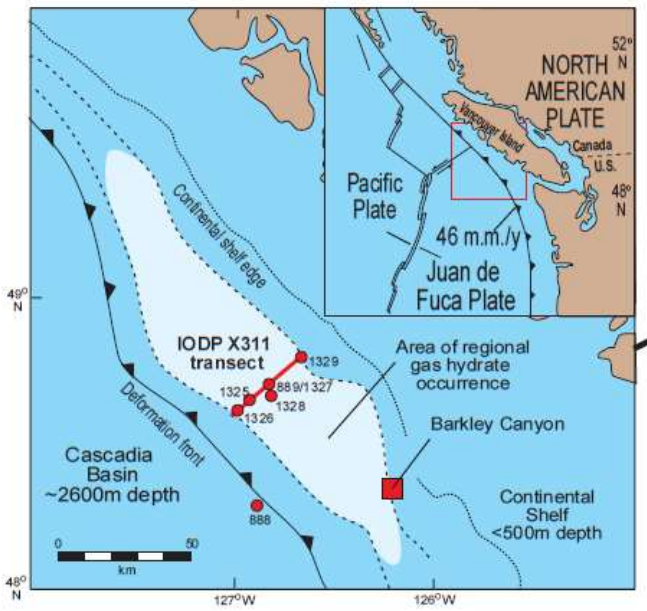
-Benefits of hydrate production on northern and coastal communities

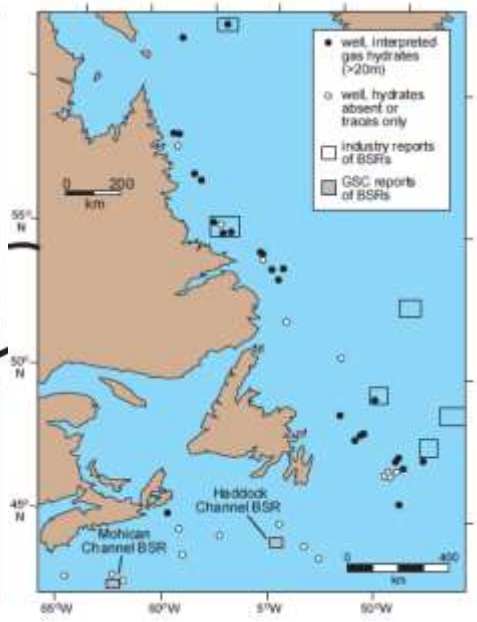
-Assess gas hydrate related geologic hazards and climate change implications

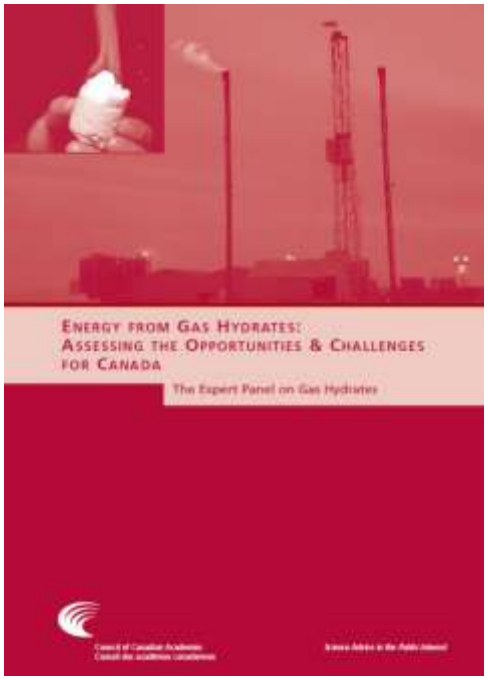




(Majorowicz and Osadetz, 2001)

