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Fire in the Ice

Fall 2007 Methane Hydrate Newsletter

NETL

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New Simulations of the Production Potential of Marine Gas Hydrates

George J. Moridis and Matt T. Reagan, Lawrence Berkeley National Laboratory

A series of recent simulations of the production potential of marine gas hydrates has been completed at the Lawrence Berkeley National Laboratory using LBNL's TOUGH+/HYDRATE code. These simulations suggest that large volumes of gas can be produced at significant rates in cases of high gas hydrate saturation within porous and permeable sands. In contrast, we find that the production potential for diffuse, low-concentration marine deposits (typically encased in mud) is very poor. In the sand reservoir case, the simulations show that dissociation induced by depressurization (fluid removal through conventionally-drilled wells) and assisted by hot water injection appears to be the most promising gas production strategy (Figure 1). These results are based on tailored applications of existing technologies.

Case 1: Diffuse Low-Concentration Deposits

The geologic system used in the simulations testing production potential in low-concentration, diffuse settings (Class 4 targets using the LBNL nomenclature) is based on conditions that are common across a large number of oceanic marine gas hydrate systems. Initial model inputs include 30% porosity, 1 milli-darcy permeability, and 3.5% gas hydrate saturation, 2.7 Mpa pressure, and temperature of 6 °C. A 1-m thick accumulation was modeled, providing results in production per unit reservoir thickness. In collaboration with Dr. Dendy Sloan of the Colorado School of Mines,

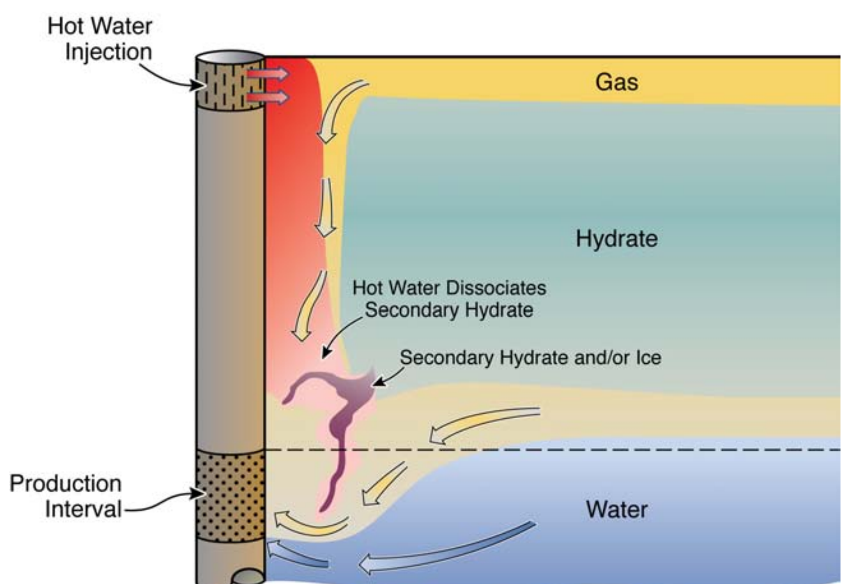

Figure 1: Gas hydrate production concept for case of sand reservoir with underlying water-bearing zone.

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Interested in contributing an article to *Fire in the Ice*?

This newsletter now reaches more than 750 scientists and other individuals interested in hydrates in sixteen countries. If you would like to submit an article about the progress of your methane hydrates research project, please contact Karl Lang at 301-670-6390 ext. 129 (karl.lang@netl.doe.gov)

simulations were run using a wide range of variations on these parameters in an attempt to cover virtually any likely natural condition of disseminated gas hydrate. The results of these simulations show that the volume of gas production is in every case very low. Potential economics are further burdened with very large rates of water production. None of the modeled conditions produced results that are likely to be economically-viable, and the study concludes that Class 4 deposits are not promising targets for gas production. Additional details can be found in the first suggested reading.

Case 2: High-saturation Marine Sandstones

The simulations for marine hydrate-bearing sandstone are based on the Alaminos Canyon Block 818 gas hydrate occurrence (see Smith *et al*, Fall 2006 FITI) that lies 1,530 feet below the seabed in 9,000 feet of water. Model inputs based on this reservoir include 18.25-m (60-ft) thickness, 30% porosity, 60 to 80% gas hydrate saturation, Darcy-range intrinsic permeability, 33 MPa pressure, and temperature of 21 ˚C. The reservoir as modeled is located at or only slightly above the base of the gas hydrate stability zone. Two variations were run in this case, one with a 15-m water-bearing sand directly below the hydrate-reservoir (a Class 2 reservoir, Figure 2), and the second where the reservoir directly overlays low-permeability marine muds (a Class 3 reservoir). In both cases, potential economic viability of the reservoirs is suggested by high ultimate production volumes and high peak gas production rates. Counterbalancing these positive aspects is a lengthy initial period of high (but declining) water production and low (but increasing) gas production.

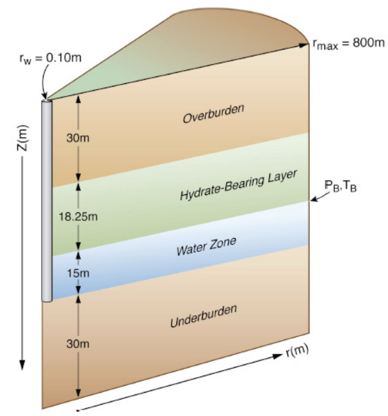

Figure 2: Class 2 reservoir model

Simulated Production – Class 2 Reservoirs

To achieve depressurization, an initial production rate of 10,000 barrels per day (BPD) of water from the underlying water zone was imposed at a single well in the middle of a 500-acre area. At the same time, warm water (~ 50 ˚C) was continuously injected at 525 BPD within the reservoir to prevent the formation of secondary hydrates that could block fluid flow to the well.

