Winter 2002

Fire in the Ice

THE NATIONAL ENERGY TECHNOLOGY LABORATORY METHANE HYDRATE NEWSLETTER

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Announcements

ChevronTexaco Gulf of Mexico Gas Hydrates Joint Industry Project

Naturally Occurring Gas Hydrate Data Collection Workshop

March 14-15, 2002, Adam's Mark Hotel, Houston, Texas

The ChevronTexaco Gulf of Mexico Gas Hydrates Joint Industry Project (JIP), in collaboration with the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL), will be holding a workshop to collect data on naturally occurring hydrates in the Gulf of Mexico (GOM). All key contributors to the understanding of naturally occurring hydrates are invited to apply to participate in the first of three workshops sponsored by the JIP.

The purpose of the workshop is to develop a clear understanding of what information currently exists in the literature, public databases, and private sources concerning naturally occurring gas hydrates in the deep water GOM. The JIP needs to know what information and technologies currently exist, so the JIP can proceed with obtaining and developing new data, information, and technologies to better understand how to operate safely in deep water.

Applications are being accepted, and additional information may be found at http://www.theenergyforum.com/hydrates.asp

Methane Hydrates Interagency R&D Conference

March 20-22, 2002, Renaissance Washington, DC Hotel

DOE's Office of Fossil Energy and NETL, Naval Research Laboratory (NRL), Minerals Management Service (MMS), U.S. Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), and National Science Foundation (NSF) are sponsoring a conference on methane hydrate research and development (R&D). The purpose of the conference is to present the results of and future plans for methane hydrate research by each of the agencies.

Topics will include (1) an assessment of the scale at which hydrates occur; (2) the connections between hydrates, global climate change, the world's oceans and newly-discovered chemosynthetic life forms; and (3) a review of international activities related to natural methane hydrates. In addition, each agency will present their research efforts by geographical region—Arctic, West Coast, East Coast, and Gulf of Mexico.

For more information, contact NETL Event Management, 304-285-4750 or 1-800-553-7681; E-mail: confserv@netl.doe.gov ; or visit our website at www.netl.doe.gov.

INTENT

Fire in the Ice is published by the National Energy Technology Laboratory to promote the exchange of information among those involved in the research and development of gas hydrates as a resource.

Giant Piston Coring Effort Gets Under Way in Gulf of Mexico—Summer 2002

The Gulf of Mexico (GOM) is unique in the world for having significant amounts of both biogenic hydrates (i.e., hydrates formed in situ by microbial production of methane) and thermogenic hydrates (i.e., hydrates formed by deep natural gas leaking into the shallow sub-surface). As commercial drilling moves into deeper water, both kinds of hydrates are of interest. They potentially threaten the safety of drilling platforms by triggering mass failure and landslides. One of the most intriguing aspects about GOM gas hydrates is their relative abundance in sea-floor mounds without reliable indicators of their presence in the surrounding deeper sediments.

The U.S. Geological Survey (USGS), Naval Research Laboratory (NRL), U.S. Department of Energy (DOE), Monterey Bay Aquarium Research Institute (MBARI), numerous companies (led by ChevronTexaco), and various academic groups are trying to understand the distribution of gas and gas hydrates in the shallow sub-bottom sediments of deep-water areas in the GOM. In July 2002, a research cruise, organized and co-funded by DOE and the USGS, will collect 25 giant piston cores, each 50 m long, to determine the lateral distribution of interstitial gas and gas hydrates in locations near known GOM hydrate-bearing gas seeps. Analysis of these cores should provide evidence of the presence of gas hydrates and the nature of gas fluxes through the sediments at locations most likely to have hydrate-bearing potential (i.e., near known gas seepage sites). The information obtained in this sampling cruise will help guide plans for drilling deeper into the gas hydrate section by the Joint Industries Program in 2003 or 2004.

Sites for the giant piston coring operations in the GOM are to be selected based on focused geophysical surveys, and information and data provided by oil companies and the USGS. The USGS will utilize elastic wave-speed measurements to assist in the evaluation of seismic data acquired in the seismic site surveys for the piston coring locations. The USGS will also study synthetic gas hydrate mixtures to prepare for changes over time under storage and transportation conditions for the hydrate samples. The synthetic hydrates will be created in their Menlo Park petrophysics laboratory, and will be comparable in composition and physical properties to the expected natural hydrates.

