Office of Naval Research International Field Office

2nd International Workshop on Methane Hydrates R&D Washington DC

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These reports summarize global activities of S&T Associate Directors of the Office of Naval Research International Field Offices (ONRIFO).
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Keywords: Methane Hydrate

Introduction

Following the 1st International Workshop on Methane Hydrates, which was held in Hawaii in March 2001, the second workshop was convened by Dr Rick Coffin (NRL) supported by Stephen Masutani (University of Hawaii) and held at the Washington Plaza Hotel, Washington DC. ONRIFO both sponsored the workshop and, using VSP, supported the attendance of two delegates from the UK [1]. 96 delegates from 8 nations [2] attended the Workshop, which was again mainly staffed by US and Japanese delegates. It was regretted that participants from Korea and Germany were not in attendance as both nations have active R&D programmes in Methane Hydrates.

Introductory presentations were given by Capt David Smith (Director, NRL), Carl Michael Smith (Ass. Sec. Office of Fossil Energy, DOE), Bhakta Rath (NRL), and Emrys Jones (Chevron-Texaco, Houston). These presentations emphasizes the importance of methane hydrates and the need for international collaboration in S&T, in order to understand the means of their formation and their energy densities and significance in terms of their:

- future energy resources [3] [4] [5]
- impact on global climate change
- association with submarine landslides and tsunami
- relevance to low frequency military sonar
- potential for energy supplies for remotely deployed systems
- and use for desalination.

Significant media coverage for the workshop was organized by the ONR Public Affairs Office (Gail Cleere), supported by Bhakta Rath, Rick Coffin, Bill McCluskey and Nick Langhorne who agreed to act as a media briefing team [6].

The proceedings of the previous workshop were distributed at the meeting (Ref: NRL/MR/6110—02-8646).

National Presentations

Canada (Ross Chapman and John Ripmeester): Canada does not have an over-arching programme in methane hydrate research but nevertheless is very active in both the polar regions (Mackenzie Delta) and off-shore (the Cascadia margin). Major research effort is from the Geological Survey of Canada, the Pacific

[1] Dr Peter Miles, Southampton Oceanography Centre and David Gunn, British Geological Society (BGS)
[2] Attendees: US 69, Japan 16, Canada 3, UK 3, India 2, Chile 1, Egypt 1 and Norway 1.
[3] Petroleum consumption (million gallons per day): World 3100, US 800, DoD 11.8, Navy 4.1.
[4] World population in year 2000 is 50% greater than that in 1975 with consequential increase in energy requirement.
[5] USGS statistics: the world's total crude oil production will peak in about year 2010.
[6] Briefings were given to United Press International (UPI) (Scott Burell) and the Virginian-Pilot & Ledger-Star (Dale Eisman) during the course of the workshop.

Geoscience Center, and the Universities of British Columbia and Calgary. Emphasis is being placed on measuring magnetic susceptibility (which is low in hydrate areas) as an indicator of hydrate concentration and on improved seismic concepts. Containerized drilling facilities are being installed on the icecap for an intensive drilling programme.

Chile (Esteban Morales): Pipeline projects are in hand to import gas across the Andes from the Argentine [7]. Large methane hydrate reserves have been established 40 miles off-shore [8] and, lacking indigenous technology and equipment, support has been obtained from CA, GE, DK, NO and the US. Further trials are planned covering a three-year programme. As discussed later in this report, Chile is keen to encourage international support for research in their area and, in return, proposes to offer research ship and other facilities free of charge. The 3rd International Workshop on Methane Hydrates R&D is planned for Santiago in late 2003.

Egypt (S H Sharaf El Din, Alexandria University): Proprietary Oil Company data indicates hydrate reserves in the Nile Delta. Negotiations are in hand with relevant Oil Companies and the definition of a national programme awaits progress.

India (S I Reddi, National Geophysical Research Institute, Hyderabad): The Indian national programme started in 1997 and methane hydrate reserves have been established in the Kerala-Konkan [9]area off the west coast and in five areas off the east coast. Current effort is focused on seismic analysis, area delineation, resource estimation, drilling technology; with hopes of production by 2010. India is also a participant in the Mallik 3L-38 (Mackenzie Delta, CA) consortia and collaborates with the Colorado School of Mines and University of Alberta.

