the ENERGY lab

Fire in the Ice

2013 Vol. 13, Issue 1 Methane Hydrate Newsletter

NETL

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U.S. DEPARTMENT OF ENERGY

BOEM Releases Assessment of In-Place Gas Hydrate Resources of the Lower 48 United States Outer Continental Shelf

Matthew Frye (BOEM – Herndon, VA), William Shedd (BOEM – New Orleans, LA), Kenneth Piper (BOEM – Camarillo, CA), John Schuenemeyer (Southwest Statistical Consulting – Cortez, CO)

The Bureau of Ocean Energy Management (BOEM; formerly the Minerals Management Service or MMS) recently released an assessment of undiscovered in-place gas hydrate resources on the Atlantic (Figure 1) and Pacific (Figure 2) margins of the U.S. Outer Continental Shelf (OCS). BOEM is the U.S. Department of Interior agency charged with managing the nation's natural gas, oil, and other mineral resources on the OCS. Combined with the 2008 publication of assessment results for the

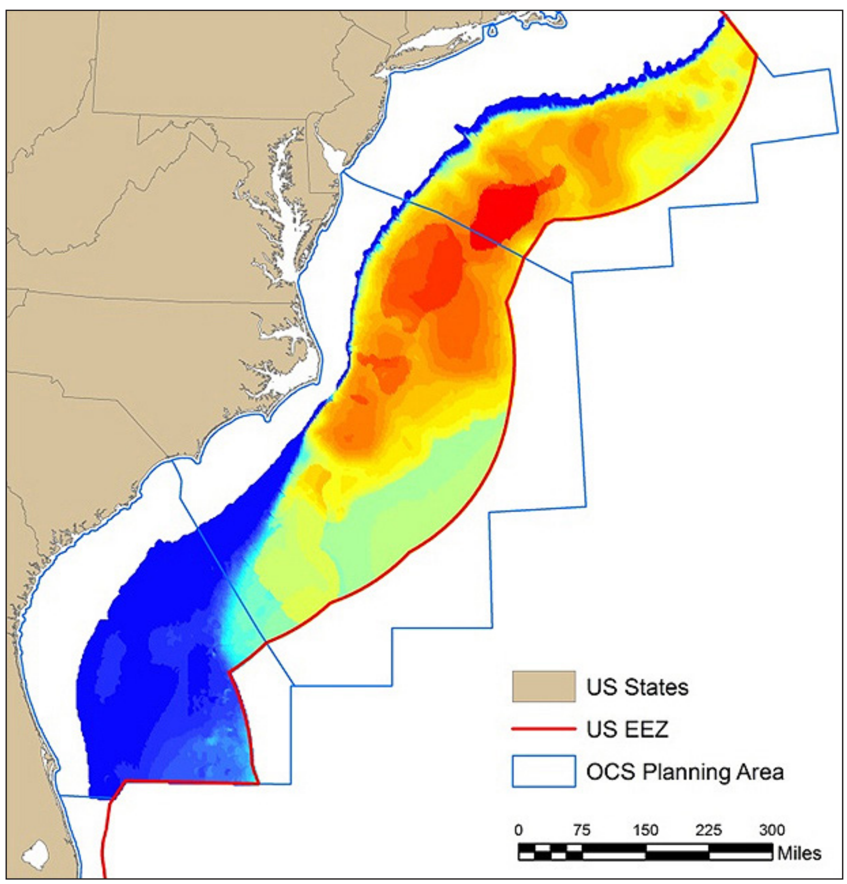

Figure 1. Spatial representation of mean in-place gas hydrate volume for the Atlantic OCS. Red colors indicate rich accumulations; blue colors indicate minimal accumulations.

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

This newsletter is available online at http://www.netl.doe.gov/MethaneHydrates

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

This newsletter now reaches more than 1400 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 724-554-3680 or karl.lang@contr.netl.doe.gov

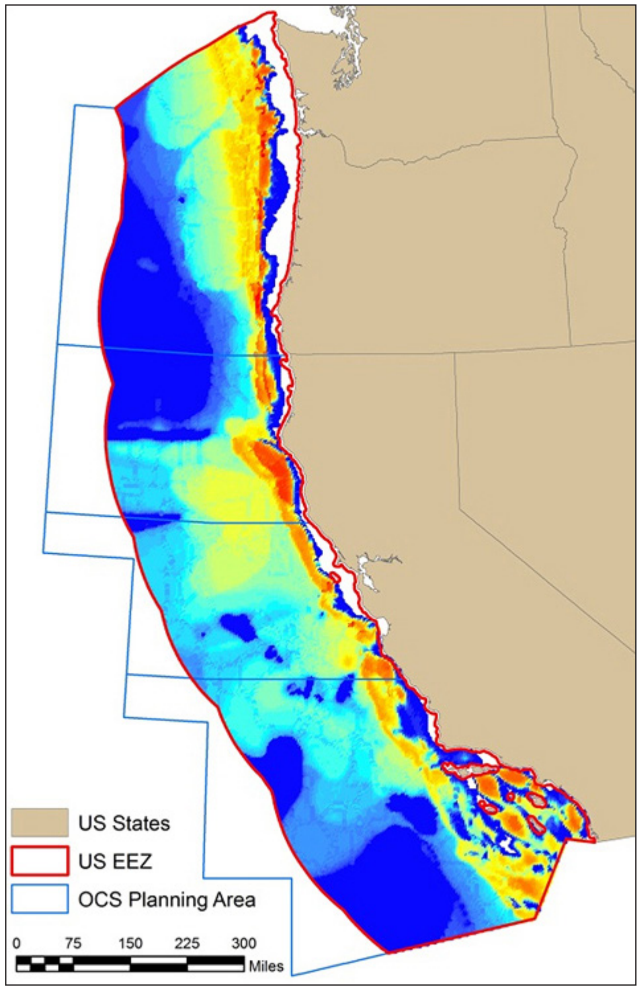

Figure 2. Spatial representation of mean in-place gas hydrate volume for the Pacific OCS. Red colors indicate rich accumulations; blue colors indicate minimal accumulations.