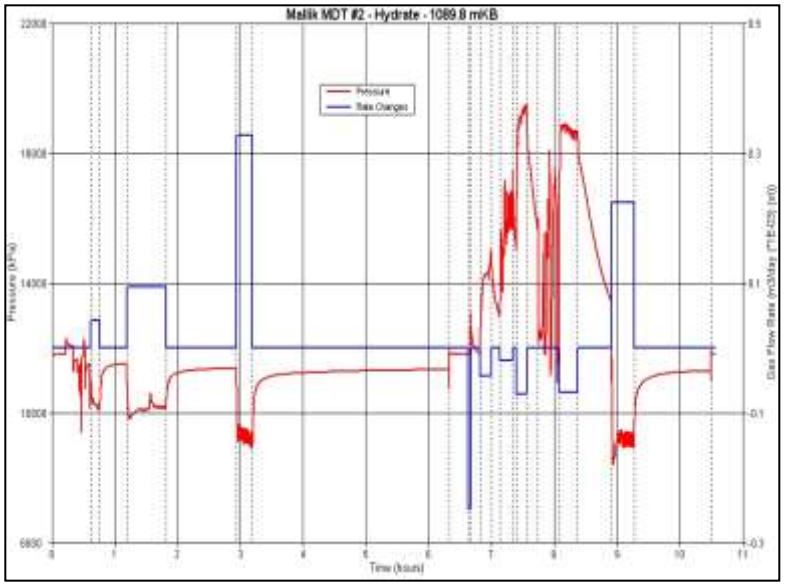


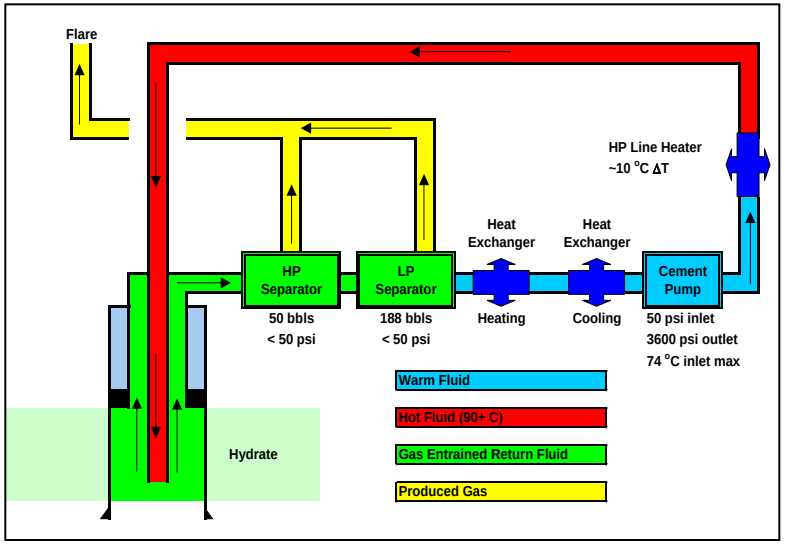


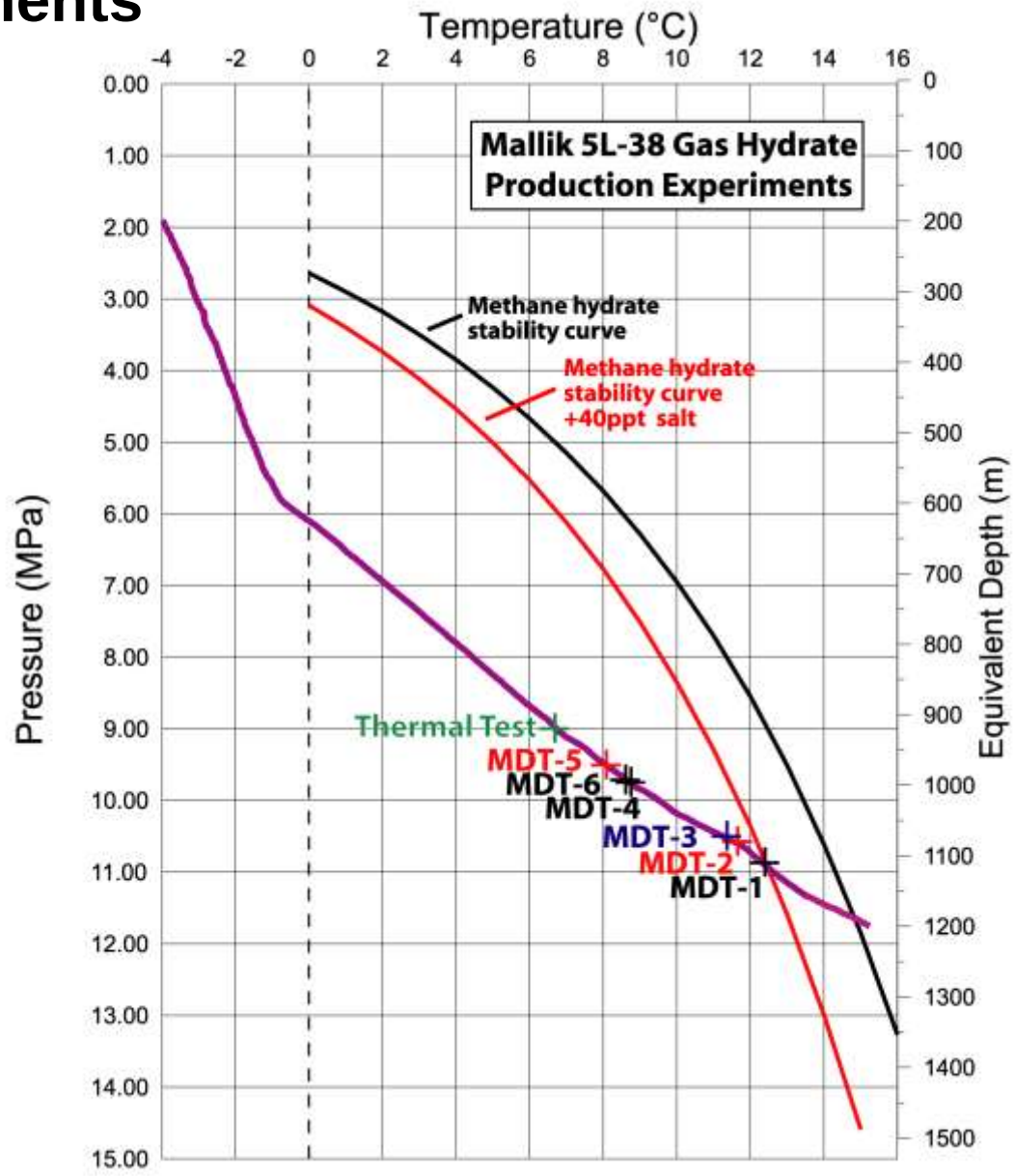


Canada

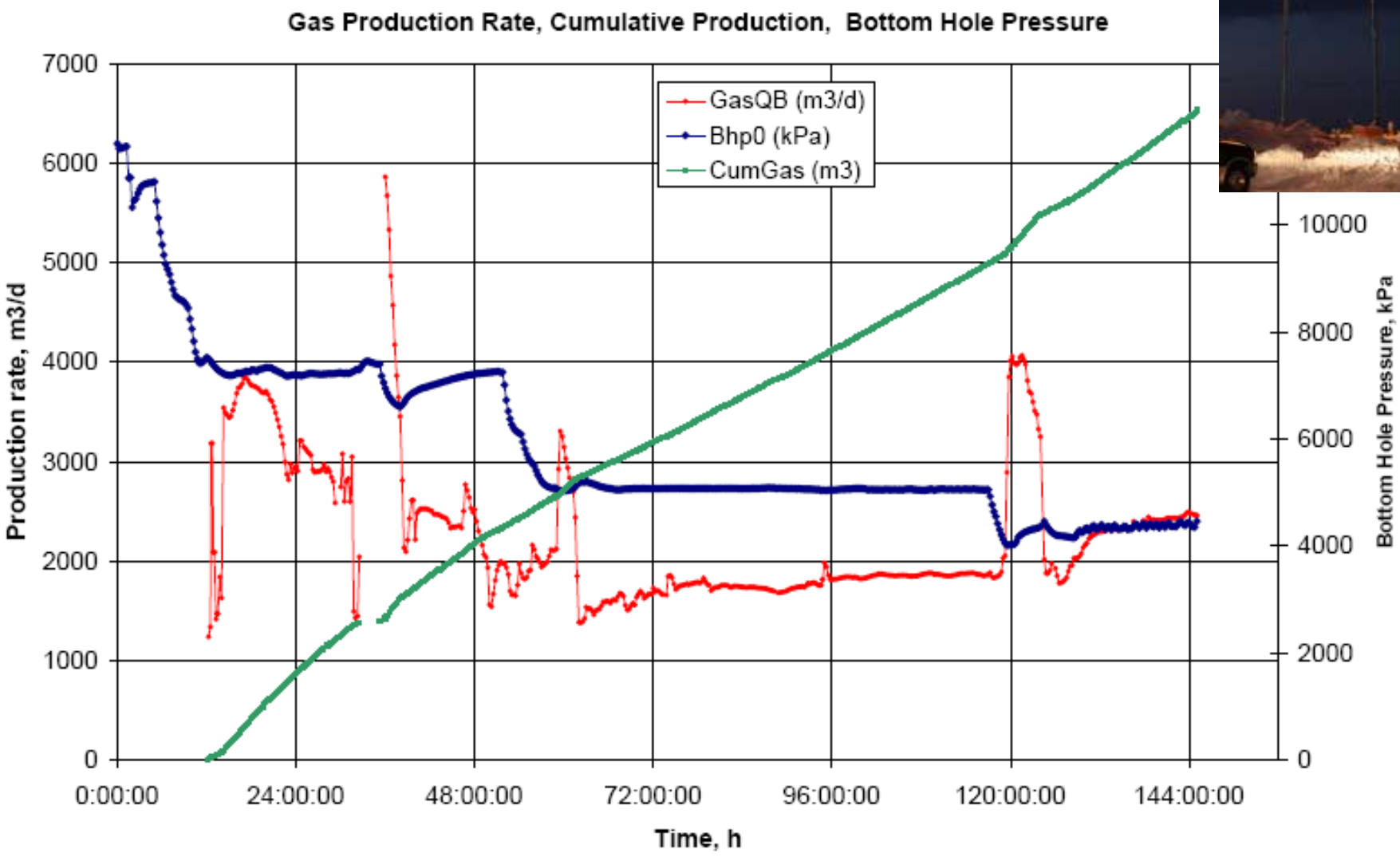
Mallik 2002 Thermal and Depressurization Experiments







Mallik 2007/2008



National Energy Board, 2008

Arctic Permafrost Gas Hydrate Testing Alaska North Slope, USA

- Alaska BP/DOE/USGS stratigraphic test, USA
- Alaska ConocoPhillips/JOGMEC/DOE production test, USA