Japan (Shoichi Tanaka, Japan National Oil corporation): The R&D research programme over the period 1996 – 2000 was budgeted at $25m with much of the effort on drilling technology, area delineation, and physical properties of hydrates. Japan has collaborated with the Mallik 3L-38 consortia, but most of their current effort is in the Nankai Trough[10]. Bore hole assessments will be completed in 2003 and followed by production tests. Production sites will be selected in 2006. Technical information is due to be posted at www.mh21japan.gr.jp but to date little data is available.

Norway (Bjorn Kvamme, University of Bergen): Much of the research is funded by commercial companies (eg: Statoil and Norsk Hydro) who are interested in

[7] !00% of natural gas and 80% of oil is imported.
[8] 500 – 600m water depth. 100m thickness of hydrates.
[9] Covering an area of some 2000sq km.
[10] The METI well indicates methane hydrates occurring at between 1135 and 1210m with saturations of between 60 and 80%.

flow in pipelines (dosage inhibitors) and reservoir stability and resource [11]. Slope stability is a major issue due to the complex array of pipelines and hubs on the seabed, which are required for current oils and gas production. Research programmes (funded by the EC) also consider carbon dioxide storage in aquifers.

Russia (G A Cherkashev, VNIIO, St Petersburg): Though scheduled to attend Dr Cherkashev did not get to the meeting and a brief statement was made by R Coffin.

UK (Peter Miles, Southampton Oceanography Centre - SOC): Peter Miles explained the UK funding mechanisms and details of the NERC Consortia for research on methane hydrates [12]. Consortia members include:

British Geological Survey (geotechnical properties)
SOC (seismic and physical properties, seafloor features)
Birmingham (seismic imaging)
Bristol (deep biosphere)
Heriot-Watt (modeling at pore scales, ultra-sonic detection)
Leicester (ODP log analysis facility and borehole research)
Royal Holloway (climate change)
Newcastle (sampling and physical properties)
Sunderland (methane flux)
Warwick Universities (microbial communities)
Geotek (coring, core retention and analysis under pressure)

Owing to restricted budgets, much of the work will be based upon laboratory experiments (synthetic hydrates and the time-series development of their crystalline structure etc) and modeling, with emphasis being placed upon environmental issues (climate change and seabed stability prediction) [13]. Strong support is being given to Geotek, working in an EU consortia, for on-going work on obtaining and retaining cores under pressure [14].

US (Brad Tomer, DoE): Studies cover the whole range of how much, where and why [15]? Laboratory facilities include GHASTLI, mobile analysis laboratory, Raman spectroscopy, infrared imagery, x-ray linear scanner, and scanning electron microscope. Studies by the University of Mississippi using the Johnson Sea Link manned submersible have obtained time lapse photography, volumetric gas escape data, and temperature probe data in the Gulf of Mexico. These data have been correlated with variations in the eddy structure, and associated

[11] Current oil resrves are expected to last fro 30 – 60 years and gas reserves for up to 300 years.
[12] Full text available from N Langhorne.
[13] Post meeting note: the UK is expressing interest in collaboration on field studies off Chile, taking advantage of the offer of ship facilities.
[14] Under the HYACE and HYACINTH programmes.
[15] $17m budget in 2001.

changes in seawater temperature at the seabed, to show that such changes affect the rate of methane seepage. NRL Stennis continues to obtain data using the Deep Tow Acoustic Geophysical System (DTAGS) [16].

further details will be available from the conference proceedings.

3. Discussion & Conclusions

National perceptions: The main nations interested in methane hydrates include, Canada, Chile, Denmark, Egypt, Germany, India, Japan, Korea, Norway, Russia, UK and US. Their level of effort is dependent upon both their wealth (including the maturity of their technology base), their 'hunger' for future energy supplies, and their proximity to potentially exploitable methane hydrate deposits. For example, Japan [17] is hoping to select a production site in 2006, and DOE plans to attain methane production in 2015. Nations with present day sufficiency in oils and gas supplies (eg: Norway and UK [18]) tend to be more interested in chemical engineering (flow delivery etc) and resource and reservoir stability, as well as concerns for environmental issues including seabed stability and the dangers of submarine landslides (which may generate tsunami or endanger seabed installations), and the more global and esoteric issue of their possible impact on climate change etc. Defence interests are also important to some nations, not only in terms of low frequency sonar propagation, but also for applications derived from the technologies, which are being developed for methane hydrate studies. These include leave-behind sensors, tomographic techniques, improved geophysical concepts (including 'smart' pulse generation), remote power sources (eg: methane fueled biological batteries) etc.