Gulf of Mexico (GOM) OCS, BOEM now has completed a comprehensive assessment of in-place gas hydrate resources for those areas of the U.S. OCS adjacent to the Lower 48 states and within the limits of the 200 nautical mile U.S. Exclusive Economic Zone. An assessment of the gas hydrate resources on the U.S. OCS adjacent to the state of Alaska is currently underway.

The mean in-place gas hydrate resource volume for the Lower 48 states OCS is 1,453 trillion cubic meters (1,453x 10^{12} m^3; equivalent to 51,338 trillion cubic feet). Gas hydrate resources are assessed as in-place volumes and reported as the amount of natural gas that resides in the form of gas hydrate in any reservoir in the subsurface of the OCS, without regard to technical recoverability. BOEM employs a spatially-resolved mass balance model that incorporates uncertainty at various levels of model component input, and the stochastic nature of the assessment approach provides a range of resources at the model cell level and at levels aggregated to greater geographic extents.

Estimates of in-place gas hydrate resources are presented at the mean level and at the 95^{th} and 5^{th} percentile levels for each of the three OCS regions (Table 1). This range of estimates corresponds to a 95 percent probability

Region	In-Place Gas Hydrate Resources					
	95%		Mean		5%	
	tcf	tcm	tcf	tcm	tcf	tcm
Atlantic OCS	2,056	58	21,702	614	52,401	1,483
Pacific OCS	2,209	63	8,192	232	16,846	477
Gulf of Mexico OCS	11,112	314	21,444	607	34,423	974

Table 1. Gas hydrate resource assessment results for the U.S. OCS. Gas volume reported in both trillion cubic feet (tcf) and trillion cubic meters (tcm).

(a 19 in 20 chance) and a 5 percent probability (a 1 in 20 chance) of there being more than those amounts present, respectively. The 95 and 5 percent probabilities are considered reasonable minimum and maximum values, and the mean is the average or expected value.

Methodology

The BOEM gas hydrate assessment model comprises a spatially resolved, cell-based stochastic model structure that utilizes a mass balance approach to calculate the volume of gas hydrate in-place in the subsurface. The assessment model includes three computational modules and an integration module, as well as numerous sub-models that quantify the many components necessary for a working gas hydrate petroleum system. The stochastic model structure allows for the introduction of component uncertainties at many levels throughout the model, resulting in the probabilistic distribution of results. Geologic risk is not introduced at any level in the model.

For every model cell at every trial run, Monte Carlo sampling of uncertain input parameters generates a value for the thickness of the hydrate stability zone (HSZ; the Container module); a value that represents the fraction of the HSZ that can be saturated with gas hydrate (the Concentration module); and a value for the amount of biogenic gas available to charge the HSZ (the Charge module). The volume of gas available is compared to the container space available in the integration module, and the smaller of the two volumes is recorded. While the desired end product of an assessment model run is an in-place volume of gas hydrate resources (reported at surface temperature and pressure), any of the interim calculations and results (such as those of the computational modules) can be reported in either numerical or spatial expressions.

The gas hydrate assessment model was initially developed for application to the GOM OCS. The preliminary assessment results for the GOM and a complete description of the model methodology and input parameters are reported in OCS Report MMS 2008-004. While some modifications were incorporated into the original GOM model structure to allow for adaptation to both the Atlantic and Pacific OCS areas, the overall mass balance modeling approach remains the same. Specific details of the inputs, components, and modeling approach for the Atlantic and Pacific OCS will be available in comprehensive reports to be released at a later date.

Assessment Results

This assessment represents a multi-year effort that is still ongoing. The modeling approach allows for a complete disaggregation of the input parameters and modeling components, and provides an opportunity to update the results as more scientific information becomes available and as industry advances this relatively immature energy resource to one that is closer to commerciality. The results presented here for the GOM OCS are those reported in OCS Report MMS 2008-004.

The Atlantic OCS study area exceeds 500,000 km^2 with an estimated mean in-place gas hydrate volume of 614 trillion cubic meters (614 x 10^{12} m^3). The Atlantic OCS is a tectonically passive margin underlain by Triassic and younger basement rock, and overlain by a relatively thick sedimentary section dominated by local limestone facies and a younger mixed siliciclastic system.

The northern and central Atlantic OCS, in particular, is characterized by submarine canyons that enabled turbidite deposition on the slope and the abyssal plain. The southern and south-central Atlantic comprise a more mud-dominated subsurface, especially in the younger section nearest the seafloor. Water depth generally increases with distance offshore (exceeding 5,000 meters in the eastern part of the study area) and a sufficient sedimentary section (~ > 1 km thick) is found across the OCS, leading to a HSZ that increases in gross thickness as water depth increases.

The modeled resource density in the northern and central Atlantic OCS (over 3.0 billion m^3/ km^2 in many places) is much greater than that reported in the southern Atlantic OCS (0.75 billion m^3 / km^2) due largely to the sand-rich lithology and the thicker sedimentary section found in the northern and central Atlantic. The presence of several large bottom simulating reflectors (BSR) are reflected in the model results as these features are imparted as areas of greater gas migration efficiency.

The Pacific OCS assessment area comprises over 750,000 km^2 with an estimated mean in-place gas hydrate volume of 232 x 10^{12} m^3. The active tectonic nature of the Pacific OCS and the resulting tectonostratigraphic features have a significant impact on the gas hydrate petroleum system (Figure 3). North of the Mendocino Fracture Zone (MFZ; approximately 40° N latitude) the Pacific OCS is a tectonically complex margin that includes both active seafloor spreading and plate subduction.

The relatively young oceanic crust in abyssal water depths limits the opportunity for gas hydrate accumulation in at least two significant ways. First, the young seafloor has had limited opportunity for gross sediment accumulation (including a large area with < 100 m of sedimentary overburden), and the sediments that are there have been exposed to optimum gas generation conditions for only a limited time. Additionally, the relatively thin sedimentary cover often serves as a limiting factor in the potential thickness of the HSZ. These natural conditions contribute to the BOEM model prediction that relatively little gas hydrate will be present in these areas.

