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Fire in the Ice

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U.S. DEPARTMENT OF ENERGY

Joint Industry Project Leg II Discovers Rich Gas Hydrate Accumulations in Sand Reservoirs in the Gulf of Mexico

Ray Boswell, Tim Collett, Dan McConnell, Matt Frye, Bill Shedd, Stefan Mrozewski, Gilles Guerin, Ann Cook, Paul Godfriaux, Rebecca Dufrene, Rana Roy, and Emrys Jones

The Gulf of Mexico Gas Hydrate Joint Industry Project ("the JIP") is a cooperative research program between the US DOE and an international industry consortium led by Chevron. In April and May of 2009, the JIP conducted a logging-while-drilling program (Figure 1) designed to test geological and geophysical models for the occurrence of gas hydrate in sand reservoirs in the Gulf of Mexico and to delineate sites for future JIP logging and coring programs (for more information on expedition planning and objectives—see Spring 2009 issue of *Fire in the Ice*). Seven holes representing 15,380 feet of sedimentary section were drilled at three sites (Figure 2).

Despite drilling by far the deepest and most challenging holes yet attempted in a gas hydrates marine expedition, the program was completed safely and under budget, and met or exceeded all its scientific objectives. Furthermore, by specifically targeting gas hydrates in sand reservoirs, the expedition accepted significant geologic risk. However, the careful work of the JIP contributors (see sidebars), including those

Figure 1: Schlumberger and Chevron personnel inspect drillstring onboard the Q4000, the floating drilling unit used on Leg II.

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This newsletter now reaches more than 1000 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 Jennifer Presley at 281-494-2560.

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involved in the site selection and the operational planning, was rewarded with the discovery of gas hydrate at high saturations (50% or more) in sand reservoirs in at least four of the seven wells drilled.

Operations

JIP Leg II was conducted from April 16 to May 6, 2009 aboard the Dynamically-Positioned (DP) Modular Drilling Unit (MODU) *Q4000* owned and operated by Helix, Inc. The program mobilized (and later demobilized) at sea, aided by the *MV Mia*. The performance of the Q4000 crew in safely and efficiently drilling the wells was outstanding. Similarly, the complex, state-of-the-art Schlumberger LWD tool string functioned extremely well, with only minimal operational issues.

Drilling parameters within JIP Leg II were carefully managed in an attempt to optimize data quality while maintaining borehole stability. Despite the large volumes of gas hydrate that the expedition encountered, the primary drilling hazards that needed to be managed during the drilling program were not specific to gas hydrate, but were instead the common problems that face any drilling program: borehole stability, drill cutting removal, gas releases into the borehole, and water flows. Throughout the expedition, critical experience was gained with respect to drilling parameters, use of weighted drill fluids, and the nature of gas hydrate reservoir response to drilling.

Drilling Results

JIP Leg II drilled seven wells as shown in Table 1: two wells at the site in Walker Ridge block 313 (WR313), three wells in Green Canyon block 955 (GC955) and two wells in Alaminos Canyon block 21. The results are summarized below.

WR 313 Site: Two wells were drilled in WR313 to test anomalous seismic amplitudes associated with phase reversals along horizons that were interpreted to be related to the updip transition from gas to gas hydrate within sand layers (Figure 3a & 3b). While drilling the primarily muddy sediments at a depth of 800 to 1,300 feet below the sea floor (fbsf) in the

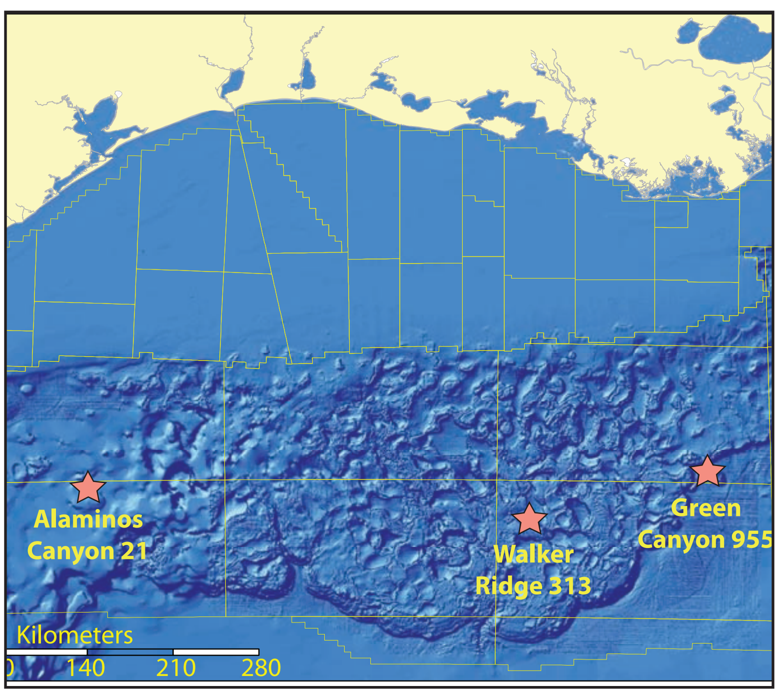

Figure 2: Locations of sites drilled in JIP Leg II.

JIP LEG II CONTRIBUTORS

JIP Executive Board

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Dave Goldberg, Stefan Mrozewski – Lamont Doherty Earth Observatory

Tim Collett – USGS

initial WR313-G well, an unexpected, 500'-thick interval of stratal-bound fracture-filling gas hydrate was encountered. Below this section, the well included numerous thin gas hydrate-saturated sands and silts (up to 10 ft-thick) within a predominantly fine-grained section. The primary target ("blue" horizon) of the G well was encountered as expected at 2,850 fbsf with a net of ~30 ft of sand containing gas hydrate at apparent high saturations within a 70 ft gross interval. Later in the expedition, the WR313-H well was drilled in an up-dip location ~1 nm to the east of the G well. The shallow, fracture-filling gas hydrate occurrence was again observed, and in accordance with predictions, the ("blue") horizon from the "G" well was found to have graded into a more mud-rich interval with reduced porosity and limited occurrence of gas hydrate. The main ("orange") target, drilled at 2,646 fbsf, consisted of 36 ft of sand in two lobes with resistivity as high as 300 ohm-m (Figure 4) . Additional reservoir-quality sands ("green" horizon) were penetrated below the inferred base of gas hydrate stability. These sands ascend into the stability zone to the east of the WR313-H well, where they display seismic responses indicative of gas hydrate occurrence.

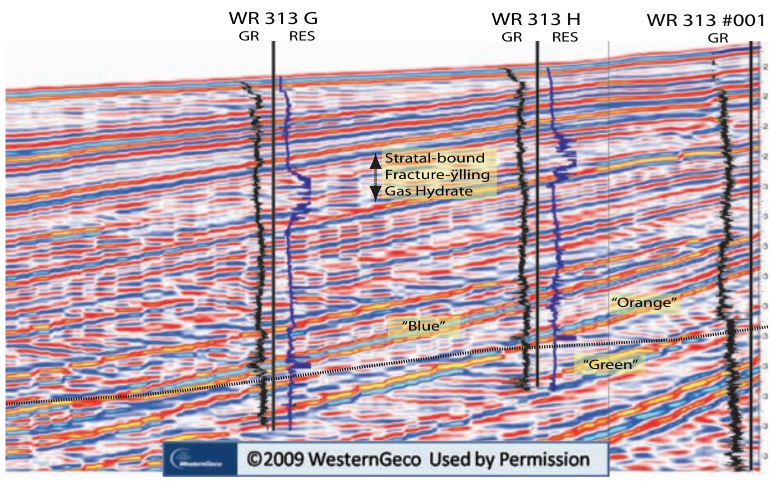

Figure 3a: West to East seismic section across the WR 313 Site, showing the JIP drilling results and target horizons. Dashed line is inferred base of gas hydrate stability. Image Courtesy WesternGeco.

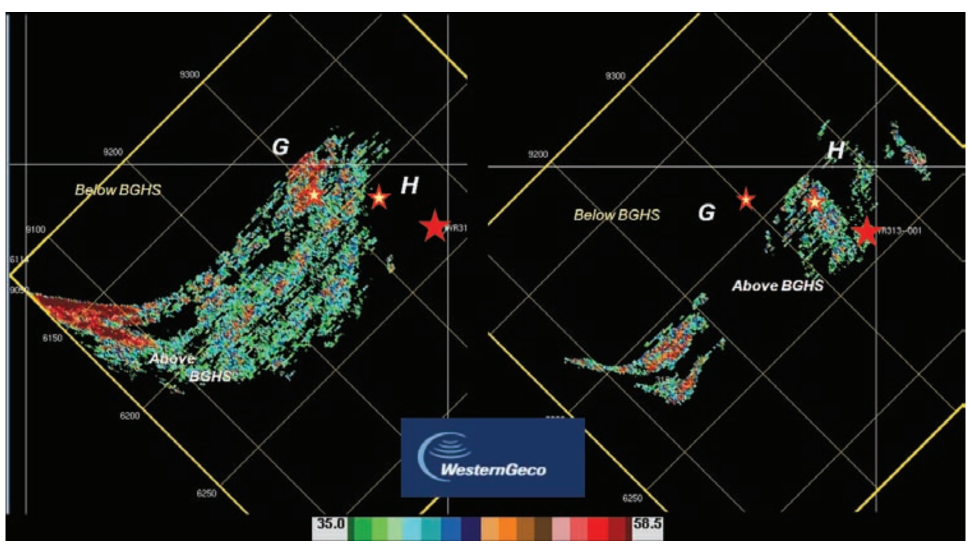

Figure 3b: Location of drilled wells WR313-G and H, and pre-existing industry well (solid red star) in relation to pre-drill predictions of gas hydrate occurrence in the "blue" horizon (Left) and the "orange" horizon (Right).

- ***GC 955 Site:*** Three wells were drilled in Green Canyon 955 to test anomalous seismic events that occur where an inferred sand prone facies has been uplifted in the gas hydrate stability zone by a shallow, faulted, four-way structural closure. The first well (GC955-I) was drilled very close to a prominent, late-stage channel axis (to maximize the occurrence of sand reservoirs) in a location off the structure with relatively muted geophysical indications of gas hydrate. The well encountered more than 300 ft of porous sands as predicted; however the sands contained less than 5 ft of potential gas hydrate fill. The well also flowed water, requiring roughly a day of effort to control. The second well, GC955-H, targeted strong geophysical anomalies suggestive of gas hydrate in a structurally higher position on the structure. While drilling the shallow section, a thick zone of gas hydrate-filled fractures in mud-rich sediments was observed from ~600 to ~1,000 fbsf. At 1,305 fbsf, the well encountered the top of a thick gas-hydrate-bearing sand interval. Three gas-hydrate-bearing zones of 88 ft, 13 ft, and 3 ft thick were logged, separated by thin zones of apparently water-bearing sands within a single, apparently contiguous sand body (Figure 5). The third GC955 well ("Q") was drilled into a separate, structurally-higher, fault block. At a depth of 1,405 fbsf, the well encountered gas hydrate-bearing sand, which continued to a depth of at least 1,458 fbsf. At that depth, drilling was halted when a short-duration gas release from the well was observed by the Q4000's remotely operated vehicle (ROV).

