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

Interagency Coordination on Methane Hydrates R&D

Demonstrating the Power of Working Together

Introduction

Perhaps no areas of science are receiving more careful scrutiny and public discussion than those that deal with the interactions among earth, ocean, climate, and humanity. At the same time, our growing demands for energy are challenging us to find additional sources of clean fuel. The science of methane hydrates, a potentially vast source of natural gas that is part of a complex of dynamic natural systems, sits squarely in the center of these issues and the debates that surround them.

Over the past two decades, scientists have been changing their view of how natural gas occurs within the Earth. New discoveries are being made in the Arctic and the deep ocean that could dramatically alter our understanding of the way the Earth's crust, oceans, atmosphere, and climate interact.

In the past five years, hydrate science has advanced significantly. Closely linked laboratory experiments and computer modeling have enabled a much more confident assessment of gas hydrate behavior in natural environments. A series of field expeditions has revealed the natural complexity and heterogeneity of hydrate systems, confirmed the producibility of methane from arctic hydrates, documented the existence of concentrated, potentially producible accumulations in marine settings, and provided further insight into the possible connections between gas hydrates and past periods of rapid global climate change.

The National Methane Hydrates Research and Development (R&D) Act of 2000 required the development of a national R&D program utilizing the talents of federal, private, and academic organizations. The recently-released "Interagency Roadmap for Methane Hydrate R&D" (July 2006) describes a coordinated approach to studying the role of gas hydrates in nature and the potential of this resource as a global fossil energy source.

This brochure describes the ongoing activity of a collaborative and interagency federal program in science and technology R&D. The program's goal is to efficiently use all the resources at the Nation's disposal resident in a number of government agencies and organizations, by maximizing their collaborative efforts on gas hydrates R&D, avoiding R&D duplication among these agencies, and ensuring that no important questions are left unanswered.

Contents

The photos in this publication have been provided by the participating agencies.

Abbreviations

AGHRP – Applied Gas Hydrate Research Program
ANS – Alaskan North Slope
APEC – Asia Pacific Economic Cooperation Forum
BPXA – British Petroleum Exploration Alaska, Inc.
CMRET – Center for Marine Resources and Environmental Technologies
DOC – U.S. Department of Commerce
DOD – U.S. Department of Defense
DOE – U.S. Department of Energy
DOI – U.S. Department of Interior
EEZ – exclusive economic zone
FAC – Federal Advisory Committee
FE – (DOE Office of) Fossil Energy
FY – fiscal year
GERG – Geochemical and Environmental Research Group (at Texas A&M)
GHASTLI – gas hydrate and sediment test laboratory instrument
GMHRC – Gulf of Mexico Gas Hydrates Research Consortium
GOM – Gulf of Mexico
GSC – Geologic Survey of Canada
ICC – Interagency Coordination Committee
IOPD – Integrated Ocean Drilling Program
INL – Idaho National Laboratory
JIP – (Chevron) Joint Industry Project
LBNL – Lawrence Berkeley National Laboratory
MBARI – Monterey Bay Aquarium Research Institute
MCS – multi-channel seismic (system)
MHR&D – National Methane Hydrates R&D (Act)
NETL – (DOE) National Energy Technology Laboratory
NIST – National Institute of Standards and Technology
NRC – National Research Council
NURP – NOAA's Undersea Research Program
OCS – outer continental shelf
ODP – Ocean Drilling Program
OE – (NOAA Office of) Ocean Exploration
OMM – Offshore Minerals Management (Program)
ONR – (DOD) Office of Naval Research
PNNL – Pacific Northwest National Laboratory
R&D – research and development
ROVs – remotely operated vehicles
SCNGO – Strategic Center for Natural Gas and Oil
TA&R – Technology Assessment and Research Program
TCT – Technical Coordination Team
USGS – U.S. Geological Survey
WHOI – Woods Hole Oceanographic Institution

What are Gas Hydrates?

Gas hydrates are ice-like, naturally occurring compounds that are composed of gas, typically methane (CH_4), physically trapped inside a solid lattice of water molecules. Gas hydrates form naturally under conditions of high pressure and relatively low temperature given sufficient sources of methane and water. Under these conditions, methane molecules are compressed into very tightly packed ice-crystal cages. As a result, methane hydrates have high energy density. For example, when dissociated at normal surface temperatures and pressures, a 1 ft^3 (0.028 m^3) block of solid methane hydrate will release approxiamtely 160 ft^3 (4.53 m^3) of methane.

Scientists have known of the existence of "clathrate" substances since their creation in the laboratory in the early 1800s. Clathrate hydrates are a class of solids in which gas molecules occupy "cages" of water molecules. However, it was not until the 1970s that scientists began to suspect that gas hydrates could be a significant part of the natural environment. The first indications of naturally-occurring gas hydrates came from Siberia and the Black Sea, enabling Russian scientists to speculate that vast amounts of gas hydrate could be present beneath the world's oceans. Then, in 1982, scientists onboard the *Glomar Challenger* retrieved a 3-foot thick sample of massive gas hydrate from the deep-water sediments off the coast of Guatemala. The Guatemala sample became the impetus for the first national R&D program dedicated to gas hydrates. Over the next 10 years, the U.S. Department of Energy (DOE), the U.S. Geological Survey (USGS), and a number of other organizations compiled the data to demonstrate that gas hydrates have the potential to occur in staggeringly vast quantities all over the globe. By the mid 1990s, it was widely accepted that the volume of energy stored in gas hydrates could exceed that of all the world's coal, oil, and conventional natural gas combined.

Today, it is known that gas hydrates occur naturally in Arctic regions and in shallow marine sediments along continental margins. Gas hydrates can form in rocks or sediments of any type, given a suitable pressure, temperature, and supply of water and methane. Gas hydrates commonly occur as disseminated grains, massive layers, nodules that grow and displace surrounding sediments, veins filling small fractures, thin layers along bedding planes, and as cement binding sedimentary grains together.

The Interagency Program in Methane Hydrate R&D: 2000-2007

Recognizing the importance of gas hydrate research and the need for coordinated effort, Congress and the President of the United States enacted Public Law 106-193, the Methane Hydrate Research and Development Act of 2000. The Act called for the Secretary of Energy to begin a methane hydrate R&D program in consultation with the National Science Foundation, and the U.S. Departments of Commerce (DOC) — represented by NOAA, Defense (DOD) — represented by NRL, and Interior (DOI) — represented by MMS and USGS. Appropriations over the five year period (2001-2005) held steady at approximately $9.5 million per year. In August, 2005, the Act was reauthorized through 2010 as Sec. 968 of the Energy Policy Act of 2005 (Public Law 109-58) with a total funding authorization of $155 million. This legislation added the Bureau of Land Management (BLM) to the interagency effort and set the following goals for the program going forward.

The Act directs the Secretary to report annually to Congress on the results of actions taken to carry out this Act. The DOE has also established an advisory committee, consisting of experts from industrial enterprises, institutions of higher education, and state and federal agencies, who are charged with recommending research priorities for the program and providing to Congress an assessment of the Interagency 5-year R&D plan by August 2007. In addition, the National Research Council (NRC) is tasked with preparing a report on the progress of the research program and recommendations for future methane hydrate R&D needs in a report due to Congress in 2009.