Routine and specialized analyses will be performed on the gases, fluids, and associated materials gathered in the cores. A critical component of the core analyses, pore water content, will be conducted by MBARI. Of particular interest are the measurements for (1) chlorinity, and (2) the thickness of the sulfate-reducing zone. These two measurements provide the most definitive evidence available for documenting the presence and abundance of gas hydrates in marine sediments. Pore water analyses will be done on board the cruise ship. Additional chemical and isotopic analyses of fluids, gases, and sediment squeeze cakes are scheduled. Gas hydrate samples and cores recovered in the coring operations will be analyzed by the GHASTLI (Gas Hydrate and Sediment Test Laboratory Instrument) system, located at USGS laboratories in Woods Hole, MA. In particular, the USGS is interested in the development of new electrical resistivity measurement capability.

The Marion Dufrense

Bill Winters (USGS, Woods Hole) and Tom Lorenson (USGS, Menlo Park) are co-chief scientists for the expedition. The cruise will be aboard the Marion Dufrense research vessel, and will utilize the French IMAGES program, which is the most experienced group in the world now taking piston cores. IMAGES is a global program dedicated to understanding the mechanisms and consequences of global climate change.

USGS Leads United States Effort in Mallik Well

This winter, in the extremely cold, far reaches of the upper Northwest Territory of Canada, there is an international consortium of researchers participating in a program to study methane hydrates. The researchers are currently drilling a 1200 m-deep production research well through the permafrost. It is one of three wells located in the Mackenzie Delta, on the shore of the Beaufort Sea. Two observation wells were drilled adjacent to the main production test well earlier this year.

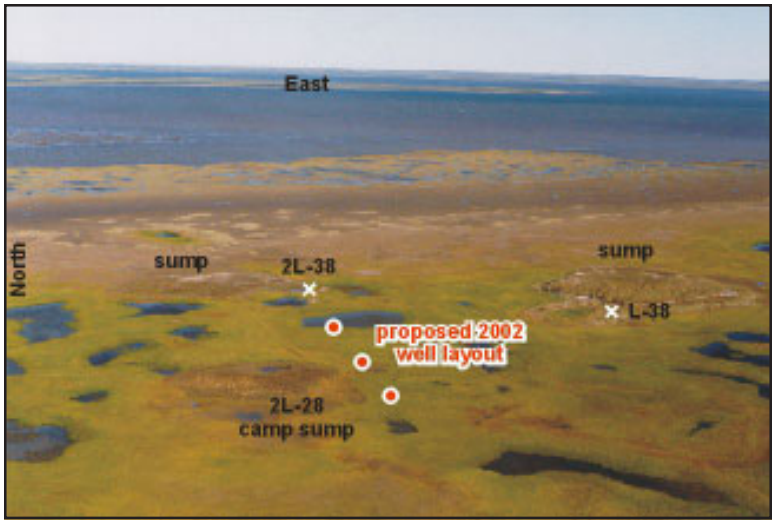
Research objectives for the program focus on two themes: (1) the assessment of the production and properties of gas hydrates, and (2) an assessment of the stability of continental gas hydrates given warming trends predicted by climate change models. Of particular interest is the physical response of the gas hydrate to depressurization and thermal production stimulation. Cores are being taken from the well, and scientists hope to retrieve at least 200 m of core, including all the gas hydrate-rich intervals. Once cored, the samples are transported 200 kilometers over ice roads to Inuvik. Nearly 60 researchers are examining the cores for everything from geophysical parameters to microbiological analyses.

Chief scientist for the program is Scott Dallimore with the Geological Survey of Canada.

The following international partners are involved in $25 million Mallik research well project:

Japan National Oil Corporation (JNOC)

Germany GeoForschungsZentrum Potsdam (GFZ)



View of Mallik Drill Site Looking East
(Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2002 and courtesy of Natural Resources Canada, Geological Survey of Canada.)

Final Construction Phase of Drill Site Camp, December 2002 (Photo by Hideaki Takahashi, Japex Canada Ltd. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2002 and courtesy of Natural Resources Canada, Geological Survey of Canada.)

Geological Survey of Canada (GSC)

United States Geological Survey (USGS)

United States Department of the Energy (USDOE)

India Ministry of Petroleum and Natural Gas (MOPNG)

Canadian Petroleum Industry

International Continental Drilling Program (ICDP)

Dr. Timothy S. Collett, Research Geologist with the USGS, is leading the USGS effort on site. Tim, who is directing the Modeling Team, designed the logging program currently used for hydrates. Other USGS researchers will also be working on the geochemical analyses of fluids and gases from the hydrate deposits. Tom Mroz (DOE-NETL) was present during initial stages of drilling and has been working with Tim on a variety of projects to characterize the hydrate resource in the Arctic.

