MHAC Methane Hydrates Science Report

*Review Executive Summary Recommendations I-VII

Summary from MHAC Planning Team

2st December 2020

MHAC Science Document – Executive Summary (I-VII)

The following are the MHAC's key findings and strategic recommendations for maintaining U.S. leadership:

(I) Methane hydrates are likely to be a ~~massive~~ substantial transitional energy source. Methane hydrates represent a significant natural gas resource for the nation and globally, which could be critical to providing long-term and transitional clean-energy fuel for many decades. Sustainable and economic production of methane hydrate reservoirs must be demonstrated and continued DOE investment is required to continue to advance our understanding of this vast resource and to maintain the U.S. global leadership in methane hydrate production. Better global and national estimates of methane hydrate resources, including in-place, technically recoverable, and ultimately economically viable reserves are needed.

(II) Advance methane hydrates production testing. The ANS ***(Should this acronym be spelled-out?)*** onshore long-term methane hydrate production test (12-24 months) will be the first in the world to address the critical questions related to commercial methane hydrate**s** production, and is a national and global priority. The current GoM methane hydrate field program is focused on reservoir characterization, which is expected to lead to U.S. offshore production testing in the future. Therefore, opportunities for improving the design and execution of these onshore and offshore tests should be a continuing focus for the program.

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(III) Assess the environmental impacts of methane hydrate production. Environmental impacts of gas production from methane hydrate accumulations, ~~including~~ **particularly the hydrodynamic properties** and geomechanical stability of the reservoir during production **and of the hydrate-bearing pressure cores,** that need further evaluation. Production operations for methane hydrates is expected to be similar in practice to production operations for conventional gas reservoirs. However, due to the lack of historical production from methane hydrates, the potential impact of their production at each site requires site-specific geologic modeling and further investigation.

(IV) Maintain U.S. participation in International Field Testing Programs. Continued support for U.S. scientists to participate in international marine methane hydrate research, testing, and future production programs is crucial to maintaining U.S. leadership. ~~and~~ This effort will provides information and insights that can be applied to future U.S. marine methane hydrate production (e.g. in the GoM).

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(V) Fundamental research linking methane hydrates to other energy resources. Accurate resource assessment of methane hydrates could reveal other large microbial gas accumulations and their relationships with methane hydrates. This requires **the understanding of the processes and rate of methane production, consumption, and losses, and the development** of techniques capable of differentiating between primary microbial versus altered thermogenic methane, as well as the possible contributions of abiotic gases. **Also,** understanding these microbial processes will be critical to exploration and assessment of the potentially massive U.S. resources of conventional biogenic gas and associated gas hydrates. Interagency collaboration is recommended to investigate the significance of abiotic gases. Note: Should the term "abiotic" be further defined for the less technical readers of this document?

(VI) Improve global estimates of methane hydrates for environmental impacts. Current estimates indicate that the impact on global climate of carbon dioxide from methane oxidation to the ocean and atmosphere may be small. However, global methane hydrate distributions and volumes remain uncertain, particularly in the Southern Hemisphere. Improving global estimates of methane hydrate distribution would increase confidence in the understanding of potential environmental impacts.

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(VII) Ensure U.S. Leadership ~~&~~ and Program Continuity. DOE funding for the program remains absolutely critical to the success of methane hydrates research. Private industry is unlikely to fund basic research in methane hydrate systems until safety and ~~feasibility~~ practically have been demonstrated, and the expected cost of production falls within regional economic thresholds. To help further demonstrate the overall feasibility of this program, support of early career scientists is essential for sustaining the domestic methane hydrates research programs. **Note**: Need a less abrupt transition between the second and third sentences in this paragraph – thus the edit.