The Act, as reauthorized, directs these seven federal agencies to collaborate on a program to:

- Conduct basic and applied research to identify, explore, assess, and develop methane hydrate as a source of energy;
- Develop technologies for efficient and environmentally sound development of methane hydrate resources;
- Develop technologies to reduce the risks of drilling through methane hydrate, and identify methane hydrate resources through remote sensing;
- Acquire and reprocess seismic data suitable for characterizing methane hydrate accumulations;
- Conduct exploratory drilling and production testing operations on permafrost and non-permafrost gas hydrates, including drilling of one or more full-scale production test wells.
- Conduct basic and applied R&D to assess and mitigate the environmental impacts of hydrate degassing (both natural and that associated with development);
- Promote education and training in methane-hydrate science through dedicated fellow ships or other means.

Merging Individual Agency Strengths

Each of the seven federal agencies collaborating in the National Methane Hydrate R&D program brings unique talents to the effort. NOAA's responsibilities in global climate and living marine resources has left it well poised to lead the effort to improve our understanding of the role of methane hydrate in the environment, including determining the role of oceanic and gas hydrates in global climate change and assessing environmental impacts of commercial hydrate production. NRL's focus on submarine defense capabilities has led to development of high-resolution seismic tools. The MMS and BLM focus on quantification and safe development of mineral resources has led to the development of expertise in the use of seismic and other tools to identify both resources and safety hazards. The USGS, in its wide-ranging mission to describe and understand the Earth, has developed geological and geophysical expertise in all of the major domestic locations where gas hydrates occur. The NSF promotes sound science and the development of the nation's scientific capacity and is the US lead in the Integrated Ocean Drilling Program (IODP), one of the leading supporters of methane hydrate field expeditions. The DOE, as the lead agency in the effort, brings its experience in technology development and the management of public-private partnerships to create the comprehensive federal R&D portfolio necessary to address the goals of the MHR&D Act.

Four Primary Collaboration Mechanisms

There are four primary ways in which collaboration among the agencies has occurred.

First, **the agencies co-fund projects of mutual interest**. For example, DOE and USGS each contributed funding and expertise to the NSF-sponsored ODP Leg 204 and IODP Expedition 311. While NSF provided the bulk of the U.S. funding (totaling nearly $20 million), interagency collaborations enabled the IODP to employ the best possible science program, including further testing and development of pressure-coring and well logging technologies.

Second, **agencies actively incorporate the research findings and expertise of other agencies' into their programs.** For example, USGS maintains scientific expertise and a database of Alaskan North Slope hydrate-relevant well data that has been tapped as an invaluable resource to DOE-funded research projects being carried out in Alaska. Likewise, USGS has actively supported DOE-funded work to improve gas hydrate numerical simulation capability, and has informed its priorities for laboratory work in its Menlo Park and Woods Hole laboratories to address that identified need for data.

As another example, an ongoing MMS-funded and directed project to assess domestic in-place and technically-recoverable methane resources in offshore gas hydrate deposits has benefited greatly from USGS participation. Similarly, the DOE-led Joint Industry Project (JIP) has made significant use

of the MMS and NRL work in appraising drilling locations and the regional distribution of sandstone reservoirs within the hydrate stability zone of the Gulf of Mexico as part of its ongoing planning for future field expeditions.

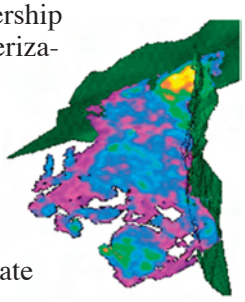
Third, **DOE directly funds other agencies to conduct work** in support of program goals when those agencies have unique abilities to provide critical data needs. Examples include funding to USGS and NRL to conduct both field and laboratory research in support of the Gulf of Mexico JIP. Conversely, DOE provides supplemental support to activities led by other agencies, including funds to augment the ongoing USGS effort with the government of India, as well as funding NRL to conduct initial geophysical and geochemical surveys with the governments of Chile and New Zealand.

Fourth, **collaborating agencies contribute valuable technical expertise towards the development of R&D plans**. The MHR&D Act recognizes each organization's special strengths and the need to effectively coordinate them. Consequently, the MHR&D Act specified that DOE form and lead interagency working groups to ensure efficient communication, reduce unnecessary redundancies, and ensure that no critical issues are left unaddressed. Two such groups have been formed and have met periodically since 2001: the Interagency Coordination Committee (ICC) consists of program managers who work to align broad R&D priorities and activities within the agencies, and the Technical Coordination Team (TCT) consists of field scientists and other technical experts who identify critical data needs and opportunities for collaborative R&D. Both the ICC and the TCT regularly provide input to the program's Federal Advisory Committee (FAC) through the generation of interagency research and development plans such as the Interagency Roadmap for Methane Hydrate R&D (2006) and the Interagency Five-Year Plan for Methane Hydrate R&D (2007).

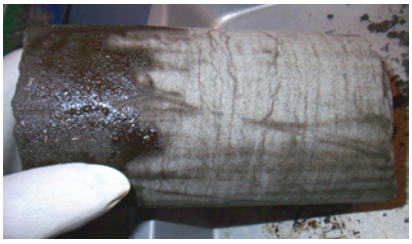
Selected Collaborative Accomplishments of the Interagency R&D Program in Gas Hydrates

From 2000 to the present, the National Methane Hydrate R&D Program has worked to accelerate the determination and realization of gas hydrate's resource potential and to better understand the role of gas hydrate in the environment. Through the efforts of this unique interagency collaborative program, fundamental advances have been made in remote detection technologies, hazards characterization, field tool development, characterization of physical properties, reservoir simulation, and other areas. The following examples are some of the more significant collaborative accomplishments funded under the MHR&D Act of 2000.

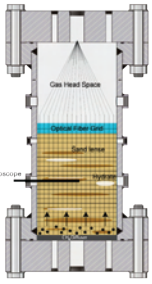
- **Arctic Gas Hydrate Detection Technologies:** In 2005, **DOE**'s program in partnership with BP Exploration (Alaska) (BPXA) resulted in the first delineation and characterization of discrete gas hydrate reservoir accumulations through remote sensing data. This critical accomplishment was enabled primarily through the contributions of the **BLM**, and most particularly, the **USGS**. These organizations worked with BP and DOE to enable state-of-the-art geophysical evaluation of BP's donated 3-D seismic data set over the Milne Point unit of the greater Prudhoe Bay region. This work was then coupled with advances in field-scale reservoir modeling to enable the first estimates of the technically recoverable portion of an in-place hydrate resource.

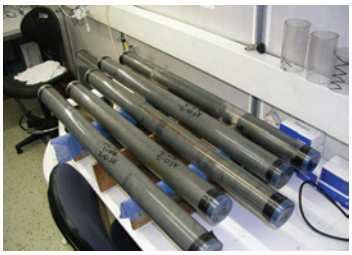


- **Arctic Gas Hydrate Reservoir Characterization:** In early 2007, **DOE**'s program with BPXA successfully drilled, sampled, and tested two gas hydrate-bearing reservoirs within the **USGS**-generated "Mt. Elbert" prospect. This ambitious data collection program included continuous wireline coring, a research-level open-hole logging program, and extensive, never-before-conducted open-hole formation pressure transient tests, resulting in the most complete data set yet collected on any natural gas hydrate accumulation. The success of this field program was enabled, in large part, by the expertise provided by the experienced field scientists at the **USGS.**

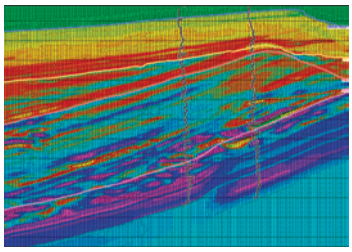


- **Improved Experimental Capability: USGS** and the **DOE** National Laboratory network have created an array of specialized sea floor process simulation reactors that enable study of the dynamics and nature of gas hydrates under natural pressure and temperature conditions. Guided in part by a 2005 **USGS**-hosted workshop on the alignment of gas hydrate laboratory and modeling work, these efforts are now increasingly focused on determining the composite properties of gas hydrate-bearing sediment.