DOE-CPAI-JOGMEC (2012): "Iġnik Sikumi" Field Trial

Potential for CO_2 sequestration through CO_2-CH_4 Exchange Technology

Conducted when BP withdrew their plan to conduct conjoined depressurization/gas exchange testing from a PBU facility

Conducted off ice… Completed in year of $0 funding to the program

- $7 Million obtained via JOGMEC
- $5 Million obtained via NETL FWP to DOE Office of Science

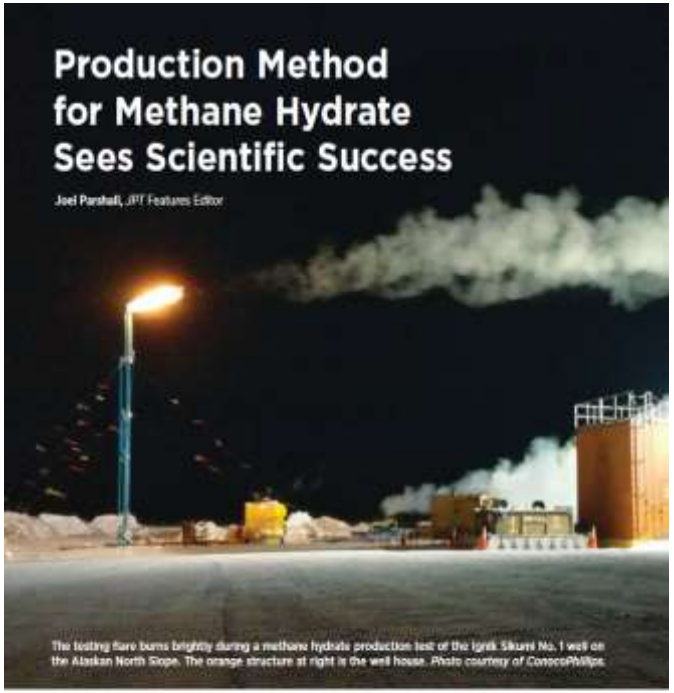
GOAL: Investigate potential role of CO_2 injection in future hydrate production approaches.

- improved carbon balance? improved geomechanical stability?

FINDINGS:

- Confirmed, delineated rich deposits in westend PBU
- Demonstrated ability to inject mixed gas and to exchange CO_2 for CH_4
- Observed favorable geomechanical response
- Injection leads to complex reactions *and will sacrifice production rate*
- Depressurization remains most promising process for production
- Exchange may have a role in select settings

NETL- international modeling consortium convened to further investigate downhole processes



Production Method for Methane Hydrate Sees Scientific Success

Joel Parshall, JPT Features Editor

The testing flare burns brightly during a methane hydrate production test of the Iġnik Sikumi No. 1 well on the Alaskan North Slope. The orange structure at right is the well house. *Photo courtesy of ConocoPhillips.*

A production method that could unlock large reserves of methane hydrate in sand-dominated reservoirs was tested successfully from a scientific and operational standpoint in a recent research experiment on the Alaskan North Slope (ANS). The experiment was conducted by the National Energy Technology Laboratory (NETL) of the United States Department of Energy (DOE) in partnership with ConocoPhillips and Japan Oil, Gas, and Metals National Corporation.

A proof-of-concept test was conducted between 15 February and 10 April at the Iġnik Sikumi No. 1 well in the Prudhoe Bay field operated by ConocoPhillips. The production technique featured the injection of carbon dioxide (CO_2) to exchange and release methane (CH_4) from the hydrate, a method developed through laboratory collaboration between the University of Bergen in Norway and ConocoPhillips. The released gas was then produced by means of reservoir depressurization.

"The test objective was to perform injection and flowback from a single well to validate that the CO_2/CH_4 exchange mechanism demonstrated in laboratory tests will occur in a reservoir of natural methane hydrates," said Ray Boswell, technology manager for gas hydrates at the NETL. It was the first field-level trial of a production method involving the exchange of CO_2 with the methane molecules contained in a methane hydrate structure. "The focus of the test, including the design of the well, was on the technical feasibility of this new technology, rather than an attempt to produce gas at commercial rates," Boswell said.

CO_2 Mixture Injected in Reservoir

The Iġnik Sikumi well test was equipped with downhole fiber-optic distributed temperature and acoustic sensing, three downhole pressure gauges, and full surface instrumentation,

ConocoPhillips JOGMEC NETL USGS

Plan for Alaska Gas Hydrate R&D

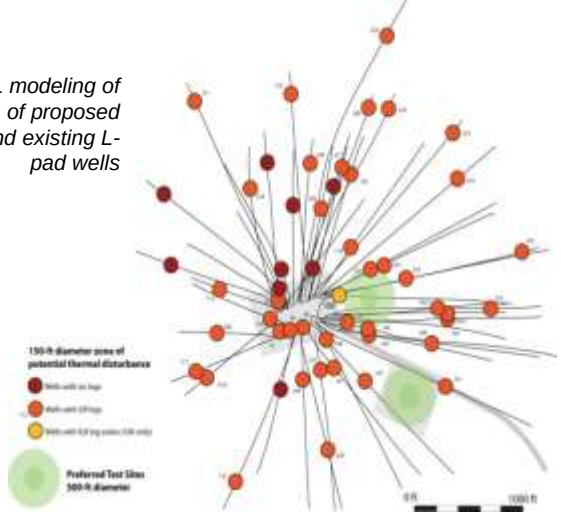
Ongoing Cooperative Agreements with BPXA and CPAI

- Test of many months duration remains necessary – not possible in Arctic w/o the infrastructure available only in the PBU.
- PBU owners have no further interest in operating such a test within the unit, and 3rd parties cannot operate within the unit.

