EMD Gas Hydrate Committee

2016 EMD Gas Hydrate Committee Mid-Year Report

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EXECUTIVE SUMMARY

Gas hydrate exploration and development activity is continuing in several countries despite the drop in global LNG prices and the continued low, natural gas price in North America.

The results India's 2015 drilling, logging and coring program under its National Gas Hydrate Program (NGHP) were released through a series of presentations at the May Offshore Technology Conference (OTC) and a summary article in the Fire in the Ice Newsletter. Significant results include the verification of pre-drill predictions for hydrate-bearing sands and the evaluation of reservoirs having potential for commercial development. India is planning a new exploratory phase that will commence in January 2017 and will include production tests.

Japan has begun drilling for its next phase of gas hydrate evaluation in the Nankai area.

As part of the OTC session, Ray Boswell (U.S. National Energy Technology Laboratory) presented an update on the state of gas hydrate production technology. Based on production tests and log and core analysis, Boswell reported that models has yielded estimates for sustained gas production of 8 million cubic feet per day from Nankai (offshore Japan) and 12-25 million cubic feet per day at Walker Ridge 313 (U.S. Gulf of Mexico). As these estimates are extrapolations from limited tests, they will need to be confirmed with actual industry-scale flow tests.

STATUS OF U.S. GAS HYDRATE ACTIVITIES

The U.S. program led by the University of Texas (Austin) will be conducting pressure core sampling at Green Canyon 955 (U.S. Gulf of Mexico) where natural gas hydrate was logged with LWD tools under the Joint Industry Program in 2009. Drilling at some additional locations is under review, possibly in 2019.

On June 17, 2015, U.S. Secretary of Energy, Dr. Ernest Moniz, asked the Secretary of Energy Advisory Board (SEAB) to form a task force to review the U.S. Department of Energy's (DOE's) methane hydrate research program. The charge was to evaluate the program's pre-commercial research activities and progress in (1) understanding the assessment and exploitation of hydrates as an energy resource, and (2) understanding the environmental impact of hydrates, whether as a result of naturally occurring phenomena or of human activity. The report was released on January 26, 2016.

Issues of particular interest included the cooperation of the United States with foreign governments in international research collaborations to investigate hydrates; the participation of such diverse stakeholders as governments, national laboratories, academic institutions, and industry; and the location, design, and execution of field experiments necessary to achieve the program's goals.

Among the task force's key findings and recommendations are the following:

- The program has made valuable scientific contributions since 2000 and should remain a DOE priority. Funding should remain at its current Fiscal Year (FY) 2015 level of $15 million per year. Given the long-term nature of the program, there should be greater funding certainty than in the past.
- Approximately one-third of the program budget should be dedicated to fundamental scientific questions whose answers are necessary for understanding methane hydrates as an energy resource and their environmental impact. Two-thirds of the program budget—approximately $10 million per year—would be used to support U.S. participation in larger international hydrates activities and complex field research.
- The United States views its cooperation with foreign governments on international energy security as a high priority. As such, a $15 million-per-annum hydrates research program is a small investment for keeping U.S. core capabilities relevant and for supporting other countries' efforts to develop their methane hydrates resources more effectively, which they see as both a promising contribution to energy security in future decades and a way to reduce coal consumption. Continued U.S. participation would help assure rigor in international activities, enabling all participants to benefit from international investments and avoid U.S. exclusion from development and information about the technology.
- The program should build on prior strong external engagement to enhance and increase industry input in a strategic direction setting, and on external academic engagement to set program priorities and provide peer review. Field experiment design should be more clearly defined in the context of program objectives, with more engagement of industry on planning.

The full report is available at:
http://energy.gov/seab/downloads/report-task-force-methane-hydrates

DOE has announced a funding opportunity related to characterization of gas hydrate deposits and their role in the natural environment. The specific objectives are:

- Fundamental laboratory and numerical simulation studies of gas hydrate reservoir response to potential production activities
- Fundamental field, laboratory and numerical simulation studies of the development and evolution of gas hydrate-bearing systems and their response over various temporal and spatial scales to natural perturbations

The current proposed 2017 DOE budget for Gas Hydrate is $2.5 million.

