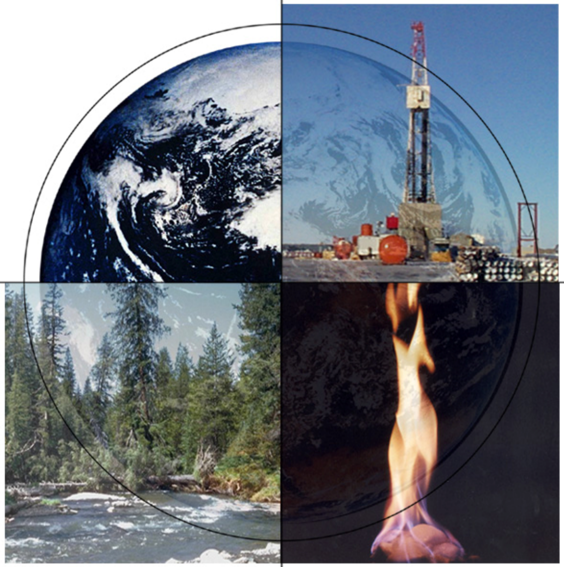
# Remaining Challenges in Commercializing Gas Hydrate



*Hart's Conference*
*Commercializing Methane Hydrates*

*December 6, 2006*
*Houston, Texas*

**Ray Boswell, Technology Manager – Methane Hydrates**
**National Energy Technology Laboratory**

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**Office of Fossil Energy**

# The Interagency Program in Methane Hydrates

## *Implementing the Methane Hydrates R&D Act of 2000*

- **Seven collaborating federal agencies**
  - Interior: (BLM, USGS, MMS)
  - Commerce: (NOAA)
  - Defense: (Naval Research Lab)
  - National Science Foundation
- **DOE's role – Implement the Act!**
  - Technology development
  - Public-Private Partnerships (60% of budget)
    - 14 cost-shared projects
  - Funding to NL/ Fed. agencies (30%)
- **Broad set of goals, with focus on**
  - gas hydrate resource potential
  - gas hydrate's role in the natural environment

PUBLIC LAW 106–193—MAY 2, 2000

METHANE HYDRATE RESEARCH AND DEVELOPMENT ACT OF 2000

USGS
science for a changing world

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# Methane Hydrate R&D

## *Challenges and Opportunities*

- **The R&D is high-cost…**
  - India: $36M expedition ('06)
  - Japan: $60M field test ('06-'07)
  - Deepwater and Arctic locales
- **The R&D is high-risk…**
  - Science is still new
  - Occurrences are complex
  - MH instability requires specialized sampling/analysis equipment
  - Ultimate outcome is very unsure
- **The Potential Resource is …**
  - Large (~700,000 Tcf globally)
  - Domestic (~200,000 Tcf)
  - Uniquely distributed
- **The Benefits are large & varied**
  - Economic
  - Energy Security
  - Environmental
    - carbon cycling
    - global climate
    - continental shelf instability
  - Education/Science Leadership
  - International Cooperation

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# DOE Funding for Natural Gas Hydrates R&D

## *Roughly ¾ of ~$17 Million Invested Annually by the U.S.*

| | Appropriation | MHR&D Act Authorization | |
|---|---|---|---|
| • FY 1999 | 0.5 | | |
| • FY 2000 | 2.9 | | |
| • FY 2001 | 9.9 | *5.0* | |
| • FY 2002 | 9.8 | *7.5* | |
| • FY 2003 | 9.4 | *11.0* | |
| • FY 2004 | 9.0 | *12.0* | |
| • FY 2005 | 9.4 | *12.0* | *MHR&D Act of 2000* |
| • FY 2006 | 12.0 | *15.0* | |
| • FY 2007 | 12/17* | *20.0* | |
| • FY 2008 | | *30.0* | |
| • FY 2009 | | *40.0* | |
| • FY 2010 | | *50.0* | *EPAct 2005* |