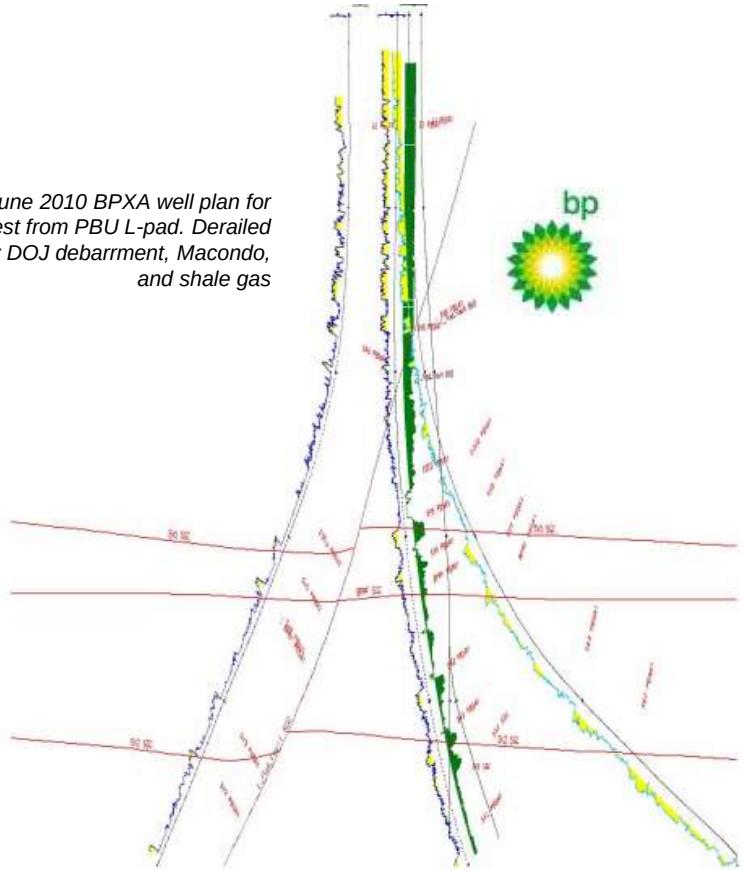
New Initiative with the State of Alaska

- State of Alaska has withheld acreage and signed an MoU with DOE to facilitate continued research.
- Meeting in Denver to review AK DNRs interpretation of proprietary G&G data.
- Solicitation will expect phased proposals to evaluate logistics, gather necessary G&G, and conduct monitored depressurization test.
- Tests will be costly (about $50 Million). Expect high cost share; perhaps 80% plus. Interested parties include JOGMEC and Statoil.

