

FIRE IN THE ICE

2017 Vol. 17, Issue 2



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GOM² EXPEDITION-1 SUCCESSFULLY SAMPLES GAS HYDRATE RESERVOIRS IN THE DEEPWATER GULF OF MEXICO

The UT-GOM²-1 Science Team

In May 2017, a science team led by the University of Texas at Austin (UT Austin) with scientists from the USGS, Ohio State, BOEM, University of New Hampshire, University of Oregon, University of Washington, and Columbia University conducted drilling and coring operations from the Helix Q4000 targeting gas hydrates in sand-rich reservoirs in the Green Canyon 955 block in the northern Gulf of Mexico (Figure 1). The expedition had two primary objectives: 1) test two configurations of pressure coring devices to assess relative performance with respect to recovery and quality of samples; and 2) gather sufficient samples to allow laboratories throughout the US to investigate a range of science questions related to the origin and nature of gas hydrate-bearing sands. The goals of this program were largely met, with more than 30 meters of pressure core acquired, much of it with minimal disturbance.

Background

In 2009, the DOE in partnership with the Chevron-led Gulf of Mexico Gas Hydrates Joint Industry Project (the JIP) conducted a multi-site drilling and logging expedition (JIP Leg II) at three sites in the Deepwater Gulf of Mexico ([click here](#)). That expedition confirmed the validity of emerging prospecting approaches that focus on direct detection of gas hydrate occurrences in seismic data and appraisal of gas hydrate stability conditions integrated with geologic evaluation of standard petroleum system elements, including gas source, reservoir, migration pathways, and desirable reservoir facies. However, JIP Leg II collected only log data—no samples—and as a result, was unable to shed light on the chemistry of either the gas or the water contained in the hydrates, or key physical properties of the hosting sediments. Such information is needed to understand the development of hydrate accumulations and potential responses to induced dissociation for gas production.

Expedition-1 Preparations

GOM² Expedition-1 represents a major advance in the staging of marine scientific expeditions. Without the presence of an industry partner, the UT Austin was required to obtain status as a deepwater operator and



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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.



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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 703-429-4841 or klang@keylogic.com



Figure 1. The science party for GOM²-Expedition-1 aboard the Q4000 in Green Canyon Block 955 in May, 2017. For a full list of GOM² Expedition-1 participants, [click here](#).

to navigate a daunting array of logistical, legal, and liability hurdles required to safely stage and conduct a deepwater drilling operation. The challenge was met due to the efforts of the UT science team, members of the UT administration, strong support from the USGS and the BOEM, and close coordination among these parties and companies Helix, GeoTek, Schlumberger, and Weatherford. The expedition was conducted on schedule and within budget, without any environmental or safety incidents.

The Site

GOM² Expedition-1 conducted coring operations in two wells that were close offsets of the JIP Leg II well GC955-H. That well logged a thick sequence of thinly-interbedded units that were interpreted from LWD data as fine sands and muds deposited in proximal levees to a submarine channel system. The unit included three separate intervals of high gas hydrate saturation, separated above, below, and between by units where the sand units were water bearing. Various hypotheses for this unexpected occurrence, including complications related to structure, petrophysics, and geochemistry were contemplated but could not be evaluated without physical samples. The GC955 system is highly faulted with complex occurrence of gas hydrate and free gas that was expected to vary between different fault blocks. As a result, close offset to the true location of the JIP “H” well was critical. This was achieved when an ROV deployed from the Q4000 observed the H-well (Figure 2) at a location ~8 m to the west of the best estimate obtained at the time of drilling. Coring was then conducted in two holes: the H002 well ~19 m to SSW; and the H005 well ~ 15.2 m to the WSW. The wells were drilled in 2035 m of water.

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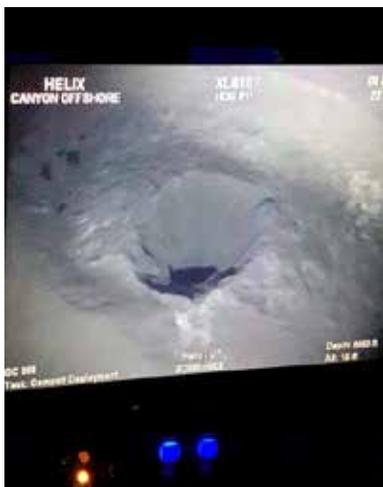


Figure 2. An ROV located the GC955-H well drilled in 2009, enabling the GOM²-Expedition-1 to assure close offset.

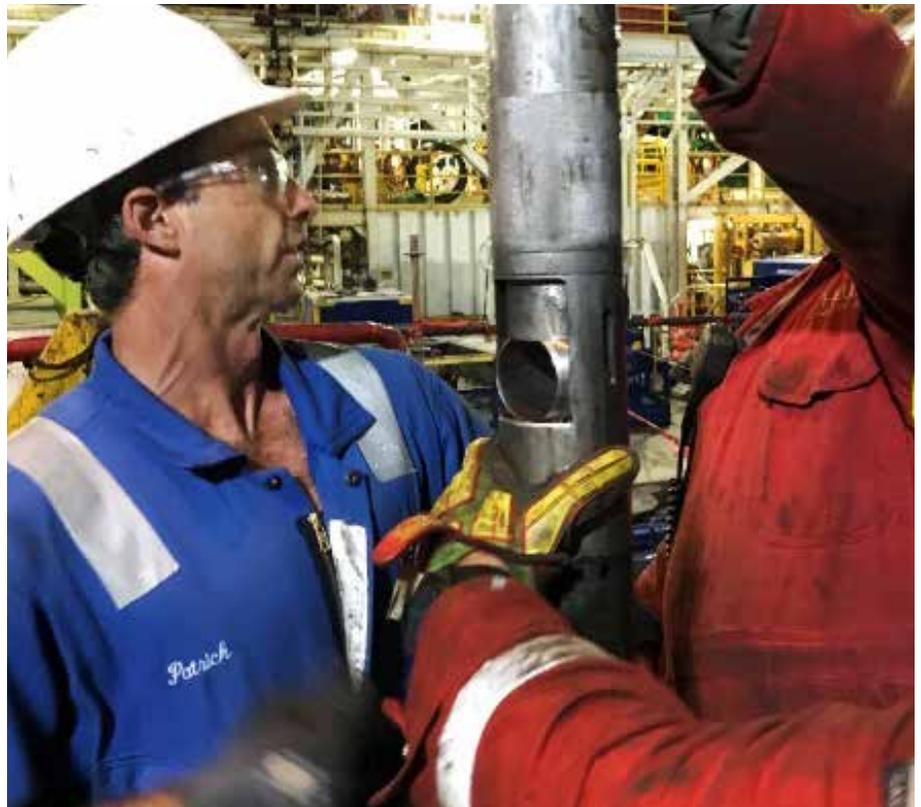


Figure 3. Patrick Riley of Geotek inspects a successful PCTB deployment (note the closed position of the ball valve) on the deck of the Q4000.