Figures are millions $US

** House and Senate Marks*

# DOE’s Methane Hydrates Program
## *Key activities related to potential production*

- **Arctic R&D**
  - Long-term production testing
  - Primary Partners: BP-Alaska/USGS
- **Marine R&D**
  - Investigate issues re: drilling safety
  - Understand the geologic systems
  - Establish scale/productivity of marine resource
  - Primary Partner: Chevron-led JIP
- **Laboratory and Modeling Efforts**
  - Provide basic science data, improved exploration tools, and numerical simulation capability
  - Partners: 12 Universities and 6 DOE National Labs
- **International Collaboration**


# Interagency Program Goals

## *Relevant to Enabling Production of Methane from Hydrates*

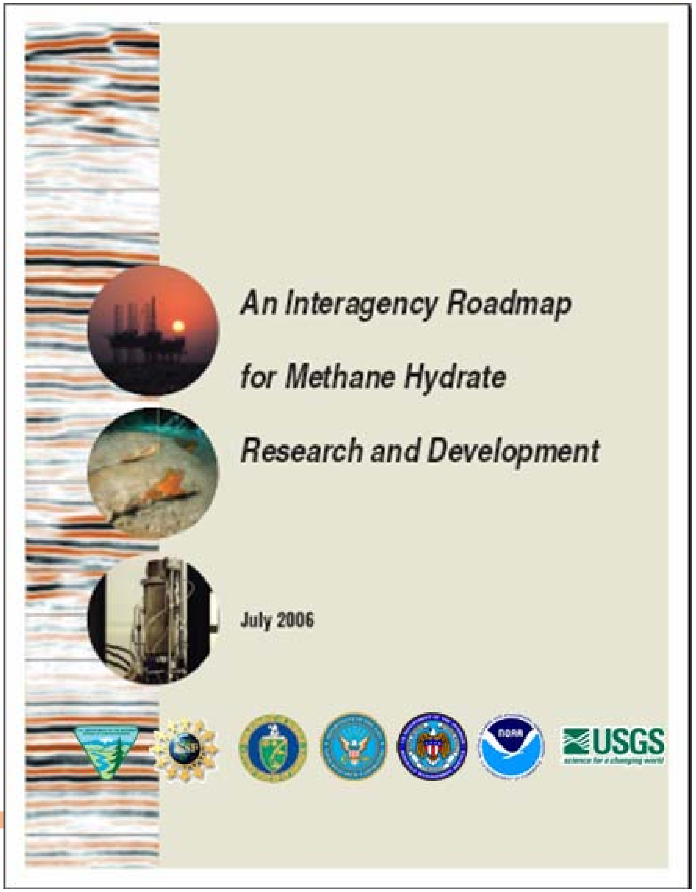
**2008** • **Initial determination if recoverable gas resource from hydrate likely exists at a meaningful scale (Department of Interior)**

**2015** • **Determine *Economic Recoverability* on the ANS**

• **Determine *Technical Recoverability* in the GoM**

**2025** • **Determine *Economic Recoverability* of resources in the Gulf**

• **Document the extent of recoverable hydrate resources outside the Gulf and assess prospects for additional resource expansion**

