

EMD Gas Hydrates Committee Report

May 7, 2015

Art Johnson, P.G., Chairman, Hydrate Energy International, Kenner, Louisiana

Vice-Chairs:

TBA, (Vice-Chair: Industry)

TBA, (Vice-Chair: Government)

United States Gas Hydrate Program

The U.S. program has a two-pronged approach, focusing on both the North Slope of Alaska and the Gulf of Mexico. The next U.S. field test is being developed under the leadership of the University of Texas at Austin, in partnership with The Ohio State University, Columbia University-Lamont-Doherty Earth Observatory, the Consortium for Ocean Leadership and the U.S. Geological Survey. Their four-year exploratory program will characterize prospective drilling locations in the Gulf of Mexico, then in 2018 drill and collect pressure cores and well logs as well as conducting short-duration pressure drawdown tests.

On the North Slope, the program is pursuing two options with Japan for a long-term test. The program is evaluating unleased acreage the State of Alaska has set aside temporarily for this test, and is also exploring the possibility of testing within one of the producing units.

The program continues to fund various researchers to evaluate gas hydrate dynamics in response to changing environments and implications for ocean-ecology and climate change feedback.

The U.S. program had been severely scaled back in recent years; however it has been revitalized by the announcement in October 2014 of a 4-year program that includes \$41,270,609 of DOE funding and a cost share of \$17,030,884

Researchers at the Office of Fossil Energy's National Energy Technology Laboratory (NETL) were part of an international team, including the United Nations Environmental Programme (UNEP) that contributed to a newly released report explaining the prospect of gas hydrate as a potential worldwide energy source that can contribute in the transition to the low-carbon energy systems of the future. "Frozen Heat: A Global Outlook on Methane Hydrates" details the science and history of gas hydrate, evaluates the current state of gas hydrate research, and explores the potential impacts of gas hydrate on the future global energy mix. The report notes that gas hydrate contains an immense quantity of methane gas that, when combusted, emits up to 40 percent less carbon dioxide than coal and 20 percent less than oil. According to the report, there may be regions in the world that realize meaningful production of natural gas from gas hydrates in the next 10 to 20 years.

Gas Hydrate: India

The second leg of India's gas hydrate drilling program commenced in February 2015, utilizing the drillship D/V Chikyu. Approximately 170 days of operations are planned, with 20 deep LWD holes and 10 core sites in the northern Bay of Bengal. The program is targeting hydrate-bearing sands with a focus on reservoir delineation and resource assessment. The goal is to identify an optimal site for a future production test.

Results of India's first gas hydrate drilling program were published in December 2014 in *Marine and Petroleum Geology*. That program included a 113.5-day voyage from April 28 to August 19, 2006 during which the expedition cored or drilled 39 holes at 21 sites (one site in the Kerala-Konkan Basin, 15 sites in

the Krishna-Godavari Basin, four sites in the Mahanadi Basin, and one site in the Andaman deep offshore areas). The drilled holes penetrated a total of more than 9,250 meters of sedimentary section, and recovered nearly 2,850 meters of core. Twelve holes were logged with logging-while-drilling (LWD) tools and an additional 13 holes were wireline logged.

Gas Hydrate: Japan

Japan's gas hydrate program continues to evolve. In a move to become a commercial rather than governmental project, a new industrial joint venture corporation was formed on October 1, 2014. The "Japan Methane Hydrate Operating Company" (JMH) was formed with the agreement and capital participation of 11 companies engaging in oil and natural gas development and in plant engineering. Commercial production of natural gas from hydrate is expected to commence from the Nankai area on Japan's Pacific margin within 3 years.

Japan has expanded its gas hydrate program beyond the Nankai area and is funding programs to explore the Sea of Japan and conduct an assessment. The areas being explored in the Sea of Japan are off the Joetsu region and off of the Akita and Yamagata regions (Figure 1). Based on the initial results of a June, 2014 drilling program, the assessment is focused on "shallow" hydrates, the term used by Japan's Agency for Natural Resources and Energy (ANRE) for chimney/fracture-fill occurrences. This represents a new development since throughout the world all commercial considerations for production of gas from gas hydrate have involved hydrate-bearing sands. It is unclear whether a viable production technology for fracture-fill hydrate is being investigated.



Figure 1. Basins drilled by the Japanese ANRE expedition in 2014.

Gas Hydrate: South Korea

As a part of the Korean National Gas Hydrate Program, a production test in the Ulleung Basin had been planned for 2015 but its current status is uncertain. The targets are the gas hydrate-bearing sand reservoirs that were found during the Second Ulleung Basin Gas Hydrate Drilling Expedition (UBGH2) in 2010.