Coring Tools and Core Analysis and Handling

GOM² Expedition-1 deployed two different assemblies of the Pressure Core Tool with Ball valve (PCTB; Figure 3), versions of which have been used successfully in recent coring programs in both Japan and India. The “cutting shoe” version is most like those used in prior expeditions. The second, called the “face bit,” was designed to minimize sample disturbance, by limiting sample rotation while the core is being cut. Both tools are designed to cut 3 m cores of 2” diameter. Once acquired, cores were scanned using the GeoTek PCATS system, where subsamples were cut and either transferred under pressure into 1 m storage vessels or depressurized in a controlled manner and curated as conventional cores. Core evaluation was conducted onboard and post-expedition at an onshore lab established at Port Fourchon, Louisiana.

Results

The cutting shoe version was deployed first (Hole GOM²-H002) and experienced significant operational issues. Through 8 deployments, 8.4 m of core were acquired (34% recovery), with only one 1.4 m section of core held under pressure (Figure 4). These issues resulted in the abandonment of the plan to acquire log data across the reservoir section in Hole H002. The science team took corrective actions that resulted in successful recovery of 12 of 13 cores (26.9m) under pressure, with a total recovery of 77% (28.7m) with the face bit tool (Hole GOM2-H005).

H002—Cutting Shoe **8.4 m core recovered**

H005—Face Bit **28.7 m core recovered**

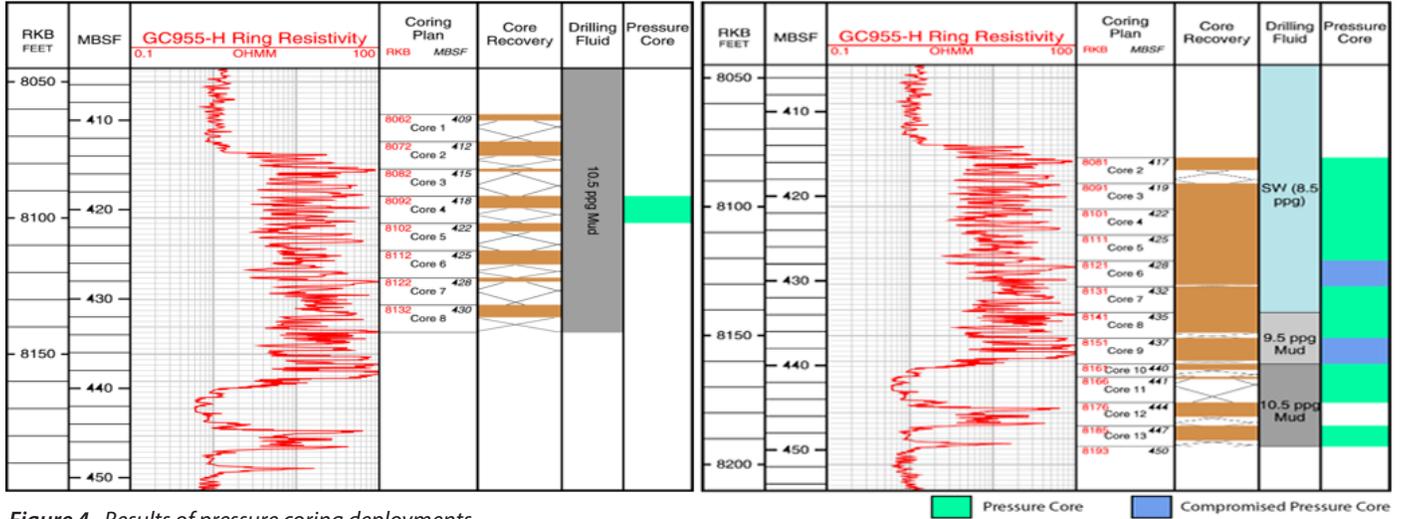


Figure 4. Results of pressure coring deployments

Many of these cores show minimal disturbance and retain the fine-scaled geologic structure of the reservoir (Figure 5). Ultimately, the expedition was able to secure 21 1-m samples of high quality pressure core, which will be sufficient to enable wide ranging science programs in multiple contributing laboratories around the country.

Next Steps

Depressurized cores obtained in GOM² Expedition-1 are currently at Ohio State University for geologic description. Pressure cores are currently housed at UT Austin (Figure 6). In the coming weeks, the GOM² Science Advisory Team will evaluate requests for core samples from throughout the science community and begin the process of allocating the 21 1-m samples currently stored in pressure vessels to specific scientific studies at UT, NETL, the USGS, and other

laboratories. Our goal is to enable a coordinated program of collaborative science that will address key issues in gas hydrate science; and to report these findings in a future peer-reviewed publication.

In addition, the GOM² science team will continue the effort to plan International Ocean Discovery Program (IODP) Expedition 386. This 56-day drilling, coring, logging and testing program focused on methane hydrates in the northern Gulf of Mexico will occur in 2020 from the R/V *JOIDES Resolution* in collaboration with the IODP and Texas A&M University (see announcement,) p. 16, this newsletter.

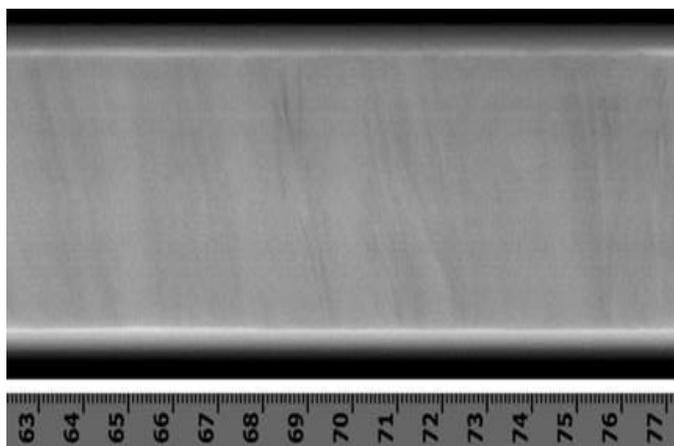


Figure 5. An X-Ray CT scan acquired with PCATS showing the high-quality of the pressure cores recovered.