On April 13 Chris Smith the DOE announced the appointment of Mr. Neelesh Nerurkar as Deputy Assistant Secretary for Oil and Natural Gas with oversight for gas hydrate programs.

STATUS OF INTERNATIONAL GAS HYDRATE ACTIVITIES

India

India's National Gas Hydrate Program (NGHP) has announced the results of it 2015 drilling, logging, and pressure coring expedition. The program, designated NGPH-02, was conducted from March 3 to July 28, 2015 off the eastern coast of India using the deepwater drilling vessel *Chikyu*.

NGHP-01 had been conducted in 2006 and discovered gas hydrate occurring primarily as fracture-filling material in fine-grained sediments. Planning for NGPH-02 began in 2009 with a specific focus on hydrate-bearing sand reservoirs. While the drilling targets for NGPH-01 had been on outer-shelf and upper-slope settings, which were likely by-pass areas for sand deposition, NGPH-02 targeted deeper-water locations at the toe of the continental slope.

NGHP-02 was managed by the Oil and Natural Gas Corporation Limited (ONGC), with a Technical Committee included representatives from ONGC, the Ministry of Petroleum and Natural Gas (MoP&NG), the Directorate General of Hydrocarbons (DGH), ONGC, Oil India (OIL), Indian Oil Corporation Limited (IOC), GAIL (India) Limited, National Institute of Oceanography (NIO), National Geophysical Research Institute (NGRI), and the National Institute of Ocean Technology (NIOT). Project planning included a review of over 80 potential drill sites in several basins offshore India. The final list consisted of 25 sites, all of them in the Krishna- Godavari and Mahanadi Basins.

Drilling was carried out with the research vessel D/S *Chikyu*, operated by the Japanese Drilling Company (JDC). The shipboard science program was managed by the Japan Agency for Marine- Earth Science and Technology (JAMSTEC). LWD, wireline logging, and formation testing services were provided by Schlumberger. Pressure coring tools were provided by JAMSTEC, and shipboard pressure core operations and analysis were provided by Geotek Coring. Additional operational and scientific support was provided by the U.S. Geological Survey (USGS), the U.S. Department of Energy (US-DOE), Japan's National Institute of Advanced Industrial Science and Technology (AIST), and the Japan Oil, Gas and Metals National Corporation (JOGMEC).

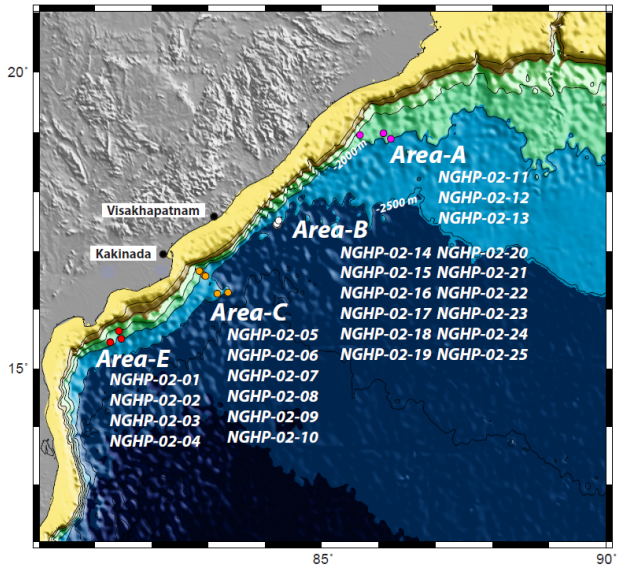

Figure 1. NGHP-02 drilling locations (from Fire in the Ice, 2016)

During March and April, 2015, the expedition conducted logging-while-drilling (LWD) operations, with 25 holes drilled and logged (Figure 1). The next three months were dedicated to coring operations at 10 of the most promising sites. It is worth noting that the five months of continuous field operations are the most comprehensive dedicated gas hydrate investigation ever undertaken. The program cost of NGHP-02 is estimated at $100 million.