South of the MFZ the dominant plate tectonic forces are right lateral strike-slip and transform movement. The sediment thickness in near-shore basins exceeds 3000 m, and the majority of the oceanic crust in the abyssal areas is older than 25 million years and has been exposed to a modest degree of sedimentary cover. The BOEM model predicts greater gas generation potential in the south Pacific OCS than in the north, based on the thicker sedimentary section and the general assumption of a richer organic component in the south.

Overall, the richest modeled accumulations of gas hydrate are found in near-shore basins that stretch along the entire Pacific coastline (generally over 1.0 billion m^3/ km^2 and sometimes exceeding 4.0 billion m^3/ km^2). These basins share a number of common model inputs, including sand-

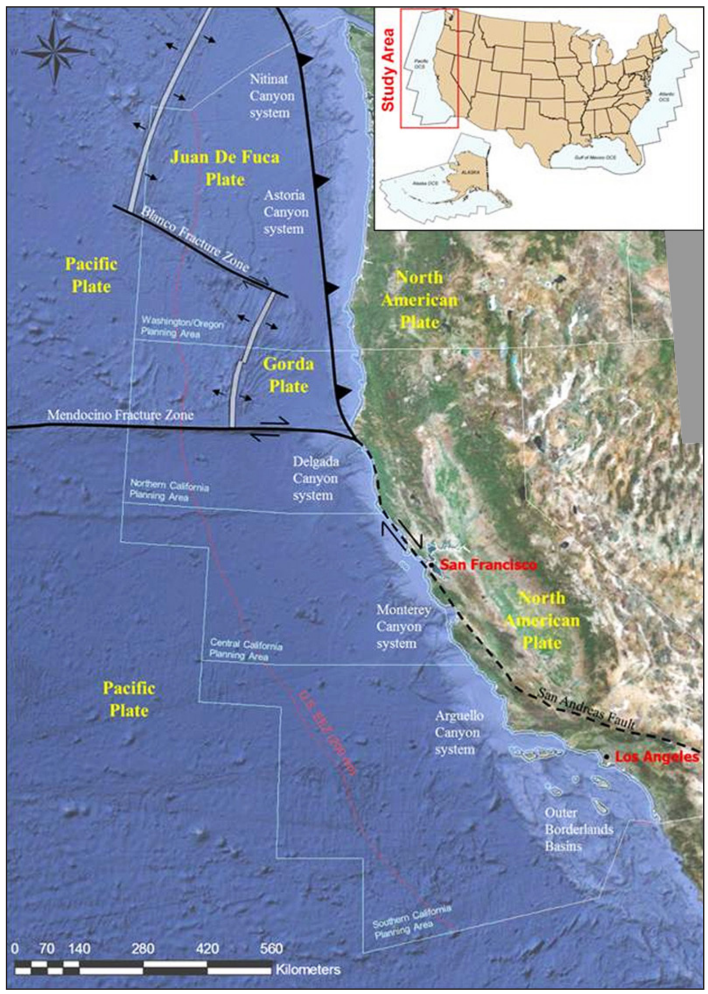

Figure 3. Pacific OCS plate boundary map.

rich depositional facies, thick sediment accumulation, modest organic component of source rocks, and evidence (on available seismic data) of bottom simulating reflectors. The sediment-starved abyssal areas of the Pacific OCS have a mean resource density of less than 0.15 billion m^3/ km^2.

Future Work

BOEM is in the process of assembling input data files and modifying the existing assessment model code for application to the U.S. OCS deepwater areas off the coast of Alaska.

Re-examination of Seep Activity at the Blake Ridge Diapir

Laura L. Brothers[1], Cindy L. Van Dover[2], Christopher R. German[3], Carl L. Kaiser[3], Dana R. Yoerger[3]

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[2] Duke University, Beaufort, North Carolina, USA
[3] Woods Hole Oceanographic Institution,Woods Hole, Massachusetts, USA

Despite the important geologic, geotechnical and biogeochemical implications of seabed fluid escape, the abundance and intensity of seeps remain poorly characterized. Along the U.S. Atlantic Margin, acoustic and geochemical water column anomalies associated with seafloor seeps have been observed in the Hudson Canyon, the mid-Atlantic shelf break, and the Blake Ridge Diapir. However, of the deep areas, only the Blake Ridge Diapir (BRD) site is known to host chemosynthetic communities, a strong seafloor indicator of active seabed fluid flow.

The BRD, drilled as Site 996 during Ocean Drilling Program Leg 164, is the locus of a seep set within the most areally extensive and best-characterized gas hydrate province on the U.S. Atlantic margin. Water column bubbles, chemosynthetic communities, and porewater geochemistry all provide evidence of modern fluid escape at the BRD seep site and authigenic carbonate found between 30 and 50 meters below the seafloor indicates that the seep has persisted since at least the early Pleistocene. However, the distribution of live and dead chemosynthetic biota (mussels and clams)