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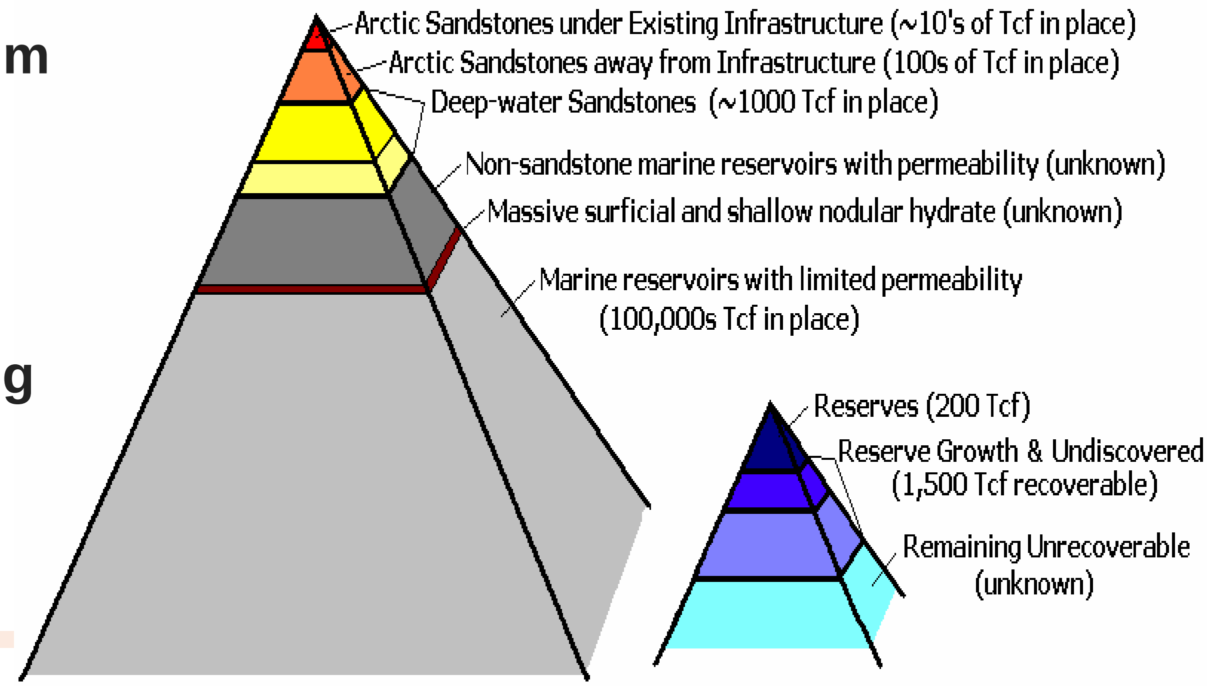
# Program Target Prioritization

## *Guided by perceived relative recoverability*

- **Target 1: Primarily as a means of investigating productivity**
  – Arctic sandstones (under infrastructure)
- **Target 2: To fulfill gas hydrate's promise**
  – Marine sandstones
- **Target 3: A paradigm shifting resource**
  – Fractured shale reservoirs
- **Target 4: A daunting challenge**
  – Low-saturation deposits

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# Critical Remaining Challenges
## *relative to commercializing gas hydrate*

1. **Understanding the physics/chemistry of gas hydrate deposits**
   - Modes of occurrence in nature
   - Impact of GH saturation on sediment properties
2. **Determining if there is a viable resource**
   - scale and distribution in nature?
   - geological models ground-truthed by drilling
3. **If there is, developing tools to efficiently find/assess it**
   - understanding the petroleum system
   - a full suite of remote sensing/diagnostic technologies
4. **If we can find them, establishing means for safe/profitable production**
   - Tailoring existing drilling, completion, production technologies
   - Integration of field (production testing) data with numerical simulation

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# Issue #1: Improved Characterization

## *Key Activities*

- **Field Studies – expensive, rare, and vital**
  - DOE/Chevron JIP
  - IODP Expeditions (204 & 311)
  - NGHP Expedition 01 (India)
- **Laboratory study**
  - USGS/ORNL (P/T simulators)
  - LBNL (flow properties)
  - Ga. Tech/Texas A&M/Rice U. (geomechanics)
- **Field Tool Development**
  - PNNL/LBNL (field imaging)
  - Ga. Tech/JIP (coring and core analysis)
- **Numerical Modeling**
  - LBNL, PNNL
  - U Texas/Ga. Tech/Rice

*Hydrate in marine sand – IODP X311*

"GHASTLI" *- USGS*

*PCS coring device – Aumann & Assoc.*

*Field measurement of physical properties of pressure corest – Ga. Tech*

# Issue #1: Characterization
## *what we're learning*

- **Physical/chemical properties of bulk hydrate sufficiently well understood**
  - Kinetics not relevant to production applications
- **Very difficult to replicate natural samples/process in the lab**
  - Must design lab work for relevant results
  - Must work to move the lab to the field
- **Distribution is highly hetereogeneous in nature**
  - Local perturbations in temperature/salinity regimes
  - Hydrate stability = hydrate occurrence
  - Lithology/Solubility key geologic controls
  - A full geologic systems approach is required