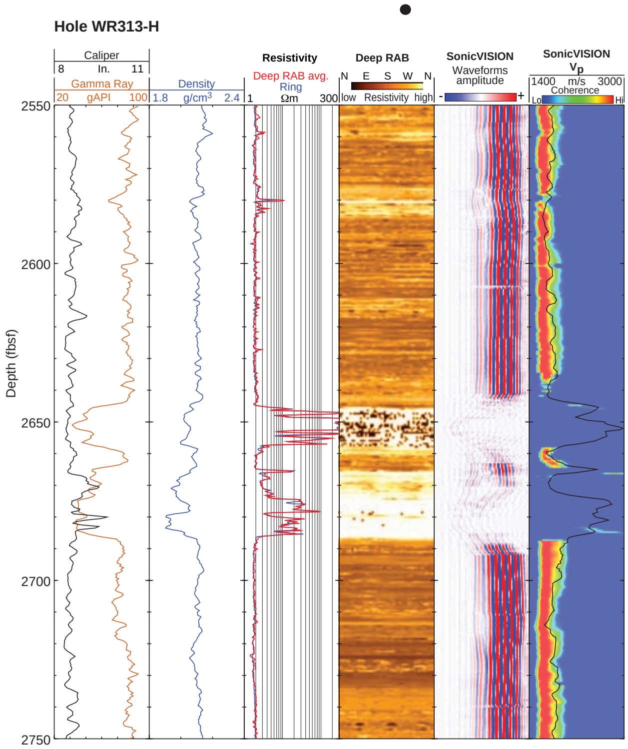

Figure 4: Log summary display of well WR 313-H at the "orange" horizon. Leftmost track shows low natural radioactivity indicative of a sand reservoir. Blue track shows reduced density indicating that the reservoir has significant porosity. Red track shows the unit to be resistive, indicating that the porosity is most likely not filled with formation water (brine). Right-most track shows the unit to have high acoustic velocities, indicating that the porosity is filled with gas hydrate.

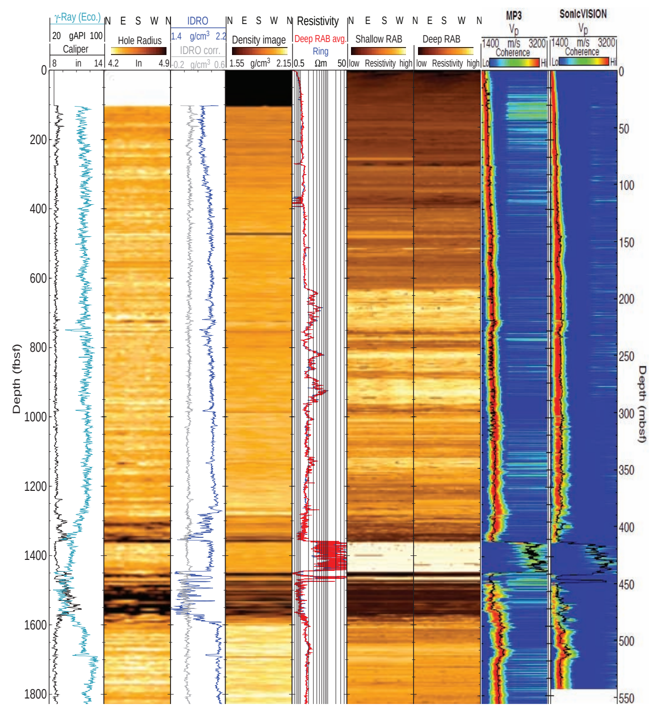

Figure 5: Summary log display from Well GC955-H. The data show the gamma-ray (green); density (blue) and resistivity curves (red) as well as 360 degree displays of each parameter as measured around the borehole. The far right columns show velocity data as recorded by the expedition's two acoustic LWD tools.

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Site Selection Team

Debbie Hutchinson, Carolyn Ruppel, Tim Collett, Myung Lee – US Geological Survey

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Gilles Guerin, Stefan Mrozewski, Ann Cook – Lamont Doherty Earth Observatory

Matt Frye, Bill Shedd, Rebecca Dufrene, Paul Godfriaux – MMS

Dan McConnell - AOA Geophysics

AC21 Site: Two wells were drilled at the AC21 site to test an extensive complex of very shallow sands with likely low to moderate gas hydrate saturation. The AC21-B well logged a single sand body 125 ft thick at 520 fbsf. The resistivity of the sand was remarkably consistent at 1.8 to 2.5 ohm-m, only slightly more resistive than the bounding shales (1.5 ohm-m). The AC21-A location, approximately 1.2 nm to the south of the B well, encountered two clean sands (at 540 and 570 fbsf) separated by a 15 foot thick shale. As in the AC21-B well, resistivity in these sands was consistently ~2 ohm-m. The elevated resistivities are suggestive of gas hydrate at low to moderate concentrations since nearby wells show resistivities of 0.2 to 0.4 ohm-m in stratigraphically-equivalent water-saturated sands.

Planned operations in the East Breaks 992 (EB992) site, were complicated by the arrival of the rig *Ocean Valiant* in AC24 to conduct development operations on behalf of ExxonMobil. ExxonMobil representatives were extremely supportive of the JIP project, and gave permission for two EB992 locations to be drilled. However, based on the consistency of drilling results from the AC21 sites with the pre-existing well data in EB992, the science team determined that further drilling was not cost-effective.

Summary

JIP Leg II set out to conduct LWD operations to confirm the existence of gas hydrate in sand reservoirs in the Gulf of Mexico and to test existing approaches and technologies for pre-drill appraisal of gas hydrate concentration. Both of these objectives were fully achieved.

Going forward, the JIP will use the drilling results to ground truth and further calibrate the seismic techniques used to produce pre-drill estimates of gas hydrate occurrence and saturation and to select locations for future drilling, logging, and coring programs. It is the intent of the JIP and the DOE to conduct JIP Leg III, to potentially include logging, conventional coring, and pressure coring, in the spring of 2010. Please check the NETL gas hydrates program website for posting of the initial scientific report related to JIP Leg II.

Hole	API Number	Latitude (N) deg/min/sec	Longitude (W)	Water Depth (ft)	Hole Depth (fbrf)	Hole Depth (fbsf)
AC21A	608054007000	26 55 23.8503	94 54 00.0702	4889	6700	1760
AC21B	608054007100	26 56 39.1900	94 53 35.6216	4883	6050	1116
GC955H	608114053700	27 00 02.0707	90 25 35.1142	6670	8654	1933
GC955 I	608114054400	27 00 59.5305	90 25 16.8928	6770	9027	2205
GC955Q	608114054300	27 00 07.3484	90 26 11.7156	6516	8078	1511
WR313G	608124003900	26 39 47.4841	91 41 01.9404	6562	10200	3586
WR313H	608124004000	26 39 44.8482	91 40 33.7467	6450	9770	3269

Table 1: Final Surveyed Locations with Water Depth and Measured Depth in feet below rig floor (fbrf) and feet below sea floor (fbsf).

Permafrost Gas Hydrates and Climate Change: Lake-Based Seep Studies on the Alaskan North Slope

M. J. Wooller (UAF), C. Ruppel (USGS), J.W. Pohlman (USGS), M.B. Leigh (UAF), M. Heintz (UCSB) and K. Walter Anthony (UAF)

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The potential interactions between climate change and methane hydrate destabilization are among the most societally-relevant aspects of gas hydrates research. Massive dissociation of deep marine methane hydrates following rapid Earth warming is the most plausible explanation for carbon isotopic data that imply widespread release of microbial methane during the Late Paleocene Thermal Maximum (~55 million years ago), and massive methane hydrate degradation may have been associated with a major warming event in the Late Neoproterozoic as well. On contemporary Earth, circumstantial evidence implies that permafrost-associated methane hydrate dissociation, possibly related to climate change, may be contributing to gas seeps in the MacKenzie Delta (Dallimore et al., 2008). Gas is also currently being released from shallow subseafloor hydrates in some areas, and transient bottom water temperature increases are sometimes known to be the destabilizing influence for these gas hydrates. Still, there is no direct evidence that gas hydrates are currently undergoing significant and systematic destabilization on contemporary Earth, that climate processes are responsible for driving any destabilization that may be occurring, or that methane released from dissociating hydrate is a substantial contributor to atmospheric methane concentrations.

The best place to study the impact of global climate change on gas hydrates is the circum-Arctic, where gas hydrates in and beneath continuous permafrost onshore and relict permafrost in the shallow offshore are particularly vulnerable to climate change (e.g., Ruppel, 2009). This region has been experiencing rapid climate change—rising temperatures and sea level rise—since the end of the Last Glacial Maximum. Reports also document widespread permafrost degradation, changes in ecological zonation, and perturbations to the hydrologic cycle and climate patterns in the Arctic over the past few decades.

The 2000 Methane Hydrate Research and Development Act and its 2005 reauthorization highlight connections between gas hydrates and environmental change as a critical research area. Starting in late 2008, the University of Alaska-Fairbanks (UAF) and the U.S. Geological Survey (USGS) in Woods Hole commenced a NETL-sponsored study to determine the source and rate of methane ebullition from lakes on the Alaskan North Slope (ANS), where previous research has indicated the potential for substantial amounts of gas hydrate to occur in and beneath the permafrost. Lake-based ebullition north of 45°N injects an estimated 24.2±10.5 Tg methane into the atmosphere (Walter et al., 2007), and this figure could rise higher with increasing degradation of permafrost and production of methane in thawing soils at high latitudes. There are several potential sources of methane that could feed lake-based ebullition in many areas of the ANS. Lakes in the western and central portion of the ANS are often underlain by thaw bulbs where microbial methane is generated from organic-rich soils. Other sources of methane—dissociating gas hydrates, deep-seated thermogenic gas, and coalbeds—could also be feeding the ebullition sites.

In 2009, field research for the joint UAF-USGS project focused on an ebullition site in shallow (~1 m deep) Lake Qalluuraq, which is located in continuous permafrost ~90 km south of Barrow. The dominant ebullition site at Lake Qalluuraq is estimated to emit ~100 kg of methane per day based on measurements carried about by Katey Walter Anthony (UAF). The lake lies near a small area of the ANS having a locally elevated thermal gradient and a very thin or completely absent gas hydrate stability zone on maps produced by the USGS in the 1990s (Figure 1). Thus, any gas hydrate at depth in this vicinity might be poised to destabilize in response to downward propagation of even relatively small perturbations in climate conditions since ~10,000 years ago.