Drilling under Arctic winter conditions presents significant engineering and logistical challenges: it's cold, the days are short, ice roads must be constructed, and moving equipment is difficult. Despite the normal setbacks associated with Arctic drilling, the two observatory wells and the drilling and coring of the main well have been completed. The next step is the collection of production data, and the ongoing analyses of the cores. The Mallik reseach well program is expected to be successfully completed and to produce valuable information on methane hydrate resource characterization.

For more information on the 2002 Mallik well program, visit the project website at http://gashydrate.com or the ICDP website at http://icdp.gfz-potsdam.de/html/sites/mallik/index/index.html.

Deep East Voyage of Discovery—Gas Hydrates on the Blake Ridge

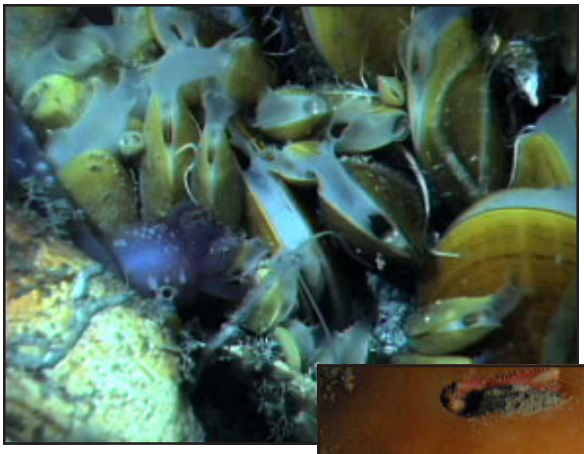
In September 2001, scientists aboard the deep submersible vehicle Alvin descended to depths of over 2,200 m for the first glimpse of a cold-seep chemosynthetic ecosystem in the Atlantic. Known as the Voyage of Discovery, the dive was centered over Blake Ridge, a buildup of sediments approximately 200 mi offshore Charleston, SC. The Blake Ridge area is of interest for two reasons: (1) it contains a very large volume of methane hydrates (approximately 55 million cubic feet of methane—equivalent to 30 times the U.S. annual consumption of methane gas); and (2) because the biological community of the region is relatively unknown. The National Oceanic and Atmospheric Administration (NOAA) and Minerals Management Service (MMS) have a great understanding of the dynamics and ecology of seep communities and the impacts of development activities. Most of the hydrates on the planet are likely formed using biogenic hydrocarbons (such as methane generated by microbial respiration), as they primarily appear to be on the Blake Ridge. Thus, the Blake Ridge is a good analog system for understanding the behavior of these types of hydrates.

In addition to gathering information on methane hydrate occurrence, scientists were also interested in getting a closer look at the mussel beds that were first documented during the Ocean Drilling Program (ODP) in 1992. Their specific objectives were to (1) describe the community and map the distribution of

megafauna associated with mussel beds that occur at a gas-hydrate seep site; (2) describe the geochemical conditions of the site; and (3) establish a correlation among seep type, geochemical conditions, and the microbial communities. The researchers conducted four submersible dives, spending a total of 24 hours near the bottom of the ocean. They collected samples of the mussel bed communities, cored sediments and bacterial mats, collected numerous organisms and rock samples, and surveyed over 150 mi of seafloor using a multi-beam bathymetric mapper. All dives were documented by video recordings.

The Blake Ridge cruise also offered the opportunity to showcase the Ocean Exploration program's commitment to merging science with education and outreach. Public schools were invited to visit the expedition via the web, and to learn about the daily activities involved in conducting scientific research. Activities included:

- Daily web logs posted on the OceanExplorer website: http://www.oceanexplorer.noaa.gov/explorations/deepeast01/deepeast01.html.
- Grade 7-12 lesson plans developed by teachers from the Charleston, SC area: http://www.oceanexplorer.noaa.gov/explorations/deepeast01/background/education/education.html.
- A pre-mission teacher development workshop in Charleston provided lesson plans and other content for grade 7-12 teachers.
- A live web chat conducted at-sea with students from around the country, hosted by National Aeronautics and Space Administration (NASA) Ames.
- An open house in Charleston involved thousands of people, including 700 school children from area classrooms, on tours of the ship and sub.



At a dense mussel bed found on the Blake ridge, the mussels had a white film around the edges of their valves (shells) that actually contained bacteria. We still do not know if the symbionts living on the gills of the mussels get their energy from methane or sulfide.