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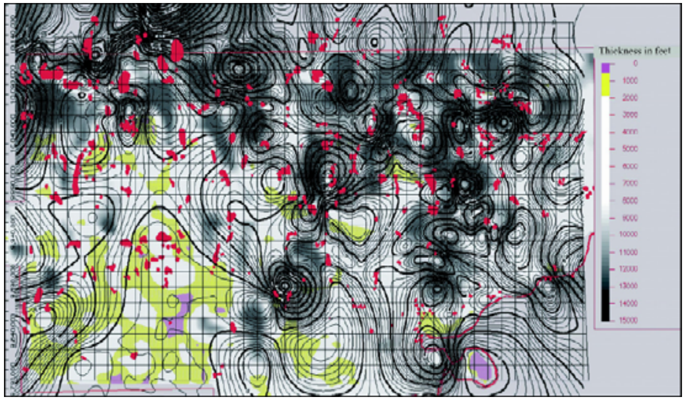
# Issue #2: Assessing the resource
## *Key Activities*

- **Ongoing investigation by DOI**
  - Estimation of in-place and technically-recoverable resources for both ANS and OCS
- **Arctic resources**
  - DOE/BP/USGS: Characterization of accumulations in Prudhoe Bay region
  - *Japan: '07-'08 Mallik program*
- **Marine resources**
  - DOE/Chevron JIP: Planned FY2007 field activity
  - IODP cruises (X311)
  - India: First field expedition completed in 2006
  - *Japan: Nankai work*
  - *Other international (China)*

*Minerals Management Service*



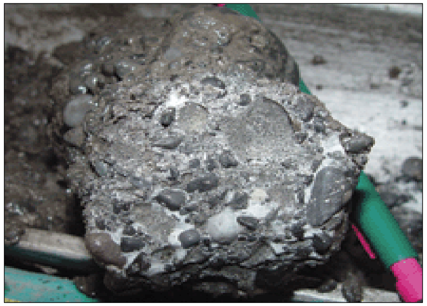

# Issue #2: Assessing the resource

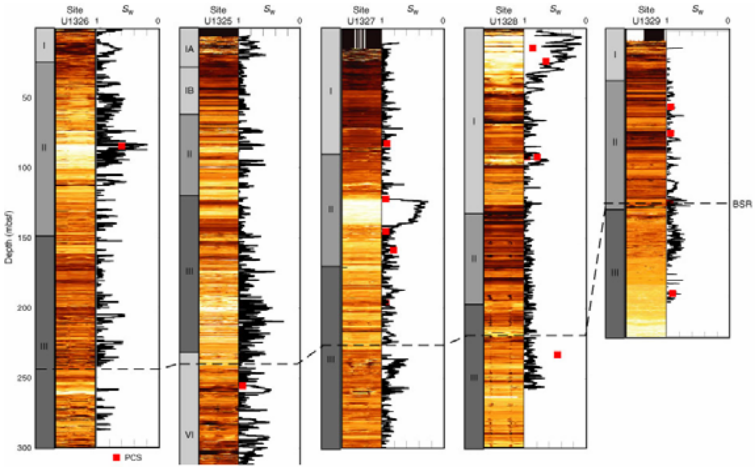
## *What we're learning*

- **Arctic resources**
  - 590 Tcf in-place: two well defined trends in area of infrastructure
  - 33 Tcf-in-place in Eileen Trend
  - 0-12 Tcf technically recoverable (BP)

- **Marine resources**
  - ~200,000 Tcf-in place
  - sandstones surprisingly common
  - surprisingly-rich deposits in fractured shales
  - much more field data needed
  - calibration of remote sensing data

*Hydrate-bearing Arctic Sandstone - USGS*






*IODP X311*

*Massive hydrate sample from offshore India – NGHP Expedition 01*

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# Issue #3: Predicting/Detecting Gas Hydrate