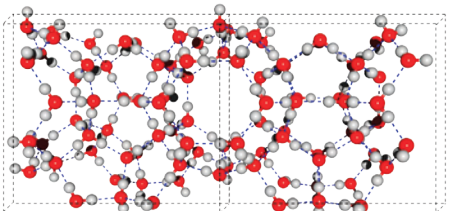




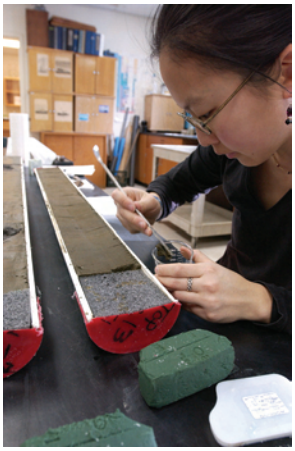
- **Understanding Natural Gas Hydrate Systems:** In the past, the general conception of the primary controls on gas hydrate occurrence in nature were pressure and temperature. However, recent field expeditions, supported by the **DOE**, **NSF**, **MMS**, **NRL**, **USGS**, and **NOAA**, have aided in the demonstration that natural gas hydrate systems are highly complex, heterogeneous, and dynamic. The occurrence of gas hydrate is now fully appreciated to be a function of geochemical and hydrological conditions, as well as many of the same factors that control more conventional hydrocarbon occurrence, namely, the presence of suitably trapped and sealed reservoir rocks. This new, more complete *petroleum systems* approach is enabling more appropriate exploration approaches and has been fully integrated into the ongoing **DOI** gas hydrate resource assessments, which will provide the first estimates of the recoverability of marine gas hydrates.



- **Understanding of the Safety Implications of Gulf of Mexico Gas Hydrates:** Field and laboratory work conducted by the **DOE**-funded Chevron (JIP), with the valuable contributions of **MMS**, **USGS**, and **NRL,** indicates that gas hydrate occurrence within near-surface hydrate bearing fine-grained sediments can be determined prior to drilling by evaluating standard industry seismic data. Furthermore, efforts to date indicate that the low levels of gas hydrate concentration that are commonly present within such sediments in the Gulf of Mexico likely do not pose a significant drilling hazard to ongoing deepwater exploration.



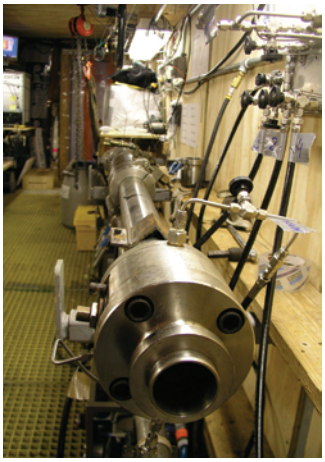
- **Improved Analytical Capability:** **DOE**-funded work on numerical modeling has resulted in the creation of a number of sophisticated computer codes that enable the investigation of gas hydrate behavior in nature under a wide range of conditions. Led by the efforts of the **DOE**'s Lawrence Berkeley National Laboratory (LBNL), these models are being fully integrated into both field and laboratory efforts, and are significantly increasing the relevance and efficiency of both. Currently, the **USGS** is working with modelers from **DOE**, LBNL, the Pacific Northwest National Lab, Canada, and Japan to conduct advance and comparative simulations on realistic model descriptions of Arctic gas hydrate accumulations based on the **DOE**-BPXA project. This international computer code comparison study is a cornerstone in enabling the confident analytical capability that will be critical to the efficient development of gas hydrate production technology.



• **Supporting Educational Opportunities:** The MHR&D Act calls for DOE to *"promote education and training in methane hydrate resource research and resource development."* The program does this in two ways. First, over the past six years, more than 100 undergraduate, graduate, and post-doctoral level students have participated in DOE-sponsored gas hydrate research at more than 30 universities, colleges and national laboratories in 21 states. Many of these students conducted this work in association with experts from the other federal agencies, including ***MMS, NOAA, NRL,*** and the ***USGS***. In addition, in 2006 National Energy Technology Laboratory (NETL) initiated an academic research fellowship program in association with the National Academy of Science designed to support the development of methane hydrate science and enable highly qualified students to pursue advanced degrees. The two-year fellowships are available to support work towards M.S. and Ph.D degrees, or in a Post-doctoral appointment. Final selection of the initial Fellows is accomplished through an Interagency panel. The first of the fellowships was awarded in early 2007.

• **Understanding the Role of Gas Hydrates in the Environment:** The global gas hydrate reservoir holds vast volumes of methane in close proximity to the seafloor and within the Arctic permafrost, raising important questions about the role of gas hydrates relative to: 1) the global carbon cycle and climate change; 2) the stability of the seafloor under structures located both on deep shelves and on slopes; and 3) gas hydrate-related chemosynthetic communities. To address these questions, the federal agencies continue to collect data in both the marine and Arctic environments to assess the potential for natural and human-induced (primarily oil and gas exploration and production related) hydrate degassing. In particular, **NOAA**, in collaboration with **DOE**, **MMS**, **USGS**, and Woods Hole Oceanographic Institution, organized the first workshop to bring **NOAA** carbon and climate modelers and measurers together with the methane hydrate research community. **MMS**, **NOAA**, and **DOE** have collaborated to support the development of the Gulf of Mexico Seafloor Observatory located in Mississippi Canyon Block 118. The gas hydrate sea floor observatory will provide continuous data collection within the hydrate stability zone and provide a platform from which to monitor the interactions among gas hydrates, seafloor sediments, the water column, and the overall ecosystem. **NRL** is also expected to contribute its expertise in advanced geophysical monitoring to the effort beginning in 2007.

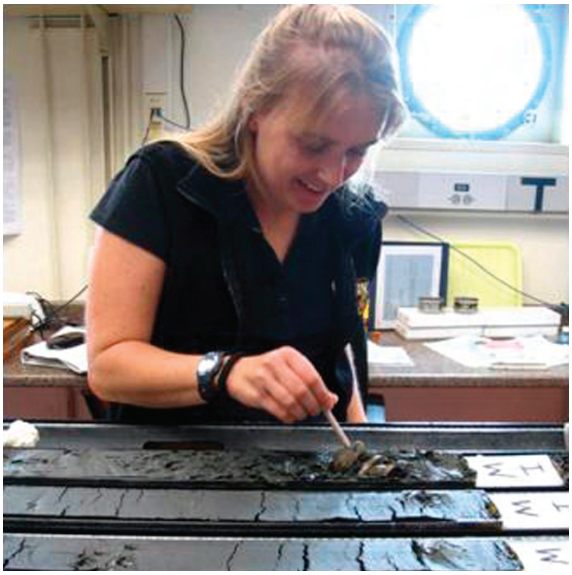
- **International Collaboration:** Over the past decade, collaborations with international gas hydrate R&D efforts provided outstanding value and contributed significantly towards the results achieved by the U.S. methane hydrates R&D program. In particular, **USGS** and **NRL** have done exceptional work in building U.S.-International scientific collaborations. Most recently, **USGS** provided critical scientific expertise to the highly-successful 2006 India expedition. **DOE** contributed technical expertise and supplemental funding to this expedition as well, and hosted an Indian observer at its 2007 field effort with BPXA and **USGS** in Alaska. Both **DOE** and **USGS** have also contributed at various stages of the Japanese R&D program, including earlier field programs, as well as ongoing numerical simulation development. Furthermore, **NRL**, with partial support from the **DOE**, continues to build strong collaborative initiatives by hosting annual international workshops and conducting geophysical/geochemical surveys in association with researchers in other countries such as Chile and New Zealand.