Sample and data acquisition for the 2009 fieldwork was staged from the Inupiat village of Atqasuk in two phases. Snowmobiles were used to transport the field party and all instrumentation in Phase I (May), when operations were conducted from the lake's ice cover. During open-water conditions in Phase II (July), transport of people and equipment relied mostly on all-terrain vehicles, with additional heavy lift support from a USGS-contracted floatplane. The Barrow Arctic Science Center provided access to the Atqasuk field station for the May research, while the South Meade K-12 school, part of the North Slope Borough School District, hosted the field party and provided laboratory space and living quarters in July. Local and Inupiat guides accompanied the field parties at all times, serving as logistics coordinators, bear guides, and overland escorts between Atqasuk and the field site along paths through traditional Inupiat hunting areas. During both expeditions, NETL-funded researchers participated in formal and informal outreach activities with local residents, teachers, and schoolchildren.

During both phases of research, UAF researchers Matthew Wooller, Mary Beth Leigh, Ruo He, and Benjamin Gaglioti and USGS scientist John Pohlman retrieved cores (Figure 2) up to 2.5 m long from lake bottom sediments along a transect from the seep to a background reference location. The field party was joined by Robert Vagnetti of DOE-NETL for the

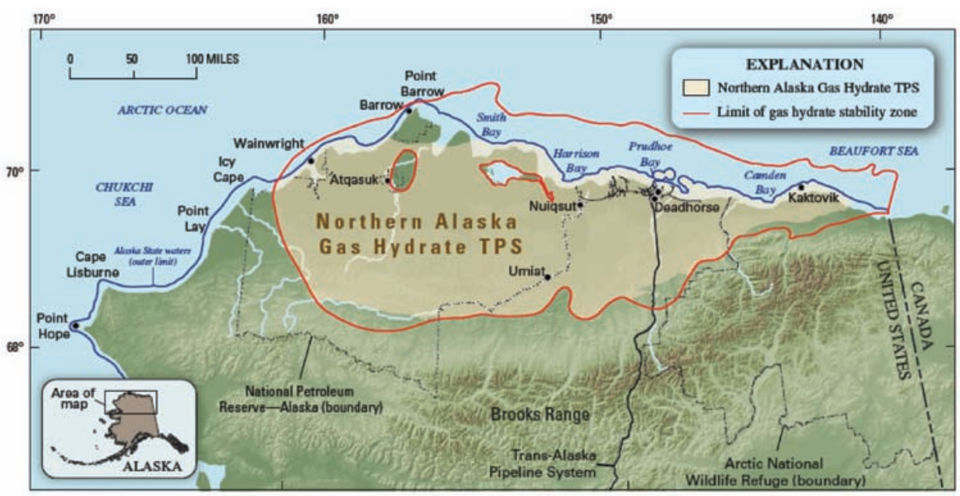


Figure 1: Map of Alaska North Slope from Collett et al. (2008), showing the location of Atqasuk, the limit of gas hydrate stability (red), and the ANS gas hydrate total petroleum system (TPS) in tan.

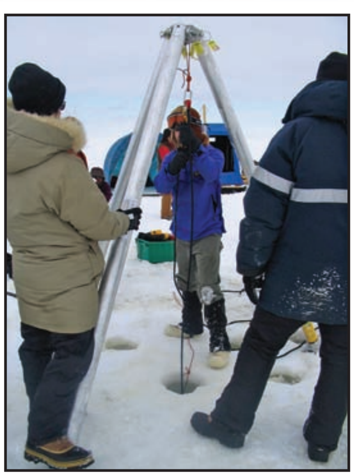


Figure 2: (Left) Mary Beth Leigh, Ben Gaglioti, and Rob Vagnetti coring from the ice in May 2009; (Right) Ben Gaglioti (UAF) and John Pohlman (USGS) using rhizons to extract pore waters from lake-bottom push cores aboard the coring platform on Lake Qalluuraq in July 2009.

May expedition, and Katey Walter Anthony (UAF) conducted limnological measurements and collected gas geochemistry samples in May as well. The cores are being used for microbial, geochemical, sedimentological, and geochronologic studies that will (1) document the Holocene record of methane emissions in the lake (Figure 3); 2) unravel active biogeochemical pathways regulating methane production and oxidation during ice-covered and ice-free conditions; and 3) characterize the taxonomy and functional role of microbes that cycle sedimentary carbon and methane. Specific core-based studies include 14C-geochronologically referenced lipid biomarker and chironomid head-capsule analyses to infer the millennial scale record of lake methane emissions, concentration and isotope ratio measurements of pore-fluid dissolved gases, inorganic species and organic compound determinations to delineate biogeochemical pathways, and stable isotope probing and intact polar lipid analysis to characterize the active microbial consortium.

Preliminary data indicate a very high concentration of methane in the seepage gas. Although compositional and isotopic analyses of seep gas samples are underway, we lack a direct sample of gas hydrate from this area. Thus, it will not be possible to link the seep gas to dissociated methane hydrate through circumstantial similarities in composition and isotopic signatures. As part of this project and related NETL-funded research, the USGS is developing fingerprinting techniques using trace gas constituents that could reliably diagnose the presence of seep gas formerly contained within gas hydrates. This technique will be applicable to seep gases from both marine and lacustrine settings.

Water column methane oxidation is a critical sink for methane in some settings. During both phases of field research, NETL-NAS graduate fellow Monica Heintz (UCSB) acquired lake water samples for determination of methane concentrations, oxidation rates, and stable isotope signatures and also collected and filtered water samples for DNA extraction. The DNA analyses are part of a larger effort within the UAF-USGS project to identify and enumerate methane oxidizers in both the sediments and water column.

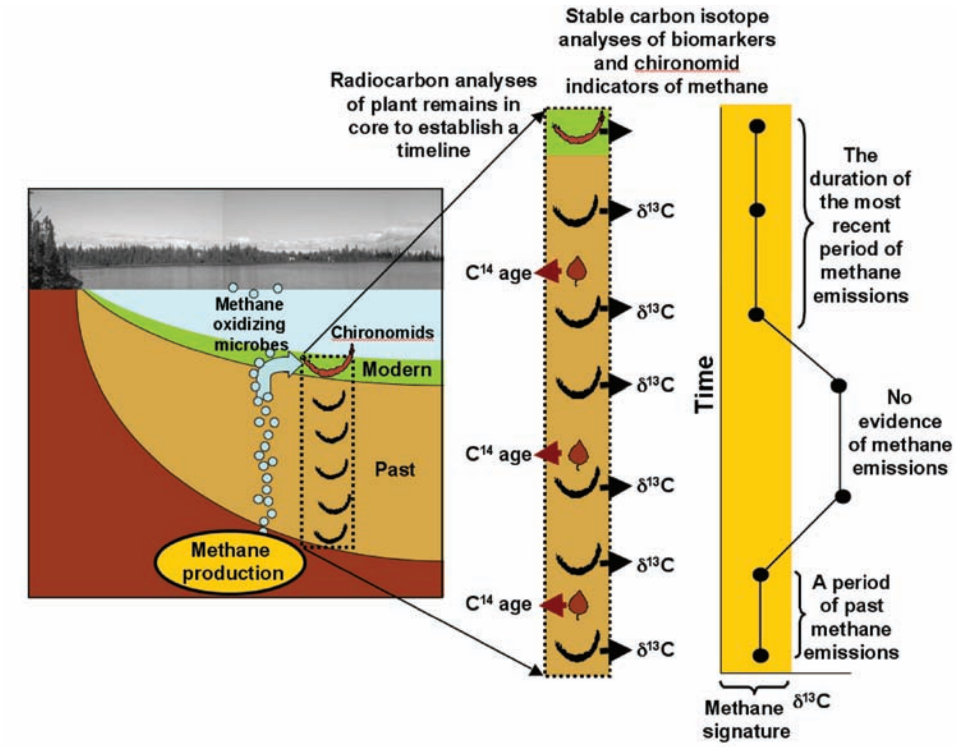


Figure 3: Integration of different types of data will be required to constrain paleoclimate and paleomethane conditions in lakes. Headcapsules of chironomids, which are larval stages of flies, are preserved in lake-bottom cores. The chironomid fossils retain isotopic signatures ($\delta^{13}C$) that can be used to reconstruct past climate and determine whether methane was present. Chironomid data therefore record some of the same information that can be inferred from foraminifera analyses in marine settings.

To provide contextual information for the geochemical, microbiological, and paleoclimatic analyses, USGS geophysicist Carolyn Ruppel and technician Charles Worley collected Chirp seismic data (4-24 kHz frequency), 50 MHz ground penetrating radar data, continuous resistivity profiles, lake-bottom sonar images, and images of methane plumes in the water column during the July field expedition (Figure 4). The data reveal a well-developed pockmark at the ebullition site and additional leakage of methane to the water column even outside the area directly below the lake's surface bubbling.

In Year 2 of the project, researchers plan to add additional sites in the Prudhoe Bay area, where both the permafrost and hydrate stability zone thicknesses are appreciably greater than near Lake Qalluuraq and where compositional and isotopic information about recovered gas hydrates is available from the 2007 BP/DOE Mt. Elbert drilling project conducted at Milne Point. To identify potential lake-based gas seeps, the USGS will conduct aerial photographic surveys in October 2009, just after the lake surfaces freeze. UAF researchers will attempt to groundtruth the existence of these seeps to lay the groundwork for coring and other activities in spring/summer 2010. In related research that is outside the purview of the joint UAF-USGS project, the USGS Gas Hydrates Project is planning summer 2010 data acquisition onshore ANS and in the shallow offshore Beaufort Sea in areas where existing information suggests the possibility of gas seepage coupled with permafrost degradation.

Project support is from DE-NT0005665 to UAF and DE-NT0006147 and DE-AI26-05NT42496 to the USGS, with additional support from a NETL-NAS fellowship to M. Heintz and DE-NT0005667 to D. Valentine at UCSB. This research would not have been possible without technical support from C. Worley, B. Jones, and P. Bernard (USGS) and from N. Stewart (UAF); assistance from the village of Atqasuk, the North Slope Borough, and employees of the Meade River School; and especially the field guiding services of W. Kippi, D. Whiteman, and T.O. Itta.

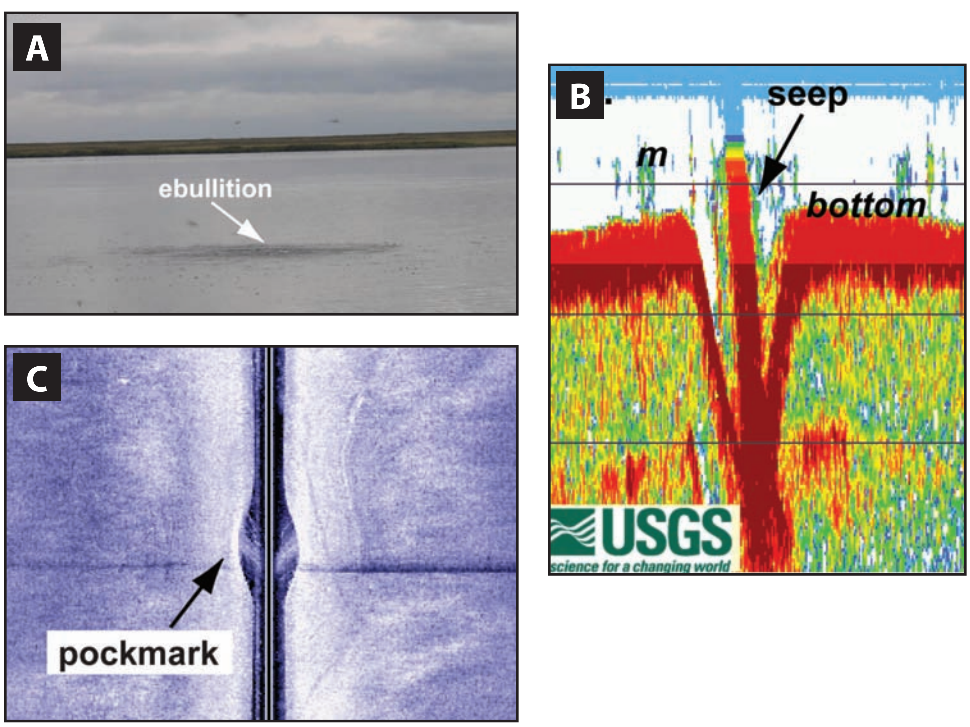


Figure 4: (A) Ebullition on the surface of Lake Qalluuraq; (B) 83 kHz image of seep, pockmark, and methane in the water column; (C) Sonar image of the pockmark associated with the ebullition site. The pockmark is ~3 m across and 2.25 m deep based on independent observations by K. Walter Anthony.