## *Key Activities*

- **Geologic Modeling**
  ***USGS, MMS, Rice U., Ga Tech, U. Texas***
  - Define/quantify controlling elements of the geologic system
  - Numerical modeling of hydrate occurrence

- **Geochemistry**
  ***USGS, NRL, Scripps Inst., Rice U.***
  - Shallow profiling for indicators of ongoing/past methane flux, salinities, and heat flow

- **Geophysics**
  ***Schlumberger, UT-BEG, USGS, NRL, Baylor, Stanford, Rock Solid Images,***
  - Rock physics models
  - New tools and applications
  - Improved interpretation using standard 3-D data
  - Utilization of advanced data (ex. OBS)
  - Additional tools (ex. CSEM)

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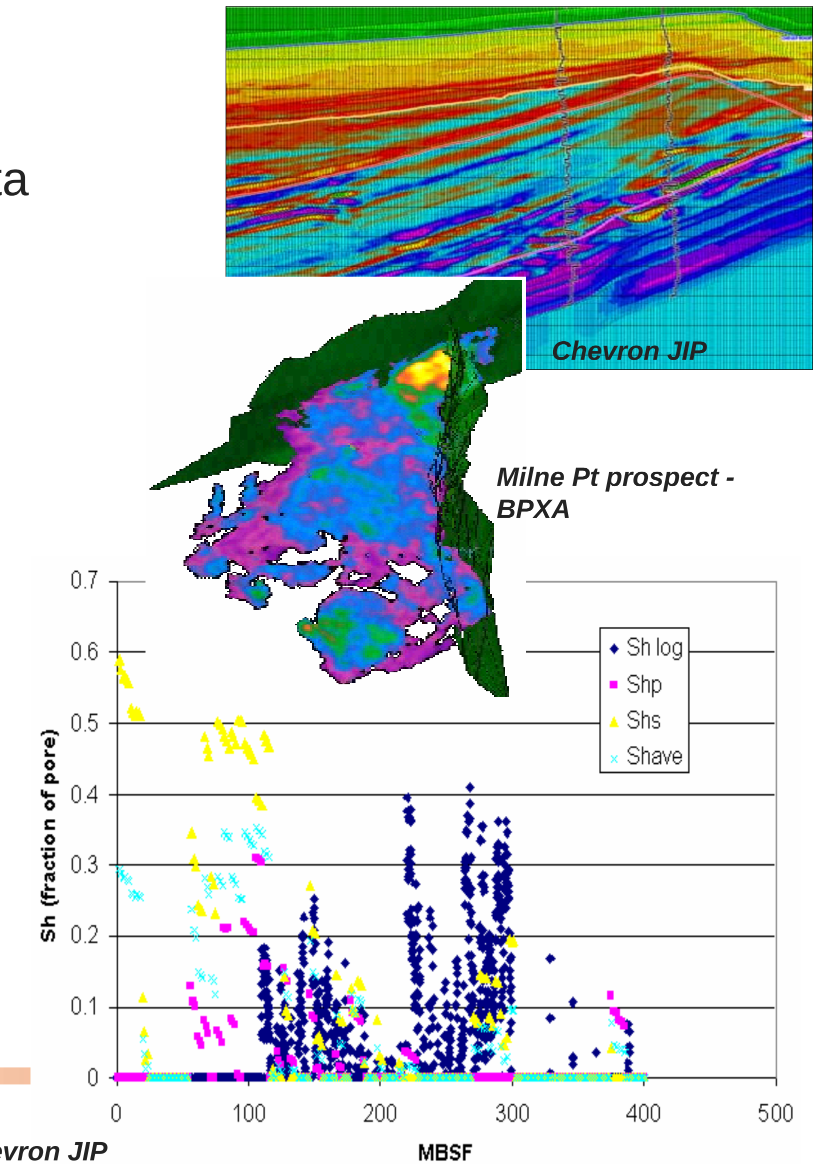
# Issue #3: Predicting/Detecting Gas Hydrate
## *What we're learning*