- **Advanced Field Sampling and Analysis Tools:** The **NSF**-funded IODP expeditions have been a proving ground for the development and testing of many critical new technologies for the sampling and analysis of gas-hydrate-bearing marine sediment. With supplemental funding from **DOE**, technologies such as pressure coring and accurate downhole pressure-temperature measurements have evolved to become standard elements of gas hydrate field programs around the world. In addition, access to tool-development expertise at **DOE**'s Pacific Northwest National Laboratory (PNNL) and LBNL, has accelerated the development of technologies such as field infra-red imaging and X-ray computed tomography scanning. A device developed by Georgia Tech (in association with the **DOE**-Chevron JIP) enabled the first measurement of hydrate-sediment mechanical properties on samples kept continuously under pressure conditions. In collaboration with the **USGS**, this device and others were used to enable unprecedented examinations of fine-scale gas hydrate structures preserved in pressure core samples collected during the Indian government's summer 2006 expedition.

These accomplishments, enabled primarily by the collaborative efforts of the various Federal agencies involved in gas hydrates research, have been significant. Nevertheless, major questions remain regarding the scale of the potentially-recoverable resource, our ability to remotely detect and appraise marine accumulations, and viable production technologies. There is also much more to learn regarding the role gas hydrate plays in the global carbon cycle, in the evolution of the sea floor, and in global climate. Finding answers to these questions will require continued collaborative effort among the participants in the MHR&D Program. The following sections provide separate descriptions of gas hydrates research activities at each of the participating agencies.

DOE - Office of Fossil Energy and National Energy Technology Laboratory



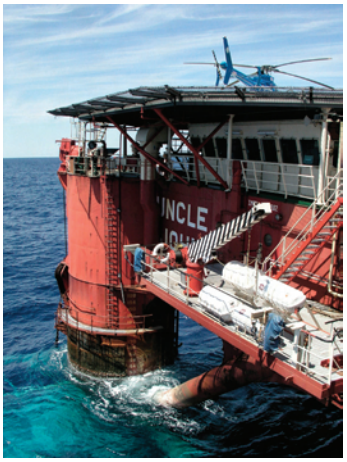
The Methane Hydrates Act of 2000 established DOE's Office of Fossil Energy (FE) as the lead organization in the National Methane Hydrate R&D Program. DOE ensures that the federal agencies involved in gas hydrates research communicate effectively with each other through two Interagency working groups (ICC and TCT), and is responsible for establishing and chairing the Methane Hydrate Federal Advisory Committee.

The National Methane Hydrate R&D Program is coordinated through the DOE FE Strategic Center for Natural Gas and Oil (SCNGO), located at NETL. SCNGO implements research, development, and demonstration through partnerships with industry, academia, and other governmental agencies. The DOE's sole mission in this program is the accomplishment of the goals and expectations of the MHR&D Act.

DOE FE conducts about 60% of its work through cost-shared, competitively awarded cooperative agreements with industry/academia research partners. Over the past five years, the average cost share has been 35% of the total R&D investment. The remainder of the funds are spent to support work within the DOE National Laboratory system or to fund collaborative activities with the **USGS** and **NRL**.

In accordance with the intent of the MHR&D Act as extended in 2005, DOE actively seeks full external scientific oversight in the execution of its program. In recent years, experts from the **USGS**, **MMS**, **NOAA**, and **NRL** have served as reviewers of research programs, both ongoing and proposed. In addition, in 2007, a panel of experts from the various agencies assisted DOE in the selection of the inaugural National Methane Hydrate R&D Program Fellows.

To facilitate the dissemination of research results and encourage collaborative efforts among hydrate scientists, DOE has established a National Methane Hydrate R&D website within the NETL website. In addition, DOE is funding the Department of Commerce's National Institute for Standards and Technology (NIST) to develop an international gas hydrates database accessible through the world-wide web in consultation with the **USGS**.



DOE-Funded Gas Hydrates Initiatives

- **Major Cooperative Agreements:** DOE continues to manage two primary R&D efforts in partnership with industry-led groups. In Alaska, our major effort is an appraisal of the resource potential of permafrost-related gas hydrates with BP Exploration Alaska. This effort has benefited from extensive collaborations with the **USGS** and support from the **BLM** and has achieved several milestones, including the remote detection of discrete gas hydrate prospects and the successful drilling, coring, and testing of two reservoirs within one of those prospects. In the Gulf of Mexico, our effort with the Chevron-led Gulf of Mexico Gas Hydrates Joint Industry Project (JIP) is advancing our understanding of the safety and resource issues around marine gas hydrates. This effort, which includes major contributions from the **USGS**, **MMS**, and NRL, has greatly advanced a wide range of research issues, including geophysical detection, borehole stability modeling, and field sampling technologies.

- **Supporting Cooperative Agreements:** DOE currently manages roughly a dozen additional research initiatives with universities, research institutions, and private technology developers. Many of these projects are conducted in collaboration with other federal agencies, most notably the work with **MMS** and **NOAA** on development of a sea-floor observatory and a suite of projects developing remote detection capabilities (U. Texas-Austin, Baylor U., U. Mississippi). DOE also co-funded, with the **NSF**, some of the earliest geophysical appraisals of the Blake Ridge accumulation off the eastern coast of the U.S. Similary, DOE partners Stanford University and Rock Solid Images are working closely with the USGS and others in the evaluation of seismic data from around the world

- **Advanced Research at the DOE National Laboratories:** DOE utilizes the expertise of the National Laboratories to advance R&D in a variety of fields, most notably experimental capabilities, numerical simulation, and field tool development. This work has been well coordinated with the **USGS** (through DOE participation at USGS workshops and **USGS** participation in DOE National Lab merit reviews), which conducts similar work at its labs, and utilizes many of the tools developed in its field programs. Direct collaboration is also common, with the Menlo Park group working closely in the past with LLNL and the Woods Hole group collaborating with LBNL, NETL, and others. Notably, the ongoing comparison study of international gas hydrate numerical simulators (with contributors LBNL, PNNL, and NETL) is collaborating closely with the field experts at the **USGS**'s Denver office to assure the appropriateness of the field characterization datasets being used in the effort.

- **Interagency Agreements:** DOE is working closely with experts in the **USGS** and the **NRL** to develop new tools and technologies to aid in the remote detection and characterization of both Arctic and marine gas hydrates. These collaborations have provided tremendous value to the DOE flagship projects with BPXA and the Chevron-led JIP. In addition, key DOE research partners, such as the University of Texas-Austin and Baylor University are working closely with the **MMS** and **NOAA** in applying the latest technologies to the evaluation of the site of the Gulf of Mexico seafloor monitoring station.

DOC - National Oceanic and Atmospheric Administration

NOAA's mission is to "understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social, and environmental needs." Success in achieving our vision depends upon how well we understand the Earth's dynamic, natural systems, and assess the effects of human activities upon them.