Without doubt methane hydrate research is a high cost endeavour – nevertheless the potential rewards are considered to be profound. The high costs are mainly on account of the deposits occurring in deep water, or in polar-regions. In both regions sophisticated deep drilling facilities are necessary, including core recovery and retention under pressure (and/or low temperature). In oceanic areas large research vessels deploying deep-tow systems [19] are required. The international S&T community has reacted well to this challenge and, with one exception [20], all sites being studies are done so by scientists and engineers from several nations, and the Ocean Drilling Program (ODP) has benefited from international funding. Nevertheless, the high-cost factors have

[16] 220 – 820Hz, Flying height above seabed 300m, seabed pixel size 39m.
[17] 96.8% of Japan's oil is currently imported.
[18] The large gas fields in the Southern North Sea are not in hydrate form due to their occurrence in relatively shallow water.
[19] Eg: Deep Towed Acoustic Geophysical System (DTAGS).
[20] Nankai Trough, Japan.

led the UK to prepare a programme [21] which is mainly based upon modelling and laboratory studies.

International research effort: The characteristics of the methane hydrate deposits are different in different areas, being dependent upon their biogenic or thermogenic origin, their crystaline structure, the temperature and pressure conditions necessary for their formation, and their association with different geological formations. As such, it is not wise to suggest that global S&T effort should be concentrated in a single region. However, the offer (to be confirmed) from Chile (Dr Esteban Morales, Catholic University of Valparaiso) to provide research vessel facilities at no cost to other nations has considerable advantages. This of course is of huge advantage to Chile, where there is no significant S&T infrastructure with relevant technologies and equipment, but it is also a major cost-saver for other nations and provides the opportunity set up a global research site and for the coordination of effort and the dissemination of data.

Bottom Seismic Reflector (BSR): Prior to deep drilling operations, much of the evidence for the existence of methane hydrates is based upon the detection of the BSR [22]. Below this reflector, increase in geothermal temperature causes dissociation and methane hydrate reverts to gas and water (hence phase reversal, a strong acoustic reflector and often evidence of 'blanking' of underlying structures). Hydrates, with different concentrations, may extend upwards from the BSR towards the seabed, depending upon the pressure and temperature regime. Indeed blocks of methane hydrate have been accidentally recovered by fishing trawls [23]. At many sites on oceanic margins a critical depth zone (pressure/temperature) occurs at which dissociation takes place and methane gas bubbles from the seabed, either to be dissolved in the water, or escapes into the atmosphere (and thereby contribute to the volume of 'greenhouse' gases).

'Smart' sonar systems: Unfortunately, the information content from tradition seismic systems is crude and despite significant advances in signal processing techniques, is mainly dependent upon the nature of the transmission pulse. For this reason, little objective or quantitative information is obtained related to the physical properties of the sediments and the concentration of methane hydrate in their pore spaces. It was therefore a recommendation of the workshop that studies should be conducted on the development of 'smart' transmission pulses, which due to definable differences in their attenuation, may be used to differentiate density differences and other physical properties [24].

[21] For submission for a Consortia Grant from the Natural Environment Research Council (NERC).
[22] Also referred to as the Base of the Hydrate Stability Zone (BHSZ).
[23] Such a case occurred of the West Coast of Canada and played a large part towards the setting up of the Cascadia research site.
[24] As is currently being researched for medical purposes using ultra-sound frequencies.

Ocean Drilling Program (ODP): Following geophysical surveys, quantitative data on methane hydrates and their densities, is dependent upon drilling programmes and this has been facilitated by the Deep Sea Drilling Program (DSDP) (D/V Glomar Challenger) from 1968 until 1983, and then the Ocean Drilling Program (ODP) and the International Ocean Drilling Program (IODP) (D/V Joides Resolution). In 1970, under the former (Leg 11), the significance of the BSR was established and the first hydrate samples were recovered in 1979. ODP Leg 164 conducted on the Blake Ridge in 1995 and Leg 204 conducted in the summer of 2002 on the Cascadia Margin, were dedicated to gas hydrate research.