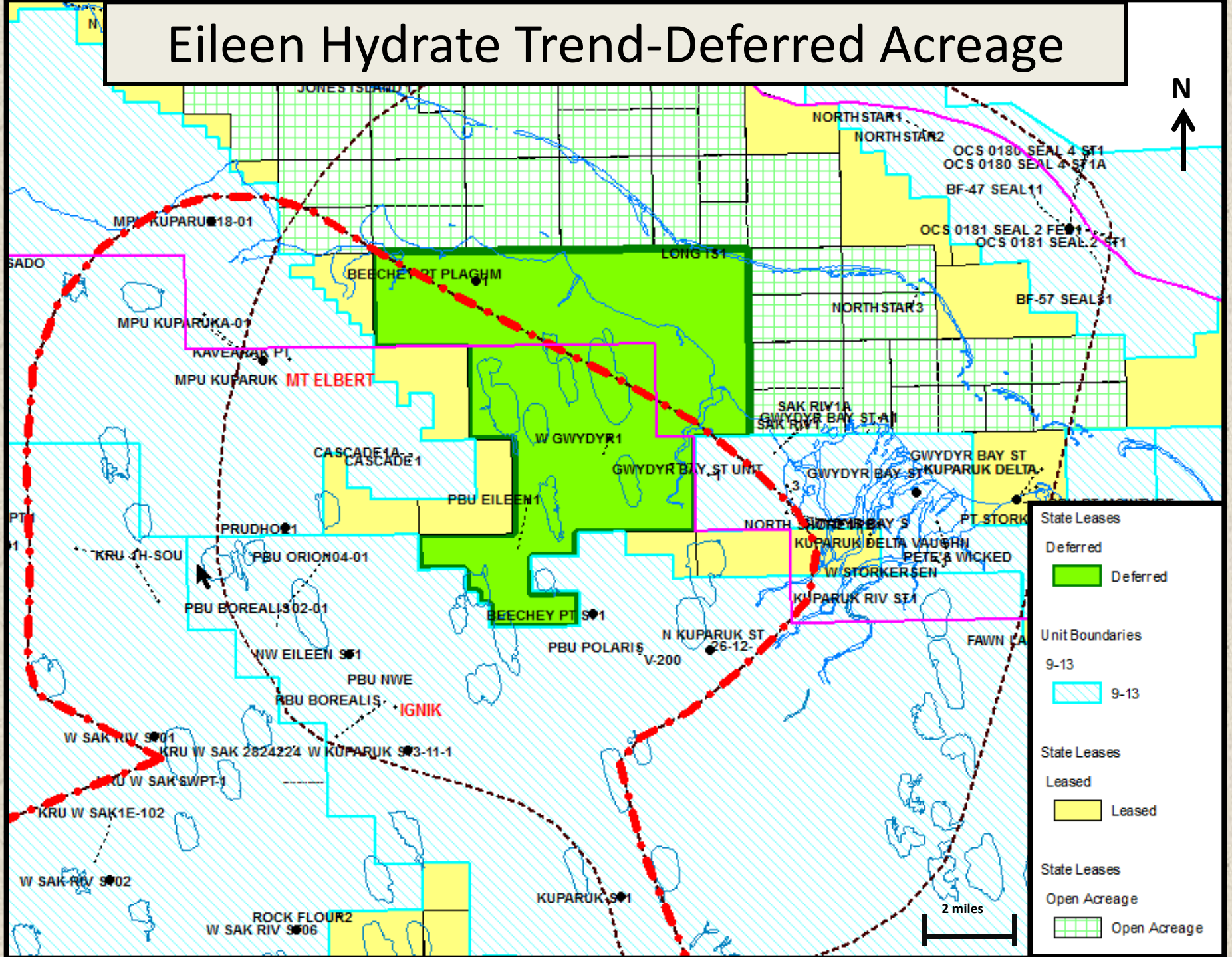
NETL modeling of interference of proposed field sites and existing L-pad wells



June 2010 BPXA well plan for test from PBU L-pad. Derailed by DOJ debarrment, Macondo, and shale gas



Eileen Hydrate Trend-Deferred Acreage

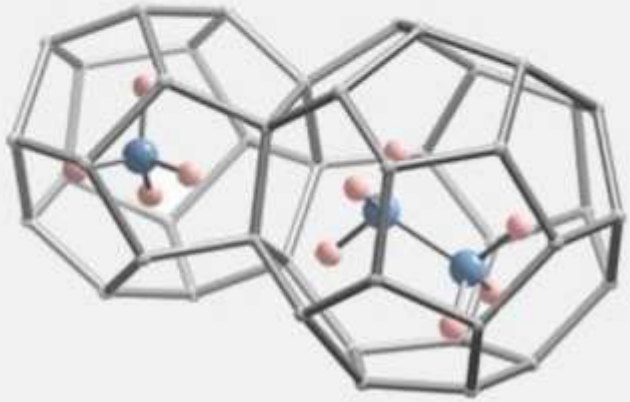


- **Statoil - Norway**

Jarle Husebø, PhD
Senior Engineer Reservoir Technology
jahuse@statoil.com
www.statoil.com

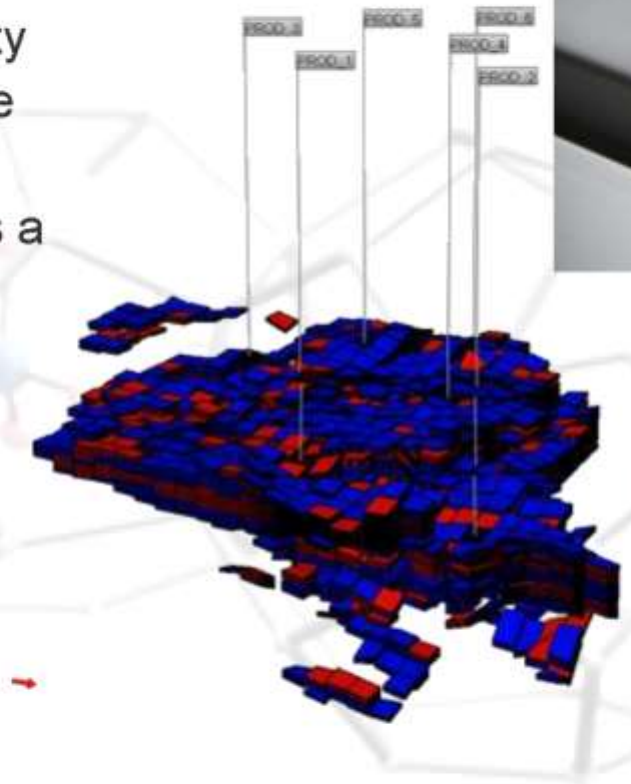
Gas Hydrates as a resource

Technology Readiness Level



Statoil's research strategy

- Increase research activity on hydrate as a resource using our extensive knowledge of hydrate as a production problem
- Evaluate possible long-term production test