As a science-based agency, NOAA relies upon both internal and external research to provide scientific information for decision makers, resource managers, policy makers, the general public, and other federal agencies. NOAA supports internal research activities to respond to immediate research needs, to sustain long-term monitoring and modeling capabilities, and to ensure that research is forward-looking and responsive to programmatic needs. NOAA also relies on extramural research partners to complement and augment NOAA's internal research capabilities, to provide critical expertise in areas not fully represented inside the agency, and to share new ideas and technologies.

NOAA studies oceanic methane and gas hydrates to improve the understanding of the role of hydrates in relation to global climate change, the unique chemosynthetic communities associated with them, the stability of the seafloor, and impacts to living marine resources from hydrate exploration and production.

NOAA began sponsoring scientists in the late 1980s to study methane hydrates and their associated chemosynthetic communities. Early NOAA-sponsored studies resulted in several landmark findings including:

- Discovery of exposed gas hydrate beds in the Northern Gulf of Mexico.
- Discovery of a new species, the ice worm *Hesiocaeca methanicola*, living on exposed gas hydrates likely subsisting on microbes assocated with the hydrate.
- Demonstration that increases in deep ocean temperature by 1°C could cause hydrate outgassing.

NOAA supports methane hydrate-related research and technology development through two programs: NOAA's Undersea Research Program (NURP) and the Office of Ocean Exploration (OE). Together, NURP and OE provide unique capabilities to our Nation and are the only federal scientific programs of their kind. NURP specializes in providing both academic and federal scientists with field support and access to a wide variety of advanced underwater technologies (e.g., manned submersibles, remotely operated vehicles, and autonomous underwater vehicles) required for studying climate issues and chemosynthetic communities associated with methane hydrates, as well as other marine environments. OE focuses on exploration of the seas, including documenting methane hydrates and their associated communities, as well as mapping other physical, biological, chemical, geological, and archaeological aspects of the ocean in unknown or poorly known regions.

NOAA, through the aforementioned programs, brings a wealth of technical and technological know how to the field of ocean methane and gas hydrate research and development. NOAA provides dedicated sensors and

platforms designed and developed specifically for seafloor and lower water column observations. These technologies provide scientists with the opportunity to study hydrates and their associated chemosynthetic communities in situ and in real-time to improve the understanding of seafloor stability, environmental impacts from hydrate exploration and production, and how gas releases from the deep ocean into the atmosphere may impact global climate change.

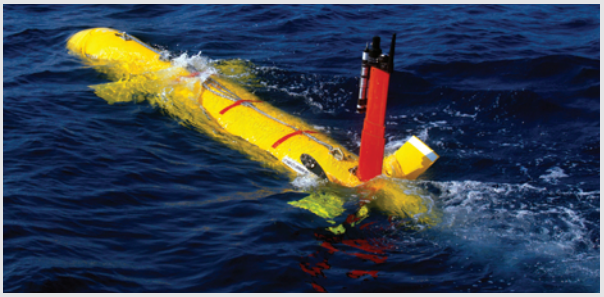
NOAA activities have added significantly to the base of knowledge on the role of hydrates in the environment and their associated chemosynthetic communities and climate change.

- NOAA hosted a workshop, co-sponsored by DOE, MMS, USGS, and Woods Hole Oceanographic Institution, entitled *The Role of Ocean Methane & Gas Hydrates in Global Climate Change* in May 2004. This workshop brought together, for the first time, NOAA carbon and climate measurers and modelers with the methane hydrate research community to discuss the state of knowledge on seafloor gas hydrates and the global carbon cycle. The workshop concluded that the prevailing paradigm that the oceans are an insignificant source of methane input to the atmosphere warrants a closer inspection as does the quantification of methane sources and sinks.

- NOAA's National Institute for Undersea Science and Technology (established in 2001) is leading the development and implementation of the Gulf of Mexico Gas Hydrates Seafloor Observatory, a consortium project involving NOAA, DOE, MMS, universities, and private corporations. The goal of this consortium is to develop, deploy, and utilize a sophisticated network of instruments to provide insight on hydrate stability over time, as well as provide information on the microbial communities associated with hydrates. In 2005, two probes measuring pore water fluid and site temperature were installed at Mississippi Canyon Block 118 at 860 m depth; and in 2006, a portion of the microbial observatory was installed to better understand the role of chemosynthetic organisms in seafloor stability, and how dissociating hydrates may have an impact on climate change.

- NOAA and MMS are partnering in the Gulf of Mexico in 2006 and 2007 to further understand hard bottom communities in depths greater than 1,000 m and how they might be affected by oil and gas exploration and production. Preliminary findings in 2006 showed that Walker Ridge Block 269 and Mississippi Canyon Block 640 contained exposed hydrates and a mosaic of habitats and physical features including hydrates, carbonate mounds, salt mounds, brine pools, and vents that were actively seeping hydrocarbons.

- NOAA has supported several competitive research projects through its extramural partners, including a study that examined the dynamics of rising bubble plumes from natural petroleum seeps in the Santa Barbara Basin as an analog for methane release from gas hydrates; and a study that tested whether natural gas hydrates in the seabed are chemically the same as synthetic gas hydrates studied in the laboratory to determine the applicability of laboratory tests to the natural environment.



DOD
Naval Research Laboratory

NRL is the U.S. Navy's laboratory for research in ocean and atmospheric sciences with special strengths in physical oceanography, marine geosciences, ocean acoustics, marine meteorology, and remote oceanic and atmospheric sensing. As the Navy's corporate laboratory, NRL conducts a multidisciplinary program of advanced scientific and technological R&D directed toward maritime applications. Activities include the development of new and improved materials, techniques, equipment, and systems for oceanic, atmospheric, and space sciences. NRL's parent organization, the Office of Naval Research (ONR), coordinates, executes, and promotes the science and technology programs of the U.S. Navy and Marine Corps through universities, government laboratories, and nonprofit and for-profit organizations. NRL brings over a decade of experience and expertise to the study of marine hydrates.

One significant contribution has been the development of the deep-tow, high-resolution, multi-channel seismic (MCS) system (called DTAGS), which provided site selection and drilling safety support for Japanese research on methane hydrates in the Nankai Trough. NRL has developed and used state-of-the-art analytical instrumentation to study methane hydrate formation and stability, the processes related to hydrate generation and dissociation, and the impact of those processes on sediment properties. Subsequent to the development of the seismic system, field work has expanded to include seismic profiles, geochemical surveys of sediment porewater, and heatflow for methane hydrate research topics.

NRL, with partial support from the ***DOE***, has participated in multidisciplinary investigations of the distribution and concentration of methane hydrates on the Texas-Louisiana Shelf in the Gulf of Mexico (in association with the ***DOE*** Gulf of Mexico JIP), on the mid-Chilean Margin, on the Hikurangi Margin off New Zealand, and on the Cascadia Margin, and in the development of new technology to predict slope failure and shallow flow related to dissociation. This research has been conducted in a broad range of national and international collaborations with government, university, and academic researchers.

To showcase this research, review state-of-the-art technologies, and identify research needs for gas hydrates, NRL and the Hawaii Natural Energy Institute-University of Hawaii co-sponsored a conference in Hawaii in March 2001. The conference, "Fiery Ice from the Seas," was billed as "the first workshop of the International Committee on Methane Hydrates." The workshop promoted international R&D partnering and was instrumental in starting a dialog on international cooperation on methane hydrates research. The 5th consecutive International Workshop on Methane Hydrate Research and Development was held in Edinburgh, Scotland in October 2006, also supported by NRL and ***DOE***. The 6th International Workshop on Methane Hydrate Research and Development is planned for the spring of 2008 in Bergen, Norway.