Figure 6. Lab manager Josh O'Connell examining UT-GOM²-1 pressure cores with the mini-PCATS at the UT Austin pressure core lab.

METHANE RELEASE ALONG CONTINENTAL MARGINS: NATURAL PROCESS OR ANTHROPOGENICALLY DRIVEN?

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Introduction

Gas hydrate stability along continental margins worldwide may be susceptible to changes in ocean temperatures associated with global climate change. Gas hydrate dissociation in this scenario could lead to widespread anthropogenically-driven release of methane. In support of this hypothesis, Westbrook and co-authors suggested that numerous gas plumes emanating from the seafloor offshore Prins Karls Forland (PKF; Figures 1A and 1B) are sourced from dissociating hydrates that have been destabilized by an increase in intermediate water temperature

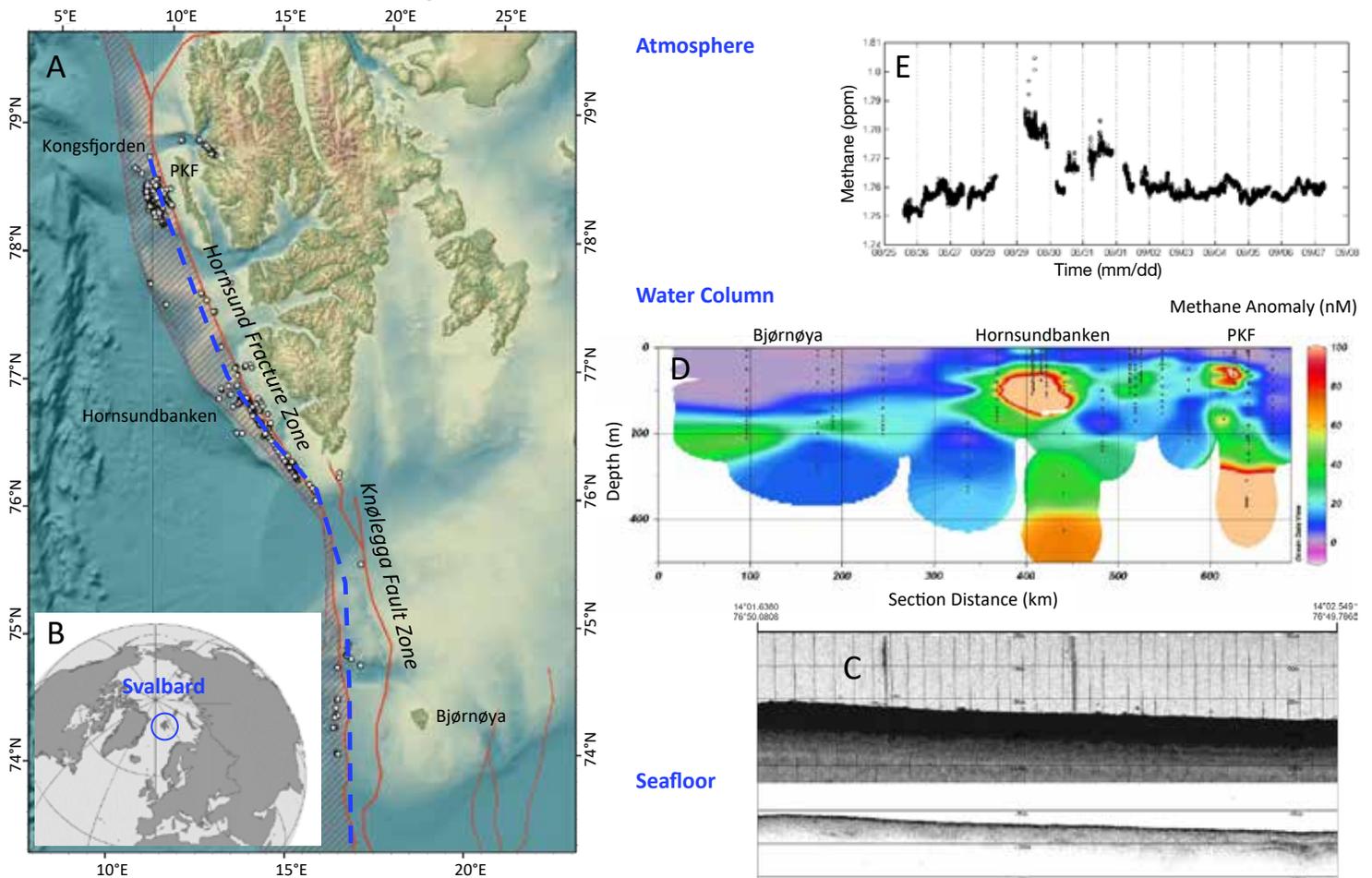


Figure 1. A Flare locations observed during HE387, HE449, and HE450 illustrated as white dots and main structural features including the Hornsund Fracture Zone. PKF stands for Prins Karls Forland. B Overview map. C Example of a sub-bottom profile showing flares on top of hard ground where most of the flares occurred. D South – North transects of dissolved methane concentrations along the shelf; position of the transect is shown as a blue line in A. Above the contour plot, the approximate location along the transect is indicated. Methane anomaly was derived by subtracting the atmospheric methane equilibrium (2.6-3.5 nM). E Methane concentrations of air measured during cruise HE450 using a GGA (Los Gatos Research). Air was continuously pumped through a tubing at ~10 m above sea-surface to the GGA. Elevated concentrations were measured crossing Hornsundbanken (08/29) and near Kongsfjorden (08/31). Figure A and D are simplified versions of the figures in Mau et al. 2017.

over the past 30 years. Hydroacoustic records, showing gas discharge on the North American Atlantic continental slope and along the Cascadia margin, have also been tied to gas hydrate destabilization at the landward edge of the gas hydrate stability zone. These postulated gas hydrate destabilization events have been proposed by Johnson and co-authors to have far-reaching consequences, including oxygen consumption, pH changes harmful to benthic biota, tsunami-generating slope failures, and climate feedbacks that enhance global warming.

We evaluated the validity of this hypothesis for the Svalbard continental shelf by examining: (1) the timing and duration of continental margin gas seepage there; and (2) the quantity of methane originating from gas hydrate dissociation at this location. Our evaluation argues against the hypothesis that the Svalbard seeps are sourced by anthropogenically-driven dissociation of gas hydrates.