REFERENCES

Collett, T.S., Agena, W.F., Lee, M.W., Zyrianova, M.V., Bird, K.J., Charpentier, T.C., Houseknecht, D.W., Klett, T.R., Pollastro, R.M., and Schenk, C.J., 2008, Assessment of gas hydrate resources on the North Slope, Alaska, 2008: U.S. Geological Survey Fact Sheet 2008-3073.

Dallimore, S.R., Bowen, R.G., Cote, M.M., Wright, F.J., and Lorenson, T.D., 2008, Degrading gas hydrates as a possible source for gas release and the formation of pockmark features, Mackenzie Delta, N.W.T., Canada, EOS, Trans. American Geophysical Union, 89(52), Abstract U23D-0083.

Ruppel, C., 2009, Methane hydrates and global climate change; a status report [abs.]: American Chemical Society National Meeting, 237th, Division of Fuel Chemistry, Salt Lake City, Utah.

Walter, K.M., Smith, L.C., and Chapin, F.S., 2007, Methane bubbling from northern lakes: present and future contributions to the global methane budget. Philosophical Transactions of the Royal Society of London A, 1657-1676.

Potential Occurrence of Gas Hydrates Offshore Mexico

By Francisco J. Rocha-Legorreta, Instituto Mexicano del Petroleo

The Instituto Mexicano del Petroleo (IMP) has conducted evaluations of geological and geophysical data in the evaluation of gas hydrate occurrence offshore Mexico. The first phase of this effort has focused on the identification of features that suggest the potential occurrence of major gas hydrate occurrences within the southwestern Gulf of Mexico, including extensive bottom-simulating reflectors, evidence for gas flux, and the existence of favorable reservoir facies. Going forward, IMP will work to further characterize the most promising locations, including assessment of potential energy resources.

This report describes one particularly interesting region in which Upper Pleistocene and Pliocene sediments are deformed into elongate folded structures that have clear expression in seafloor topography (Fig 1). IMP's evaluation of this region has ulitized high-quality 3-D poststack seismic data without post-processing or any method that could modify the stacked amplitudes. The seismic data cover over 4,000 km^2 in water depths ranging from 800 to 2000 meters. No wells have yet been drilled in this area. The overall geology of this area appears analogous to that of the reported Alaminos Canyon Block 818 gas hydrate occurrence (see suggested reading), however with much more areally and vertically extensive gas hydrate potential.

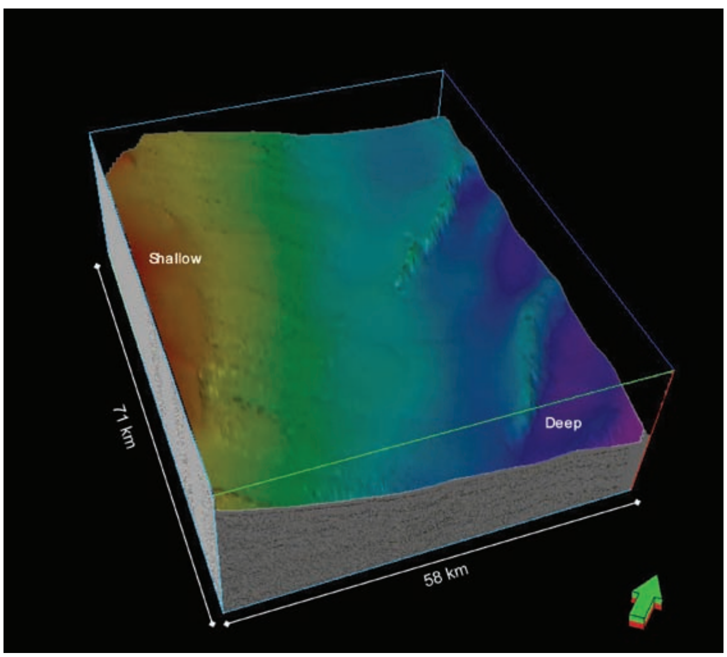


Figure 1: Topography of sea-floor in the study area in the southwestern Gulf of Mexico. Gas hydrate indicators are observed within folded structures associated with the linear structures on the left of the figure. (courtesy IMP and Pemex).

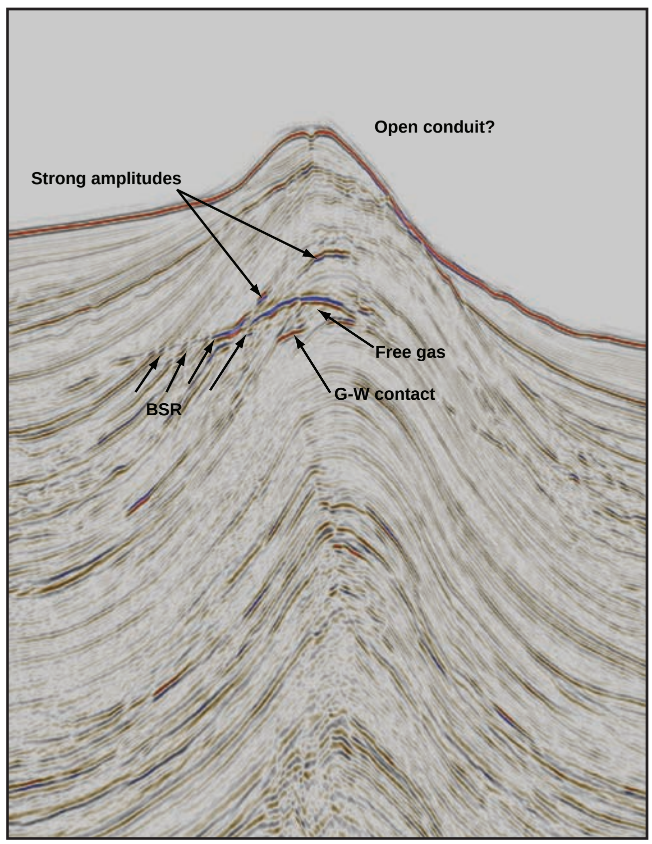


Figure 2: Seismic data showing the occurrence of a BSR in association with the fold structure, as well as potential gas-water contacts below the BSR, strong amplitudes above the BSR, and evidence of gas venting on fold crest (courtesy IMP, Pemex, and SEG).

The existence of gas hydrates along the crest of these structures is indicated by numerous features that can be seen in the seismic data (Fig. 2). Most notable in the seismic data are indications of seismic blanking and strong bottom-simulating reflectors that are both of the continuous and segmented type (see Shedd et al, FITI Spring 2009). The BSRs are seen to extend for tens of kilometers along the strike of these structures. Numerous topographic features on the seafloor suggestive of high gas flux, such as vents and mounds, are also present. One notable crater 2 km in diameter and 250 meters deep (Fig. 3) is thought to represent a relatively large gas release event most likely associated with tectonic activity and reactivation of the faults that bound the fold structure.

Particularly favorable for the existence of highly-concentrated gas hydrates within porous and permeable sand sediments are the existence of seismic "flat-spots" below the BSR (see Fig. 2). These features have polarity opposite that of the BSR (and the seafloor) and suggest possible gas-water contacts, indicating the existing of thick sand reservoirs that cross through the base of gas hydrate stability. Strong amplitude reflections within the section between the BSR and the seafloor are also favorable indications of potential resource-quality accumulations.

IMP anticipates conducting further research on this and other sites to further constrain the volume and resource potential of gas hydrates in Mexico.

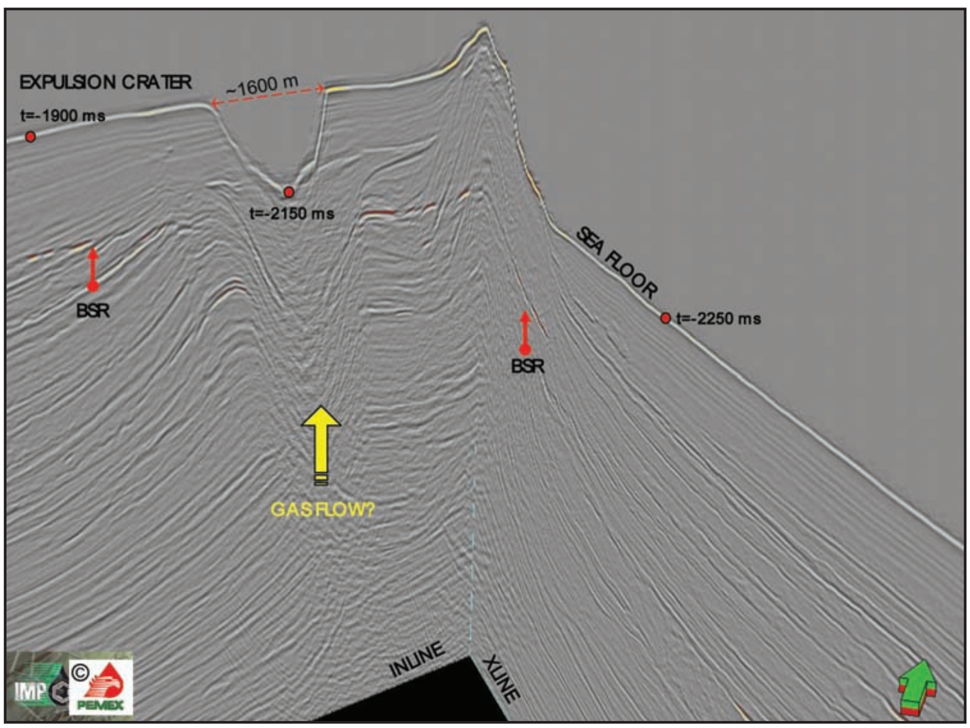


Figure 3: Seismic data showing the nature of the BSR and the large seafloor expulsion feature (courtesy IMP and Pemex).