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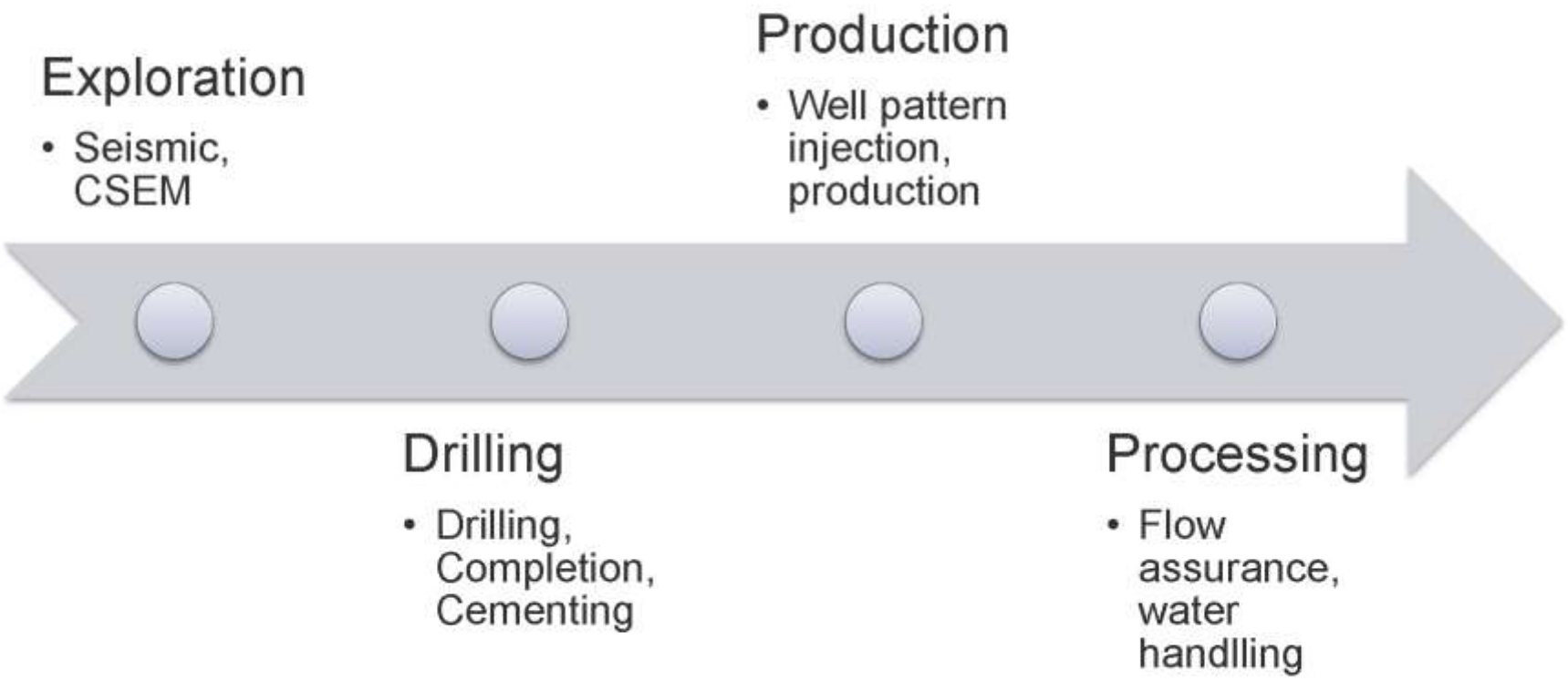
Value Chain for gas hydrates



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Gas Hydrate as a Resource
- Statoil's Hydrate Initiative