Timing of Continental Margin Seepage

We argue that the presence of methane-derived authigenic carbonate deposits along Svalbard and elsewhere is evidence that methane discharge is a natural process that has been ongoing for much longer time periods than anthropogenically-driven global climate change. On the Cascadia margin, for example, carbonate deposits indicate that methane seepage dates back to the Eocene. Abundant carbonate crusts found at methane discharge sites off Prins Karls Forland provide evidence that seepage off Svalbard has been ongoing for at least 3000 years. These observations point to long-lived methane seepage at these sites, challenging the idea that methane release at these locations is driven by recent, anthropogenic change.

Methane Release Along the Svalbard Continental Margin

In addition to establishing the timing of the onset of seepage, it is important to constrain the quantity of methane released at the upper end of the hydrate stability zone, relative to its natural discharge levels. A water column survey in 2015, aimed at mapping methane release in the global warming-sensitive Arctic region offshore Svalbard, documents that Prins Karls Forland gas emissions are part of a much broader seepage system, which extends from 74° to 79° N.

Along this seepage trend, more than a thousand gas discharge sites were imaged in hydroacoustic data. Extensive gas seepage from this system generates a dissolved methane plume, designated as the Svalbard plume, which is hundreds of kilometers in length and transports ~8.4 Gg (gigagrams) methane. This methane load is on the upper end of what has been observed in dissolved methane plumes originating from natural seepage systems elsewhere. For example, the down-current portion of the methane plume originating from the well-known Coal Oil Point seep field in California transports ~50 Mg (megagrams); methane seepage loads at Hydrate Ridge (off the coast of Oregon) and the Batumi seep area (eastern Black Sea) amount to approximately 37 and 11 Mg, respectively. The annual methane release from mud diapirs offshore Costa Rica is estimated to be only 0.2-8 kg (kilograms).

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Methane release feeding the Svalbard plume follows the trace of the Hornsund Fracture Zone (HFZ; Figure 1A). The majority of the gas emission sites feeding this plume are located on bathymetric highs characterized by acoustically highly-reflective hard grounds (Figure 1C). This suggests that fine-grained postglacial deposits in the troughs seal structural pathways or at least limit methane-rich fluid migration to the seafloor. The long trend of methane emission sites feeding the Svalbard plume intersects the critical boundary of gas hydrate stability offshore Prins Karls Forland. However, methane release along the Hornsund Fracture Zone is not limited to 400 m water depth, but is observed in water depths from 33 to 429 m. The highest methane concentrations were found near locations of intense seepage at 90 m water depth on Hornsundbanken, and at 80 m and 350 m off Prins Karls Forland (Figures 1A and 1D).

Consistent with reports recently summarized by Ruppel and Kessler, that methane released along the edge of gas hydrate stability does not contribute to global atmospheric inventories, data from the Svalbard plume also suggest significant methane consumption by microbes. Measured methane oxidation rates within the Svalbard plume range from 0.01 to 2.19 nM d⁻¹ (nanomolar per day) and are in agreement with previous measurements offshore Prins Karls Forland. Microbial activity in this area thus consumes 0.02 to 7.7% of the dissolved methane input.

It is worth noting that gas emission zones feeding the Svalbard plume shallower than ~120 m extend from the seafloor to the sea surface. Highest dissolved methane concentrations were measured above the shallow seeps off Prins Karls Forland, Hornsundbanken, and Soerkappbanken, with values reaching 878 nM (nanomolar) above atmospheric equilibrium (Figure 1D). High supersaturation values during summer surveys lead to highs in sea-air fluxes of up to 2.0 nmol m⁻² s⁻¹ (nanomoles per square meter per second). The increase in wind speeds during the winter months may increase this flux, as has been demonstrated for natural seeps in the central North Sea. Furthermore, direct gas bubble transport will likely enhance the fluxes based on dissolved methane, because seeps are located in water less than 120 m deep.

It remains unclear whether atmospheric methane anomalies measured in the 2015 surveys (Figure 1E) represent direct input from the shallow mapped seeps, from seeps closer to land, or from methane discharge on the island itself. Nonetheless, supersaturation values measured in the upper 10 m of stations closer to the shelf indicate a contribution to the atmosphere from the shallow portion of the Svalbard plume. Whereas it has been shown that methane release along continental slopes does not contribute to the atmosphere, it is important to evaluate the potential sea-air flux from natural seeps along continental shelves.

Conclusions

Large methane plumes such as the Svalbard plume appear to be long-lived, natural phenomena. Advances in hydroacoustic detection tools have significantly increased our knowledge of bubble emission sites, and they

have shown that gas emissions sourcing the Svalbard plume, and other plumes along continental margins worldwide, are located at and above the gas hydrate stability zone. It is thus likely that few, if any, of these methane discharge events along continental slopes are directly tied to anthropogenic climate change and global warming. Seepage at these locations is instead part of long-term continental margin processes that respond to hydrogeologic mechanisms, and not necessarily to gas hydrate stability constraints. Of additional significance, methane discharge from the part of the continental shelf that lies *above* the limit of gas hydrate stability may constitute a substantial source of methane release to the atmosphere, and this source needs to be better characterized.

It is undeniable that the atmospheric increase in CO₂ is a serious problem, with wide-ranging effects including global warming, ocean acidification, and sea-level rise. However, based on our evaluation of Svalbard seepage timing and plume size, we argue that methane release offshore Svalbard is not a direct consequence of gas hydrate destabilization triggered by human-induced ocean warming. Instead, it appears to be part of a long-lived, natural process. As the Arctic is extremely susceptible to ocean warming, it is likely that our conclusions for the Svalbard area are also applicable to lower latitude regions.

NEW CODE COMPARISON STUDY OF GAS HYDRATE RESERVOIR SIMULATORS

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Y. Seol, National Energy Technology Laboratory

T. Kneafsey, Lawrence Berkeley National Laboratory

To understand the production of natural gas from methane hydrate reservoirs, scientists and engineers rely on numerical simulations to unravel complex interactions between dissociating gas hydrates, surrounding host rock/sediments, and fluids. This year, NETL and the USGS are guiding the second international gas hydrate code comparison study to evaluate numerical simulators used in methane hydrate research. The study is being co-lead by Yongkoo Seol, NETL, Mark White, Pacific Northwest National Laboratory (PNNL), and Tim Kneafsey, Lawrence Berkeley National Laboratory (LBNL). The emphasis of this study is first to re-evaluate the state-of-the-art of numerical simulation in hydrate reservoir modeling, and then to tackle problems that incorporate geomechanical processes into the mix. A kickoff workshop for the new code comparison study was held prior to the 2016 AGU fall meeting, but the study will start in earnest at the start of Fiscal Year 2018. Participation in the study is encouraged by researchers from international and national universities, research institutes, and industry.