- **Arctic**
  - Direct detection/characterization possible from standard 3-D seismic data
- **Marine**
  - Relative quantification of gas hydrate occurrence is possible
  - 4C OBS showing great promise
  - New processing approaches may be necessary
- **There are no easy answers**
  - BSRs take various forms & are not diagnostic
  - Geochemical correlations complex
  - Full integration of all disciplines

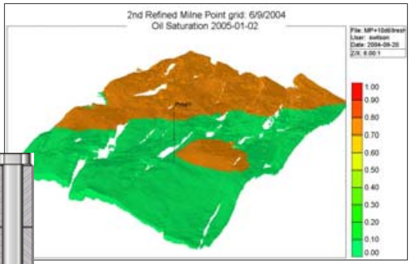



*Chevron JIP*

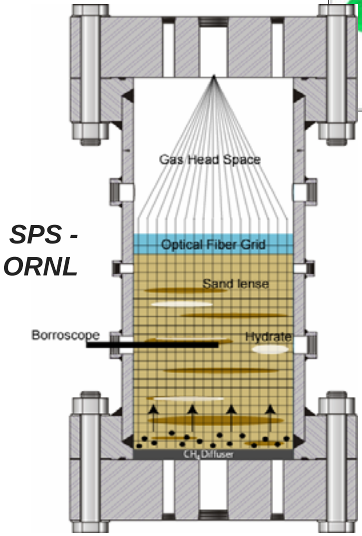
# Issue #4: Production Technologies
## *Key Activities*

- **Experimentation/Numerical Simulation**
  ***LBNL, ORNL, PNNL, UAF, NETL, GIT, TEES, Rice***
  – Investigating fluid/flow properties
  – Investigating geomechanical response
  – Mesoscale production simulator
  – CO2-CH4 exchange
  – All experimentation linked to reservoir-scale model development
  – Public code release/Code comparison activity

- **Field Work**
  ***BP/USGS***
  – Additional field data acquisition including MDT in multiple zones