The orange gas hydrates are home to Hesiocaeca methanicola, a newly discovered species of marine worm found in the Gulf of Mexico in 1997. This lobe of hydrates was exposed on the seafloor. The Deep East Expedition will investigate the life above and in a shallow bed on the Blake Ridge where other lobes of exposed gas hydrates are believed to be located.

The Blake Ridge investigations yielded some surprising results. Previous ODP studies on the Blake Ridge revealed a massive bed of gas hydrates containing approximately 55 trillion cubic feet (Tcf) of methane derived from bacterial composition of organic deposits on the ridge. Based on origin, the rate of seepage was expected to be much slower on the Blake Ridge versus that in the Gulf of Mexico (GOM), and perhaps the chemosynthetic organisms feeding on them would be smaller and less dense.

Instead, some of the largest seep organisms ever described were found with densities and diversities comparable to or greater than any known seep and vent sites. The large size of the mussels observed at the Blake site may be attributed to long life and/or rapid growth rate. Shell samples are being aged. The chemosynthetic fauna of the site is of particular biogeographic interest because of its shared components with Florida Escarpment and Barbados seeps, and because of arising issues on oceanographic processes that allow the exchange of propagules (structures, such as cuttings, seeds, or spores, that propagate a plan) among these sites.

Xenophyophores, a one-celled organism closely related to foraminifera, were seen in high abundance just outside the mussel beds. Although xenophyophores are common in deep-sea settings, to the investigators' knowledge, they have not previously been observed at methane seeps. Xenophyophores collected in push cores are being analyzed to determine if they have specific adaptations that allow them to inhabit the hydrocarbon and sulfide-enriched locale of the Blake Ridge gas hydrate field.

Bacterial mats were observed for the first time at the Blake Ridge. Preliminary analysis of meiofauna (microscopic organisms) from Blake Ridge mats suggests a low density of organisms, which contrasts to a high density of metazoan meiofauna from GOM bacterial mat samples. Analysis of adenosine triphosphate (ATP: nucleotide molecules present in all living cells that can be used as a fuel for chemical reactions) in foraminifera from Blake Ridge bacterial mats indicates that specimens lived in the mats, unlike in the GOM mats where all analyzed specimens were dead.

Most of the vast bed of hydrates at the Blake Ridge is buried under sediments, as are most gas hydrates in the ocean. Disturbance around the ODP drill hole opened a crevasse large enough to drive the submersible into. The walls of the crevasse are layered with hydrates and seeping gas was evident. For the first time, the formation of a gas hydrate outcrop in a natural setting was observed. The Blake Ridge area continues to provide an unprecedented opportunity to address the new multi-agency Methane Hydrate Program's need to better understand the nature of hydrates, hydrate-laden sediments, and the interaction between the global methane hydrate reservoir and the world's oceans and atmosphere.

The Blake Ridge Voyage of Discovery was only one part of the Deep East Expedition in which scientists explored three regions of the Atlantic Ocean from Maine to Georgia. The deep submersible Alvin dives were supported from the National Undersea Research Program (NURP) southeast regional center at the University of North Carolina at Wilmington. Chief Scientist for Leg 3—Blake Ridge was Cindy Van Dover, Biology Department, College of William and Mary, Williamsburg, VA. Other participating scientists included Joan Bernhard, University of South Carolina; Carolyn Ruppel, Georgia Tech University; Barun Sen Gupta, Louisiana State University; Andrew Shepard, University of North Carolina at Wilmington (expedition coordinator); and Paula Keener-Chavis, College of Charleston (education specialist).

RODNEY D. MALONE
(1939 – 2002)

Renowned Hydrates Pioneer Remembered

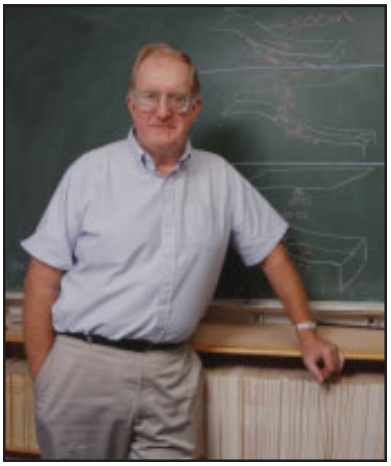
Rodney D. Malone, who established the first National Gas Hydrate Research Program, died January 30, 2002 in Morgantown, West Virginia. Rod, fondly known as a friend to hydrate enthusiasts, was a pioneer and legend in the field of gas hydrates. For 20 years, he was project manager for natural gas research and development at the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL), where he was a widely recognized expert on methane hydrates. From 1982 to 1992, under his direction, DOE built a framework of basic knowledge about the distribution and physical/chemical nature of naturally occurring methane hydrates. In particular, he was instrumental in directing a national multi-year R & D effort for methane hydrates recovery. The focus of this comprehensive plan was to:

- Implement an initial strategy for a cooperative multi-agency, industry, and academia focused on essential research and development for methane hydrates;
- Establish the existence of hydrates in the Kuparuk Field on the north slope of Alaska;
- Complete studies of 15 offshore hydrate basins;
- Develop alternative models for production of methane through both the depressurization and heating of hydrates;
- Develop preliminary estimates of gas-in-place for hydrate deposits; and
- Build the Gas Hydrate and Sediment Test Lab Instrument, a device that can simulate deep-sea conditions to allow testing of the properties of hydrate-bearing sediment.

Rod served in the U.S. Air Force after high school and went on to receive an MS degree in Geology from West Virginia University. He began his career with Michael Baker, Jr. of Beaver, PA, and was instrumental in the design of the New River Gorge Bridge, longest single-arch, steel bridge in the world. After retiring from NETL, he established Malone Consulting, continuing his research and monitoring the progress of gas hydrate development as a viable energy source. Rod enjoyed playing cards, golf, traveling, and collecting old comic books. He will be warmly remembered for his wonderful sense of humor.

He is survived by his beloved wife Cheryl Jackson Malone, his son Sean, and many close friends.

Spotlight on Research: William Dillon, USGS Retired



BILL SAYS WE SHOULD THINK LIKE A GAS HYDRATE CAGE!

Bill Dillon has been fascinated by seafloor gas hydrates for over 25 years—since the late 1970s. He began his initial work with hydrates shortly after they were first discovered in Deep Sea Drilling Project cores. These initial core samples were from the Blake Ridge, within his U.S. Geological Survey (USGS) project area.

But gas hydrates were just a side issue then—a geological curiosity.

Bill's research evolved into a full-scale project that was funded by DOE in 1990. His research included an intensive study of the Blake Ridge area, which apparently has the greatest concentration of hydrates off the U.S. East Coast. This work culminated with the first Ocean Drilling Program (ODP) cruise devoted exclusively to gas hydrate studies in 1995. Bill and coworkers collaborated extensively with ODP scientists, and ran several cruises associated with the drilling.

His original 1990 project now encompasses all gas hydrate research at USGS, and involves five cooperating sub-projects that cover seismic studies at sea, testing of natural and laboratory-formed gas hydrate-bearing sediment, physical testing of pure gas hydrates, organic geochemistry, and well-logging and Arctic hydrate studies.

Bill has also studied the structure and evolution of continental margins and active plate boundaries. He has worked off the coast of West Africa, Spain, and along much of the active plate boundary of the northern Caribbean—from Guatemala, Belize, and Honduras on the west, through the region south of Cuba, north of Haiti, and eastward to Puerto Rico and the Virgin Islands (where the hazards include earthquakes and tsunamis).

Bill graduated from Bates College and Rensselaer Polytechnic Institute and received a Ph.D. in marine geology from the Graduate School of Oceanography at the University of Rhode Island. He joined the USGS in 1971. He was in charge of the USGS's marine geology work in the Atlantic, Gulf of Mexico and Caribbean as Branch Chief from 1982 to 1986. He has been a member of the international editorial board of Marine and Petroleum Geology since the journal's inception in 1983, has received the Department of Interior Meritorious Service Award, and was named a Fellow of the Geological Society of America.

Gas hydrates, Bill says, is an incredibly broad topic that includes most fields of science: geology, geophysics, physics, organic geochemistry, civil engineering, drilling and well-logging, microbiology, isotope chemistry, and so on. In fact, one of Bill's goals is to see gas hydrates become an integrated study topic that covers all these areas.

Bill and Charlie Paull have recently edited and published an American Geophysical Union monograph, "Natural Gas Hydrates: Occurrence, Distribution and Detection" (AGU Monograph 124), which attempts to establish present-day cutting-edge gas hydrate research. Bill retired in January 2002, but he is continuing at USGS in an emeritus position. He expects to be a consultant on gas hydrates in an international group.

Bill says that he once heard Lewis Weeks, a famous oil finder, asked what a petroleum geologist should do to be successful. Weeks replied that one needed to think like an oil droplet.

So Bill concludes by noting: "We need to think like a gas hydrate cage—where would we form; when will we dissociate; how will we become concentrated? We are just beginning to understand how to think like gas hydrates," he adds. "But figuring out how a natural system works is what makes research fun and exciting."