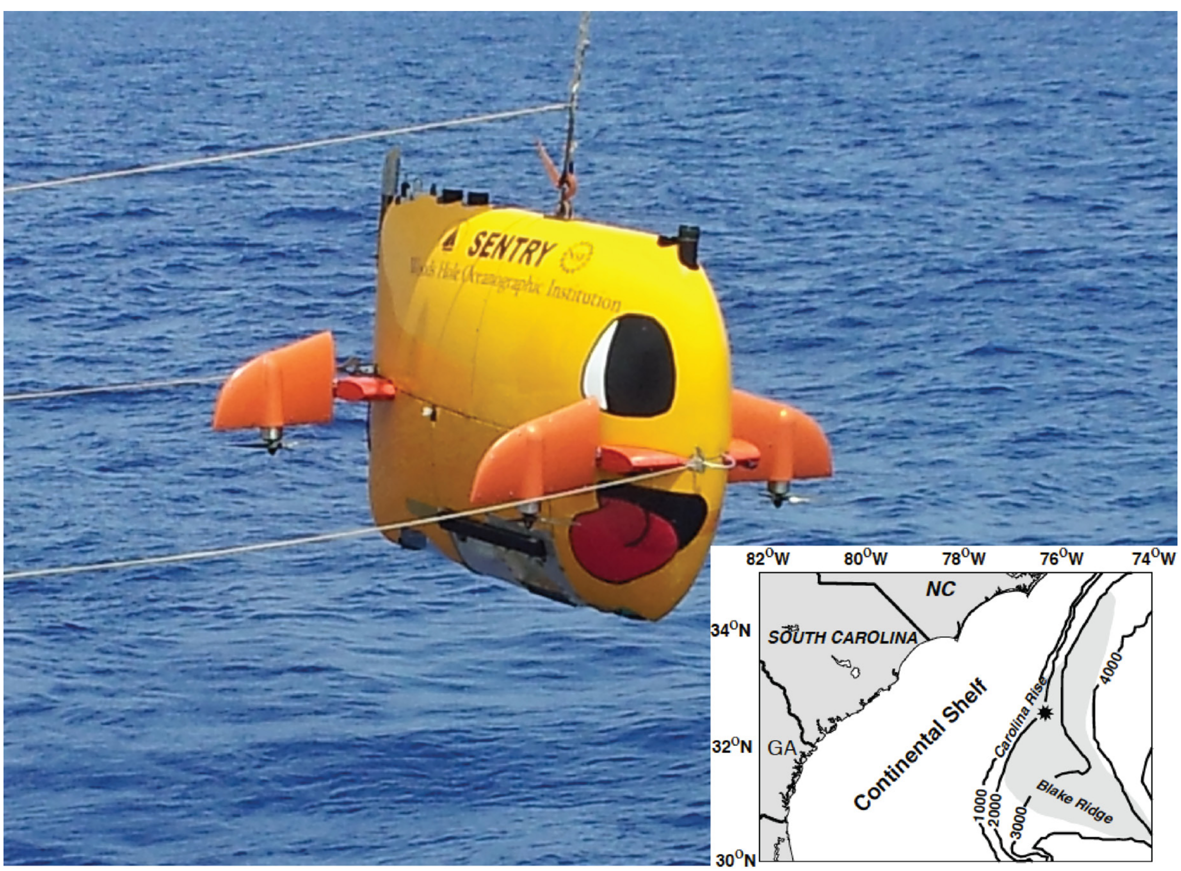


Figure 1. Photo of the AUV Sentry being recovered after a dive on the Blake Ridge Diapir. Inset map shows study site location (star).

on the seafloor suggests the flux of fluids that sustain seep organisms may be transient at a local scale. High-resolution mapping of the subsurface conduits implied a dendritic fluid migration pattern, suggesting that small-scale subsurface heterogeneities could affect seabed emissions patterns. However, despite the evidence for fluid flux, a detailed characterization of the spatial extent and distribution of seabed seep activity at the BRD site has yet to be fully determined.

In July 2012, NOAA Ocean Exploration Program expedition EX1205L1 characterized seeps in the Blake Ridge gas hydrate province using data collected by the instruments on the R/V *Okeanos Explorer* and by the Autonomous Underwater Vehicle (AUV) *Sentry* (Figure 1), operated as part of the National Deep Submergence Facility by Woods Hole Oceanographic Institution and funded for this expedition by National Science Foundation. Shipboard instrumentation included EM302 (30 kHz) multi-beam and EK60 (18 kHz) single-beam echosounders, a 3.5 kHz Knudsen sub-bottom profiler and a CTD (Conductivity, Temperature, Depth meter). *Sentry* was instrumented with a Reson 7125 multi-beam sonar with 400 kHz transducers, an Edgetech 2200 M capable of gathering side scan sonar and sub-bottom data, a high dynamic range (12-bit) 1024 x 1024 digital still camera, and other oceanographic sensors. Sentry flew 5 to 80 m above the seafloor, enabling high-resolution mapping.

Multi-beam and photographic data collected by *Sentry* created comprehensive sub-meter resolution bathymetric and biological maps. These results confirm the observations of bubbles and pockmarks noted

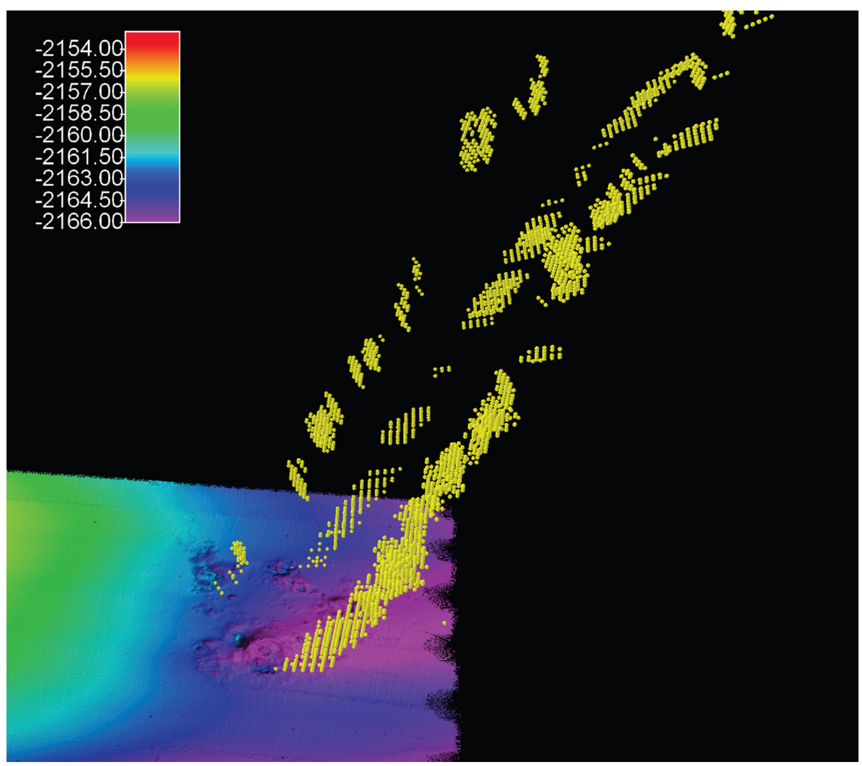


Figure 2. An oblique view of bathymetry collected using the AUV Sentry at the Blake Ridge Diapir seep site (Site 996). Yellow spheres are water column anomalies identified using the ship-collected multi-beam data and are interpreted as bubble plumes. Plumes extended up to ~1300 meters above the seafloor.

by earlier researchers, while resolving the features in unprecedented detail. Data from the *Okeanos Explorer's* multi-beam and echosounder systems also imaged water column anomalies originating within hundreds of meters of the seabed and extending up to 900 m above the seafloor (Figure 2). Interpreted as bubble plumes, these anomalies seem to emanate from seafloor depressions. The expedition also collected sub-bottom data with the same instrumentation and acquisition parameters as the 2003 pseudo-3D survey analyzed by Hornbach and co-workers. The co-located surveys provide the chance to analyze changes in the seep site over the intervening 9 years.