Selected NRL Hydrates Projects

- NRL, Geologic Survey of Canada, and University of Victoria - integrated (deep-tow MCS, heatflow, core samples, fluid flux) investigation of methane hydrates in the complex region of the Cascadia Margin.

- NRL and the Catholic University of Valpariaso, with supplemental support from ***DOE***, led methane hydrate exploration off the mid-Chilean coast on two cruises during 2003 and 2004. NRL included seismic surveys, heatflow and porewater geochemistry for evaluation of hydrate distribution. Piston coring and heatflow resulted in a strong data test for deep sediment hydrates in this region. Shallow hydrate samples were obtained during the piston coring.

- NRL performed pre-cruise site geochemical and vertical fluid migration survey in preparation for the 2005 ***DOE***-Chevron Gulf of Mexico JIP drilling cruise in the GOM. Also collected high-resolution sidescan sonar and multibeam bathymetric data in the Atwater Valley area of the GOM to provide detailed maps in support of the JIP project. This effort is continuing in the plans for the second phase of the JIP during 2007 and 2008.

- NRL and the Geologic Nuclear Survey from Wellington, New Zealand, with supplemental funding from ***DOE***, lead a preliminary geochemical and heat-flow hydrate survey on Ridge I in the Hikurangi Margin during July 2006. Preliminary data on porewater geochemical surveys and heatflow matches other locations that have deep sediment methane hydrate deposits, e.g., Texas-Louisiana Shelf, Cascadia Margin, and mid-Chilean Margin.

- In 2007, NRL is expecting to conduct a deep-tow MCS test in association with the ***MMS-NOAA-DOE***-funded project with the CMRET (Center for Marine Resources and Environmental Technology) Hydrates Observatory in the Mississippi Canyon, Gulf of Mexico. The goal of this work will be to test an upgraded array and provide additional seismic data in support of the observatory.

DOI
Minerals Management Service

The mission of the Minerals Management Service (MMS) is to manage the mineral resources on the Nation's Outer Continental Shelf (OCS) in an environmentally sound and safe manner and to collect, verify, and distribute, in a timely manner, mineral revenues generated from onshore and offshore federal and Indian lands. The MMS manages mineral resources through the analysis of geological and geophysical data and information which is acquired through private, public, and governmental sources. The bureau maintains an interest in methane hydrates because of the potentially large volume of natural gas that they contain.

The MMS has a three pronged effort with regard to methane hydrates focusing on: (1) resource assessment and evaluation, (2) environmental assessment, protection and monitoring, and (3) exploration and production activities, including offshore safety.

MMS expects to complete an updated assessment of the potential quantities of methane hydrates that may exist on the OCS. With the assistance of the ***USGS***, MMS has developed a probabilistic, analytical methodology for the assessment of technically recoverable hydrate resources. This stochastic methodology relies heavily on MMS' extensive holdings of 3-D seismic data in the Gulf of Mexico (GOM). The methodology was extended for use in the other areas of the OCS where only older 2-D seismic data exists in the areas of interest. In-place estimates of hydrates on the OCS will be developed followed by an assessment of technically recoverable estimates for the federal offshore. In addition, a regional geophysical sea floor mapping project is being completed to assist in evaluating hydrate resources. This project is expected to enhance overall risk assessment, environmental protection, and resource evaluation. In addition to its overall Gulf of Mexico efforts, MMS continues to participate as an active member in the ***DOE***-Chevron Gulf of Mexico JIP. Data generated during the MMS's mapping and resource appraisal efforts was a major contributor to recent site selection for potential 2007 activities within the JIP. Tangentially related to the Methane Hydrates R&D Program, MMS oversees a safety research program involving the detection and prevention of gas hydrates in pipelines at the University of Tulsa. The MMS also maintains a Technology Assessment and Research (TA&R) Program that supports operational safety and pollution prevention research. Several TA&R projects related to gas hydrates as geohazards have been funded since the 1980s. MMS is currently funding hydrates hazard research through the Resource Geoscience Division of the Geochemical and Environmental Research Group (GERG) at Texas A&M University. GERG has established the Applied Gas Hydrate Research Program (AGHRP).

The MMS continues to fund and manage the Center for Marine Resources and Environmental Technology (CMRET), a research center for marine geology and geophysics at the University of Mississippi. Most of the current research at the CMRET is devoted to gas hydrates in the Gulf of Mexico. Technical support and review of the CMRET work is provided by the Gulf of Mexico Gas Hydrates Research Consortium (GMHRC), a committee of academic, industry, and government experts.

MMS is particularly interested in protecting sensitive and unique biological and chemosynthetic communities from deterioration as a result of oil and gas activities. These communities are often associated with outcrops of gas hydrates that may be identified remotely using 3-D seismic data. MMS has funded two large-scale studies on chemosynthetic communities that exist in the GOM near oil seeps and gas hydrate outcrops.

With the oil and gas industry moving into ultra deep water, a more detailed understanding of the location and extent of hydrates on the continental rise is necessary, especially in areas such as Mississippi Canyon and Atwater Valley, where the potential for gas hydrate extraction is attractive.

Selected MMS Hydrates Projects

- Through the *Northern Gulf of Mexico Continental Slope Chemosynthetic Communities Program* ten different researchers studied regional distribution of chemosynthetic communities across the continental slope in the northern Gulf of Mexico, the geologic and geophysical characterization of associated hydrocarbon deposits (including gas hydrates) and then described the habitats, ages, and general ecology of the communities thriving on the hydrates near oil and natural gas seeps.

- *Stability and Change in Gulf of Mexico Chemosynthetic Communities* was designed to provide information necessary to manage the sensitive biologic communities on the ocean floor. This study provides an understanding of the processes that control the distribution, health, and succession of these communities and the effects of fossil energy exploration on them. At the regional level, this effort focuses on geological, chemical, and oceanographic processes that maintain the stability of these communities.

- Currently, a joint venture with ***NOAA***'s Office of Exploration through the National Ocean ship Program (NOPP) is conducting the study *Investigations of Chemosynthetic Communities on the Lower Continental Slope of the Gulf of Mexico*. This study is an extension of previous work described above that was conducted in water depths less than 1000 meters. Already, the joint venture has resulted in the discovery of nine new chemosynthetic community sites at depths between 1,082 and 2,875 meters using remotely operated camera systems. These sites will be further investigated in detail using the submersible *Alvin*.

- The Gulf of Mexico Resource Evaluation office has mapped the seafloor bottom reflector and other geologic trends to determine if these seismic data can help identify hydrocarbon reservoirs at depth. Higher velocities resulting from hydrates, carbonates, and chemosynthetic communities associated with hydrocarbon seeps all result in positive seismic amplitude anomalies in the seafloor reflector. This project is expected to enhance overall risk assessment, environmental protection, and resource evaluation.

- The CMRET is developing water column, seafloor, and down-hole instrumentation for a permanent gas hydrates monitoring station to be placed in the Mississippi Canyon area of the Gulf of Mexico. Some of the instruments have been deployed at the site in MC Block 118, with the remainder expected to be in place by the end of 2007. Funding for the monitoring station is provided by ***MMS***, ***DOE***, and ***NOAA***.

