International Gas Hydrate Research

March 2014
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
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-FO0010195
Project Title: Development of a Scientific Plan for a Hydrate-Focused Marine Exploration and Coring Program

Project Science Team

Tim Collett – project lead Community Liaison (LC)
U.S. Geological Survey
Jang-Jun Bahlk
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
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-FC0301105
Project Title: Development of a Scientific Plan for a Hydrate-Focused Marine Drilling, Logging and Coring Program

Project Science Team

Tim Collett – project lead Community Liaison (CL)
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 Huseby
Statoil ASA

Carolyn Koh
Colorado School of Mines

Mitch Malone
Texas A&M University

Craig Shipps
Shell International Exploration and Production Inc.

Marta Torres
Oregon State University

Project Management Contacts
Greg Myers
David Divins
Margo Morel

Contents

4. Methane Hydrate Research Drilling Expeditions
4.1. ODP Leg 164 (1995)
4.3. ODP Leg 204 (2004)
4.5. Gulf of Mexico JIP Leg I (2005)
4.6. IODP Expedition 311 (2005)
4.8. India NGHP Expedition 01 (2006)
4.10. Republic of Korea UBGH Expedition 01 (2007)
4.11. Gulf of Mexico JIP Leg II (2009)
4.13. MH-21 Nankai Trough Pre-Production Expedition (2012-2013)
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**
  - 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*
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
• 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.
News Releases

Gas Production from Methane Hydrate Layers Confirmed

March 12, 2013

President, Yuzuru Sakurai, of JOGMEC (Japan Oil, Gas and Metals National Corporation), has been conducting production works for the first methane production test off the coasts of Aomori and Ishikawa prefectures, starting a few tests applying the depressurization method and confirmed production of methane gas extracted from methane hydrate layers on March 12, 2013.
National R&D Program for Methane Hydrate Resources in Japan

Tokai-oki Kumano-nada Drilling 2005

MH21 Production Test 2012-2013

Nankai Trough Drilling 1999-2000

Okhotsk Sea 1996

Seismic/Gravity/Magnetics

Joetsu-Noto Sea of Japan

Nankai Trough 1996

Seismic/Gravity/Magnetics

Tokai-oki Kumano-nada Drilling 2005
Research Consortium for Methane Hydrate Resources in Japan

Japan’s Methane Hydrate
R&D Program

Phase 1
Comprehensive Report of
Research Results

August 2008 Edition

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**
- **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

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

**Phase 2**
- **FY2009**: Preparation for Offshore Methane Hydrate Production Test
- **FY2012**: Offshore Methane Hydrate Production Test
- **FY2015**: Offshore Methane Hydrate Production Test

- (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**
- Preparations for Commercial Productions
- Comprehensive Evaluations (Economic Potential, Environmental Impact Assessment)

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

Site Selection and Formation Evaluation at the 1st Offshore Methane Hydrate Production Test Site In the Eastern Nankai Trough, Japan
Test Site:
Water depth 998 m
Seafloor slope 10 degrees
Reservoir top 277 mbsf
Core interval 250-340 mbsf
Geologic/Geophysics Characterization of the JOGMEC Gas Hydrate Production Test Site

(1) Interpretation of Channel Facies
Identifying bottom frame (BF) of channels

(2) P-impedance from seismic inversion

Channel Distribution (NE-SW)

Results of Geotechnical holes (2011)
Well to well correlation
Sea floor bathymetry

Location of the Production Test

From BSR to top of MHCZ

Noguchi et al. (2011): ICGH 7

Noguchi et al. (2011): ICGH 7

AT1 (2012)
One production well (AT1-P), two monitoring wells (AT1-MC and MT1), and one core well (AT1-C) were established.
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)
• 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.

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
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: “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)


- 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**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Regional Seismic Survey &amp; Basic R&amp;D</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Prospect I Survey &amp; Drilling (Component research)</td>
<td></td>
<td></td>
<td>UBGH1 2007</td>
<td></td>
</tr>
<tr>
<td>3. Prospect II Survey &amp; Drilling (Base technology for production)</td>
<td></td>
<td></td>
<td></td>
<td>UBGH2 2010</td>
</tr>
<tr>
<td>4. Test Production &amp; Confirmation of production method</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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
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

Diagram showing a drilling ship, DP Vessel for ROV and AUV, R/V Tamhae 2 (KIGAM), and various monitoring systems and equipment around a Gas Hydrate formation. The diagram highlights elements such as production water, gas leakage, drilling mud, Deformation, AUV, ROV, Seabottom monitoring system, Monitoring Well, Production Well, Monitoring survey, and Base-line survey.
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: “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
Fluvial Erosion or Bypass  Shelf-Edge Delta with offlap

Regressive Slope Onlap Surface

FALLING STAGE SYSTEMS TRACT: HIGH RATE PROGRADATION AND OFFLAP

Source: WOB, Mumbai
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

Amplitude in Thalwag of the canyon within the stability zone

Base of Stability zone

MNGH-2
W.D.-1990m

Within Pleistocene Amplitudes

Pliocene Top

Time section
• GMGS-1 and GMGS-2
• Muli Spot, Qinghai-Tibet
• Mohe Basin, Heilongjiang
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.

SH2 hydrate 40%
SH3 hydrate 20%
SH4 Hydrate in sands
SH5 no hydrate evidence on logs

SH6 & SH9 no hydrate evidence on logs

Pore volume saturations from hydrate bearing intervals
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

Gamma Density (g/cc)

P-wave velocity (m/s)

Electrical Resistivity (Ohm.m)

Gamma (API)

GMGS-2-08F Pressure Core

Zhang et al., 2014, FITI
China Permafrost Gas Hydrate Drilling and Testing

Qinghai-Tibet

Mohe Basin
2011
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
Canada: Gas Hydrate Research Interest
NRCan – Geological Survey of Canada
- Current Objectives & Status -


-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
Canada
Mallik 2002 Thermal and Depressurization Experiments

Flare
Hot Fluid (90+ °C)
Hydrate
HP Separator
Gas Entrained Return Fluid
Produced Gas
Warm Fluid
LP Separator
Heating
Heat Exchanger
Cooling
Heat Exchanger
Cement Pump
HP Line Heater
~10 °C ΔT
50 psi inlet
3600 psi outlet
74 °C inlet max

Mallik 5L-38 Gas Hydrate Production Experiments

Methane hydrate stability curve
Methane hydrate +40ppt salt

Thermal Test
MDT-5
MDT-6
MDT-4
MDT-3
MDT-2
MDT-1

Flare

Warm Fluid
Hot Fluid (90+ °C)
Gas Entrained Return Fluid
Produced Gas

50 bbls < 50 psi
188 bbls < 50 psi

50 psi inlet
3600 psi outlet
74 °C inlet max

Pressure (MPa)
Temperature (°C)
Equivalent Depth (m)
Mallik 2007/2008

Gas Production Rate, Cumulative Production, Bottom Hole Pressure

- GasQB (m3/d)
- Bhp0 (kPa)
- CumGas (m3)

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
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
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.
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
Value Chain for gas hydrates

**Exploration**
- Seismic, CSEM

**Production**
- Well pattern injection, production

**Drilling**
- Drilling, Completion, Cementing

**Processing**
- Flow assurance, water handling
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
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.
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.