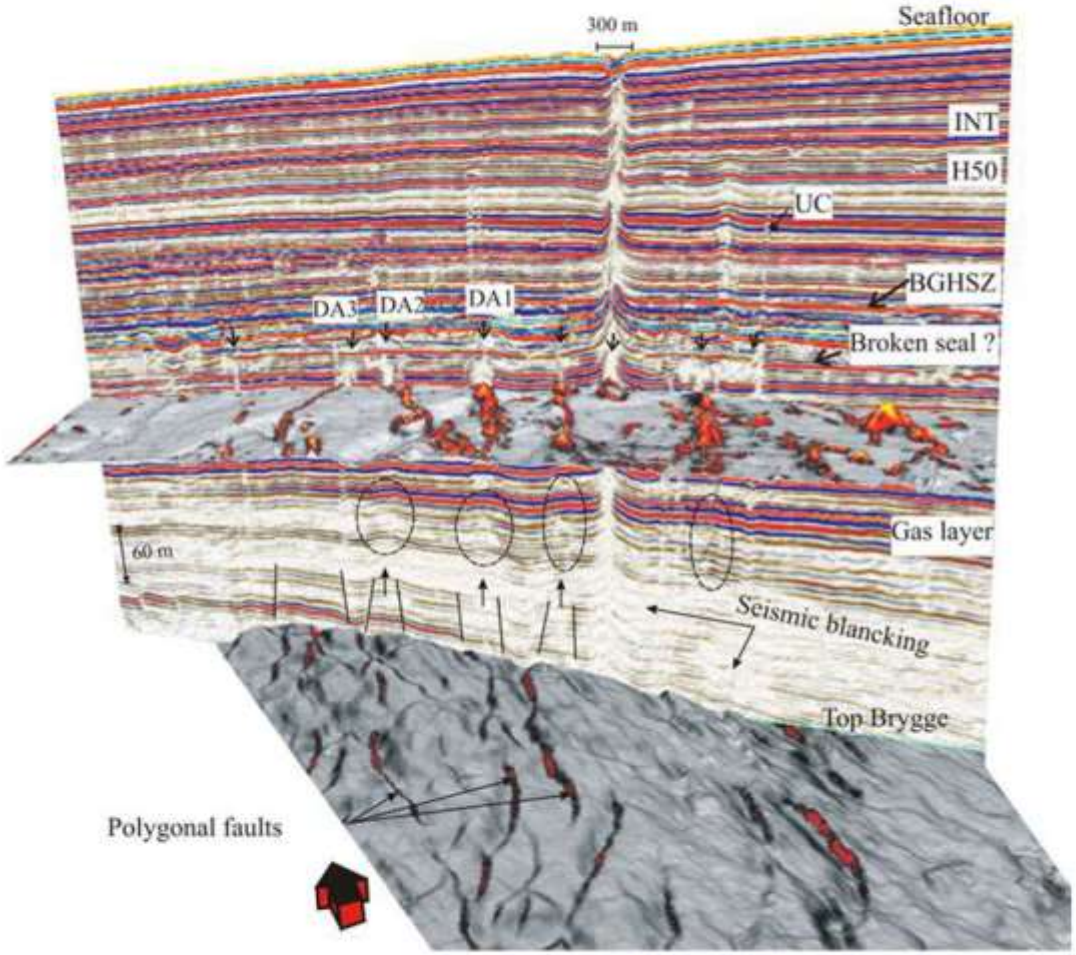
Thomas Reichel & Jarle Husebø
Exploration Global New Ventures / R&D Explore Unconventionals

Statoil Internal Gas Hydrate Focus

- Exploration Technology
  - Global Screening for Hydrates
  - R & D Geological and Geophysical Research

- Drilling & Production Technology
  - Hydrates as Geohazard during drilling
  - R & D production strategies from Hydrates
  - Flow Assurance

Gas Hydrate Indications on the Mid-Norway Continental Margin



Results

- Evidence for thermogenic sources
- Migration along deep seated polygonal faults
- Gas hydrates act as "broken" seal
- Migration to seabed through vents/pockmarks

Resources

- Huge GIP ~ **150-1400 GSm^3**
- Poor reservoir quality
- Low (**0,2 GSm^3/km^2**) resource density, ~ comparable to similar hydrate provinces

from Plaza-Faverola et al. 2010b

Statoil

Marine Methane Hydrate Field Research Plan

Consortium for Ocean Leadership

Recommendations

Drilling Programs

Top priories for dedicated scientific drilling are: (1) an expedition designed to further our understanding of the highly concentrated sand-rich methane hydrate reservoirs in the Gulf of Mexico and (2) a drilling program designed to characterize the hydrate systems along the Atlantic margin.

Wells of Opportunity

Establish a high-level international committee to monitor and identify cooperative research and specific scientific drilling opportunities to advance our understanding of methane hydrates in nature.

Marine Methane Hydrate Field Research Plan

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Recommendations

Drilling and Measurement Technology Developments

Review and update technology and operational requirements for each drilling expedition.

Include wireline logging and logging while drilling in all future methane hydrate expeditions.

Further develop downhole geotechnical and scientific tools for methane hydrate related research.

Develop devices specifically designed to monitor methane systems.

Continue to test and develop the Hybrid-PCS, and strongly encourage its use in the field.

Marine Methane Hydrate Field Research Plan

Consortium for Ocean Leadership

Recommendations

Data and Science Integration

Support efforts to coordinate the use and integration of field, laboratory, and model derived data.

Information and Technology Transfer

Make use of all available communication channels to disseminate well-vetted data and information on the role that methane hydrates may play as an energy resource, geohazard, or agent of global climate change.

Monitor the methane hydrate scientific community and deal effectively with misinformation through the peer review process and the judicious use of published reviews and rebuttals.


U.S. Geological Survey
http://energy.usgs.gov