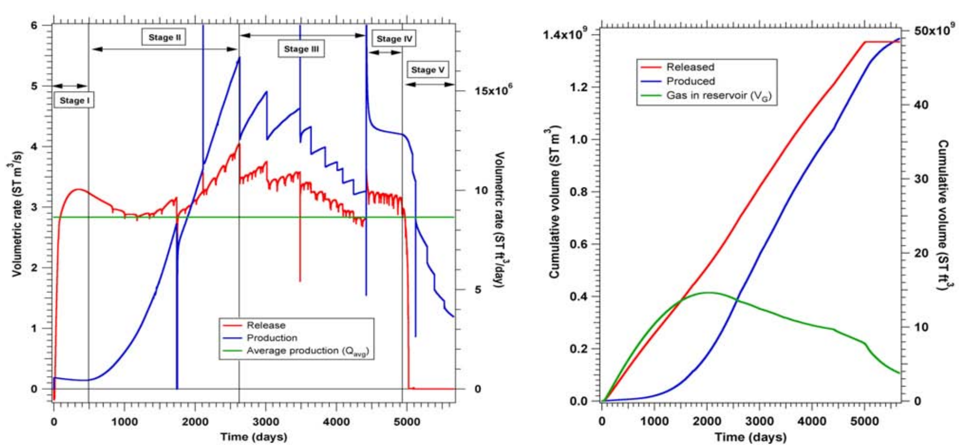

Figure 3: Class 2 reservoir simulation results

The resultant production is shown in Figure 3. The cyclic nature of the production reflects periodic episodes of rapid pressure drop at the well (cavitation) and a suspension of gas production. Within each cycle, gas production rate continuously increases with a corresponding reduction in the water production. At the end of the 15 ½ year (5,660 day) simulation period, 49 billion cubic feet of gas has been produced, most of which originated from the gas hydrate. Please see the second suggested reading for more details of the modeled production operation, including enhanced recovery operations (indicated as Stage IV in Figure 3) and response.

Simulated Production – Class 3 Reservoirs

Simulation of potential production from the Class 3 deposit (with no underlying, permeable water-bearing zone) involved a well completed across the entire reservoir thickness. In these simulations, a constant pressure of 435 pounds per square inch (psi) was applied at the well. The use of constant pressure production was dictated by the very low initial effective permeability within the reservoir. The simulations results (Figure 4) indicate a cyclical pattern in the evolution of the gas release within the reservoir (red curve) and gas production (blue curve). Production begins immediately with depressurization, and levels that often exceed 15 mcf/d. At the end of the ~16 ½ year simulation (6000 days), a total of 48 bcf of gas has been produced, all of which originated from the gas hydrate. A thorough review of the well design and operation, and the progression of various phenomena within the reservoir during production can be found in the third suggested reading.

Conclusions

Our recent simulations using LBNL's TOUGH+/HYDRATE model indicate no production potential from diffuse, low-concentration methane hydrates. However, we find that very large volumes and rates can be produced over extended time periods from high-concentration, permeable reservoirs using existing technologies. The result is potential ultimate recovery per wells at 500 acre spacing approaching 50 bcf. Most surprising is that Class 3 hydrate deposits have a gas production potential that is as good as that of Class 2 deposits, and are even more desirable at the early stages of production. However, because of the paucity of data on such formations, additional studies (involving field data collection from potential target studies and further numerical investigations) and field tests are necessary before firm conclusions can be reached as to the production potential of gas hydrates.

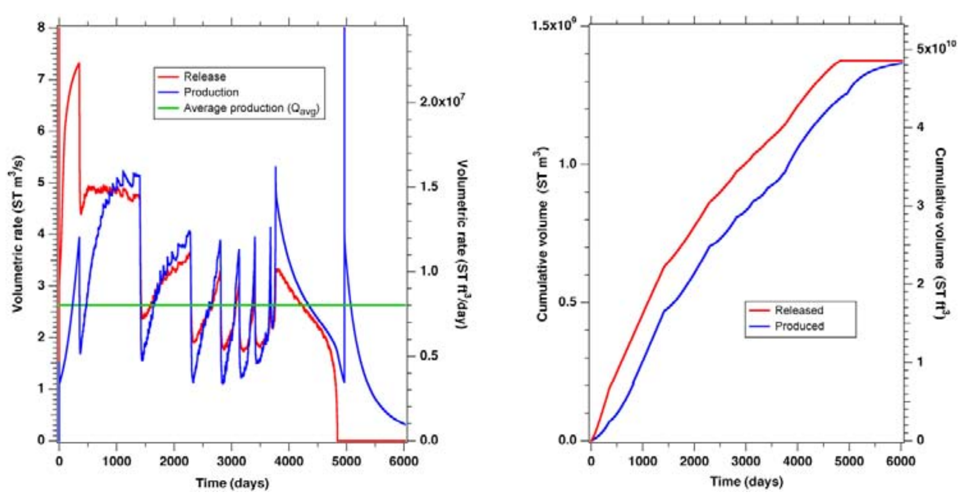

Figure 4: Class 3 reservoir simulation results

FURTHER READING

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Repeated Episodes of Methane Flux from Bering Sea Sediments During the Last Glacial Period

Mea S. Cook, University of California, Santa Cruz
Lloyd D. Keigwin, Woods Hole Oceanographic Institution

Inorganic and organic geochemical data suggest that methane repeatedly escaped from Bering Sea sediments during the last glacial period 40 to 20 thousand years ago. This was a time period when climate rapidly shifted between warm and cold states on millennial time scales, and methane concentration in the atmosphere was elevated during the warm climate events. Based on observations in the Santa Barbara Basin, Kennett *et al*. (2000) hypothesized that destabilization of marine methane hydrates could have contributed to global warming during each of the climate events. Evidence of methane flux during glacial times from other locations is sparse (see Figure 1), and until now another record of repeated methane flux from sediments with similar timing and duration as the global climate changes has remained elusive.

We originally discovered puzzlingly low $^{13}C/^{12}C$ ratios in Bering Sea sediments while attempting to reconstruct climate records from the calcite shells of foraminifera. Foraminifera are protists that live in the surface ocean and seafloor that passively incorporate trace metals and isotopes into their shells that are representative of ocean chemistry and temperature. We discovered that the original isotope ratios in the foraminifera were overprinted by diagenetic carbonate minerals that were depleted in ^{13}C by 22 permil relative to values typical of Quaternary seawater (Figure 2). Although this made the sediment cores unusable for our original project, the authigenic minerals were intriguing, and the depletion of ^{13}C made us think that they might be associated with sedimentary methane (CH_4), which has a characteristically low $\delta\,^{13}C$. With the support of NETL, we undertook a program of research designed to shed light on the timing and cause of these mineral overprints.