SUGGESTED READING

Rocha-Legoretta, F. J., 2009. Seismic evidence and geological distinctiveness related to gas hydrates in Mexico. *The Leading Edge*, June 2009, pp. 714-717.

Shedd, B, et al., 2009. Variety in seismic expression of the base of gas hydrate stability: *Fire in the Ice* Newsletter, Spring, 2009.

Boswell, R., et al., 2009, Occurrence of gas hydrate in Oligocene Frio Sand, Alaminos Canyon 818, northern Gulf of Mexico, *J. Marine and Petroleum Geology*, v. 26, pp. 1499-1512

The Identification of Sites for Extended-term Gas Hydrate Reservoir Testing on the Alaska North Slope

By Tim Collett, US Geological Survey; Ray Boswell, US DOE

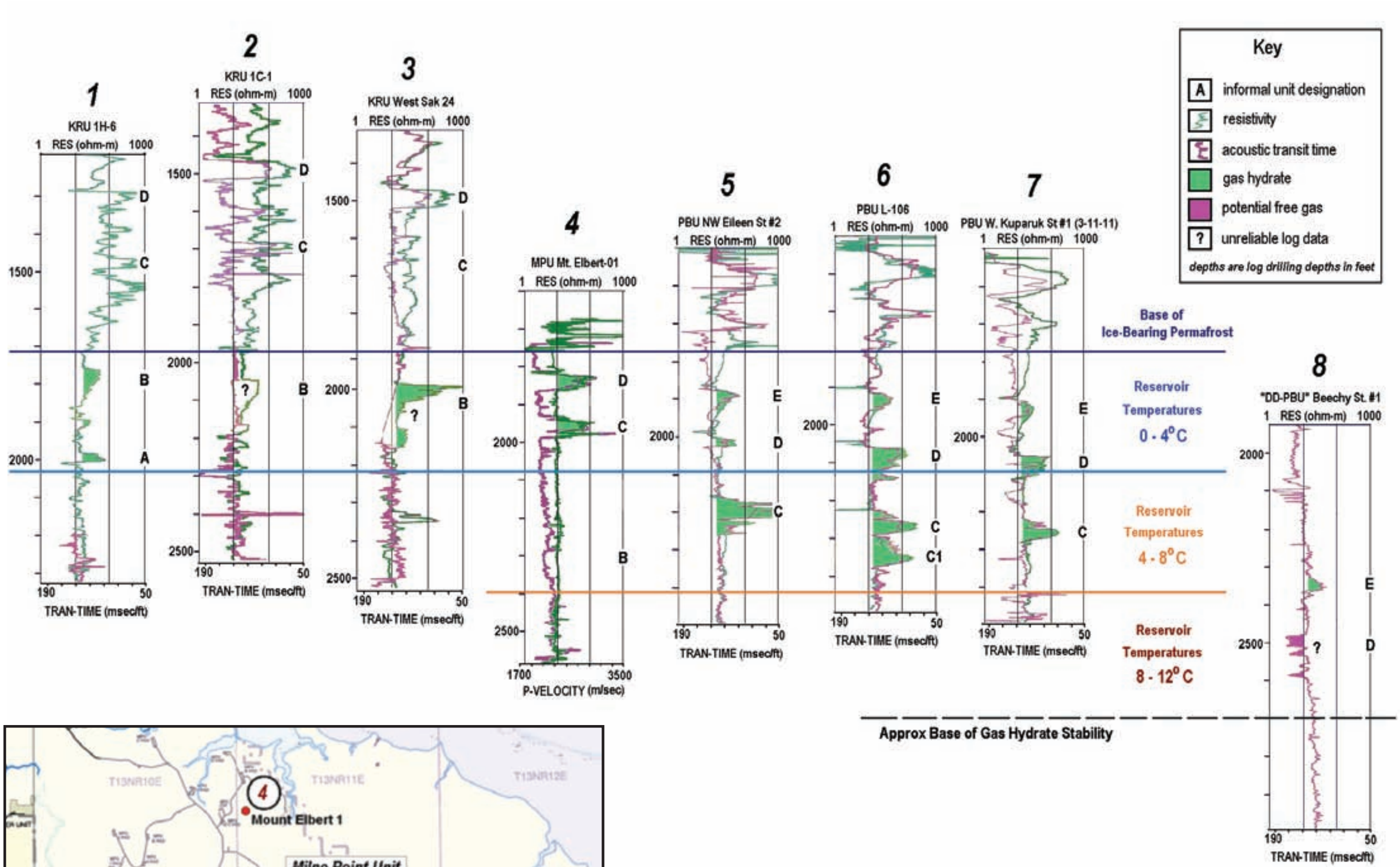
Since the establishment of the Methane Hydrate R&D Act in 2000, a primary goal of gas hydrate research has been the determination of the commercial viability of gas production from gas hydrate reservoirs. Today, a wealth of data gathered in the lab, during field tests, and in numerical simulation studies indicates clearly that gas is technically recoverable from gas hydrates housed in porous and permeable (sand or sandstone) reservoirs using existing technologies. However, what is not well understood is how long it might take to recover those volumes, from how many wells, with what water production, and with what reservoir/wellbore completion and maintenance requirements. A program of extended-term field tests is needed to address these issues and move toward a better understanding of the potential commercial viability of natural gas production from gas hydrates reservoirs. To be most effective, this program should feature a series of tests, utilizing different approaches, and applied over a range of geologic settings.

Over the past 6 years, a series of short term and controlled tests (at Mount Elbert in Alaska: see Boswell et al., ICGH-2008; and at Mallik in northern Canada, Yamamoto and Dallimore, FITI Summer 2008) have provided a wealth of petrophysical information and insight on potential reservoir performance. However, a reservoir's initial production response often provides limited insight into actual deliverability due to transient effects that are very difficult to understand. Because the time required for the production response to stabilize may take many months or more, a key criterion for gas hydrate production testing is the availability of a site that allows continuous access over a sufficient duration to provide meaningful data on reservoir performance. This could mean only a month or so if the test produces large and stable volumes quickly; it could mean several years if all the planned contingencies for supplemental testing need to be invoked. In Alaska, this means that a surface location on an existing production pad, which will allow year-round access to the well site and to needed services and infrastructure, is required.

Toward a Production Test on the ANS

At present, the U.S. government is working closely with industry and state and local governments in Alaska to develop a variety of potential testing options. The most mature effort is being conducted in partnership with BP Exploration (Alaska) Inc. The BP-DOE-USGS program has been underway since 2002, and has produced many key contributions to the evaluation of ANS gas hydrates, including the successful drilling of the Mount Elbert stratigraphic test well at Milne Point Alaska in early 2007. Currently, DOE and BP are working to expand this program into a broader collaboration (the "ANS Joint Industry Project, JIP") that will solicit participation from numerous groups in Alaska and beyond.

The primarily objective of this JIP would be the execution of an extended-term production test focused on depressurization that will build upon the recent findings at both Mallik and Mount Elbert. Over the past 18 months, DOE and USGS have worked with the members of the BP project team to develop recommendations as to the most appropriate location and operational design for the initial production test site. Seven potential



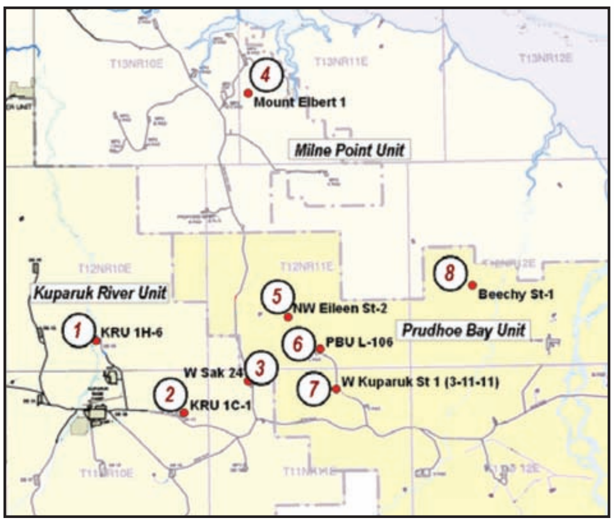


Figure 1: *Montage of drill log data from MPU-KRU-PBU area. The data are shown relative to interpreted base of ice-bearing permafrost. The indicated zones of reservoir temperature are approximate only. Note that the PBU logs (5, 6, & 7) show inferred gas hydrate in multiple zones and are the deepest (warmest) identified locations of gas hydrate in areas with established surface facilities. The next data pointdown-dip from these wells (Well #8) has relatively poor log data and anomalous responses that may reflect drilling effects.*

Target	Depth (ft)	Lower Contact	Thickness (ft)	Gas Hydrate Saturation (%)	Porosity (%)	Intrinsic Permeability (mD)	Temperature (°C)	Pessure Gradient	Salinity (ppt)
Milne Point Unit – Mount Elbert Prospect									
C-sand	2132	Water	52	65	35	1000	3.3 - 3.9	Hydrostatic	5
D-sand	2014	Shale?	47	65	40	1000	2.3 - 2.6	Hydrostatic	5
Prudhoe Bay Unit – L-pad vicinity									
C2-sand	2318	Shale	62	75	40	1000	5.0 – 6.5	Hydrostatic	5
C1-sand	2226	Shale	56	75	40	1000	5.0 – 6.5	Hydrostatic	5
D-sand	2060	Shale	50	70		1000	3.0 – 4.0	Hydrostatic	5
E-sand	1915	Shale	50	60		1000	2.0 – 3.0	Hydrostatic	5
Prudhoe Bay Unit Down-Dip from L-pad									
C-sand	2500	Shale*	60*	75*	40*	1000*	~12	Hydrostatic*	5*
Kuparuk River Unit – West Sak 24 vicinity									
B-sand	2260	Shale?	40	65	40	1000	2.0 – 3.0	Hydrostatic	5