Gas Hydrate: European Union

The European Cooperation for Science and Technology (COST) has initiated MIGRATE (Marine Gas Hydrates: An Indigenous Resource of Natural Gas for Europe), a program to integrate the expertise of a large number of European research groups and industrial players to promote the development of multidisciplinary knowledge on the potential of gas hydrates as an economically feasible and environmentally sound energy resource. In particular, MIGRATE aims to determine the European potential inventory of exploitable gas hydrates, to assess current technologies for their production, and to evaluate the associated risks. National efforts will be coordinated through Working Groups focusing on 1) resource assessment, 2) exploration, production, and monitoring technologies, 3) environmental challenges, 4) integration, public perception, and dissemination. Study areas will span the European continental margins, including the Black Sea, the Nordic Seas, the Mediterranean Sea and the Atlantic Ocean.

MIGRATE will examine the potential of gas hydrates as an economically feasible and environmentally sound energy resource. Stefan Bünz, associate professor at Centre for Arctic Gas Hydrate, Environment and Climate (CAGE) at The Arctic University of Norway, was elected the Vice Chair of the action. Three working groups have been established in MIGRATE: resource assessment; exploration, production and monitoring technologies; and environmental and geohazard challenges.

Gas Hydrate: Turkey

After many years of planning, Turkey has begun an extensive evaluation of the nation's gas hydrate potential in the Black Sea. The program is being led by Dokuz Eylül University in conjunction with the Turkish National Oil Company (TPAO). This comprehensive program includes depositional modeling that integrates onshore and offshore studies, hydroacoustic and geophysical surveys (multibeam, sonar, chirp, high-resolution seismic acquisition, and bathymetry surveys), water column sampling, sediment sampling, laboratory studies, and computer modeling. The initial cruise began in March and data collection will continue for more than one year.

After three years, a second phase is planned that will include 3D seismic and electromagnetic data acquisition, along with evaluation and development of production technology.



Figure 2. Mediterranean and Black Seas

Gas Hydrate: New Zealand

As part of a larger project focused on understanding the dynamic interaction of gas hydrates and slow moving active sediment mass flows, a joint New Zealand-German research team mapped a large area of hydrate-bearing sediment off New Zealand's eastern coast in April and May, 2014. The project utilized 3D and 2D seismic data and found evidence of gas hydrate along with 99 gas plumes venting from the seafloor. The plumes formed columns extending up to 250 meters into the water column. The venting and the presence of gas hydrate have significant implications for slope failure along New Zealand's coastal margin.

New Zealand also has an active research program investigating the resource potential of New Zealand's gas hydrate deposits. The program is led by GNS Science, in collaboration with NIWA, the University of Otago, and the University of Auckland; with funding from the Ministry of Business, Innovation, and Employment. The current program builds on a 2010-2012 pilot program funded by the Foundation for Research, Science, and Technology.

The key objectives for the resource assessment program are to study the regional distribution of gas hydrate and to characterize individual gas hydrate reservoirs. The initial area of investigation is a zone outside of the Hikurangi Margin. This characterization effort is utilizing analysis of seismic data to improve the understanding of gas-hydrate reservoir rocks and investigation of gas-hydrate-formation mechanisms. Initial production modelling has been completed as well as a first assessment of seafloor communities that may be affected by gas hydrate production. The overarching goal within the current program is to identify targets for scientific exploration drilling.

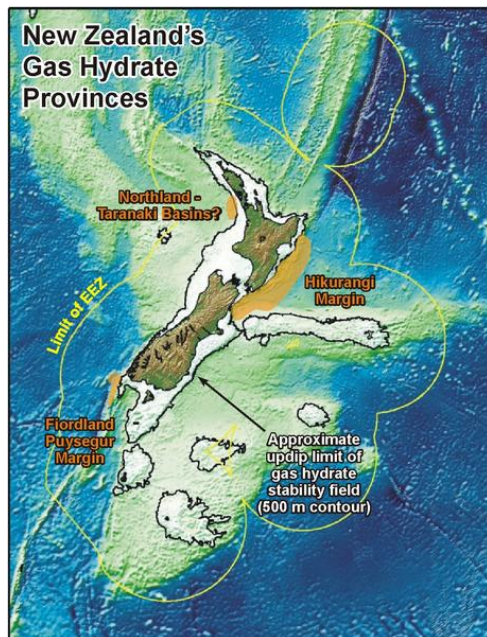


Figure 3. New Zealand's Gas Hydrate Provinces

In its 2015 lease offering for the Offshore Pegasus and East Coast Basins, the Petroleum and Minerals Department of New Zealand's Ministry of Business, Innovation and Employment, noted that the basins (Fig. 4) are prospective for oil, gas, and for **gas hydrates**.