Planning Team & Study Participants

Task Force Members:

Joel Johnson, Miriam Kastner, Carolyn Koh, George Moridis, Mark Myers, John Thurmond

Committee Manager:

Gabby Intihar

Study Participants:

- Ray Boswell, U.S. DOE-NETL, PA – 9/03/20
- Timothy Collett, USGS, CO – 9/03/20
- Fumio Inagaki, Inst, Marine-Earth Exploration & Eng. (MarE3), (JAMSTEC), Japan – 8/04/20
- Dale Nesbit, ArrowHead Economics LLC, CA – 8/27/20
- Mitch Schulte, NASA, Wash DC – 8/07/20
- Scott Tinker, UT Austin, TX – 8/20/20

Study Process – June to Oct 2020

- ~16 meetings to formulate study objectives, select speakers, write Q's for speakers, write/organize/edit science document

- Study participants/guest speakers addressed the following topics:

(I) Hydrates as a Future Transitional Energy Supply.
(II) Field Experimentation.
(III) Environmental Impact due to Hydrate Dissociation.
(IV) International Programs & Leadership.
(V) Fundamental Research.

Q's Provided to Guest Speakers

General Q's

1. What is your view of the state of knowledge in terms of resource assessment/production in hydrates?
2. What is the significance of biogenic methane gas to the different energy systems?
3. What is the role of hydrates in the global carbon cycle?
4. What new directions would you suggest for the methane hydrates R&D & DOE program?

(i) Industry perspectives on energy demand/energy security

a. What do you see as the role of methane hydrates in the future global and US domestic energy supply? *(Industry perspective is likely different from that of environmental-minded scientists)*.
b. Do you believe that there are future energy scenarios where hydrates will/will not be a part of the energy mix?
c. Do you believe that methane hydrates can be producible at the rates required for commercialization?

Q's Provided to Guest Speakers

(ii) International activities

a. When/where will the next/planned methane hydrate production test(s) occur? What issues need to be addressed? Could the US be of any help?
b. When/where will the next/planned research & exploration drilling expedition(s) occur?
c. What are the priority focus areas of the different national gas hydrate R&D programs?
d. What is the funding allocation in the different national gas hydrate programs?
e. How much industry involvement is there?

Q's Provided to Guest Speakers
(III) Planetary Systems/Abiotic/Astrobiology

a. Is there a potential synergy between gas hydrate studies under the DOE program and the NASA led discoveries and studies of gas hydrates on other planetary bodies? What can be learned from extraterrestrial observations that informs our understanding of gas hydrates systems (particularily abiotic) on Earth and what can be learned from Earth based studies that informs our understanding of extraterrestrial gas hydrate systems? How significant is the role of abiotic methane in the formation of gas hydrates on Earth and other planetary bodies?

b. Is there potential to use methane hydrates as an energy source on Mars?

c. What are the latest observations related to methane-astrobiology on Mars: Abiotic origin via serpentinization or biotic generation via an organic carbon cycle? What is the current state of knowledge about methane or more generally gas hydrates on other planetary bodies like Titan, Enceladus, and Europa?
    - Is there interest at NASA in the examination of abiotic methane synthesis on Earth through studies in natural environments or experimental work?

d. What role might hydrogen/methane production via serpentinization play or have played in the origin of life throughout the solar system? What possible role might gas hydrates play?

Q's Provided to Guest Speakers
(iv) Global/oceanic carbon cycle & microbial/biogenic gas

a. What is the role of microbiology in carbon transformations in newly discovered deep biosphere and cryospheric environments? How long can microbes remain in a dormant or resting state then re-emerge and become active again? What does that mean for processes like methanogenesis or AOM and for extra-terrestrial explorations?
b. What are the residence times for methane in the subseafloor environment? What is the origin and fate of methane that leaves the seafloor at methane seeps? What is its role in the present and past oceanic C cycle and ocean acidification?
c. Do gas hydrates play a role in the large biogenic gas accumulations on Earth? If not, how might such accumulations form? What are the best exploration criteria to predict where the large gas hydrate or methane accumulations are?
d. How much of the methane in gas hydrates has a primary biogenic origin, and how can we identify primary biogenic vs. secondary biogenic methane produced via biogenic degradation of thermogenic methane?

See SCIENCE DOCUMENT – WORD DOC.