D/V Joides Resolution: D/V Joides Resolution is due to be paid-off in 2003, with Leg 210 being the last leg scheduled. Several initiatives are in place for a continuation of deep sea drilling. These include a new vessel from the US (mainly funded by NSF), a riser platform from Japan, as well as several smaller 'mission-specific' platforms from the European Union (EU). Even with success with any one of these programmes, there will be a one year, to eighteen months, gap during which no deep sea drilling capability will be available. This situation was explained to the delegates at the meeting and support was sought, from the different nations, for keeping D/V Joides Resolution in service until a replacement vessel is available.

The operational costs of D/V Joides Resolution work out at about $50m per year, or approximately $0.5m per drill hole. Little time exists to expedite the necessary funding and promote the research requirements, which would be undertaken by extending the operational life of R/V Joides Resolution beyond late 2003. An alternative suggested was commercial charter from the off-shore oil & gas industry, but this has the disadvantage that such charter would not be supported by the very considerable back-up provided on the dedicated and well proven R/V Joides Resolution [25]. There was also the feeling that the lack of an in-fill programme of work may be interpreted as a lack of commitment to the requirement for such data and thereby endanger the new vessel programme. Conversely, it is fully appreciated that deep drilling is extremely expensive and the value of the data obtained may be considered (by the non-geological community) unsupportable. Furthermore, a delay may be useful as time is required to develop the technologies for 'leave-behind' sensors. The use of such sensors, deployed in capped-off drill holes with necessary power supplies, has considerable potential for spatial and temporal acoustic and geophysical studies (including tomography), and thereby render each drill hole to be that more valuable. Should the bid for continuation of the D/V Joides Resolution be successful, it is important that its cost should not mitigate against the rest of the research required for methane hydrates (e.g.; the provision of geophysical vessels etc).

[25] Computing systems, JANUS data base, core handing and retention under pressure and temperature etc

Core recovery and retention under pressure: Geotek UK, working in EU Framework Five Programme HYACINTH [26], have successfully developed a system for obtaining and retaining cores under pressure. Successful operations have been conducted on ODP Legs 201 and 204 and further sampling is planned for European waters in 2003 and 2004.

Next international meeting: It was proposed that the next meeting should be held in Chile (ref: http://biblioteca.ucv.cl/hydrates/) and advantage taken at this meeting to formulate an international programme, taking advantage of the provision of ship facilities offered by Chile. It is recommended that ONRIFO's new office in Santiago should be encouraged to support this initiative and take a leading part in encouraging participation, coordinating technical input and the dissemination of data and its analysis.

4. Further meetings:

1. A NERC Ocean Margins LINK Programme Science & Partnership Meeting was held at the Dept. of Trade & Industry (DTI), London [27]on 19th November 2002 with the objective of setting up research partnerships and the pull-through of results for commercial and environmental considerations. This UK programme has affinities with the US Ocean Margins programme and the US, UK, Japan Inter-Margin programme [28] [29]. The Ocean Margins LINK programme includes a theme topic 'Gas hydrates as a hazard and potential energy source' and a presentation was given on the physical properties of gas hydrates by Mike Lovell, Leicester University [30] [31]. Both DTI and NERC are generating programmes on methane hydrates and keen to participate in international programmes [32].

2. RADM Gaffney (National Defense University) is organising the following series of seminars:

17 Dec 02	DoD energy crisis – fact or fiction
Feb 03	The potential for renewable energy
April/May 03	Methane Hydrates (and summary and conclusions)

Invitations to attend are due to be issued to ONRIFO (ref: Burton Hurdle).

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[26] A programme which was started in Dec 2001 and succeeds the MAST III HYACE programme. Collaborators are from Bristol UV (John Parks) , BGS Keyworth UK, Technical University Berlin, Technical University Clausthal, and Fugro Netherlands

[27] Co-sponsored by DTI and NERC.

[28] UK National Leader; Bob Whitmarsh, SOC RbW@soc.soton.ac.uk

[29] Discussions on joining are being held with China, Germany and Norway.

[30] Working with the British geological Survey and Geotek.

[31] Poster presentation available from N Langhorne.

[32] It is intended to arrange follow-up meetings with Cameron Stewart, Head of Technology and Innovation (Oil & Gas) at DTI. Cameron-stewart@dti.gsi.gov.uk

5. Annex A: Supporting Documentation [33]

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[33] Available from N. Langhorne

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