Initial results of NGHP-02 were released through a series of presentations at the May Offshore Technology Conference (OTC) and in a summary article in the U.S. DOE Fire in the Ice Newsletter. Given the extensive amount of core and log data collected, there will be many technical papers in the months and years ahead that will provide additional detailed analyses. The key results announced to date include the following:

- The nature of the discovered gas hydrate occurrences closely matched pre-drill predictions, confirming the project-developed depositional models for the sand-rich depositional facies in the Krishna-Godavari and Mahanadi Basins.
- The availability of gas to charge several of the discovered reservoir systems appears to be a limiting factor for the formation of highly concentrated gas hydrate accumulations in some settings along the eastern margin of India, particularly in the Mahanadi Basin.
- The existence of a fully developed gas hydrate petroleum system was established in Area-C of the Krishna-Godavari Basin.
- The acquisition of closely spaced LWD and core holes in the Area-B L1 Block gas hydrate accumulation have provided one of the most complete three-dimensional petrophysical-based views of any known gas hydrate reservoir system in the world.
- Wireline formation pressure testing, nuclear magnetic resonance (NMR) log data, and shipboard pressure core analysis have shown that the effective permeabilities of hydrate-bearing sand reservoirs are possibly significantly higher than those interpreted from previous field and laboratory studies.
- Area-B and Area-C contain important world-class gas hydrate accumulations and represent ideal sites for the consideration of future gas hydrate production testing.

The next phase of India's program (NGHP-03) will involve the drilling of 20 wells beginning in January, 2017. Flow testing is planned from November, 2017 through the first quarter of 2018.

Japan

Japan continues to move toward commercial production of natural gas from hydrate. In evaluating data from the 2013 production test, the Japanese program recognized the need to address some critical technology issues. One of these is the need for greater sand control than previous production tests in Japan, Canada, or Alaska had achieved. As the hydrate-bearing sands are poorly consolidated, the *in situ* dissociation of the hydrate to its component gas and water, followed by flow to the wellbore, has consistently resulted in movement of the reservoir sands. Unless improved methods of sand control are developed, producing wells are expected to quickly fail.

A second issue being addressed is the technology required to restart a hydrate well after it has been shut in. While computer models indicate that hydrate reservoirs might be able to sustain production at commercial rates for many years, it is likely that the production would have to be shut in periodically during the life of a well, and then restarted. Several scenarios for accomplishing this are under consideration.

To address these issues, Japan is planning a 1-month production test. The date of the test has not been officially announced; however drilling operations were in progress in May, 2016. It should be noted that the goals of the test do not include the determination of a maximum IP rate. A timeline for commercial production has not been announced.

China

On September 1, 2015 China completed its third gas hydrate exploration program (GMGS-3), an 88-day expedition in the South China Sea. Utilizing results from the previous programs and newly acquired geophysical and geochemical data, GMGS-3 targeted a range of depositional settings with a goal of identifying gas hydrate reservoirs for future development. The expedition consisted of two LWD legs that included 19 sites, followed by a coring leg that recovered samples from four sites.

Initial results analyses indicate that gas hydrates were present at nearly all of the drilled sites. At least some of the sites included course clastic lithologies.

A fourth program is believed to have begun (GMGS-4) however details have not been made public.

European Union

The European Union's MIGRATE (Marine Gas Hydrates: An Indigenous Resource of Natural Gas for Europe) Program was convened in Malaga, Spain on October 5 and 6, 2015 and requests for proposals have been issued.

The European Cooperation for Science and Technology (COST) initiated this program to integrate the expertise of a large number of European research groups and industrial players in the field of natural gas hydrate. MIGRATE will examine the potential of gas hydrates as an economically feasible and environmentally sound energy resource 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.