Numerical Simulation in Scientific Disciplines

Numerical simulation is employed across a wide range of disciplines. For subsurface scientists and reservoir engineers, numerical simulators are utilized for understanding systems involving complex or coupled processes. The petroleum industry depends on numerical simulation to forecast reservoir lifetimes, schedule water-alternating-gas cycles, and select production strategies, such as well infilling versus enhanced oil recovery. Environmental scientists can assess the performance of novel subsurface remediation technologies before field deployment or testing via numerical simulation. For enhanced geothermal systems, numerical simulation is used in both the fracture stimulation and fluid circulation stages. These systems are controlled by coupled thermal, hydrological, geomechanical, and geochemical processes, which yield problems untenable by analytical methods.

What is numerical simulation? Numerical simulation solves a suite of mathematical equations in an attempt to describe interrelated physical processes. Typically, these equations do not completely describe the modeled system; instead, assumptions are made and some complexities are simplified in order to generate practical equations. This is where the art of numerical modeling comes in—the modeler must decide how to mathematically describe observed processes, such as gas hydrate dissociation in geologic media, and they must select which equations to include in order to obtain meaningful results.

Numerical Simulation Applied to Gas Hydrate Reservoirs

Many numerical simulators used to model gas hydrate reservoirs parcel the ground into three-dimensional chunks and solve a collection of mathematical equations within and between adjacent chunks. The time it takes to solve gas hydrate production problems depends on how finely the ground is parceled and how many equations are being solved. If one includes too many equations or discretizes the ground too finely, the execution speed suffers. Conversely, if one excludes critical processes, or divides the reservoir too coarsely, simulation results do not match real-world and laboratory observations. Figure 1 provides an example of a numerical simulation result used to predict gas hydrate reservoir behavior at the Igñik Sikumi well after the mixed gas injection period.

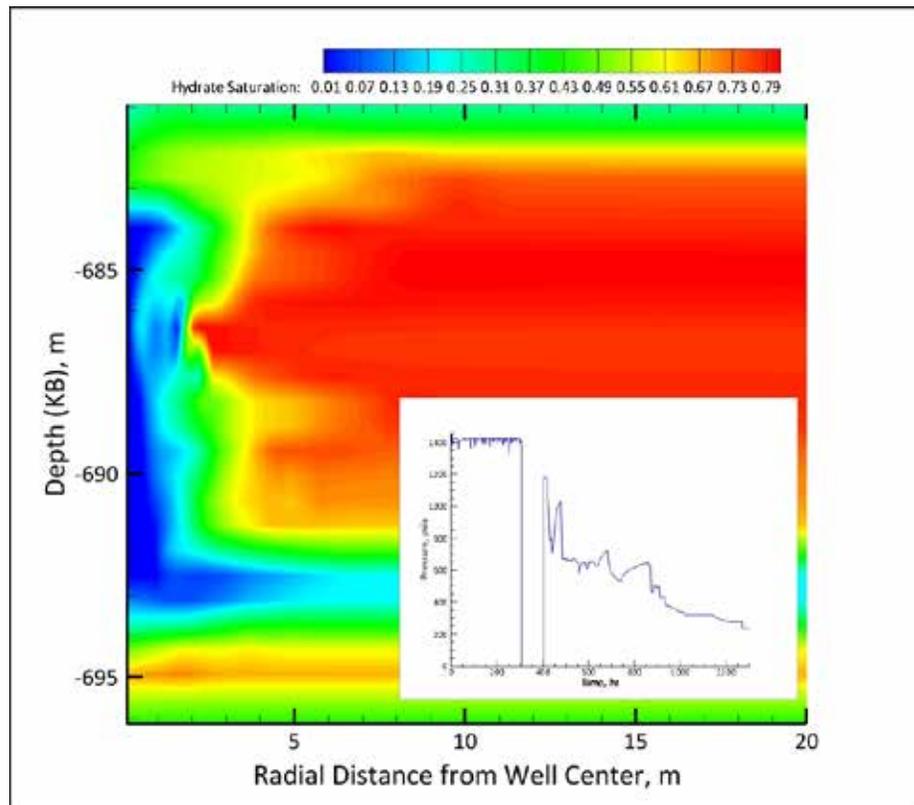


Figure 1. Numerical simulation was used to predict the distribution of hydrate equilibrium pressure surrounding the Igñik Sikumi well at the end of the mixed-gas injection period.

Modern numerical simulators have become increasingly complex with the evolution of computers. Gordon Moore, the co-founder of Fairchild Semiconductor and Intel, published a paper in 1965 that stated that the number of transistors in an integrated circuit doubled every year, and, in 1975, he revised the forecast to every two years. This observation has held until recently, and the impact on numerical simulators has been a vast increase in the number of equations that may be included in numerical simulations. Computer codes today for modeling gas hydrate production can comprise millions of lines of coding and be designed to operate on single-processor computers, shared-memory multiple processor computers, and distributed-memory multiple processor computers

(so-called supercomputers). While this increased computational power allows scientists and engineers to tackle problems of greater and greater complexity and dimensionality, at the same time, we are more vulnerable to human error in the computer codes.

The Need for Code Comparison

Code comparison studies are an effective approach to verifying numerical simulators. The core strategy behind a code comparison study is to develop a common set of problems to be solved by teams of researchers with various numerical simulators and then compare simulation results. Code comparison studies are most effective when the problems isolate specific physical processes, and multiple problems are developed to cover a range of reservoir conditions or production strategies. For example, the Geothermal Technologies Office just completed a two-year code comparison study of numerical simulators developed by selected universities and U.S. National Laboratories for enhanced geothermal systems, involving both benchmark and challenge problems. Results are used to identify areas where simulators converge on a consistent and robust result vs problem areas, where follow-up work is needed on code development.

In 2006, NETL and the USGS guided the first international code comparison study for gas hydrate reservoir simulators (see [Fire in the Ice, Winter 2007 issue](#), p. 5). That code comparison study considered problems that ranged in complexity and dimensionality and were focused on coupled thermal, hydrologic, and hydrate thermodynamic processes for thermal stimulation and depressurization production technologies. Hydrate reservoir simulators have evolved significantly since that study was conducted, and this new study is being launched to review the current state of the art and to incorporate geomechanical processes into the test problems.