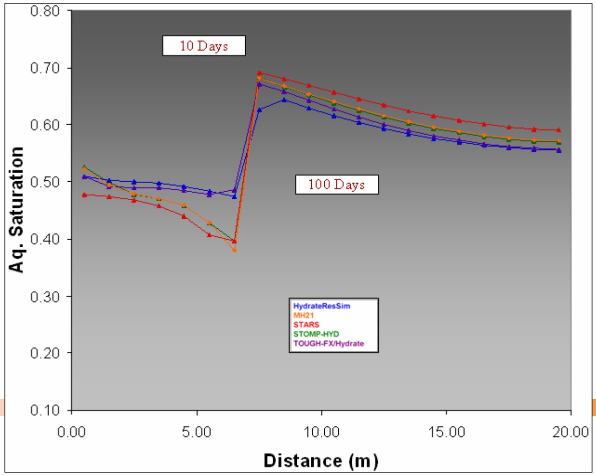


*STARS modeling - BPXA*



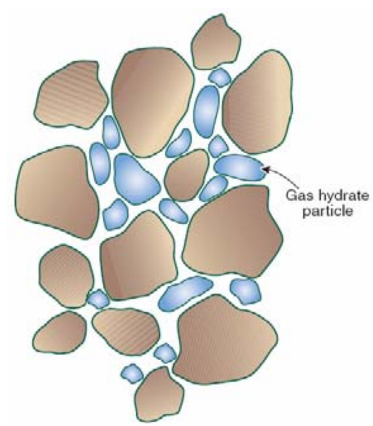
*SPS - ORNL*


*MDT - Schlumberger*

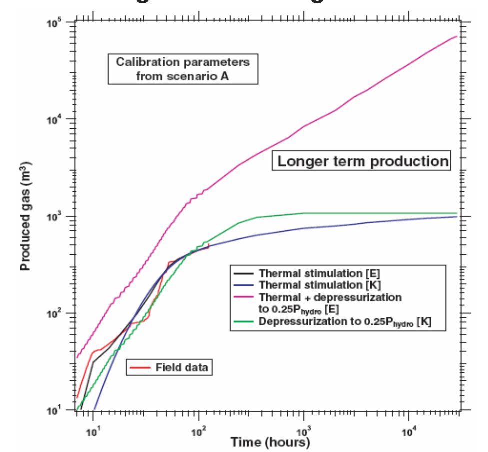


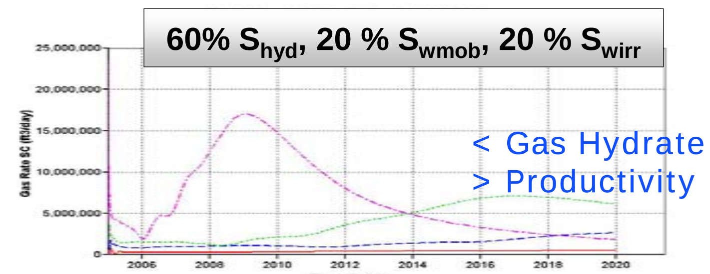
# Issue #4: Production Technology
## *What we're learning*

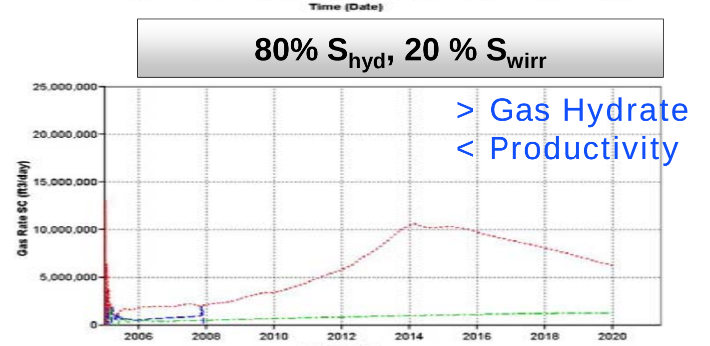
- **Most promising are those with subjacent free gas or water**
  - 4 to 5 million/day with little water
- **Other settings show promise**
  - Depressurization: mobile phase needed
  - Near-wellbore icing a problem: local heating may be necessary
  - Heterogeneities may be key
- **Production prospects from disseminated deposits is bleak**
  - Low gas/high water
  - An inability for P/T perturbation to access the reservoir