In two Umnak Plateau cores we made high-resolution records of foraminifer $\delta\,^{13}C$ from the last glacial period until today. We established independent chronologies in each core using radiocarbon measurements on unaltered foraminifera. We found that the authigenic-carbonate rich sediments only occurred during the time period with millennial scale climate events

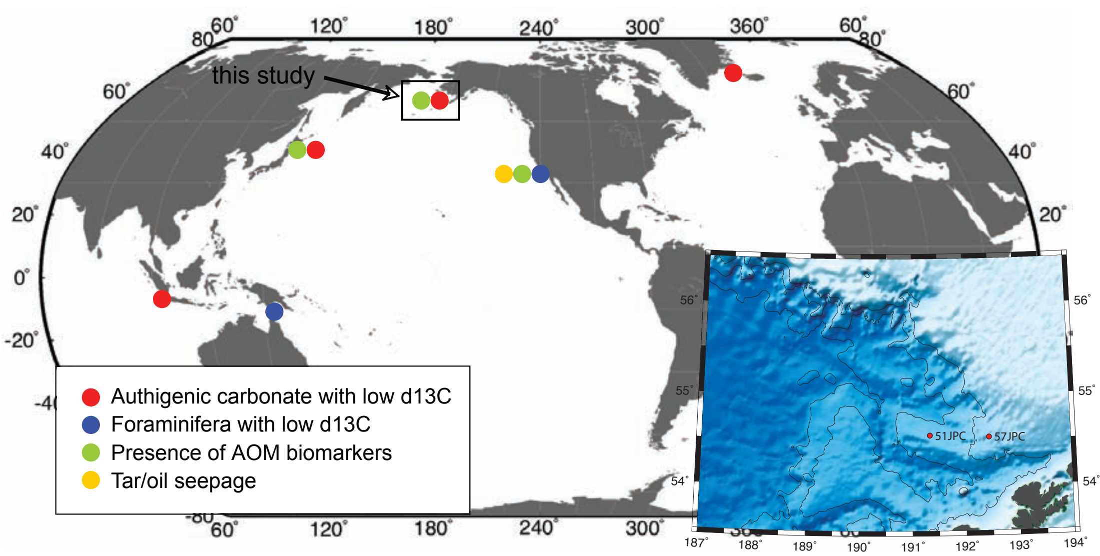

Figure 1. Locations with geochemical evidence of upward flux of methane during the last glacial period. (Kennett et al., 2000; Hinrichs et al., 2003; Uchida et al., 2004; Ohkushi et al., 2005; de Garidel-Thoron et al., 2004; Millo et al., 2005; Wiedicke & Weiss, 2006). Inset on right, location of cores in the study area, Umnak Plateau, southeast Bering Sea.

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(Figure 3). To further pin down the origin of the authigenic minerals, we extracted and characterized lipid biomarkers from the sediments. In intervals containing authigenic carbonates, we found unique biomarkers that are produced in the cell membranes of archaea that perform anaerobic oxidation of methane (AOM), archaeol and glyceryl dibiphytanyl glyceryl tetraether. The $\delta^{13}C$ of the biomarkers was as low as -77 permil, which is in the range expected for AOM communities.

We did not detect biomarkers produced by methane-oxidizing organisms that live in the oxic water column, and AOM doesn't necessarily have to happen at the sea floor. Accordingly, to determine whether the methane flux was great enough to reach the seafloor, we studied the species distribution of benthic foraminifera. We predicted that if their environment were flooded with methane, some species would tolerate the change in their geochemical environment better than others. We found that the benthic foraminifer populations shifted in sync with the occurrence of authigenic minerals, suggesting that in each episode, the methane flux was high enough that methane could have been exiting the sea floor.

Our findings in the Bering Sea show that the reservoir of methane in marine sediments can be very dynamic, and it appears that there have been repeated, large fluxes of methane upward through the sediment column in the Umnak Plateau region. These events left behind layers rich in authigenic carbonate minerals, the remains of a methane-oxidizing microbial community, and a shift in the species distribution of benthic foraminifera. The most recent of these events are radiocarbon dated, and they occur during a time of known climate warming and elevated methane concentrations in the atmosphere.

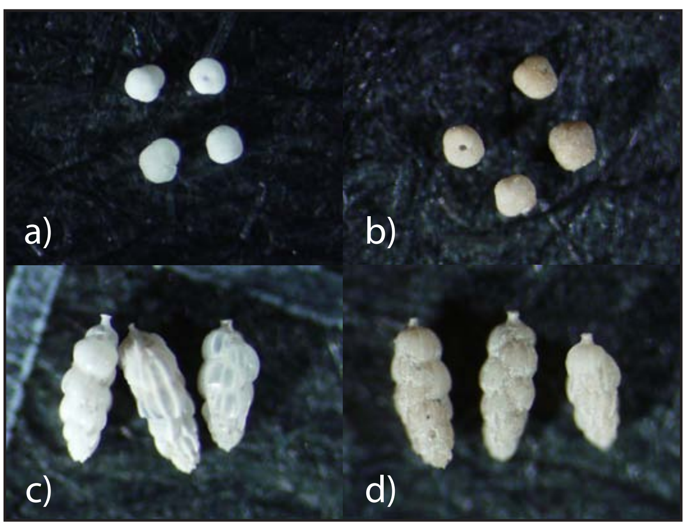


Figure 2: Planktonic (a,c) and benthic (b,d) foraminifera. The samples in a and c are well-preserved and contain no authigenic minerals. The samples in b and d have a thick coating of authigenic overgrowth, which is yellowish in color.