To learn more about the new study, please contact Yongkoo Seol (yongkoo.seol@netl.doe.gov), Mark White (mark.white@pnnl.gov), Tim Kneafsey (tjkneafsey@lbl.gov), or Ray Boswell (ray.boswell@netl.doe.gov).

EXPLORING U.S. ATLANTIC MARGIN METHANE SEEPS WITH A REMOTELY-OPERATED VEHICLE

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In May 2017, scientists from the U.S. Geological Survey (USGS) and the British Geological Survey (BGS) led an expedition that used Oceaneering's *Global Explorer* remotely-operated vehicle (ROV) to survey seafloor methane seeps located on the U.S. upper continental slope offshore Delaware, Maryland, and Virginia (Figure 1). The *Interagency Mission for Methane Research at Seafloor Seeps: MidAtlantic* (IMMeRSS) was sponsored by NOAA's Office of Ocean Exploration and Research, the USGS and BGS, and DOE's Methane Hydrates Research and Development Program. The IMMeRSS project built on the results of previous multidisciplinary studies conducted by the USGS and others since the discovery of hundreds of upper slope methane seeps on this part of the Atlantic margin starting in 2011 (for more information, see Skarke and others article, listed under Further Reading).

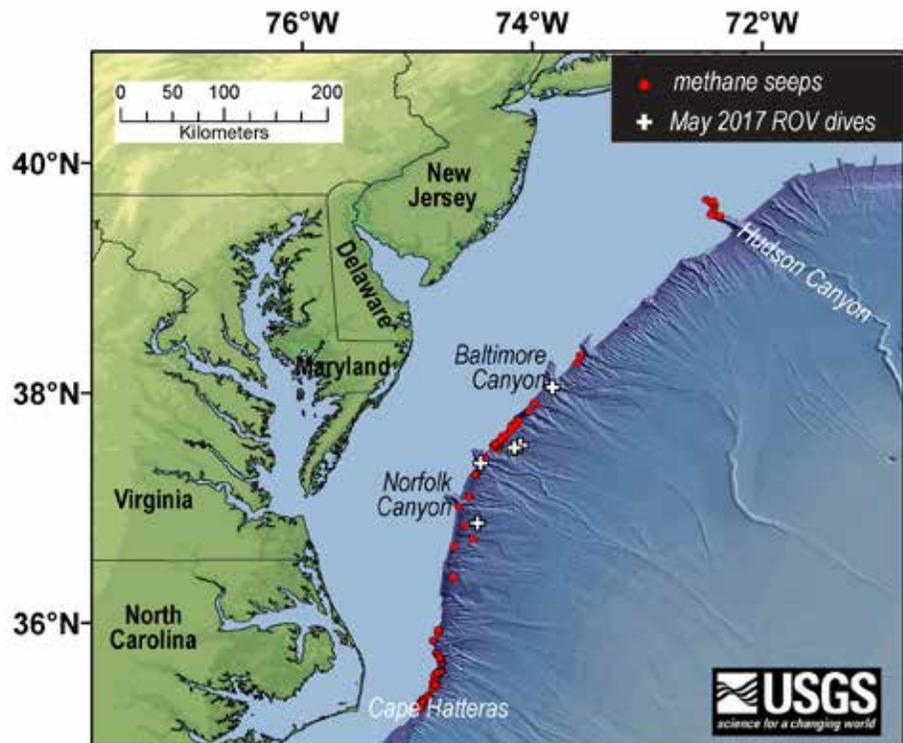


Figure 1. The IMMeRSS expedition conducted five *Global Explorer* ROV dives at the locations marked by the white crosses. Red circles show the locations of methane seeps identified on the margin since 2012.

The *Global Explorer* conducted five scientific dives during the cruise aboard the *R/V Hugh R. Sharp*. Three dives were carried out at deep water (>1000 m water depth) methane seeps that originate well within the gas hydrate stability zone. These seeps had earlier been interpreted as

leaking old methane of microbial origin from accumulations within now-fractured Eocene rock. The other two dives visited upper slope seeps at depths shallower than the landward limit of gas hydrate stability. One of these is the well-characterized Baltimore Canyon site and the other was the Washington Canyon discovery site, which had never before been seen by scientists.

One of the *Global Explorer* discovery dives visited deep water seeps first located by the USGS aboard the *R/V Armstrong* in March 2016 using water column imaging technology. Video recorded by the *Global Explorer* revealed effusive, sometimes pulsing, patterns of bubble emissions at the site (Figure 2), in contrast to the more continuous, discrete mode of bubble emission so far observed at other seeps north of Cape Hatteras. Like other deep water seep sites surveyed during the cruise, the newly-discovered site also had extensive beds of chemosynthetic mussels that rely on methane and/or hydrogen sulfide to fuel their metabolic processes.

A major focus of the expedition was the collection of methane-derived authigenic carbonate samples (Figure 3) that will be used by BGS to determine the age of methane emissions at the seeps. Coincident seawater and sediment samples collected by *Global Explorer* will constrain the source and character of the methane emissions. Compiled maps showing the spatial distributions of healthy mussels, other benthic organisms, and bacterial mats should reveal the locations of recent methane seepage. During the cruise, the USGS also acquired new multibeam and split-beam water column imagery that identified previously-unknown plumes and surveyed over previously-identified plumes that were not active at the time of the surveys.

Public outreach was a critical component of the IMMERS expedition. Oceaneering, Inc. supplied the equipment to enable Internet streaming of the video acquired at the seafloor during the *Global Explorer* dives, and NOAA logged over 74,000 views of the videostream during the cruise. The USGS and BGS supplemented the video feed with social media posts to Facebook and Twitter, and the USGS recorded a more than 2000% increase in Facebook engagement during the period that included the cruise. Social media engagement was particularly high on posts that included video clips and human interest (e.g., life at sea, profiles of the ship's crew and the science party).

The IMMERS expedition marked the third USGS-led and partially DOE-sponsored cruise focused on U.S. Atlantic margin seeps north of Cape Hatteras since 2015. The data from these cruises are providing insights into methane sources, the underlying gas hydrate reservoir dynamics (Figure 4), and the driving forces for methane emissions.