ToughFX Modeling - *LBNL*



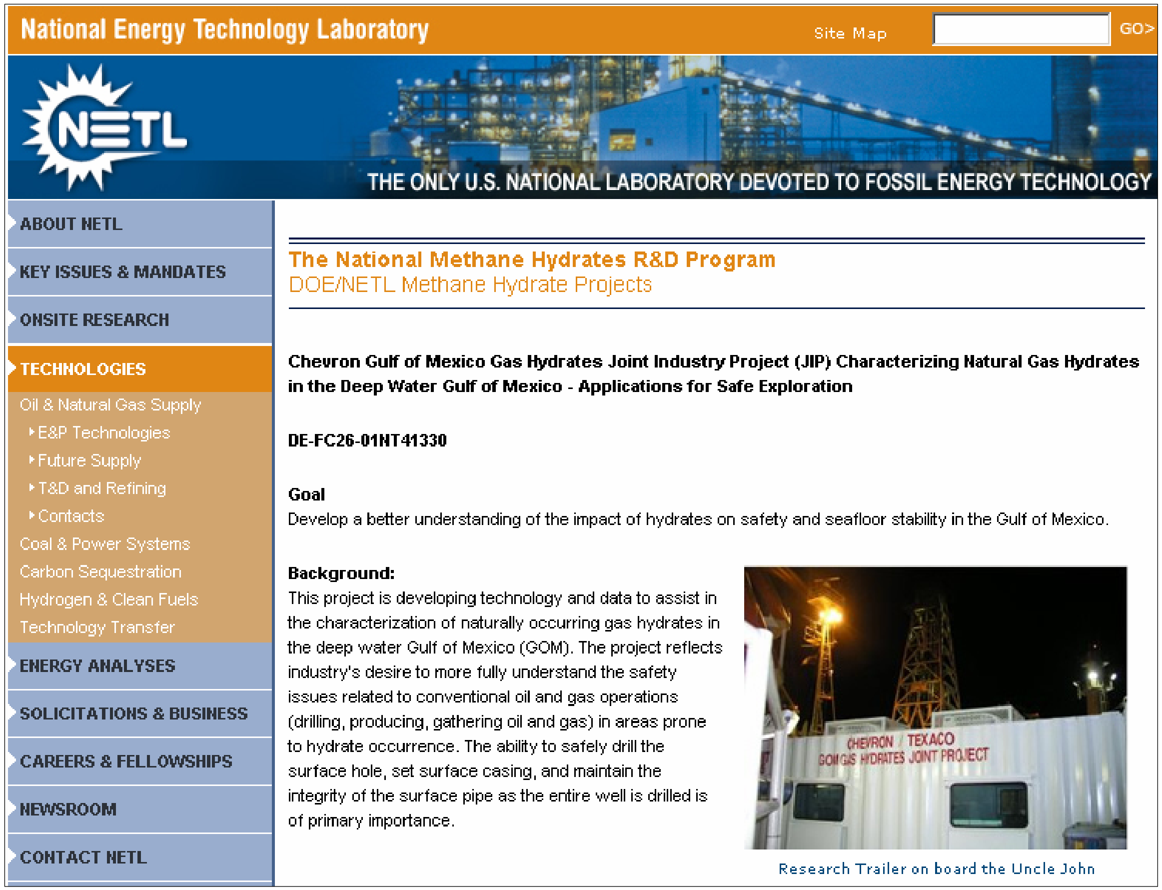




*CMG Stars Modeling - BPXA*

# Information

## *website and electronic newsletter*



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**The National Methane Hydrates R&D Program**

DOE/NETL Methane Hydrate Projects

**Chevron Gulf of Mexico Gas Hydrates Joint Industry Project (JIP) Characterizing Natural Gas Hydrates in the Deep Water Gulf of Mexico - Applications for Safe Exploration**

**DE-FC26-01NT41330**

**Goal**

Develop a better understanding of the impact of hydrates on safety and seafloor stability in the Gulf of Mexico.

**Background:**

This project is developing technology and data to assist in the characterization of naturally occurring gas hydrates in the deep water Gulf of Mexico (GOM). The project reflects industry's desire to more fully understand the safety issues related to conventional oil and gas operations (drilling, producing, gathering oil and gas) in areas prone to hydrate occurrence. The ability to safely drill the surface hole, set surface casing, and maintain the integrity of the surface pipe as the entire well is drilled is of primary importance.

CHEVRON / TEXACO GOM GAS HYDRATES JOINT PROJECT

Research Trailer on board the Uncle John

U.S. Department of Energy • Office of Fossil Energy • National Energy Technology Laboratory

Fire in the Ice

Fall 2005 Methane Hydrate Newsletter

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Shirish L. Patil

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**INTEGRATED OCEAN DRILLING PROGRAM EXPEDITION 311 – CASCADIA MARGIN GAS HYDRATES**

*by the IODP Expedition 311 Shipboard Scientific Party*

The Integrated Ocean Drilling Program's (IODP) Expedition 311 was designed to further constrain models for the formation of marine gas hydrate in subduction zone accretionary prisms. The scientific objectives of this expedition included characterizing the deep origin of the methane, its upward transport, its incorporation in gas hydrate, and its subsequent loss to the seafloor.

From September 19, 2005 through October 28, 2005, IODP Expedition 311 drilled and cored a transect of four sites (U1325, U1326, U1327, U1329) across the Northern Cascadia Margin to study gas hydrate occurrences and formation models for accretionary complexes. In addition to the transect sites, a fifth site was visited (Site U1328, representing a cold vent with active fluid and gas flow). The four transect sites represent different stages in the evolution of gas hydrate across the margin, from the earliest occurrence on the westernmost first accreted ridge (Site U1326) to its final stage at the eastward limit of gas hydrate occurrence on the margin in shallower water (Site U1329).

Pressure Core Specialist manipulates a pressure core recovered during the IODP Expedition 311.

1

***www//netl.doe.gov/methanehydrates***

# Thank You!

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