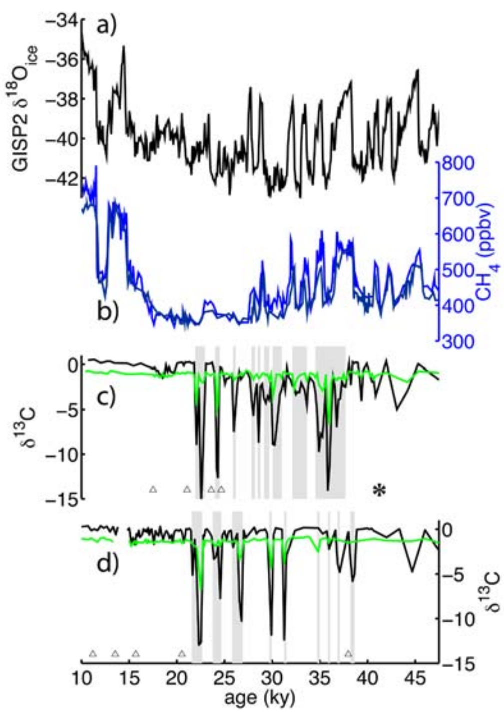


*Figure 3: Ice core records of proxy surface air temperature (a) and atmospheric methane concentration (b) (Blunier & Brook, 2001, Dallenbach et al., 2000, Grootes et al., 1997). Stable isotopic data plotted versus depth in 57JPC (c) and 51JPC (d). Radiocarbon measurements are marked with triangles. The time scale of 57JPC is tied to 51JPC at * based on magnetic susceptibility records (not shown). The low $\delta^{13}C$ events have similar timing and duration as the climate events recorded in the ice cores.*

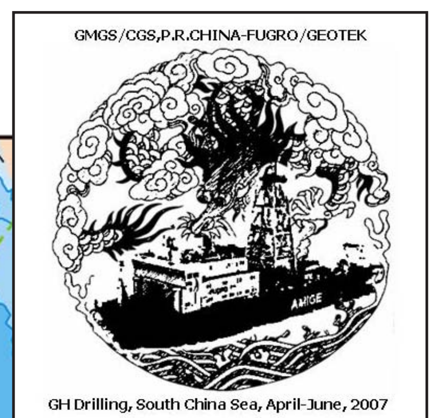
Successful and Surprising Results for China's First Gas Hydrate Drilling Expedition

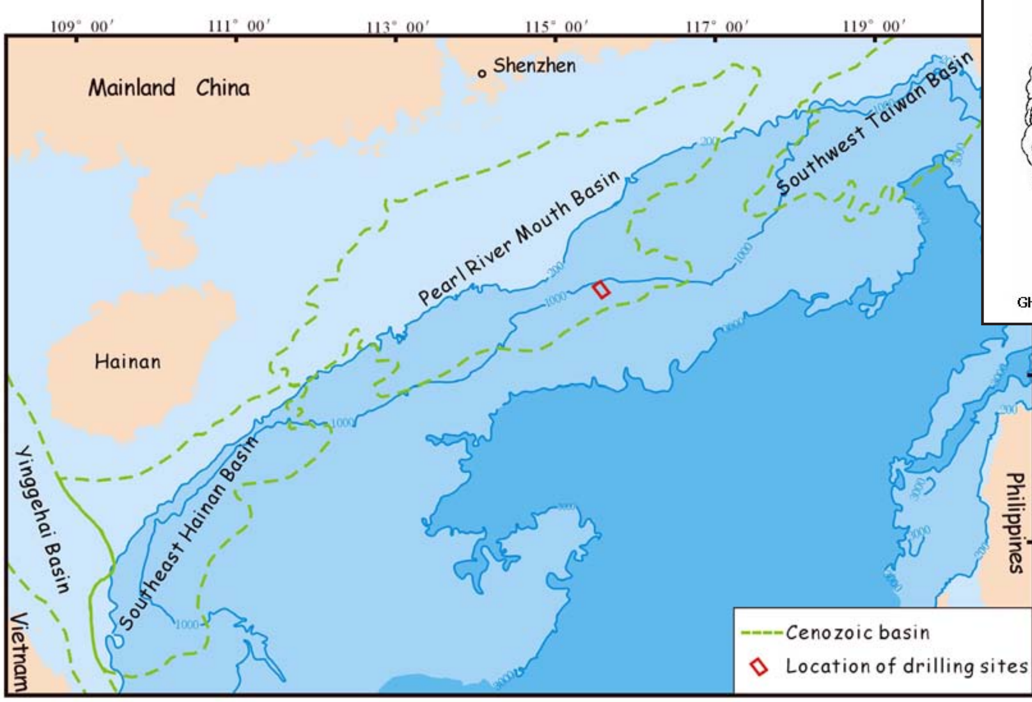
Haiqi Zhang (CGS), Shengxiong Yang (GMGS), Nengyou Wu (GMGS), Xin Su (CUGB), Melanie Holland (Geotek), Peter Schultheiss (Geotek), Kelly Rose (NETL), Heather Butler (Fugro), Gary Humphrey (Fugro), and GMGS-1 Science Team

In June, 2007, the geotechnical drillship *SRV Bavenit* sailed into Shenzhen, People's Republic of China, with a crew of smiling Chinese scientists and a cargo of frozen gas hydrate samples. China's first gas hydrate drilling expedition, GMGS-1, was carried out by Fugro and Geotek for the Guangzhou Marine Geological Survey (GMGS), China Geological Survey (CGS), and the Ministry of Land and Resources of P. R. China. The expedition, which comprised two legs from April 21st–May 18th and May 19th–June 12th, visited eight sites in the northern South China Sea and described both a new gas hydrate province and a potentially new gas hydrate habit.

Expedition Objectives & Strategy

Expedition GMGS-1 set out to survey gas hydrate in the Shenhu area of the Northern South China Sea (figure below). Our goal was to determine the distribution of gas hydrate at as many different sites as possible in the allotted time which required a program designed with maximum flexibility. At each site, a pilot hole was drilled and then logged with a suite of high resolution wireline tools. Based on these downhole logs, a decision was made to either immediately drill an adjacent coring hole or to move on to another site. The coring hole was generally offset about 10-15 m from the pilot hole along the geological strike. As the expedition progressed, we acquired enough ground truth core data to build confidence in the downhole log interpretation. This overall strategy enabled us to maximize the number of sites investigated.





Location of GMGS-1 Expedition sites (red box) in the Shenhu area of the South China Sea.