**Conditions assumed for the Prudhoe Bay Unit Down-Dip "L-pad" site*

Table 1: *Summary of Reservoir Parameters for Potential Locations/Targets*

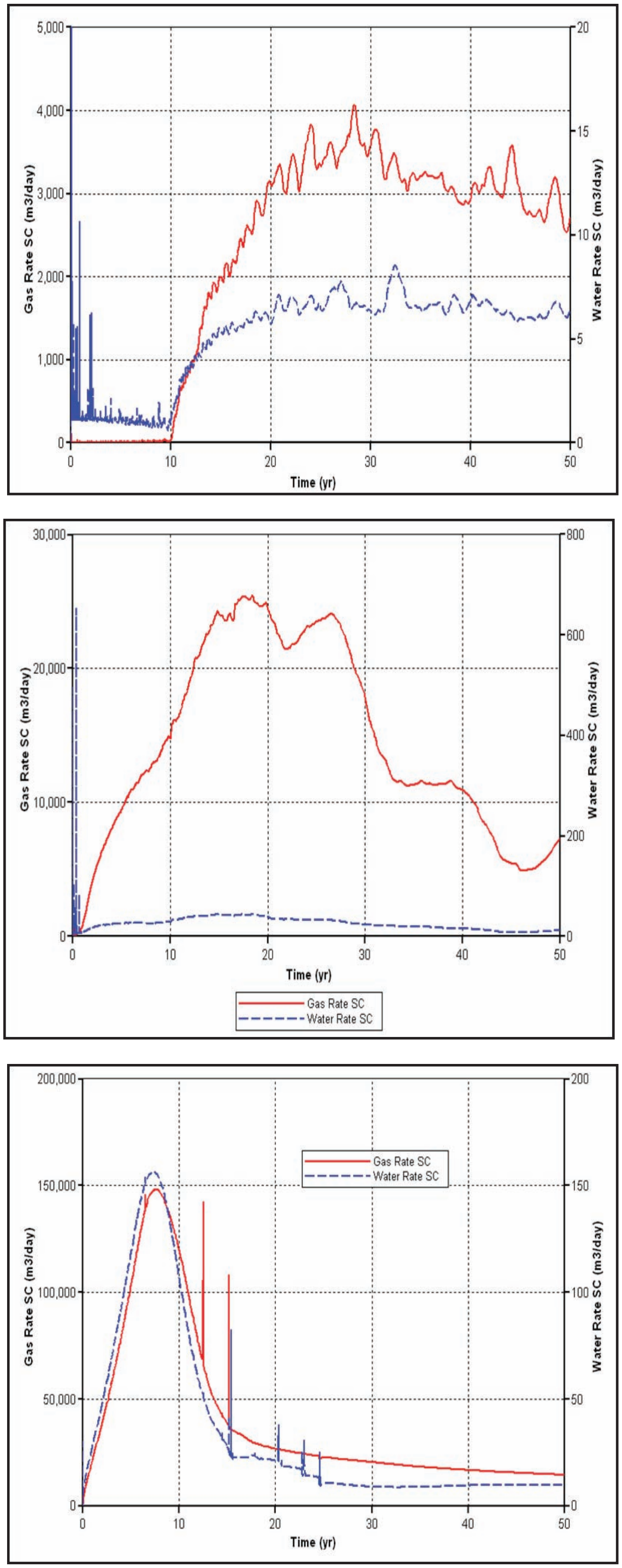


Figure 2: Comparison of typical production simulation results for ANS gas hydrate reservoirs. Top: A setting typical for known MPU and KRU reservoirs (3-4 °C); Center: Westend PBU setting (5-6 °C). Bottom: Down-dip PBU setting (10-12 °C): Courtesy: International Gas Hydrate Code Comparison Group)

surface locations within the existing infrastructure (the Prudhoe Bay, Kuparuk, and Milne Point fields) were considered. These sites were grouped into four locations for detailed evaluation (Table 1).

Criteria were developed against which each of these sites was evaluated. These criteria dealt primarily with two factors; 1) mitigating geologic risks including criteria of reservoir quality, reservoir temperature, nature of bounding units, nature of production modeling forecasts, and presence of multiple potential testable zones; and 2) mitigating operational/logistical risks including criteria of ease of physical access to the test location, drilling/ completion complexity, capability/capacity of local facilities, local need/use for gas produced during the test, disposal of water produced during the test, impact on ongoing operations, and overall program complexity. These evaluations are summarized below and in Table 2.

Evaluation of locations in Milne Point Unit

The 2007 BP-DOE-USGS Mount Elbert stratigraphic test well fully mitigated any geologic risk at the site and no other significant inferred GH accumulation in MPU has yet been confirmed by well data, consequently, any production test conducted in MPU would likely test this site. The accumulation features two reservoirs (Units C and D) that are clean, high-porosity, fine-grained, shallow marine sands with high GH saturations (Figure 1). However, log data indicates that the lower unit (Unit C) is likely in contact with free water, which could significantly complicate an extended well test. Most importantly, the position of this reservoir just below permafrost would pose additional operational difficulties related to the low formation temperature (between 2 and 3°C). Furthermore, drilling into the accumulation from one of the existing gravel pads (MPU B or E-pads) would require a high-angle to horizontal well path that would cross at least one major fault, adding additional complexity to the well drilling, completion and logging operations, as well as the test data analysis. Logistically, the MPU sites provide ample infrastructure support.

Evaluation of locations in Prudhoe Bay Unit area

Two locations (PBU L-pad and the site of the Kuparuk State 3-1-11 well)) in the PBU area were evaluated. At both locations, a series of stacked gas hydrate filled sands have been indentified in existing well data (Figure 1). The sands (Units C, D, and E) are expected to be very similar petrophysically to the units cored and logged at Mount Elbert. Furthermore, a location closely offset to the PBU L-106 well will likely also encounter a fourth gas hydrate-saturated sand (Unit C-1) at the base of the reservoir section.

In total, GH-bearing sands at the PBU L-pad site total 218 feet in thickness. The primary test target, the composite C sand (including C and C1), is roughly 100 ft thick, and is ~3°C warmer than the potential target at MPU. Units D and E also provide excellent uphole targets to accommodate operational contingencies or to provide testing options across a range of initial temperature conditions. Geologic risk for the Unit C, D and E sands is low given nearby well control and the inferred laterally continuity of the marine shelf sands; however, seismic delineation of the sand-bodies would be needed before the selecting the final well location. The second evaluated PBU location would closely offset the Kuparuk State 3-1-11 well. The geology seen in this well mimics that of the PBU L-106 well (Figure 1), with the exception that the C1 sand is not present but, the Kuparuk State 3-1-11 well is not on a operational gravel pad and would require significant investment in infrastructure development and greater operational/ logistical support for the testing program.

Evaluation of Locations in Kuparuk River Unit

Gas hydrates are present in the eastern margin of the KRU and could be accessed from a several of existing well pads. However, well data from KRU are of lower quality than those at PBU and the reservoirs sands occur structurally up-dip (to the west) of the potential PBU sites. The Unit C and D hydrate reservoirs at KRU are well within the permafrost section and are therefore not viable targets for an initial production test. However, Unit B, which is a very high-quality reservoir throughout MPU and PBU, appears to be GH-saturated from the available log data. Overall, the temperature and reservoir quality of the single KRU target is expected to be very similar to those in MPU, but with somewhat higher geologic risk.

Evaluation of Locations in "down-dip" PBU

USGS regional mapping in the greater ANS infrastructure area indicates that there should be opportunities to track the gas–hydrate-bearing Unit C, D, and E sands down-dip to the east of the PBU L-pad site. Such a location would be highly favorable as the gas-hydrate-bearing reservoirs would occur at higher temperatures up to 12°C. However, there is a lack of well penetrations in this region. The only control point in the area is the Beechy

parameter	MP E-pad	MP B-pad	PBU L-pad	PBU Kup St. 3-11-11	PBU Down-dip L-pad	KRU W24	KPU 1H
Reservoir Temperature	H	H	M	M	L	H	H
Ownership	L	L	H	H	H	M-L	M-L
Site Access	M	M	L	L	H	L	L
Geologic Risk	L	L	L	L	H	M	M
Data Availability	L	L	L	M	H	M	M
Well Risk	L-M	L-M	M	M	H	M	M
Facilities Access	L	L	L	M	H	M	L
Gas Disposal	H	H	H	H	H	H	H
Interference w/Operations	L	?	H?	L	L	L	H?
Water Disposal	L	L	L	M	H	M	L
Use for Gas	L?	L?	M	M	M	L	L?
Test Options	M-H	M-H	L	L	M-H	H	H

Table 2: *Review of relative favorableness of each location for long-term production testing. H = high risk associated with this parameter (unfavorable); M = medium risk; L = low risk (favorable)*

State #1 well (Figure 1) which encountered apparent free gas in the Unit D sand and it is not possible to confirm with any confidence the continuity of the reservoirs between the Beechy State location and the western PBU wells. As a result, and any location selected would have very high geologic risk. Significant additional seismic interpretation and well correlation work would be required to determine if gas hydrate exist at this site. Furthermore, this area also lacks existing surface facilities in the region.

Modeling results

To better understand the potential reservoir response for the locations considered in this study, DOE and USGS collaborated with BP and the participants of the International Code Comparison group (see Anderson et al., ICGH-2008) to conduct numerical gas hydrate production simulations for the idealized MPU, KRU, PBU, and DD-PBU settings. These analyses leveraged the 2007 Mount Elbert data in order to compare production between different geologic settings and between the various participating modeling approaches. To ease these comparisons, the geologic representations input to the models were simplified and homogenized. As a consequence, the most meaningful data from this effort are not the absolute predicted production values, but instead the comparative productivity between sites and the relative performance of the models (see FITI, 2009 Anderson, et al.).

Given the similarity of the KRU and MPU settings, only three sets of modeling runs were undertaken (Figure 2). Although these cases differed somewhat in reservoir thickness and pressure, the modeling group agreed the reservoir temperatures were the primary control on the modeled production rates. The MPU/KRU model showed consistent predictions, with very modest production rates and long "lead" times (time before first gas production occurs and all production is water). Analysis of the PBU case (production from the composite Unit C and C1 sands) resulted in production rates roughly five times those of MPU and with zero lead time. The DD-PBU case revealed the clear benefits of higher temperatures, with rates increasing another five-fold (Anderson et al., ICGH-2008).

Summary

From this review, the PBU site, particularly the L-pad location, is clearly favored as the optimal site for an initial extended gas hydrate production test. The site offers the best combination of low geologic risk, maximal operational flexibility (multiple zones), low operational risk (vertical wells adjacent to infrastructure) and promise of near-term and meaningful reservoir response. The primary concern with this location is the logistical issue associated with gaining approval of three major resource industry partners. Although MPU remains a possibility, the site is clearly less favorable due to a much more complex operational environment (colder reservoirs, deviated wells, a single potential target). The KRU locations were assessed as offering no geological advantages to the MPU location, but with greater geologic risk. The PBU down-dip location, though offering the potential for encountering the warmest reservoirs in the region (and therefore potentially the most successful test in terms of rates), was deemed unacceptable due to high geologic risk, and the lack of existing facilities to support a test.

SUGGESTED READING

Anderson, B. et al. 2008, Analysis of modular dynamic formation test results from Mount Elbert-01 stratigraphic test well, Milne Point Unit, North Slope, Alaska. *ICGH*, 2008.

Anderson, B. et al. 2008, Effects of reservoir heterogeneity on productivity of gas hydrate reservoirs. *Fire in the Ice*, Fall 2008.

Boswell, R. et al. 2008, Investigation of gas hydrate-bearing sandstone reservoirs at the Mount Elbert stratigraphic test well, Milne Point, Alaska. *ICGH*, 2008

Yamamoto, K., Dallimore, S. 2008. Aurora-JOGMEC-NRCan Malik 2006-2008 gas hydrate research project progress. *Fire in the Ice*, Summer 2008.

Naval Research Laboratory Contribution to Global Methane Hydrate Research

By Richard Coffin (NRL, Marine Biogeochemistry Section Lead– Washington, D.C.) and Warren Wood (NRL, Geology/Geophysics Section Lead – Stennis, MS)

Approximately 10 years ago, scientists in The Naval Research Laboratory's Marine Biogeochemistry Section in Washington, D.C. and the Geology-Geophysics Section in Stennis, Mississippi began working towards a shared goal of understanding the processes surrounding methane hydrate development in coastal regions.