The expedition stemmed from a unique NSF/NOAA Ocean Explorer partnership and was a multi-institutional effort with scientific and engineering leads from Duke University, U.S. Geological Survey and Woods Hole Oceanographic Institution. The cruise was also novel in that there was an extensive telepresence component to the scientific and engineering missions. Students, principal scientists and senior engineers were onshore during the expedition, with only two scientific and engineering leads aboard the *Okeanos Explorer*. This created an exploration research cruise model where significant analytical and decision-making responsibilities were physically separated from the field data collection process. This enabled the participation of a much wider pool of experts in data processing, data synthesis, and scientific decision-making.

Acknowledgements: Expedition EX1205L1 was supported by NSF OCE 1031050(CLVD) and NOAA's Office of Ocean Exploration and Research. Laura Brothers was supported by a DOE NETL/NRC Methane Hydrate Fellowship under DE-FC26-05NT42248. The authors thank the *Sentry* engineering team, the NOAA OER onshore and offshore expedition teams, the crew of the *Okeanos Explorer*, M. Hornbach and C. Ruppel. Mention of trade names does not imply U.S. government endorsement of commercial products.

SUGGESTED READING:

Brothers, L. L., Van Dover, C.L., German, C.R., Yoerger, D.R., Kaiser, C.L.,Lobecker, E., Skarke, A.D., Ruppel, C.D., 2012. Evidence of extensive gas venting at the Blake Ridge and Cape Fear Diapirs. 2012 AGU Fall Meeting.

Hornbach, M.J., Ruppel, C., Van Dover, C.L., 2007. Three-dimensional structure of fluid conduits sustaining an active deep marine cold seep. Geophysical Research Letters 34, L05601, doi:10.1029/2006GL028859.

Paull, C.K., Ussler III, W., Borowski, W.S., Speiss, F.N., 1995. Methane-rich plumes on the Carolina continental rise: Associations with gas hydrates. Geology 23, 89-92.

Paull, C. K., R. Matsumoto, P. J. Wallace, and Shipboard Scientific Party, 1996. Proceedings of the Ocean Drilling Program, Initial Report, vol. 164, Ocean Drill. Program, College Station.

Van Dover, C. L., et al., 2003. Blake Ridge methane seeps: Characterization of a soft-sediment, chemo synthetically based ecosystem, Deep Sea Res., Part I, 50, 281–300.

Wagner, J.K.S., McEntee, M.H., Brothers, L.L., German, C.R., Kaiser, C.L., Yoerger, D.R., Van Dover, C.L., 2013, Cold-seep habitat mapping; High-resolution spatial characterization of the Blake Ridge Diapir seep field, Deep Sea Research II: Topical Studies in Oceanography http://dx.doi.org/10.1016/j.dsr2.2013.02.008

Field Data from 2011/2012 ConocoPhillips-JOGMEC-DOE Iġnik Sikumi Gas Hydrate Field Trial Now Available

Well log and production test data from the ConocoPhillips-JOGMEC-DOE Iġnik Sikumi gas hydrate field trial, which was carried out on the North Slope of Alaska during the winters of 2010/2011 and 2011/2012, are now available for scientific use from the DOE/NETL. These *in-situ* data represent valuable ground-truth information that will serve to bolster our understanding of gas hydrate reservoirs. With this data release, the DOE/NETL hopes to foster collaboration among field scientists, laboratory researchers, and numerical modelers who are striving to describe and constrain the geology and production behavior of sub-permafrost methane hydrate deposits.

The Iġnik Sikumi gas hydrate test well on the North Slope of Alaska was drilled and logged during the winter of 2010/2011, and gas hydrate production testing was carried out there during the winter of 2011/2012. For more information on the Iġnik Sikumi project, please visit the project web site as well as previous issues of this newsletter (FITI, Vol. 8, Iss. 4; FITI, Vol. 10, Iss. 3; FITI, Vol. 11, Iss. 1).

Available data include:

- Log data from the 2010/2011 logging program in las format
- Production test data from the 2011/2012 program in xls, matlab, and SQL formats
- Volumes and rates of produced CH_4, CO_2, and N_2 (see Figure 1)