Operations & Methods

During Expedition GMGS-1, eight sites were drilled in water depths of up to 1500 meters. Each site was wireline logged to depths of up to 300 meters below seafloor with a set of high-resolution slim wireline tools. Five of these eight sites also had an adjacent coring hole for *in situ* measurements & sampling. Two pressure coring systems (the Fugro Rotary Pressure Corer, formerly known as the HRC, and the Fugro Pressure Corer) and two conventional coring systems (the Fugro Hydraulic Piston Corer and the Fugro Corer, a hammer corer) were used on this expedition. The use of a seabed frame and pipe clamp, coupled with real-time data, enabled controlled *in situ* measurements to be made of temperature as well as *in situ* sampling of porewater using the Wison EP to drive the Fugro Temperature Probe and the Fugro Porewater Sampler (FPWS).

A comprehensive onboard core analysis program ensured that gas hydrate in the sediment was identified and quantified. Infrared thermal imaging was employed to determine gas hydrate locations in all conventional cores. This thermal data was used to select samples for porewater analysis (for gas hydrate quantification) and gas analysis (for gas hydrate composition). Samples were also taken for microbiological analysis to characterize the biogeochemistry of the gas hydrate environment. MSCL-S analysis was then performed on cores to place them into context with the downhole log data.

The gas hydrate data set from conventional cores was augmented by a pressure core data set. All pressure cores were analyzed under pressure using the Geotek MSCL-P (Pressure Multi-Sensor Core Logger), where gas hydrate generally can be identified at temperature and pressure by relatively low densities and/or high acoustic velocities, as well as grain-displacing gas hydrate structures being visible in X-ray images. While some pressure cores were rapidly depressurized for preservation in liquid nitrogen, most pressure cores were subjected to controlled depressurization experiments to quantify

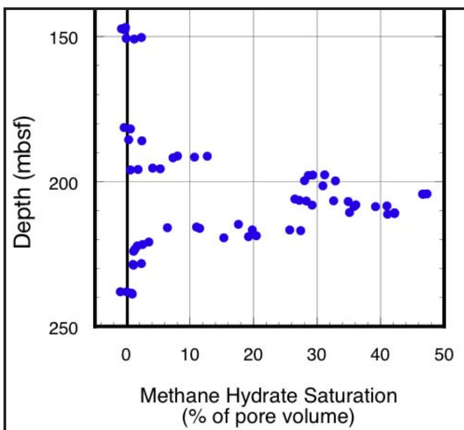
Coring from the Russian geotechinical drillship SRV Bavenit. Russian drill crew and Fugro operators from the Netherlands, Germany, and America cooperate to safely and quickly recover hydrate-bearing core for Chinese clients.

Safety first: the expansive, hydrate-bearing cores must be handled with care. Ben Lunsford and Ricardo Alvarez of Fugro place a safety shoe in front of the corer before removing the cutting shoe.

the methane concentration and thus the gas hydrate saturation within the core. Once depressurized, pressure cores were sampled for porewater analysis to determine porewater freshening from gas hydrate dissociation. This complete conventional and pressure core data set, along with the downhole wireline logs, allowed us to have a high degree of confidence in our reported gas hydrate saturations.

Scientific Results

Gas hydrate was detected at three of the five sites cored. The sediments were predominantly clay, with a variable amount of silt-sized particles including foraminifera. Methane was the predominant gas within core voids as well as in gas hydrate; ethane was 0.1% or less of most gas samples (maximum ethane concentration 0.8%). Even at relatively high gas hydrate saturations, all the gas hydrate found during the expedition was dispersed within the pore spaces of the sediment as determined from the nondestructive analyses of pressure cores. Quantification of gas hydrate from both pressure core methane mass balance and porewater freshening analysis (figure to left) confirmed that the hydrate-bearing sediment layers contained 20-40% gas hydrate as a percentage of pore volume. These gas-hydrate-containing sediment layers were 10 to 25 meters thick and were situated directly above the base of gas hydrate stability, which was near 200 meters below seafloor. No other gas hydrate was found within the stability field above these layers, which was supported by the pressure core data which indicated undersaturation of methane in the porewater above the gas-hydrate-rich layers.



The presence and absence of gas hydrate correlated well with electrical resistivity log data at all five sites cored, and despite the relatively low values of the resistivity anomalies, there appeared to be a direct relationship between the resistivity and the measured gas hydrate concentrations in the cores. While there was no obvious correlation between gas hydrate occurrence and seismic data, further research on this topic is ongoing.

Dr. Nengyou Wu cleans a sediment sample before squeezing it for sedimentary porewater. Freshening noted in porewater samples is one method used to calculate gas hydrate concentration (above).

Gas-hydrate-bearing sediment samples being transferred into liquid nitrogen for delivery to GMGS.

"Classic" but Novel Hydrate Distribution

The gas hydrate found in the Shenhu area in the northern South China Sea was the first recorded gas hydrate drilled in the South China Sea. The distribution of gas hydrate in these passive margin sediments, in a relatively homogenous layer, limited to the strata immediately above the base of gas hydrate stability, is the type of distribution predicted from simple models of gas hydrate formation (e.g. Hyndman & Davis, 1992; Xu & Ruppel, 1999). However, a clear field example of such a gas hydrate distribution has not previously been reported. This occurrence of thick (>10 m) and uniform (all samples with gas hydrate at 20-40% of pore space) gas hydrate just above the bottom simulating reflector (BSR) makes the Shenhu region very appealing for studies connecting modeling of gas hydrate formation with real field data.

Prior to this cruise, there has been no evidence that such high concentrations of gas hydrate could occur in clay sediments in such thick layers with this disseminated, pore-filling, morphology. We believe that the Shenhu gas hydrate accumulation, containing large concentrations of disseminated gas hydrate in extremely fine-grained sediments, is unique among known marine gas hydrate deposits. The evidence for this surprising occurrence comes primarily from the nondestructive measurements on the pressure cores but also from direct observations of depressurized cores. The homogeneous, pore-filling small-scale hydrate distribution is the type of distribution typically used when modeling gas hydrate formation and dissociation in sediments of all grain sizes. Again, this allows gas-hydrate-bearing sediments in the Shenhu deposit to be used to test the assumptions and predictions, at various scales, of some of the community's simplest gas hydrate models.