The rationale behind the program is that natural gas from indigenous gas hydrate deposits should play an important role in the future European energy system. It could 1) enhance the security of energy supply, 2) contribute to the reduction of CO_2 emissions by replacing coal, and 3) complement renewable energies and stabilize the power grid by proving electricity during low-wind and/or low-light periods. Ultimately, gas hydrates could replace Europe's conventional gas reserves that will be depleted within the next decades and mitigate the growing dependence of Europe on natural gas imports.

Of the four working groups, only Working Groups 1 and 3 have published any reports. Working Group 1 (WG 1 – Resource Assessment) has published a map on "European Gas Hydrate Distribution". Working Group 3 (WG 3 – Environmental Challenges) released an annual report in February, 2016. This report outlined research needed to achieve the goals of assessing potential environmental impacts:

- Assess how slope stability may be compromised by gas production from hydrates under different geological boundary conditions;
- Identify suitable precursors/changes for slope failure to be targeted in a monitoring program;
- Develop a generic strategy for environmental baseline studies and the environmental monitoring of gas production from hydrates;
- Develop a specific environmental baseline and monitoring program for the planned production test;
- Develop a system for geohazard classification of marine gas hydrates and classify the main European gas hydrate deposits, determined from WG1;
- Evaluate whether national legal frameworks regulating offshore oil & gas production are appropriate for gas production from hydrates using Norway and Bulgaria as a case study.

The full report is available at:
https://www.migrate-cost.eu/documents/1134909/1134981/Report_WG3_26feb2016.pdf/9d12d6d4-659b-426c-991a-bdb17f775259

Industry Activity

The downturn in oil and gas prices has led to significant cuts in corporate budgets by many of the operators and service companies that had been pursuing gas hydrate potential and

technology. In addition to program cuts, many employees involved in gas hydrate have been reassigned to "core" business or have left employment.

Meetings

The Offshore Technology Conference (OTC) included a session on "Gas Hydrate Exploration and Production Testing: Encouraging Results and Future Plans" that included presentations by Timothy Collett (USGS), Ray Boswell (DOE-NETL) and Pushpendra Kumar (ONGC). These presentations summarized the current state of gas hydrate programs throughout the world, current estimates of gas hydrate resource potential, and India's 2015 NGHP-02 results. Unfortunately, the presentations are not included in the conference CD.

Significant Publications

The February 2016 issue of the AAPG/SEG journal "Interpretation" included a special section on "Exploration and Characterization of Gas Hydrates". The section contained an introductory overview and eight excellent articles providing summaries of current interpretation technology and approaches. Topics include hydrate characterization and quantification, along with reservoir evaluation. Specific basins described include offshore areas of Japan, New Zealand, India, China, and the Gulf of Mexico.

"Fire in the Ice" 2016, Volume 1 was released on April 26, 2016 and included four articles:

- Reservoir Systems in the Offshore of India: Results of the India National Gas Hydrate Program Expedition by P. Kumar, T.S. Collett, K. Vishwanath, K.M. Shukla, J. Nagalingam, M.V. Lall, Y. Yamada, P. Schultheiss, and M. Holland,
- The Potential for Abiotic Methane in Arctic Gas Hydrates by Joel E. Johnson, Kate Alyse Waghorn, Jürgen Mienert, and Stefan Bünz
- Coupled Thermo-Hydro-Chemo-Mechanical (THCM) Models for Hydrate-Bearing Sediments by Marcelo Sánchez, J.Carlos Santamarina, Xuerui Gai, Mehdi Teymouri, Ajay Shastri
- Emerging Issues in the Development of Geologic Models for Gas Hydrate Numerical Simulation by Ray Boswell and Timothy Collett

This and previous issues of Fire in the Ice are available for download at: http://www.netl.doe.gov/research/oil-and-gas/methane-hydrates/fire-in-the-ice

Summary

There is a continued focus on natural gas hydrate as part of a petroleum system, and a realization that exploration must be more than merely a hunt for bottom simulating reflectors (BSRs). All of the petroleum system elements must be present (reservoirs, gas flux, and seals), whether a BSR is present or not.

Japan, India, and China continue to move forward toward commercial production.