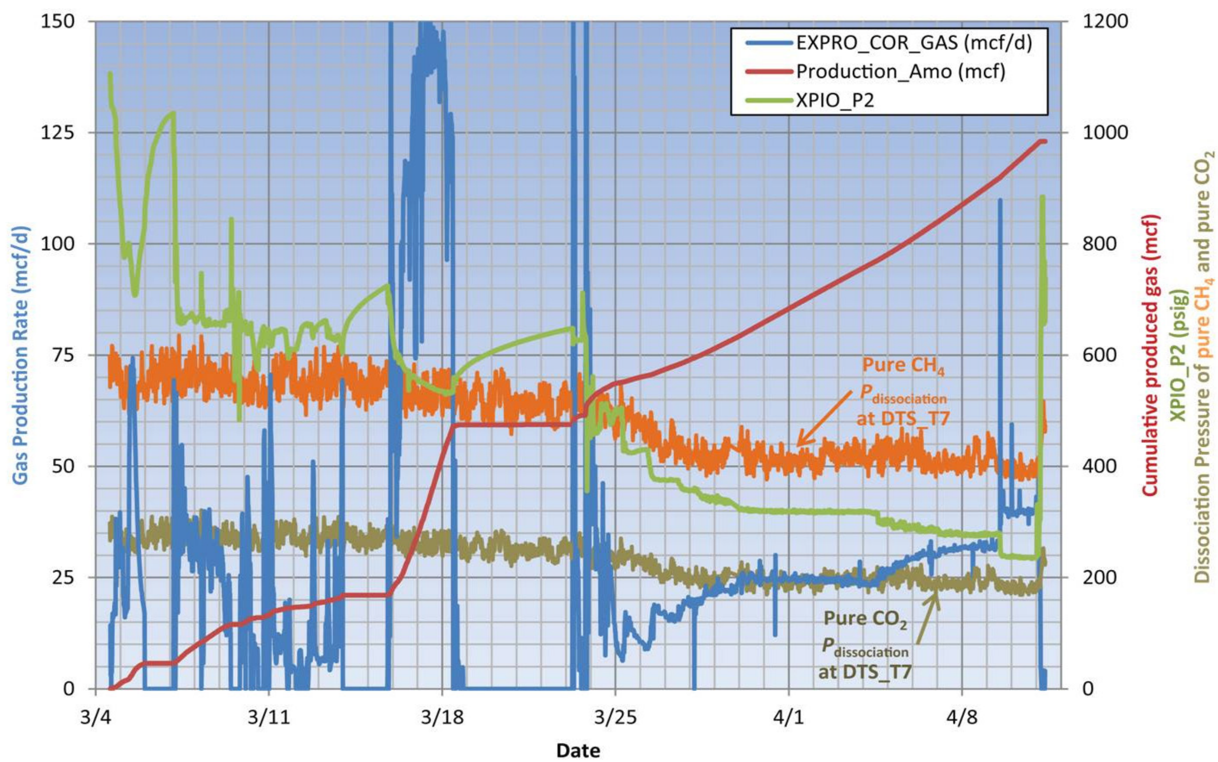


Figure 1. Summary of flowback phase, including gas production rate (blue), cumulative gas production (red), and pressure (green). Changing dissociation pressure at ambient temperature for pure methane (orange) and CO_2 (olive) hydrate are also shown although these data are not included in the dataset.

- Volumes and rates of injected N_2 and CO_2 (see Figure 2)
- Temperature and pressure data recorded throughout both field programs using downhole gauges
- A detailed operations log from production test program
- Physical descriptions of the test well and facilities layouts

Data are available in raw form and in final, corrected form, and in both 1-minute and 5-minute averages.

The data are available for download at: http://www.netl.doe.gov/technologies/oil-gas/FutureSupply/MethaneHydrates/rd-program/ANSWell/co2_ch4exchange.html

The DOE strongly supports scientific collaboration in the analysis of these datasets. Therefore, our Iġnik Sikumi field data download site includes a request for information on your general research goals and plans for use of these data. Within approximately 1 year, we plan to begin assembling research results that utilize the Iġnik Sikumi data. Results will be combined into a single, comprehensive Iġnik Sikumi Scientific Results Volume (please go to http://www.sciencedirect.com/science/journal/02648172/28/2 for an example). We will contact those who have downloaded the data to assess your interest in contributing to this Special Volume.

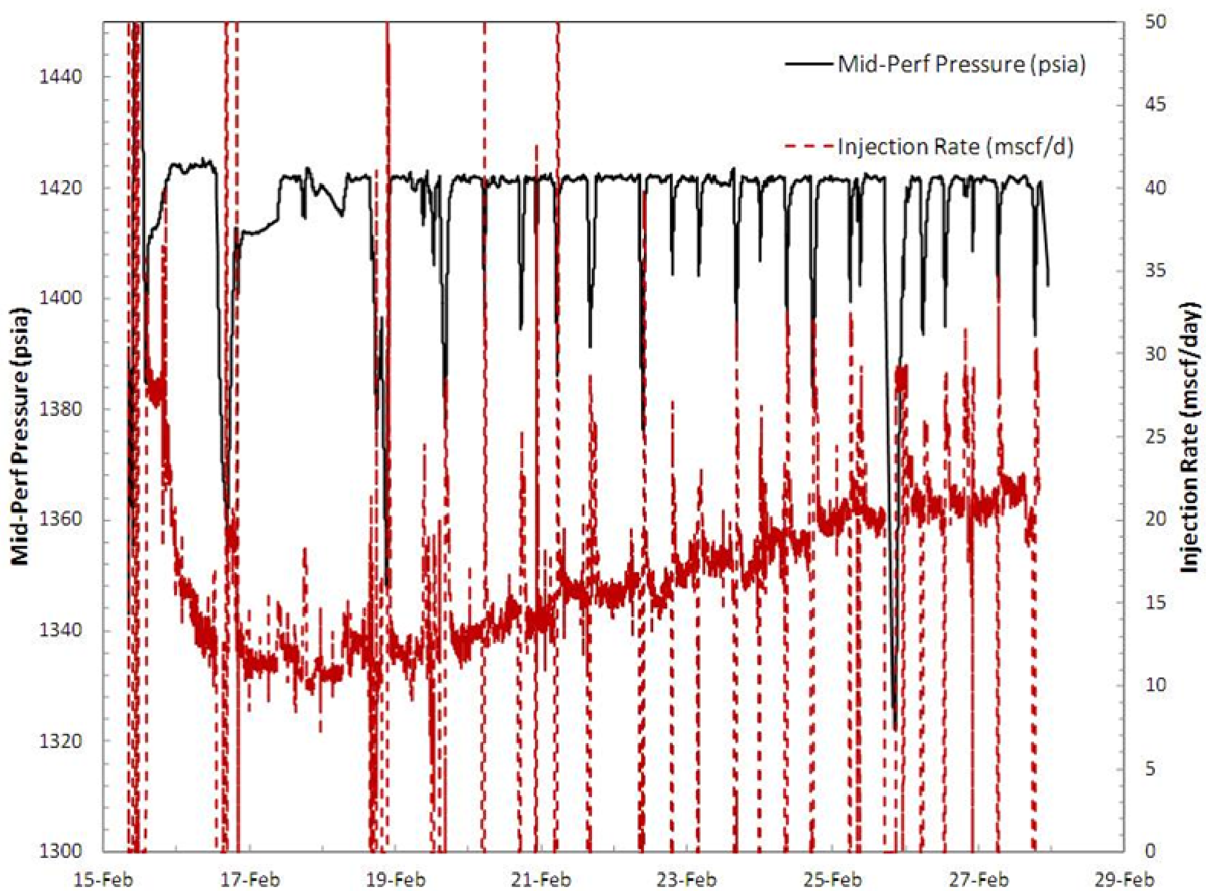


Figure 2. Rate of gas injection during the initial injection phase of the test (red) end pressure at the mid-point of the perforated interval (black).