Future Plans

Further analysis of samples and data collected during the expedition will continue at GMGS and throughout China. Cores will be split, described, and sampled at GMGS in the coming months. Analysis of samples taken on board the ship are already underway, including samples of gas-hydrate-bearing sediments preserved in liquid nitrogen. The core data will be correlated with the downhole log data, especially the electrical resistivity, to improve predictive models of gas hydrate concentration for future expeditions to the Shenhu region, and both the core and log data will be used to closely re-examine the seismic data to develop predictive capability from remote data sets. Potential future expeditions to both the Shenhu area and other regions of the northern South China Sea margin are currently under discussion.

Drs. Haiqi Zhang and Peter Schultheiss show their excitement as a gas-hydrate-containing pressure core is slowly depressurized, releasing methane. The gas released is analyzed and quantified to obtain a mass balance for each pressure core, allowing the gas hydrate within the core to be accurately determined.

Gas Hydrates Observatories Workshop attendees

Gas Hydrates Observatories (GHOBS) Workshop Report

Marta Torres, Anne Trehu, and Rick Colwell, Oregon State University

Ongoing planning efforts for gas hydrate observatories have evolved as a result of the recognized need to determine processes and rates of gas hydrate formation and dissociation in marine sediments. At present, these plans are in various stages of implementation.

On July 18-20, 2007, the Joint Oceanographic Institutions (JOI) and the Department of Energy (DOE) jointly funded a workshop in Portland, Oregon to define the scientific issues and challenges associated with conducting sustained, *in situ* observations of marine gas hydrates and to develop guidelines for moving forward with these efforts. Seventy-five scientists and engineers met to develop specific plans and strategies for borehole and related seafloor and water column instrumentation that can be implemented during the next several years. Working groups focused on five topics: site characterization, measurement of the *in situ* physical state, measurement and sampling of mobile fluids in seafloor, benthic and water column observations, and education and outreach.

All groups agreed that the first generation of marine gas hydrate observatories should be at sites of active fluid flow where the dynamics of the subseafloor gas hydrate and free gas system vary over spatial and temporal scales that allow detection of perturbations with currently available observatory technology. Accordingly, discussions focused on sites of active fluid flow in the Cascadia margin and the Gulf of Mexico, which have been extensively investigated during the last decade. At these sites, the amount and distribution of gas hydrate present and the pathways along which hydrocarbons migrate are well characterized and there are good working hypotheses for gas hydrate dynamics that can be tested with seafloor and borehole observatories.

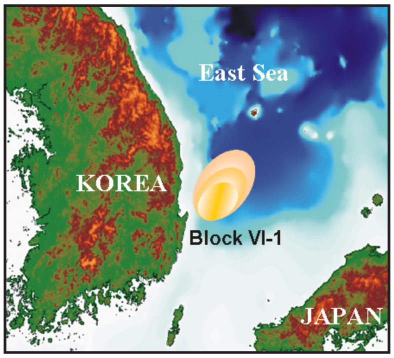
Experiments will generally require two stages. During the passive phase, the goal should be to measure myriad parameters at various spatial and temporal scales over a number of years to constrain the natural baseline for the hydrogeologic system and its response to various natural forcings (e.g., seismic perturbations, tidal loading, etc.). During the subsequent active phase, various artificial perturbations can be applied to the hydrogeologic system at the observatory site. A number of tools and sensors are needed to adequately monitor the combined tectonic, oceanographic and biological feedback mechanisms of the system. Whereas some of these are readily available for deployment (e.g. seafloor photography, seafloor flow meters), others require various degrees of development.

A seafloor observatory is feasible in the short term with available technologies, and a staged approach is recommended to understand the perturbation to the system introduced by each of the observatory components. High-priority, near-term engineering developments include improvements in reliability, stability, resistance to biofouling, and serviceability of sensors. Capabilities for long-term measurement of critical *in situ* physical state parameters (temperature, pressure, salinity, electrical resistivity, and methane concentration and phase) and ground motion at frequencies extending from ~0.1 to 1000 Hz must be developed. For all of the above activities, tools and sensors should be standardized so as to be useable at a variety of sites and subsurface deployment installations. Furthermore, as data acquisition is initiated, a mechanism is needed for data-handling, efficient database design, and coordination to avoid interference during collaborative use of the observatory installations and with ancillary experiments in the vicinity of the observatory.

There are numerous opportunities for related education (both formal and informal) and outreach activities associated with established observatories. Chief among these are the potential for a greater understanding of our ability to effectively manage natural resources and our role in global climate change. There is also the potential for developing ways to mitigate against natural hazards associated with submarine slope stability. The role of microbial communities in processes associated with gas hydrate formation and stability may have applications and benefits that are as yet unsuspected and a better understanding of biological processes in extreme environments can shed light on basic evolutionary and adaptive processes.

Early Results from Korean Gas Hydrate Research Effort Are Encouraging

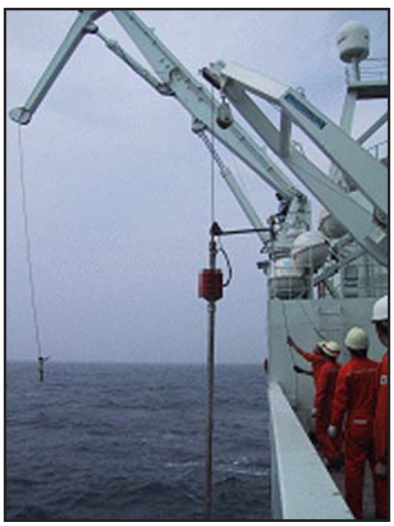
The government of South Korea is pursuing a 10-year national project to develop natural gas hydrate in Korea's East Sea. In July 2005, a gas hydrate development team was formed that includes state-owned Korea National Oil Corporation (KNOC), Korea Gas Corporation (KOGAS) and the Korea Institute of Geoscience and Mineral Resources (KIGAM). The project is managed by the Gas Hydrate R&D Organization (GHDO) and funded through the Ministry of Commerce, Industry and Energy (MOCIE).



June 2007 piston coring in the East Sea confirmed the presence of gas hydrates

Analysis of regional seismic data collected from 2000 to 2005 identified two highly promising areas. In June 2007, piston coring confirmed the presence of gas hydrate in one of these areas, about 135 kilometers (85 miles) northeast of the southeastern industrial city of Pohang, not far from the offshore Donghae gas field. A deep drilling and coring expedition to test the full extent of the gas hydrate stability zone at five locations got underway in late September.