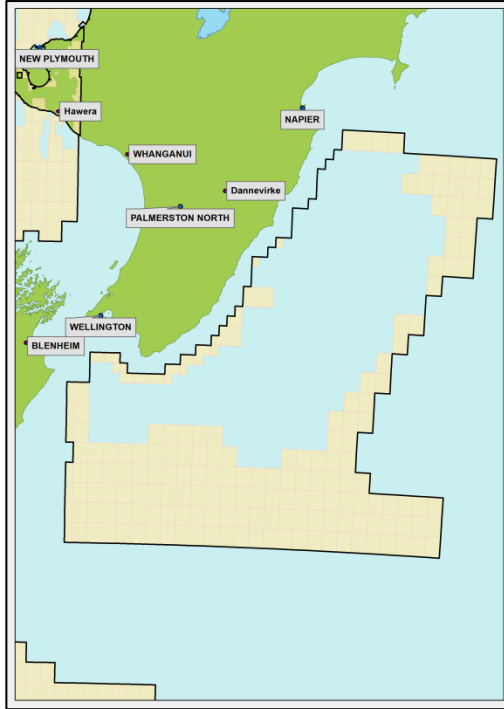


Figure 4. Offshore NE New Zealand Pegasus and East Coast Basins

Meetings:

The American Geophysical Union (AGU) annual meeting was held in San Francisco December 15 – 19, 2014, with 46 abstracts in four sessions accepted for oral or poster presentation.

The 2015 Offshore Technology Conference (OTC) was held in Houston from May 5-8. Although there were no sessions specifically focused on gas hydrate, several of the papers presented included discussions of gas hydrate as related to drilling safety.

The AAPG P3 Arctic Conference will be held September 29 – October 2, 2015 in Stavanger, Norway. The conference includes a session on “Geological Occurrence and Implications of Gas Hydrates in the Circum Arctic”

Other National Programs

Gas hydrate characterization programs are also underway in Brazil, Colombia, Iran, Mexico, South Africa, Uruguay, and Vietnam. As Japan achieves full commercial production within the next several years, it is likely that other nations with deepwater coastal margins will initiate programs to assess the gas hydrate resource potential off their shores.

Publications of Note:

Marine and Petroleum Geology, Volume 58, Part A , Pages 1-550, December 2014

“Geologic implications of gas hydrates in the offshore of India: Results of the National Gas Hydrate Program Expedition 01”

Edited by M.V. Ramana, T Ramprasad, Timothy S. Collett, P Kumar, R. M Boswell, Michael Riedel, A.V Sathe, M Lall, Krishna Vishwanath, A Muzumdar, Kalachand Sain and James Cochran

“Frozen Heat: A Global Outlook on Methane Hydrates”

The United Nations Environmental Programme released this new, two-volume report in March 2015. The publication details the science and history of gas hydrates, evaluates the current state of gas hydrate research, and explores the potential impact of this untapped natural gas source on the future global energy mix. An executive summary of report is also available. Researchers from the National Energy Technology Laboratory were part of an international team that contributed to the report.

The NETL semi-annual publication “Fire in the Ice” continues to be a primary venue for the dissemination of news and research results.

Fire in the Ice may be downloaded from <http://www.netl.doe.gov/research/oil-and-gas/methane-hydrates/fire-in-the-ice>

Recent articles include:

- Concentrated Gas Hydrate Deposits in the Kumano Forearc Basin, Nankai Trough, Japan
Katie B. Taladay and Gregory F. Moore University of Hawaii at Manoa
- Recent Advances in NETL's Laboratory Studies of Hydrate- Bearing Sediments
Yongkoo Seol, Jeong-Hoon Choi, Sheng Dai, and Karl Jarvis U.S. Department of Energy, National Energy Technology Laboratory
- Initial Interpretation of Results from the Ignik Sikumi Gas Hydrate Exchange Field Trial
- A Fresh Look at the Mediterranean and Black Sea Basins: Potential for High-Quality Hydrate Reservoirs, Michael D. Max, Arthur H. Johnson, Hydrate Energy International

The November 2015 issue of “Interpretations” will include a special section on the topic “Exploration and Characterization of Gas Hydrates”.

The papers are intended to document the latest techniques, concepts, and findings from the evaluation of gas hydrate accumulations in either deepwater or permafrost-associated settings. The emphasis is on the description of gas hydrate occurrence in nature as revealed through integrated geological and geophysical investigation.

Proposed topics include:

- Regional resource assessment and characterization
- Prospecting approaches for occurrences with energy resource potential
- Evaluation of potential reservoir quality and productivity
- Integration of well and seismic data in hydrate-bearing regions
- Lithologic controls of gas hydrate occurrences through time
- Geohazard evaluation
- Characterization of gas hydrate occurrence in climate-sensitive settings

Editors for the special section are: Ray Boswell, Tim Collett, Matthew Frye, Stefan Buenz, Ingo Pecher, Thomas Reichel, Dan McConnell, Jurgen Mienert, Tetsuya Fujii, Byong Jae Ryu, Kook-Sun Shin, and Dianna Shelander