Along the way, their research program grew to include collaborative research partnerships with scientists in domestic and international science communities. The success of NRL's methane hydrate research program can, in part, be attributed to these collaborative partnerships, which have produced results in countries as near as Canada and as far away as New Zealand.

In this article we will touch briefly on the NRL hydrates research program, elaborate more on the global partnerships that have formed, and discuss how these partnerships played an important role in the contributions to the study of methane hydrate made by NRL.

The Program

Comprised of 10 scientists from the NRL and a large number of domestic and international scientists, the research team seeks to integrate geophysics, geochemistry, and geology to address a wide range of basic and applied research topics. Using seismic data, shallow sediment geochemical data and vertical fluid migration data, the research team can determine:

- Deep sediment methane and potential hydrate beds
- Variations in the vertical gas flux
- Shallow sediment carbon cycling
- Methane flux to the water column

A large amount of this data is collected by team members in the field to ensure that the expedition addresses all planned project research topics. These topics typically include:

- Seismic data interpretation of gas and gas hydrate accumulations and fluid flow conduits
- Initial prediction of deep, sediment methane deposits
- Shallow sediment and water column carbon cycling
- Influence of methane on microbial community diversity, ocean carbon modeling, and climate change

NRL has expertise in seismic data acquisition and interpretation, onboard analysis of shallow sediment and porewater samples, elemental isotope analysis (^{13}C, ^{14}C, ^{18}O, and deuterium) to track sediment methane sources and cycling and state-of-the-art analysis of microbial community diversity.

Thinking globally

Through a series of international workshops, the global reach of the NRL methane hydrates research team has extended considerably over the last 10 years. Led by scientists from NRL, University of Hawaii, the National Institute of Advanced Industrial Science and Technology (AIST)-Hokkaido, and the University of Bergen, these workshops have been attended by over a thousand scientists from 22 nations.

From these workshops, several collaborative field research programs in the Gulf of Mexico, Cascadia Margin, mid-Chilean Margin, Hikurangi Margin, and the Beaufort Sea have been developed.

A return to the Gulf of Mexico, mid-Chilean Margin, and the Hikurangi Margin is in discussion to continue previous research efforts. In September 2009, NRL-led researchers will travel to Barrow, Alaska to participate in the Beaufort Sea Methane Hydrate Expedition onboard the U. S. Coast Guard *Polar Sea*. US scientists from NRL, NETL, USGS, University of Delaware, University of Texas, University of Maryland, University of Hawaii and Saint Mary's College are collaborating with international researchers from NIOZ (Netherlands), IFM-Geomar (Germany), and Heriot-Watt University, Scotland. Research focuses on methane sources and cycling in the shallow sediment and water column in a nearshore to continental slope field plan.

There are also discussions currently being held for new field programs in the Laptev and East Siberian Seas off the coast of Russia, as well as areas in the Norwegian-Greenland Sea, and in the Bay of Bengal off the coast of India. Future participants for these expeditions will include researchers from Canada, Chile, Germany, the Netherlands, Norway, New Zealand, the United Kingdom and the United States.

Reflecting on the Past: Domestic and International Field Program Successes

Over the last 10 years, several NRL accomplishments via domestic and international collaborations have contributed to a more thorough understanding of hydrate formation, stability, and abundance.

By coupling geochemical analyses of shallow sediment carbon pools to stable carbon/radiocarbon isotope analysis of different organic and inorganic carbon pools, the strong control that methane has over the shallow sediment microbial carbon cycling in regions that have a strong vertical methane flux is demonstrated.

The hydrate structures in the coastal sediments on the Texas-Louisiana Shelf were originally believed to be Structures I and II. Structure H hydrate was thought to only be formed in laboratory experiments. However, there was recognition of gas compositions from samples collected during the 2004 research expedition located in the Gulf of Mexico's Atwater Valley that indicated that the naturally-formed samples could be Structure H hydrates. Using these samples, a thorough analysis of the structural composition using the Advanced Photon Source (APS) by researchers at the Argonne National Laboratory confirmed the presence of Structure H hydrate in the Gulf of Mexico (Figure 1)

Further analysis of hydrates collected from the Cascadia Margin during 2004 also confirmed the presence of Structure H hydrates in this region. Related to this discovery, field work had been focused on the distribution of biogenic methane hydrates in the Hydrate Ridge. With the accidental discovery of shallow sediment hydrates by nearby trawlers at the Barkley Canyon site, NRL, University of Victoria and Canadian Geological Survey research teams conducted seismic and geochemical surveys. There they found Structure II thermogenic hydrate in a region that was thought to be a dominantly biogenic methane source.

In 2003, NRL-led researchers from the United States, Chile, Canada and Japan, initiated methane hydrate exploration off the mid-Chilean Margin.

In October of that year, acquired seismic data set the stage for geochemical evaluation of hydrate loadings during 2003 and 2004 (Figure 2). A combination of shallow sediment geochemistry, analysis of vertical fluid migration and seismic data interpretation resulted in the first discovery of hydrates in this region. This resulted in the Chileans developing a long term methane hydrate exploration program. NRL plans to continue contribution to this research in 2011. (For more information on this expedition, please see *International Science Team Studies Hydrates Off the Coast of Chile* in the Summer 2003 edition of *Fire in the Ice*.)

With this field protocol well developed, the NRL researchers joined a New Zealand research team led by Ingo Pecher from Geological and Nuclear Sciences in Wellington to conduct the initial hydrate exploration on the Hikurangi Margin, across the Porangahau Ridge. The thorough seismic, geochemical and vertical fluid migration data interpretation suggested that the initial region did not have a large deep sediment methane hydrate distribution.

However, when the NRL field data was later coupled with data from IFM-Geomar's field work and a controlled source electromagnetic survey, a thorough data evaluation revealed horizontal and vertical distribution of methane hydrate deposits.

These past expeditions have developed broad knowledge for basic research in methane hydrate exploration. For example, observation of shallow sediment pore water methane and sulfate profiles can be used to assess spatial variation in deep sediment methane concentrations. However, the sulfate profiles are influenced by the deep sediment methane vertical flux and the shallow sediment methane and sulfate cycling. For a complete interpretation, the biogenic cycles controlling methane and sulfate need to be understood at each site.

While it is assumed that biogenic methane is a dominant source in many study regions, there is potential for thermogenic methane nearby; suggesting some

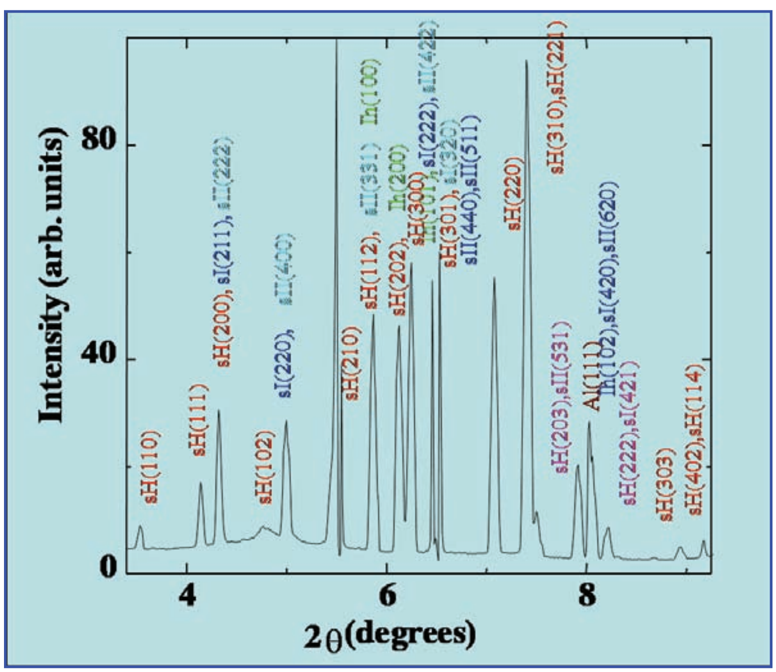


Figure 1: Hydrate structure analysis on the Argonne National Laboratory Advanced Photon Source showed the presence of Structure H in natural hydrate samples from the Texas-Louisiana Shelf in the Gulf of Mexico.

deep sediment hydrate deposits are localized and not spread across long distances. Basic research in sediment biogeochemistry shows clear potential for methane to be the dominant energy source in the shallow sediment carbon cycling, and has potential to contribute to the water column carbon cycling.

Stable carbon and radiocarbon isotope analysis of different carbon pools in Atwater Valley sediment show the vertical flux on methane on a mound can contribute to 97% of the shallow sediment organic carbon (Figure 3). This approach is currently planned to address the variation between permafrost and deep sediment hydrate contribution to shallow sediment and water column carbon cycling in the Beaufort Sea, Laptev Sea and Norwegian-Greenland Sea over the next three years.

To obtain peer-reviewed manuscripts and reports for the different research projects, contact Richard Coffin (richard.coffin@nrl.navy.mil) or Warren Wood (warren.wood@nrlssc.navy.mil).

Figure 2: The international science team involved with methane hydrate research off the mid Chilean Margin during 2004. Juan Diaz Catholic (University of Valparaiso) and Rick Coffin served as chief and co chief scientists off the coast of Concepcion Chile.

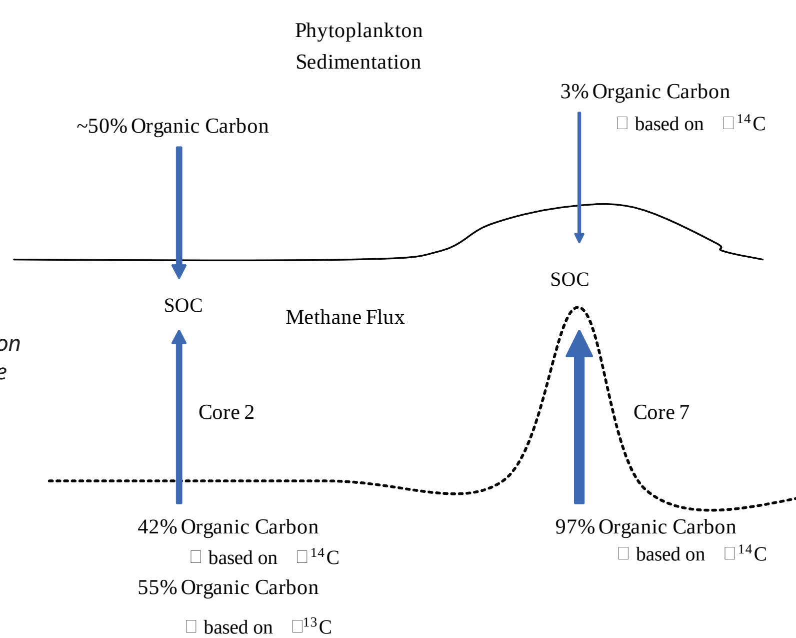
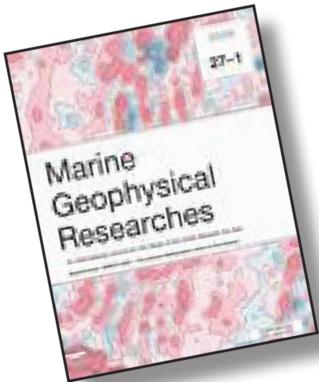


Figure 3: Estimates of deep methane contribution to shallow sediment carbon cycling between regions with advective (on the mound) and diffusive vertical fluxes (off the mound).