GHDO's three-phase, 10 year, program is designed to conduct a production test and confirm a viable production method by 2015. The motivation for this aggressive R&D program is clear: South Korea is the world's second largest LNG buyer after Japan and relies on imports to meet its demand. In 2006 the country imported more than 25 million metric tons of LNG. A commercial capability to produce natural gas from hydrates in the East Sea could dramatically alter that situation.



Natural gas hydrate discovered by piston coring in the East Sea.

Methane from recovered gas hydrate sample is set alight during coring operation.

Fresh Water Hydrates from Lake Baikal

Peter Schultheiss and Melanie Holland, Geotek Ltd.

Prospective participants for specialized geological meetings are often enticed with a pertinent field trip that provides an opportunity to observe an example of the geologic topic of interest “in the flesh.” For a natural gas hydrate meeting, the ephemeral nature of the subject matter makes the equivalent field trip rather more difficult to arrange than some. That is, unless you hold the meeting on the shores of the deepest lake in the world, Lake Baikal, containing not only about 20% of the world’s fresh water but also a rare occurrence of fresh water gas hydrates.

The Limnological Institute in Irkutsk (Siberian Branch of the Russian Academy of Sciences) recently organized a four-day international Conference on Gas Hydrates from 3rd - 8th September, 2007, in the small lakeside settlement of Listvyanka. The meeting focused on many aspects of gas hydrate research but with a particular emphasis on gas hydrate occurrences in Lake Baikal. Amongst many other things, we learned that massive Structure I and Structure II hydrates have been found adjacent to each other just beneath the lake bed.

On the last day of the conference, the *G. U. Vereshchagin* sailed from Listvyanka at 4 o’clock in the morning. By 10 am it was bright, warm, and sunny, and we had recovered, from a water depth of 1300 meters, a 1.5 meter long gravity core from a previously sampled “mud-volcano-like” feature (guided by a strategically placed handheld GPS hanging out of the bridge window). When the core was split open, abundant, thick, dipping gas hydrate layers were revealed that popped and fizzed to the excitement of the assembled participants. An additional core was collected and examined and this was followed by celebratory bubbly wine and later, the obligatory vodka.

With the plethora of gas-hydrate-related meetings that are now taking place, the challenge to future organizers should be to rival what was an extraordinary field trip in an extraordinary gas hydrate environment!

Triennial Hydrates Conference Set for Vancouver in 2008

The 6th International Conference on Gas Hydrates (ICGH 2008) will take place in Vancouver, British Columbia, Canada on July 6-10, 2008. ICGH 2008 is the latest in a series of conferences held every three years since 1993. The conference aims to bring together the entire gas hydrates research community; academic researchers, industrial practitioners, government scientists and policy makers are all welcome. The organizing committee is confident that each participant will be able to meet others with similar interests, and exchange ideas, expertise and experience.

Themes for the 2008 conference will include: Energy and Resources, Environmental Considerations, Geohazards, Oil and Gas Operations, Novel Technologies, and Fundamental Science and Engineering. Please visit the conference website http://www.icgh.org/ for more details

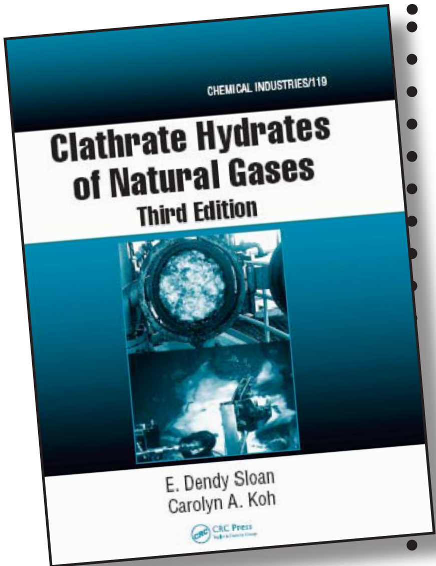
Second Award Made Under Methane Hydrate Fellowship Program

New NETL-NAS gas hydrate research fellow Evan Solomo

A second fellowship has been awarded under the newly inaugurated Methane Hydrates Fellowship program. This program, supported by the U.S. Department of Energy's National Energy Technology Laboratory (NETL) and managed by The National Academies, is designed to support the development of methane hydrate science and enable highly qualified postgraduate students to pursue advanced degrees in an area of increasing importance to the Nation.

Evan Solomon, currently a Ph.D candidate at Scripps Institution of Oceanography in San Diego, was selected from among a field of highly-qualified applicants to pursue post-doctoral research related to the study of constraining rates of biogeochemical reactions and methane generation and their implications for fluid and gas sources, transport processes and gas hydrate formation. Evan's work will utilize data he gathered as a shipboard chemist during Leg 3 of last summer's National Gas Hydrate Program Expedition 01 in the Indian Ocean. That portion of the Expedition targeted the Krishna-Godawari (K-G) basin located along the eastern margin of India.

According to Solomon's research proposal, the number and close proximity of test holes drilled at the K-G location, coupled with the heterogeneity of the hydrate occurrences observed there, provide an excellent opportunity to study the processes that lead to variations in gas hydrate distribution and concentration within marine sediments. Evan will quantify these variations using dissolved chlorine ion profiles, pressure core de-gassing data and infrared images. In addition, a suite of major, minor and trace elements, as well as isotope ratios will be analyzed to deduce *in situ* diagenetic reactions, migration of fluids from deeper within the sediment section, fluid and gas sources, and flow pathways. A newly-developed robust numerical method will be used to compute methane production rates based on pore fluid chemical data and sediment physical properties. Evan will be working in collaboration with Drs. Miriam Kastner (Scripps Institution of Oceanography), Arthur Spivack (University of Rhode Island) and Marta Torres (Oregon State University). The new data provided by this study will have implications for new estimates on the size of the global marine gas hydrate reservoir and its importance as a future energy resource, gas hydrates' role in the carbon cycle, and their potential role in climate change.