- The MMS also has an ongoing study through Louisiana State University and the Coastal Marine Institute to improve the capability of 3-D seismic surface amplitude data for identifying chemosynthetic communities. One focus of the study is to determine if 3-D seismic data are sufficient to evaluate shallow geohazards. The MMS is also studying seismic waveform analysis of the sea floor reflector to determine if that process can help distinguish hydrates from other hard reflectors such as authigenic carbonates.

- *The MMS Hydrate Assessment Model* is being developed to assess hydrate potential in the Federal Offshore. An assessment of in-place and technically recoverable numbers are expected to be released in 2007.

DOI
U.S. Geological Survey

The Department of the Interior's U.S. Geological Survey (USGS) serves the Nation by producing and providing reliable scientific information to:

- Describe and understand the Earth;
- Minimize loss of life and property from natural disasters;
- Manage water, biological, energy, and mineral resources; and
- Enhance and protect our quality of life.

The Department of the Interior manages all federal offshore lands and a significant proportion of onshore lands where gas hydrates occur. To fulfill regulatory and stewardship responsibilities, the three DOI bureaus of ***BLM***, ***MMS***, and USGS work collaboratively on gas hydrate issues of overlapping interest. USGS, neither a regulatory nor funding agency, is an objective, fact-finding organization that collects, monitors, analyzes, and provides information to enhance scientific understanding about natural resource characteristics, issues, and problems. USGS accomplishes its mission using in-house scientific expertise and through collaboration with domestic and international government agencies, academic institutions, and private-sector companies.

USGS spends approximately $2 million per year on gas-hydrates research related to energy resource potential, natural hazards, influences on the environment, and information and data management. The goal of the USGS program is to understand the behavior of natural gas hydrate as it relates to energy resources, geohazards such as sea-floor stability/drilling safety, and global carbon budget/climate change. USGS research is focused on developing methods to identify and quantify the location of gas hydrate deposits by remote sensing, and understanding processes controlling gas hydrate occurrence in nature. USGS scientists maintain expertise in the major domestic locations where natural gas hydrates are concentrated: the North Slope of Alaska, the Cascadia margin, the Gulf of Mexico, the Bering Sea, and the Blake Ridge, as well as international sites such as the Mackenzie Delta, offshore India, and Japan. Work is being conducted at three USGS centers (Woods Hole, Denver, and Menlo Park) by five study groups.

- ***Geophysics***. Geophysical data interpretation utilizes both 2D and 3D seismic surveys from marine and permafrost locations. Detailed attribute analysis of 3D data from the Milne Point region of the Prudhoe area of Alaska has revealed likely concentrations of gas hydrate in fault-controlled basins. This model was tested successfully in a cooperative project with ***DOE***-BP Exploration (Alaska) in early 2007. Regional high-resolution seismic studies in the GOM have been used to determine the acoustic character of the gas-hydrate stability zone, the potential distribution of gas hydrates, and the potential link between gas hydrates and slope stability. Regional maps of gas hydrate variability have been completed on the U.S. Atlantic continental margin and the USGS is working with ***MMS*** in developing the next assessment of in-place and technically recoverable gas hydrate resources in the Outer Continental Shelf.

- ***Well Logging***. Fundamental observations of natural gas hydrates are provided by measurements obtained from drill holes in both permafrost and marine environments. USGS scientists have been scientific leaders in extensive drilling done in permafrost environments of northern Alaska and northern Canada as well as marine environments such as offshore Vancouver, offshore Oregon, in the Gulf of Mexico, and offshore India. USGS partnered with the Japan National Oil Corporation, the Geological Survey of Canada, the ***DOE***, and others as part of the Mallik Research Consortium in which three test wells were drilled in Canada's Mackenzie Delta. The results, published in 2005, demonstrated the producibility of methane from gas hydrate. Utilizing well information together with regional geologic mapping and high-resolution seismic data, the USGS is working with the ***BLM*** and the State of Alaska to assess North Slope hydrate energy resources and also as a partner with the ***DOE*** and BP Exploration (Alaska) to characterize, quantify, and determine the commercial potential of gas hydrate and associated free gas resources in arctic regions.

- ***Physical Properties and Petrophysics***. Properties and characteristics of laboratory-formed and natural gas hydrate-sediment mixtures, including acoustic velocities, thermal properties, mechanical strength and related properties, compositional and structural characteristics, and sample conformation are studied at the Woods Hole and Menlo Park laboratories. Low-temperature scanning electron microscopy of both natural and laboratory-formed test specimens is also routinely performed. The data from these measurements and instruments are used to predict in situ behavior of gas hydrate, to relate predictions to remote sensing data and well logs, to assess how properties change during gas-hydrate formation and dissociation, and to provide input parameters for numerical models of gas hydrate production scenarios and sediment stability.

- ***Models***. Numerical models relating field and laboratory measurements to natural environments are critical components of USGS research. These models range in complexity from simplified physical models comparing hydrate concentration to acoustic velocity to more complex numerical simulations where thermal, chemical, and pressure conditions control fluid flux and shallow hydrogeology. Models that incorporate observations from field and laboratory data are used to understand, explain, and visualize both laboratory and field data as well as predict the behavior of natural gas hydrate systems during drilling and production scenarios.

- ***Organic Geochemistry***. Understanding the origin and chemical signature of the gas contained within hydrate-bearing sediments is fundamental to characterizing and predicting the behavior of individual gas hydrate deposits. A goal of this research is to compare and contrast the gas compositions from gas hydrates worldwide, and to improve our understanding of hydrate genesis and gas migration through near-seafloor geologic formations and in Arctic permafrost settings.

Selected USGS Hydrate Projects

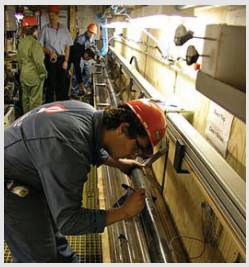
- Collaboration with ***DOE*** and BP Exploration (Alaska) to characterize the hydrate resource in the Milne Point area of the North Slope and prepare for drilling a field test well.

- The collection of seismic data and site characterization at gas hydrate drilling locations in the Gulf of Mexico, in collaboration with the Gulf of Mexico Gas Hydrates JIP led by Chevron and ***DOE***.

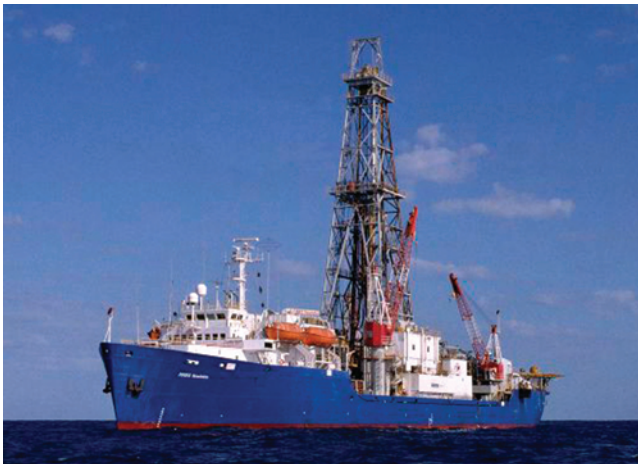
- Scientific co-lead in an international consortium managed by the Geological Survey of Canada that drilled and successfully tested the Mallik 5L-38 gas hydrate research well in March 2002.

- An analysis of velocity amplitudes in the Bering Sea to determine the volume of gas contained in buried gas hydrate interpreted to be causing the velocity anomalies.