CENTRE FOR ARCTIC GAS HYDRATE, ENVIRONMENT AND CLIMATE
CAGE

Norwegian Center of Excellence to Receive Ten Years of Arctic Research Funding

The Center for Arctic Gas Hydrate, Environment and Climate (CAGE) in Tromsø, Norway, was recently selected by the Norwegian Research Council to receive 10 years of arctic research funding. CAGE will receive 14 million Norwegian Krone (equivalent to $2.5 million dollars), which will be augmented with internal funding. Scientists at the center will study methane release from hydrates beneath the Arctic Ocean in an effort to understand potential impacts on marine environments and global climate systems. Field programs will utilize a state-of-the-art Norwegian polar icebreaker research vessel that is planned to be launched in 2015 and will be based in Tromsø.

The Research Council of Norway selected 13 research groups, from a diverse pool of 139 applicants, to be elevated to the status of Norwegian Centers of Excellence. The other research centers cover a broad range of disciplines-- including space science, medicine, public health, biological diversity, and radioactivity.

The director of CAGE is Professor Jurgen Mienert, the head of the Department of Geology at the University of Tromsø.

Dr. Mienert says: "Our aim is to be an important contributor to arctic gas hydrate and climate research internationally. Our research group is Norway's leading in its field, and, as the world's northernmost university, we are in an excellent location for arctic research. We also have a strong commitment to collaborating with relevant research entities in Europe, Russia, and the United States."

Professor Jurgen Mienert (photo credit Halfdan Carstens/geoforskning.no)

Announcements

In support of its research goals, CAGE will be recruiting PhD students and scientists for the following research positions:

Geophysicist, Modeller
Methane hydrate and free gas reservoirs
Uncertainty exists concerning the quantity of methane that is stored in arctic marine hydrates. CAGE seeks scientists with expertise in geophysics and modeling to develop new geophysical technologies for high resolution imaging of methane hydrate reservoirs in arctic marine sediments. Expertise in acquisition, processing, inverse modeling, and interpretation of acoustic and electromagnetic data is sought.

Geologists, Modeller
The role of ice ages for fluid flow and methane hydrate
One of the greatest uncertainties in reconstructing fluid reservoir response in ice ages relates to the chronology of ice sheet advances and retreats. CAGE seeks research scientists with expertise in geology and modeling to perform research aimed at reconstructing this chronology for the Barents Sea and Svalbard margins for the last 9 million years. Today methane hydrate is in many areas just outside of the methane hydrate equilibrium field, but methane would have been stable as hydrate during the ice ages, when more than 1000 m of ice loaded the area.

Biologists, Modeller
Methane release and benthic community faunal response
Sediment-ocean CH_4 flux creates reservoirs in which micro- and macrofaunal responses occur at varying times and magnitudes. CAGE seeks scientists with expertise and biology and modeling to lead research efforts to observe seafloor methane release sites and associated benthic communities. Observations may be achieved with high-resolution, multibeam, ship-mounted instruments as well as automated underwater vehicle (AUV) techniques. Analyses of faunal structure and function in response to methane fluxes may be achieved through a variety of standard and innovative approaches.

Oceanographer, Hydro-acoustic Specialist, Modeller
Methane release and gas quantification
Understanding the temporal variability of methane release and its dependence on oceanographic changes will aid in the quantification of local and regional methane fluxes. CAGE seeks scientists with hydro-acoustic, oceanographic, and modeling expertise to lead research efforts to detect gas bubbles in the water column. Bubble sizes and fluxes may be derived from sophisticated analyses of echo-sounder data and new processing code developments in cooperation with Kongsberg Simrad (Norway).

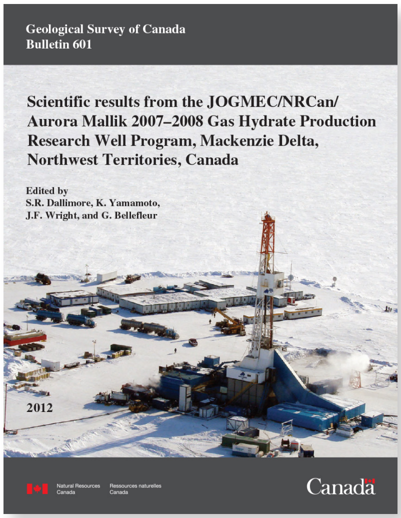
Announcements

Geochemist, Modeller
Paleo-methane history through the Neogene-Pleistocene
There is a need to combine the results of 1) field studies of active hydrate release sites and 2) laboratory results pertaining to methane paleohistory. CAGE seeks scientists with geochemistry and modeling expertise to develop realistic modeling approaches for integrating methane paleohistory with recent methane observations.

Microbiologist, Biogeochemist, Modeller
Pleistocene to present methane, ocean temperature, and CO_2
Benthic communities are sensitive to methane emissions and methane hydrate dissociation. CAGE seeks scientists with expertise in microbiology, biogeochemistry, and modeling to develop multiple proxy approaches focusing on changes in methane release, ocean acidification, and related benthic responses.

Interested applicants, including PhD candidates, postdoctoral researchers, and tenure track professors, may send an application (CV, three letters of references, and proposed research outline) to Dr. Jurgen Mienert (jurgen.mienert@uit.no), University of Tromsø, N-9037 Tromsø, Norway.