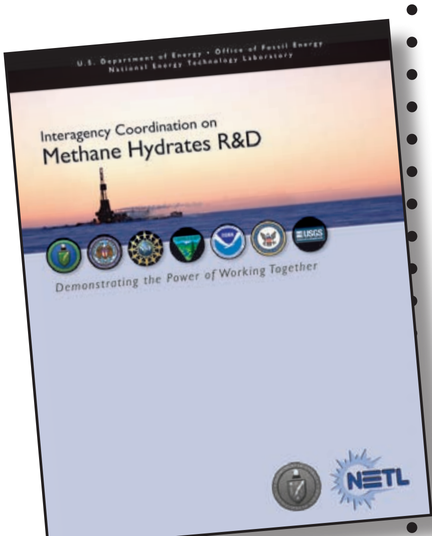
A Thorough, Up-to-Date Account of Natural Gas Hydrates

Hydrate research has expanded substantially over the past decade, resulting in more than 4,000 hydrate-related publications. Collating this vast amount of information into one source, Clathrate Hydrates of Natural Gases, Third Edition, presents a thoroughly updated, authoritative, and comprehensive description of all major aspects of natural gas clathrate hydrates. The authors, E. Dendy Sloan and Carolyn A. Koh of the Colorado School of Mines' Center for Hydrate Research, begin with a historical perspective of natural gas clathrate hydrates and progress through flow assurance, thermodynamics and kinetics, hydrate structural and physical properties, and methods for prevention and dissociation. The new edition of this bestseller offers updated information and incorporates two software programs on an accompanying CD-ROM. It also presents case studies on low dosage hydrate inhibitor prevention, phase equilibrium data and kinetic models, and a description of the flow assurance paradigm shift to risk management. Other new material discusses natural hydrate reservoir assessment and summarizes the *in situ* conditions associated with hydrates in both arctic permafrost and the ocean. The 752-page reference book is available from CRC Press at http://www.crcpress.com/ or by calling 1(800)272-7737 in the U.S. *Fire in the Ice* subscribers will receive a 20% discount. Reference code 463JK WB14 when ordering.

Fellowship Program Announces Change in Proposal Review Schedule

Starting with the February 1, 2008 application deadline, the NETL-NAS Methane Hydrate Fellowship program will begin semi-annual rather than quarterly proposal reviews. Open seasons for applications will now occur in December and June with proposal reviews beginning in March and September, respectively.

The Fellowship program will continue to support highly qualified postgraduate students in the advancement of methane hydrate science. In particular, interest is in advanced geological and geophysical projects that will provide improved methods and tools for remote or *in situ* detection, characterization and appraisal of gas hydrate occurrence and distribution in nature, as well as their potential as an energy resource.



Interagency Brochure Available on NETL Methane Hydrates Website

An updated version of the brochure titled "Interagency Coordination on Methane Hydrates R&D" is now available on the NETL methane hydrates website. The brochure, prepared by representatives of the Department of Energy, the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, the Minerals Management Service, the Bureau of Land Management, the Naval Research Lab, and the National Science Foundation, describes the unique contributions of, and active collaborations between, seven federal agencies in the advance of gas hydrates science. A second publication titled "Interagency Roadmap for Methane Hydrate R&D," produced by the Methane Hydrates Program Technical Coordination Team, provides details on the medium- and long-term R&D goals set for the program and the path outlined to meet them. Both documents are available at http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/maincontent.htm/.

McGill Professor Brings Hydrate Field Experience Into the Classroom

MICHAEL RIEDEL

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The little bit of time he has left after teaching, expeditions, and writing new research proposals to fund new projects, Michael spends studying classical music and playing the piano and oboe. If time permits, he tries to squeeze in a concert or opera performance once or twice a year.

Michael Riedel's favorite place to be (aside from a piano bench or at an opera performance) is the classroom. "Teaching and interacting with graduate students are certainly among the most rewarding aspects of my work," says Michael, who holds the T.H. Clark Chair in Sedimentary and Petroleum Geology in the Department of Earth and Planetary Sciences at McGill University in Montreal, Canada. And the most challenging aspect? "Teaching again, but this time I mean the never-ending problem of maintaining sufficient support for students to carry out independent state-of-the-art science and get them involved in cutting-edge research projects."

At McGill, Michael's courses currently include elementary earth physics, geophysical applications, seismic data processing, and borehole geophysics. He received his Diplom in Geophysik in 1998 at the Christian-Albrechts University in Kiel, Germany, and his PhD in Geophysics at the University of Victoria (BC), in 2001. He credits the late Dr. Friedrich Theilen at Chistian-Albrechts University and Drs. Roy Hyndman, George Spence and Scott Dallimore with providing the early inspiration and motivation that led him to become a scientist and teacher himself. "And more recently, Tim Collett has been a big influence as well," he adds.

Riedel's interest in marine geoscience first developed within the Marine Geophysik group in Kiel. This in turn led to his focusing on methane hydrates when pursuing his Ph.D and subsequently to a post-doc appointment at Natural Resources Canada, where he also worked as a research scientist prior to taking his current post at McGill.

"While studying at the University of Victoria I was fortunate to take part in the first hydrate recovery off Canada's west coast during a research cruise in 2000," says Michael. "I was onboard the Canadian Coast Guard's research vessel *John P. Tully* as a watch-keeper and to perform physical property measurements." Subsequently, he took part in the Ocean Drilling Program Leg 204 off the coast of Oregon (as a physical-properties specialist), the Integrated Ocean Drilling Program Expedition 311 (where he was co-chief scientist) and last year's India National Gas Hydrates Program Expedition 01 (where he also was co-chief scientist). Riedel also spent some time onshore, as a physical properties specialist and helping to facilitate regional seismic measurements during the Mallik 2002 production test. These research cruise opportunities provide Riedel with a lot of raw material that he incorporates into his courses, both graduate and undergrad.

"Next to teaching, I also find being at sea and conducting hydrate research with scientists from other countries to be very rewarding," adds Michael. "Interacting with other disciplines, seeing how it all works together and how you cannot treat one aspect separate from all other disciplines, you quickly realize that only by combining all of the results and perspectives can one get a complete picture." Michael will be following up on that notion as he soon departs for Korea where he will be co-chief on the Korean Gas Hydrates Expedition 01 in the Ulleung Basin off the East Sea/Sea of Japan.

His opinion on the biggest challenges facing gas hydrates research? "Detecting and quantifying hydrates remotely using geophysical methods; we surprisingly are still in the beginning steps here, especially in marine environments … and addressing climate change and geohazard issues should also not be forgotten over the energy resource aspects."