Acknowledgments

Ship and ROV costs for IMMERS were sponsored by the NOAA Office of Ocean Exploration and Research through interagency agreement 16-01118 with the USGS. Additional support for the project is provided by the USGS, the British Geological Survey, and the U.S. Department of

SUGGESTED READING

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Prouty, N.G., Sahy, D., Ruppel, C.D., Roark, E.B., Condon, D., Brooke, S., Ross, S.W., and Demopoulos, A.W.J., 2016, Insights into methane dynamics from analysis of authigenic carbonates and chemosynthetic mussels at newly-discovered Atlantic Margin seeps, *Earth and Planetary Science Letters*, v. 449, pp. 332-344, doi:10.1016/j.epsl.2016.05.023

Skarke, A., Ruppel, C., Kodis, M., Brothers, D., and Lobecker, E., 2014, Widespread methane leakage from the seafloor on the northern US Atlantic margin, *Nature Geoscience*, v. 7, pp. 657-661, doi:10.1038/ngeo2232

Toran, A., Ruppel, C., Demopoulos, A., and N. Prouty, N., 2017, Real-time public engagement in deep-water remotely operated vehicle dives at methane seeps, *Sound Waves*, May 2017, Online: <https://soundwaves.usgs.gov/2017/05/outreach.html> (online only)

Energy under interagency agreement DE-FE0023495 with the USGS. The cruise was only possible due to outstanding support from the pilots and engineer for the *Global Explorer*, the crew of the *R/V Hugh R. Sharp*, and operational and technical personnel from the USGS. Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.



Figure 2. Dense plumes of methane bubbles emitted at vents within beds of chemosynthetic mussels at ~1000 m water depth on the Virginia margin. Gas hydrate is stable in the water column to at least 575 m above the seafloor. Image acquired by Oceaneering, Inc.



Figure 3. The mechanical arm of the *Global Explorer* ROV samples methane-derived authigenic carbonate near a seep site on the Virginia margin. The British Geological Survey will conduct uranium-thorium geochronologic analyses on the rocks to determine the timing of methane emissions. Image acquired by Oceaneering, Inc.

SUGGESTED READING CONTINUED

Weinstein, A., Navarrete, L., Ruppel, C., Weber, T.C., Leonte, M., Kellermann, M.Y., Arrington, E.C., Valentine, D.L., Scranton, M.I., and Kessler, J.D., 2016, Determining the flux of methane into Hudson Canyon at the edge of methane clathrate hydrate stability, *Geochem. Geophys. Geosyst.*, v. 17, pp. 3882–3892, doi:[10.1002/2016GC006421](https://doi.org/10.1002/2016GC006421)

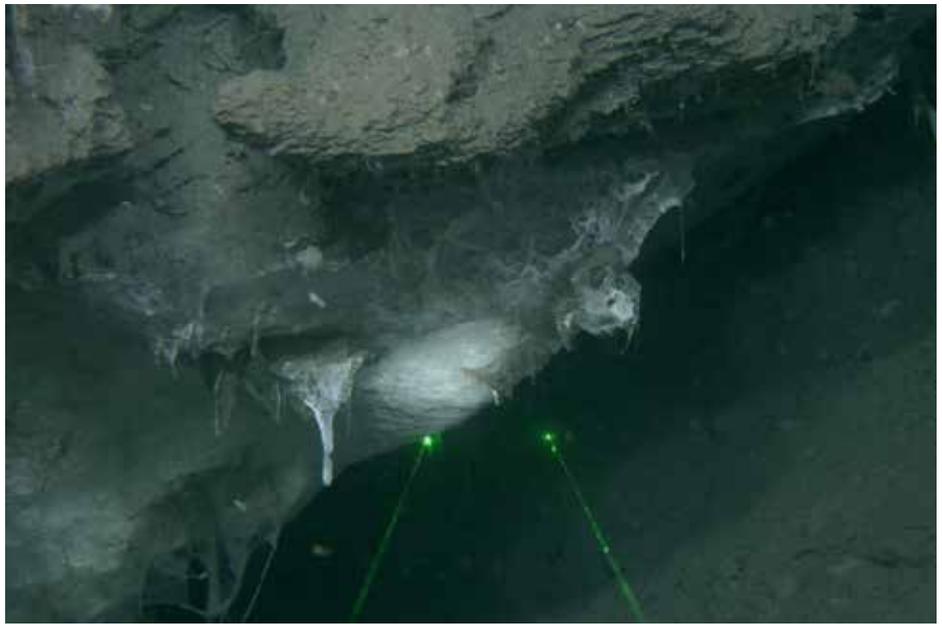


Figure 4. Gas hydrate accumulated under a carbonate ledge at a deep water seep site on the Virginia margin. Lasers are separated by 10 cm. Image acquired by Oceaneering, Inc.

Announcements

IODP EXPEDITIONS TO FEATURE GAS HYDRATE SCIENCE

The International Ocean Discovery Program (IODP) has approved and scheduled deployment of the *R/V JOIDES Resolution* for two future expeditions to study marine gas hydrates.

Expedition 372 will take place November 26, 2017- January 4, 2018 along the Hikurangi margin, off the east coast of New Zealand. The objective will be to investigate the role of gas hydrate in seafloor instability, particularly in slow, downhill creep. It will be led by chief scientists Ingo Pecher (University of Auckland, New Zealand) and Philip Barnes (National Institute of Water and Atmospheric Research, New Zealand). Further information on IODP Expedition 372 can be found at:

https://iodp.tamu.edu/scienceops/expeditions/hikurangi_gas_hydrate_slides.html

Expedition 386 is currently scheduled for 2020 and will be conducted in the Gulf of Mexico. The objective is to explore the origin, sourcing, and evolution of concentrated gas hydrates in sand-rich sediments. Expedition 386 will be led by the GOM2 Science team, under the leadership of Peter Flemings (University of Texas at Austin). Further information on IODP Expedition 386 can be found at:

http://iodp.tamu.edu/scienceops/expeditions/gulf_of_mexico_hydrate.html



IODP
INTERNATIONAL OCEAN
DISCOVERY PROGRAM



Announcements

GAS HYDRATE SESSIONS PLANNED FOR AGU FALL MEETING

Technical sessions on gas hydrates are being planned for the upcoming AGU Fall Meeting, to be held December 11-15, 2017 in New Orleans, Louisiana.

Abstracts have been received and are being evaluated and organized into two sessions (subject to change, based on abstracts received):

OS013. Naturally Occuring Gas Hydrates, convened by S. Haines, K. Darnell, Y. Yamada, and T. Collett; and

OS005. Gas Hydrate Environments: Genesis, Stability, and Influence on Seafloor Morphology and the Biosphere, convened by G. Snyder, S. Lin, N. Sultan, and T. Matsumoto.