Marine Geophysical Researches Call for Papers

The Journal of *Marine Geophysical Researches* (MGR), a high-quality resource for the analysis of geophysical data in deep-ocean basins, is expanding their focus to include submissions on geophysics, structure, stratigraphy, and sediment deposition processes along continental margins. MGR recently issued a call for papers for their upcoming special issue: *Application of Geophysical Methods on Gas Hydrate Exploration*.

Papers need to be submitted before November 1, 2009. For more information, please see http://www.springer.com/earth+sciences/oceanography/journal/11001. For questions, please contact the special issue editors Tan-Kin Wang (tkwang@mail.ntou.edu.tw) and Win-Bin Cheng (wbin@just.edu.tw).

2009 Hydrate Fellows Announced

Ann Cook


Hugh Daigle

This year's call for applications to the Methane Hydrate Research Fellowship program created a large pool of highly qualified applicants for the selection committee to choose from. It was recently announced that from this applicant pool, Ann Cook and Hugh Daigle were selected as the next recipients of the Methane Hydrate Research Fellowship.

Ann is a Ph. D. candidate in Marine/Borehole Geophysics at Columbia University in New York City and plans to defend her thesis, *Gas hydrate-filled fracture reservoirs on continental margins*, this fall. Using data she helped collect during the 2009 Gulf of Mexico Gas Hydrate Joint Industry Project (JIP, DOE/NETL Methane Hydrate Project DE-FC26-01NT41330), Ann plans to study gas hydrate distribution and concentration in the Gulf of Mexico at the meter scale and at the reservoir scale. Her study of hydrate at the reservoir scale will utilize data collected with the azmuthial resistivity tool, PeriScope, during the recent GOM drilling expedition as well as controlled-source electromagnetic (CSEM) survey data collected over the 2009 JIP sites. Ann will work in collaboration with Dr. David Goldberg with the Borehole Research Group at Lamont-Doherty Earth Observatory.

Hugh, a Ph. D. candidate in Earth Science at Rice University in Houston, Texas, will study the feedback processes that surround a variety of related conditions, including environmental factors, sediment physical properties, fluid flow through fractured and porous media, and methane hydrate formation. To achieve this goal, he will primarily focus on the numerical modeling of methane hydrate accumulations, in particular the modeling of fluid flow through porous medium flow and fractured medium flow. His project will utilize results from Ocean Drilling Program Legs 164 and 204, and DOE/NETL Methane Hydrate Projects DE-FC26-01NT41330 (Gulf of Mexico Gas Hydrate Joint Industry Project), DE-FC26-06NT42960 (Detection and Production of Methane Hydrates) and DE-FC26-06NT43067 (Mechanisms Leading to Co-existence of Gas and Hydrate in Ocean Sediments). Hugh will work in collaboration with Dr. Brandon Dugan at Rice University.

USGS Mendenhall Postdoctoral Fellowship in Climate-Hydrates Interactions

The USGS announces the start of the annual Mendenhall Postdoctoral Fellowship (http://geology.usgs.gov/postdoc/) competition. One of this year's Fellowship opportunities again focuses on the interaction of gas hydrates and climate, with a particular emphasis on studies related to onshore and shallow offshore permafrost gas hydrates (http://geology.usgs.gov/postdoc/2011/opps/opp7.html).

Applicants must be within 5 years of completing a Ph.D. in geology, geochemistry, geophysics, microbiology, or a related field and have a broad enough understanding of chemistry, physics, and biology to contribute to multidisciplinary projects. Applications are due on November 9, 2009 for fellowships starting on or after October 1, 2010.

The duty station for this fellowship will be Woods Hole, Massachusetts, with C. Ruppel (cruppel@usgs.gov) and J. Pohlman (jpohlman@usgs.gov) as designated research advisors within the USGS Gas Hydrates Project. The successful applicant will have the opportunity to collect new data during field campaigns on the Alaskan North Slope or the shallow Beaufort Shelf.

Hydrates to be the Focus of Two Sessions at the 2009 Annual Meeting of the AGU

Two sessions on gas hydrates will be held at the 2009 Annual meeting of the American Geophysical Union. The first session, *Gas Hydrates—Results of Recent Field Investigations,* will be devoted to reporting on the results of recent field expeditions designed to assess and characterize deeply buried gas hydrates in either marine or permafrost settings.

Details on this session (OS2) can be found at:
http://www.agu.org/meetings/fm09/program/scientific_session_search.php

The second session, *Geological Setting of Gas Hydrate Reservoirs and Seeps: A Source for Clean Energy and/or a Storage for CO_2*, will focus on field, experimental, and numerical simulations related to the conversion of methane clathrates into CO_2 hydrates.

Details on this session (OS5) can be found at:
http://www.agu.org/meetings/fm09/program/scientific_session_search.php

Conference on Gas Hydrate Resource Development set for Moscow in November

Gas hydrate properties and the development of hydrate resources will be the focus of oral presentations to be delivered at the upcoming International Conference on Gas Hydrate Resource Development. The conference is scheduled to take place on November 17-18, 2009 and will be held at Moscow's Gubkin Russian State University of Oil and Gas. For more information on the conference, please visit http://www.h-conf.gubkin.ru.

Gordon Research Conference on Natural Gas Hydrates to be held in 2010

The inaugural Gordon Research Conference (GRC) on Natural Gas Hydrates will be held 6-10 June, 2010 at Colby College in Waterville, Maine. The focus of this first meeting will be the interaction among gas hydrate, sediments, fluids, and free gas at pore to regional scales. Invited full-length presentations will discuss the physical, chemical, and biological aspects of such interactions. Speakers will include both established gas hydrates researchers and those from scientific/engineering communities with knowledge critical to advancing gas hydrates research. Any attendee may contribute a poster.

Founded in 1931, the Gordon Research Conferences provide a forum for in-depth interactions and discussion beyond those permissible in the usual meeting format. Currently there are over 300 Conferences in chemistry, physics, medicine, and other fields over each two-year cycle. With no formal proceedings, GRCs emphasize sharing of state-of-the-art, unpublished research, which will be featured in a mix of formal talks, informal discussions, and afternoon poster sessions. GRC meetings have a retreat-like atmosphere that provides ample time for socializing and sharing of ideas.

In the spring of 2008, Carolyn Ruppel (USGS) and Peter Flemings (UT-Austin) submitted a proposal for this inaugural meeting and were appointed Chair and Vice-Chair respectively. Their proposal was one of a small handful accepted by the GRC for initiation of a new conference series. GRC organizers have conveyed that the multidisciplinary nature of gas hydrates studies made this meeting particularly attractive to their Board. The popularity of more traditional gas hydrates meetings like the International Conference on Gas Hydrates also played a role in convincing the Board that this GRC could be successful.

The GRC welcomes participants at all career stages, from all over the world, and from government, academic, and industry sectors. Partial financial support will be available to some participants to offset the costs of the all-inclusive (lodging and meals at Colby College and workshop registration) price. Additional funds are currently being raised to offset participation costs for some attendees.

If the meeting is well-attended, the GRC Board will ask participants to choose the focus of and leaders for the 2012 Gordon Research Conference on Natural Gas Hydrates during the 2010 meeting.

Regular updates to the meeting description and program will be made at http://www.grc.org/programs.aspx?year=2010&program=naturalgas. The preliminary program of speakers and discussion leaders will be posted by GRC in December 2009. For more general information on the Gordon Research Conferences, please visit their website at www.grc.org.

DAN MCCONNELL

Vice President,
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When he is not studying hydrates, Dan enjoys camping around the state of Texas with his wife and daughters. He and his family also enjoy music of all kinds, outdoor cooking and just about any day at the beach.

Dan McConnell

If life is a journey, then the people you meet along the way can have a lot to do with both your final destination and how you get there. For Dan McConnell, his path towards hydrates research started while he was a student at the University of Texas, and a research assistant to the clastic sedimentologist Dr. Earle McBride. "I was certainly influenced by Dr. McBride even though we didn't do any advanced work together," says Dan. "My other influence at UT-Austin was Dr. Milo Backus, the renowned geophysicist, who taught me a simple but important lesson about interpreting geophysical data. Milo often said 'it is all geology until proven otherwise.' I take that message to heart every time I begin an interpretation of geophysical data."

After completing his B.A. in History and B.S. in Geology at UT-Austin, Dan began a career in the oil and gas industry working in the technical software side of exploration. Later, he gained his skills as a seismic interpreter while at Fugro-McClelland Marine Geosciences (FMMG), where the daily mission involved quick-response, detailed mapping of deepwater marine sediments.

Through his work at FMMG, Dan met two men that would have a great influence on his future area of work: Kerry J. Campbell and Jim Hooper. "Kerry fostered in me an enthusiasm for the science and the data, an appreciation for client service, and a passion for detail," says Dan.

"Early in my career as a seismic interpreter, Jim told me that if I was going to map shallow gas in deepwater areas, I should be thinking about gas hydrates," says Dan. "Jim introduced me to Dr. Dendy Sloan's CSMHYD gas hydrate modeling program, the rudiments of a phase stability diagram, and the details of his gas hydrate characterization work for industry."

Over the years, opportunities to investigate the implications of gas hydrate relative to field development provided Dan with some remarkable memories. "Dr. Harry Roberts of LSU invited me on one of the DOE-sponsored manned submersible cruises on the *Johnson Sea-Link* to study seafloor gas hydrates," he recalls. "Seeing the natural hydrocarbon seeps and gas hydrates on the seabed beneath 580 meters of ocean was a surreal, extraordinary, event."

But this was not to be the only extraordinary event. In 2000, while reviewing data from the Gulf of Mexico's Walker Ridge, Site 313, Dan had an epiphany. "I was working very late at night mapping sediments by building animations out of the amplitude patterns on a series of horizon slices when I truly had a 'light-bulb' moment," Dan recalls. "I realized that the patterns on the screen marked the base of gas hydrate stability. It didn't take long to plot the pattern out on a phase stability diagram and show that the amplitude phenomena were most certainly caused by the formation of gas hydrate."

It was not until nine years later – during the 2009 Gulf of Mexico Gas Hydrate Joint Industry Project (JIP) Leg II – that Dan's suspicions were confirmed. "We drilled two deep holes at Site 313 and found fully saturated gas hydrates in sands where we predicted they would be. The fact that we drilled and confirmed that late-night insight is still hard for me to believe!"

Dan currently serves as the VP of AOA Geophysics, a geoscience company. Asked for his thoughts on the most important challenges facing hydrate researchers today, Dan says, "Although the JIP has established a method for finding gas hydrate deposits that seems to hold, we still understand very little about the distribution and character of these deposits. There is plenty of fundamental characterization work to do."