- Scientific leadership in collaboration with India's Ministry of Petroleum and Natural Gas, to conduct studies prior to, during, and after gas hydrate drilling and coring offshore India in summer, 2006.



National Science Foundation



NSF is an independent U.S. government agency responsible for promoting science and engineering through programs that invest over $3.3 billion per year in almost 20,000 research and education projects. NSF was established in 1950 to promote the progress of science; advance national health, prosperity, and welfare; and secure our national defense. NSF partnerships — with academia, industry, and state and local governments — advance science, engineering, mathematics, and technology through nationwide research and education programs.

NSF funds programs through grants to and cooperative agreements with more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations, and other research institutions (about one fourth of all federal support to academic institutions for basic research). The Foundation operates no laboratories itself, but does support national research centers, oceanographic vessels, and Antarctic research stations. It also supports cooperative research between universities and industry and U.S. participation in international scientific efforts.

One example of cooperative research funded by the NSF, with particular relevance to methane hydrates, is the Integrated Ocean Drilling Program (IODP), an international research program that explores the history and structure of the earth as recorded in seafloor sediments and rocks. IODP builds upon the earlier successes of the Deep Sea Drilling Project (DSDP) and the Ocean Drilling Program (ODP), which revolutionized mankind's view of Earth history and global processes through ocean basin exploration. IODP expands the reach of these previous programs by forming a collaborative union among the United States, Japan, and the European Union. Within the structure of the IODP, the United States is responsible for operating the riserless drilling vessel JOIDES Resolution. The vessel was used on IODP Expeditions 301, 303-309, and 311-312.

The IODP collects and logs geologic samples from the floor of deep ocean basins through rotary coring and hydraulic piston coring. Logs and samples of the cores are available to scientists worldwide for research projects. Joint Oceanographic Institutions, Inc. (JOI) and its partners, the Lamont-Doherty Earth Observatory (LDEO) of Columbia University and Texas A&M University (TAMU), were selected by NSF to be the implementing organization for JOIDES Resolution operations. Drilling operations are managed by Texas A&M University, and logging is managed by the Lamont-Doherty Earth Observatory at Columbia University. With respect to hydrates, NSF is particularly interested in investigating: (1) potential drilling regions, especially by means of regional geophysical field studies; (2) the feasibility and initial development of downhole instruments and techniques; and (3) downhole geophysical and geochemical experiments.

NSF has been a major supporter of ODP hydrates studies offshore Oregon and Vancouver. It contributed to the Deep East expedition, and has funded investigations of how changes in the composition of atmospheric gases affect climate (e.g., paleo-climate studies by measurement of atmospheric gases trapped in ice cores). Because rapid climate changes in the past were related to an increase in the amount of greenhouse gases in the atmosphere, and since large quantities of carbon are trapped in methane hydrates, it is important to investigate and model the effects of methane release into the atmosphere.

NSF's methane hydrate research is a collaborative effort involving several research institutions, such as the University of Texas Institute of Geophysics, Georgia Institute of Technology, Woods Hole Oceanographic Institute, University of Wyoming, and the University of Oregon. The primary goal of research on extreme environments is to define microbial communities and processes in brine and gas hydrate environments, and to understand the interre-

lationship between the microbiota and the geochemistry of the system. Microbial communities that inhabit Earth's extreme environments provide a framework for studying the origin and evolution of life on Earth, and the potential for detecting life on other planets. It is vital that we understand all facets of the environment before any exploitation of methane hydrates can occur.

Selected NSF Hydrates Projects

- The *Life in Extreme Environments* project, jointly funded by NSF's Division of Biological Oceanography and the ODP, focused on the microbiology and biogeochemistry of "extreme" sea-floor environments, including brine pools and methane hydrate mounds.

- Along with the German Ministry of Education, NSF funded a marine geophysical cruise on the German *R/V Sonne* to study processes involved in the formation of bottom simulating reflectors (BSRs, geophysical indicators of hydrates) offshore Peru.

- NSF and the ***DOE*** co-funded an experiment on the Blake Ridge to deploy ocean-bottom seismographs (OBSs) to map part of the ridge, in an attempt to use more sensitive shear waves to locate methane hydrate accumulations.

- NSF funded ODP leg 204, with supplemental funding from ***DOE*** and key scientific contributions from the ***USGS***, to Hydrate Ridge offshore Oregon in 2002 to study the occurrence of gas hydrates on convergent margins. NSF funded a program to conduct converted-wave experiments in the ODP boreholes to acquire a continuous shear wave velocity profile through gas-hydrate bearing marine sediments that would permit calibration of converted-wave studies of gas hydrate reservoirs elsewhere.

- In 2003, NSF supported two cruises to the Beaufort Sea to document methane leakage from the Arctic Shelf caused by gas hydrate decomposition related to a rise in the sea level.

- In 2005, NSF supported IODP Expedition 311, with supplemental funding from ***DOE*** and key scientific contributions from the ***USGS***, to drill and core four sites across the Northern Cascadia Margin to study gas hydrate occurrences and formation models for accretionary complexes.

DOI
Bureau of Land Management

The mission of BLM is to manage federal onshore energy resources in an environmentally sound and safe manner; and verify production for onshore federal and Indian lands.

BLM manages the Onshore energy program on federal and Indian lands which includes the leasing and post leasing operations as well as production verification of energy resources which are coordinated with MMS for royalty accounting. BLM evaluates the mineral potential of selected areas for hydrocarbon leasing by

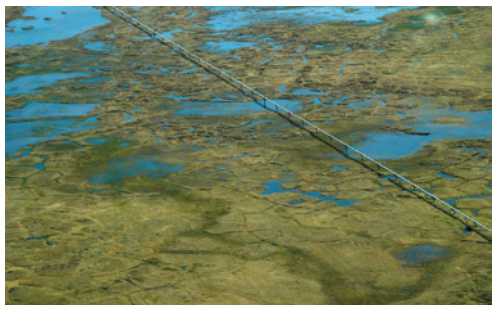
- Analyzing geologic, geophysical, and other geo-scientific data in support of its leasing program.
- Assessing the potential effects of hydrocarbon leasing and development activities on wildlife, cultural and human environments; and
- Participating in research specific to issues associated with onshore mineral leasing and development.

BLM coordinates closely with various public, industry, and government interests in developing workable solutions to multi-disciplinary problems associated with resource development. BLM is interested in the energy resources potential from methane hydrate because of the large volume of natural gas contained within this resource on the Arctic North Slope of Alaska.

BLM is involved in a cooperative assessment of gas hydrate potential on Alaska's Arctic North Slope with USGS and the State of Alaska, Department of Natural Resources, Division of Geologic and Geophysical Service (DGGS). BLM is using the USGS as principal investigator for the project which involves seismic reprocessing, collection of shallow chip samples from newly permitted NPRA wells, and modeling of the hydrate occurrence and distribution on the North Slope.

This assessment program complements work being done under the DOE-sponsored ANS studies that combine the efforts of Industry and USGS on state lands and then moves the assessment to bordering federal lands.

In addition, BLM is sponsoring and USGS is providing oversight and guidance for graduate studies at the University of Alaska, Fairbanks (UAF) which are evaluating remote sensing techniques for detecting hydrates.



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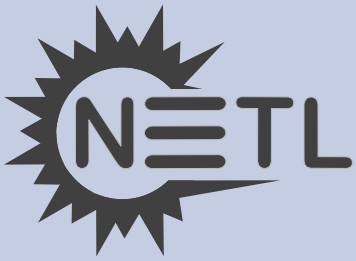

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