For more detailed information on each session, please visit the AGU Fall Meeting web site at: <http://fallmeeting.agu.org/2017/>

JOURNAL OF GEOPHYSICAL RESEARCH SPECIAL COLLECTION ON GAS HYDRATES

The American Geophysical Union's *Journal of Geophysical Research (Solid Earth)* will publish a special collection of papers focused on gas hydrates in porous media. Guest Associate Editors for the collection are Dr. Carolyn Ruppel (US Geological Survey; cruppel@usgs.gov) and Dr. Joo Yong Lee (Korean Institute of Geoscience and Mineral Resources; jyl@kigam.re.kr). The official call for papers has been posted here: [http://agupubs.onlinelibrary.wiley.com/hub/jgr/journal/10.1002/\(ISSN\)2169-9356/features/call-for-papers.html](http://agupubs.onlinelibrary.wiley.com/hub/jgr/journal/10.1002/(ISSN)2169-9356/features/call-for-papers.html)

Papers must be submitted between 1 August, 2017 and 15 February, 2018. The papers will be published as they are accepted and will later be collected into a virtual online special collection with links to other seminal gas hydrates papers published by AGU.

All papers must be submitted through the AGU electronic system (GEMS) and must conform to the rigorous editorial standards of the AGU and JGR. There is no requirement that authors contact the guest editors prior to submission. Authors wishing to submit papers that expand on recent conference proceedings should contact the Guest Associate Editors for guidance in avoiding perceptions of duplicate publication, which could cause delays in the review process.



Announcements



Gordon Research
Conferences
Frontiers of Science

2018 GORDON RESEARCH CONFERENCE AND GORDON RESEARCH SEMINAR ON NATURAL GAS HYDRATE SYSTEMS

Conference

A Gordon Research Conference on methane hydrate science will be held February 25- March 2, 2018 in Galveston, Texas. The full title of the meeting is “The Symbiotic World of gas Hydrate Laboratory, Modeling, and Field Research to Assess the Role of Gas Hydrates as an Energy Resource, Geohazard, and as an Agent of Climate Change.”

The conference aims to link the latest advances in gas hydrate science to current issues of scientific, economic, and societal relevance. It will promote an integrated approach to fundamental research and technology development, encompassing global field programs, where tools are being developed for gas hydrate characterization, detection and monitoring, multi-scale modeling from microstructure to reservoir scale, and system assessments. The meeting is being organized by Carolyn Koh (ckoh@mines.edu) and Timothy Collett (tcollett@usgs.gov).

Applications to attend the conference must be submitted by January 28, 2018. Early applications are encouraged, as these meetings do become full. For more information, please visit: <https://www.grc.org/programs.aspx?id=14541>

Seminar

A related Gordon Research Seminar will be held February 24-25, 2018 at the same location. The full title of the seminar is “Advancing the Integration of Hydrate Laboratory, Modeling, and Field Research.”

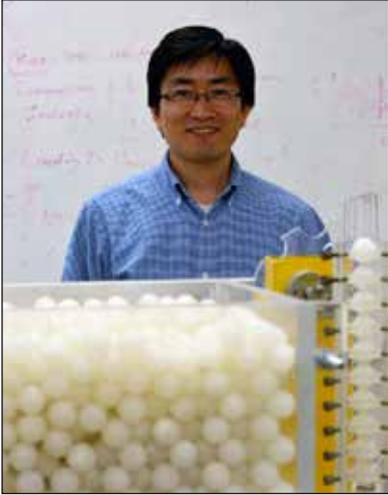
The seminar is a forum for graduate students, post-docs, and other scientists to exchange new data and innovations related to the role of methane hydrates in energy production, geohazards, and climate change. The seminar will explore next generation tools and methods developed and implemented for gas hydrate detection, characterization, monitoring, and modeling from the microstructure to reservoir scales. The seminar is being organized by Thomas Charlton (thomas.charlton@research.uwa.edu.au).

All seminar participants are expected to present a poster or an oral presentation, so all applications must include an abstract. Applications for the Gordon Research Seminar *oral presentations* must be submitted by November 24, 2017. Applications for *poster presentations* must be submitted by January 27, 2018. For details, please visit: <https://www.grc.org/programs.aspx?id=16577>



Gordon Research Seminars

Spotlight on Research



SHENG DAI

Professor, School of Civil Engineering and Environmental Engineering, Georgia Institute of Technology

From Nanjing to Atlanta

Professor Sheng Dai grew up in a small town near Nanjing, China. The younger of two brothers, he spent much of his childhood playing in ponds and rivers near his home, catching fish and crawdads and other critters. As a school boy, Sheng developed a passion for basketball and table tennis and even entertained the notion of becoming a professional ping pong player. His parents did not consider this a serious career path. But they were not worried—they were content to let him enjoy his childhood exploring outside with friends.

It was not until middle school and high school that Sheng began to take school seriously, to study hard, and to distinguish himself as a top student. He developed a strong interest in physics and enjoyed discovering the hidden rules that govern how things work in the natural world. His high school teachers recognized his gift for academic achievement and coached him to pursue a degree in engineering. His parents and grandparents, who had not had opportunities themselves for higher education, encouraged Sheng to go to college. They did not push him toward a particular field.

Sheng left his hometown to study a broad range of engineering fields at Tongji University, a highly prestigious school in the city of Shanghai. He settled on civil engineering, and, after graduation, he knew that he wanted to pursue a career as an academic researcher and professor. Sheng explains, “I realized that I could gain deep and long-lasting pleasure in an environment of continuous learning. I like the combination of hard work and critical thinking. It requires a level of dedication that is sometimes accompanied by frustration and difficulty. But there is always the reward of looking back and seeing all that one has accomplished.”

Sheng went on to pursue his PhD at Georgia Tech, where he studied Geosystems Engineering under the direction of J. Carlos Santamarina. Sheng says “Professor Santamarina brought me into the hydrate world and provided unconditional support to help me grow as an independent researcher.” After completion of his PhD in 2013, Sheng was hired on as a post-doc at NETL in Morgantown, working closely with NETL’s gas hydrate research team, under the mentorship of Dr. Yongkoo Seol.

Late in 2014, Sheng spotted an opening for an engineering professorship at his alma mater, Georgia Tech. He applied and was offered the position. He returned to Georgia Tech in 2015, as an assistant professor in the School of Civil and Environmental Engineering. His current research interests are focused on how soils behave during infrastructure construction, hydrocarbon extraction, and natural hazards. He enjoys teaching and advising students, and learning new things every day from colleagues and collaborators. His one bit of advice for students who may be considering a career in science and engineering is “always remain curious.”

When he is not working, Sheng enjoys jogging, working in his vegetable garden, and spending time with his wife and two young children.