Announcements



Release of Mallik 2007-2008 Results

The Geological Survey of Canada has released Bulletin 601, "Scientific Results from the JOGMEC/NRCAN/Aurora Mallik 2007-2008 Gas Hydrate Production Research Well Program." This publication contains results of a collaborative, scientific research effort led by Natural Resources Canada (NRCAN) and Japan Oil, Gas and Metals National Corporation (JOGMEC), and supported by the Aurora Research Institute. The goal of the two-year program was to establish proof-of-concept for a simple and effective gas hydrate production technique based on depressurization, through production experiments at the Mallik site in Canada's Mackenzie Delta, Northwest Territories. Successful production testing carried out during the winters of 2007 and 2008 culminated in 6 days of continuous gas production from the Mallik gas hydrate reservoir during March, 2008.

A digital copy of Bulletin 601, containing scientific papers and accompanying databases from the Mallik 2007-2008 program, can be downloaded from:

http://geoscan.ess.nrcan.gc.ca/cgi-bin/starfinder/0?path=geoscan.fl&id=fastlink&pass=&format=FLSHORTORG&search=R=291751

For information on obtaining hard copies of the bulletin, please contact Scott Dallimore, at: scott.dallimore@NRCAN-RNCAN.gc.ca

Goldschmidt Conference

A session on the geochemistry of gas hydrates will be convened by Missy Feeley (ExxonMobil) and Ray Boswell (DOE/NETL) as part of the Goldschmidt 2013 Conference, to be held in Florence, Italy, August 25-30, 2013. A complete listing of the thematic sessions to be included in the conference is available at: http://goldschmidt.info/2013/program/programViewThemes. The hydrate session is listed under "Theme 12: Earth Resources: Energy" and is entitled "Geochemistry of Gas Hydrate Systems: From the Laboratory to Natural Deposits."

According to the conveners: "Gas hydrates are the ultimate source of fossil energy, but our understanding of the geochemistry of hydrate systems is still limited. This session attempts to show advances in stable isotope geochemistry, organic geochemistry, and general geochemistry of gas hydrate systems form natural and laboratory studies." The conveners encourage submission of abstracts that capture the latest findings of studies performed in the field, in the laboratory, or through numerical simulation. Studies of gas hydrate as a resource and as a potential environmental stressor are both welcome. Abstract submissions will begin soon and will close on April 12th. For more information, please contact Ray Boswell at: ray.boswell@netl.doe.gov.

2012 Methane Hydrate Research Fellowship Awarded to Jeffrey James Marlow

Jeffrey James Marlow, a graduate student in Geobiology at the California Institute of Technology, was recently selected as the 2012 recipient of the NETL-National Academy of Sciences (NAS) Methane Hydrate Research Fellowship. The fellowship program provides two years of funding to promising student researchers pursuing advanced degrees related to methane hydrate science. Past recipients include Evan Solomon (now an assistant professor at the University of Washington School of Oceanography), Laura Brothers (now a research geologist with the U.S. Geological Survey at Woods Hole, MA), and Rachel Wilson (currently a post-doctoral researcher at Florida State University).

Jeffrey's research will focus on the effects of microbial processes on the growth and stability of methane hydrate deposits. Methane hydrate deposits are dynamic systems that are directly influenced by methanogenic organisms, which release methane as a metabolic by-product, and methanotrophic organisms, which consume methane for energy. Jeffrey will undertake a three-part investigation of how microorganisms affect methane hydrate accumulations, by (1) measuring growth rates of methanogens and methanotrophs, (2) examining relevant species and environmental microcosms to learn how metabolism influences the physical stability of methane hydrates, and (3) studying the proteins involved in methane-processing metabolic pathways.

The fellowship provides two years of research funding. For more information on the NETL-NAS Methane Hydrate Research Fellowship Program, please visit:

http://www.netl.doe.gov/technologies/oil-gas/futuresupply/methanehydrates/GradFellowship.html

Jeffrey James Marlow, recipient of 2012 Methane Hydrate Research Fellowship

Spotlight on Research

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Dr. Bjørn Kvamme was raised in Bergen, Norway, a picturesque harbor city on the west coast of Norway. Situated against a backdrop of spectacular mountains, Bergen is a popular tourist destination and an international center for North Sea petroleum research and development.

Kvamme studied in Bergen as an undergraduate, pursuing a degree in chemical engineering at Bergen University College. He later pursued a Master of Science in chemical engineering and a PhD in molecular physics at the Norwegian University of Science and Technology, in Trondheim, 700 km to the north.

Kvamme says that during his graduate studies, he grew increasingly independent, because there were not many experts available in the highly specialized subjects that he chose to study. He became fascinated by molecular physics and focused his graduate research on statistical mechanics and molecular modeling.

While he was completing his PhD, Kvamme was asked by a new student to supervise him in a methane hydrate study sponsored by STATOIL. This student was Are Lund, who became Kvamme's first PhD student and his first methane hydrate research collaborator. After a few years at Bergen University College, Kvamme spent 11 years at Telemark University College, and then joined the faculty at the University of Bergen.

Kvamme says that his natural curiosity played a big role in fueling his interest in methane hydrate research. He says "Many groups were doing hydrate experiments, and many of the results seemed confusing. I wanted to know why things happened the way they did. Molecular modeling gave me a completely different perspective on methane hydrate dissociation processes, and hydrate phase transitions in general."

Dr. Kvamme worked with scientists at University of Bergen and ConocoPhillips to prove and further develop a process for producing methane from natural hydrate deposits by exchanging CO_2 for CH_4 in the hydrate structure. The simplicity of CO_2 and CH_4 exchange as a production strategy was met with optimism by the scientific community and was recently tested at a methane hydrate production test on the North Slope of Alaska.

Dr. Kvamme reflects, "Regarding the exchange between CH_4 and CO_2, my background in molecular modeling gave me very detailed insight into the role of entropy – and then, also, how methane hydrate dissociation processes can be optimized."

Today, Dr. Kvamme has 12 PhD students and 1 postdoc, whom he supervises, together with Dr. Tatiana Kuznetsova in the Group for Thermodynamic Modeling at University of Bergen. He says the most fulfilling part of his job is interacting with his students. He is dedicated to helping them progress in their research, and he admits that he also serves as a substitute parent, at times, because their real parents are so often on the other side of the globe!

When he is not working, Dr. Kvamme enjoys music, film, theater, and long dinners that involve "small amounts of quality wine, plenty of good food, and interesting conversations with people of different backgrounds and education."