

Report for the 2007 Annual Meeting Gas Hydrate Committee

Art Johnson and Robert Lankston, Chairs

1. Active areas and the ones most likely to see future growth

The potential for gas hydrate as a commercial natural gas resource is being investigated by at least nine countries, with the United States, Japan, India, Canada, China, and South Korea with drilling operations for hydrate assessment either conducted during 2006 or planned for 2007. Mexico, Chile, and Ireland are conducting evaluations that may lead to drilling.

In the U.S., the primary focus areas are the North Slope of Alaska and deepwater areas of the Gulf of Mexico. Hydrate-bearing sands and gravels have been logged and cored on the North Slope in previous years, and activity has now progressed to detailed petroleum system modeling and preliminary assessments of prospect economics. A stratigraphic test conducted in February 2007 may lead to a production test in 2008.

The initial industry focus for gas hydrate in the Gulf of Mexico was the safety of conventional oil and gas operations (see item #9) and led to the establishment of an industry consortium. With significant federal funding, the consortium drilled two areas of the Gulf in 2005. Since mid-2006 the consortium focus has evolved to include the assessment of hydrate resource potential. Sites are being evaluated and drilling may be conducted before the end of 2007.

An additional area of interest is the deepwater Atlantic off the northeastern coast of the U.S. Recent assessments by the Minerals Management Service (MMS) suggest an optimal setting for significant gas hydrate resource potential. Public opposition to petroleum industry activities off the East Coast is likely to delay the pursuit of this potential.

A joint Canadian/Japanese hydrate program is being conducted in the Mackenzie Delta of Canada during 2007 to test hydrate-bearing sands that were briefly tested during a 2002 program. An extended production test is planned for 2008. The information obtained will guide the development of hydrate-bearing sands off the Japanese coast.

Canada has not had a national gas hydrate program yet has undertaken significant investigations of its Arctic and marine hydrate accumulations by leveraging its efforts with those of other nations, particularly Japan. The Canadian government is currently reviewing a proposal for the establishment of a comprehensive research and assessment program.

India conducted offshore drilling operations for gas hydrate at 39 locations from April to August, 2006, and has announced plans for a production test in 2008. China plans to conduct offshore gas hydrate tests in spring, 2007. South Korea has announced plans for hydrate drilling during autumn 2007.

2. Forecast for future production

While at present the commercial potential of gas hydrate as a natural gas resource is unproven, the investigations currently being conducted could result in viable commercial production by 2015. The timing of future production will depend on regional market conditions and on the perceptions of those markets by the national governments involved and on the perceived business potential for operating companies.

The technical issues associated with prospect identification and development are included in item #8. Transportation is an additional issue as many promising gas hydrate prospects are "stranded". The construction of pipelines or the development of other means of transport to markets is a prerequisite for gas hydrate to become a significant resource.

3. Sources of funding for current and planned activity

In the U.S., the primary funding source for gas hydrate research and development is the federal government, with the Department of Energy providing 75% of all funding (\$12 million in FY2006). Other agencies that provide the remaining funding are the United States Geological

Survey, Bureau of Land Management, Minerals Management Service, Naval Research Laboratory, National Science Foundation, and National Oceanographic and Atmospheric Administration. Corporate support is primarily in the form of in-kind participation such as staff time and data.

The gas hydrate programs of some other nations are funded at higher levels, with India investing approximately \$36 million in 2006 and Japan investing approximately \$60 million in 2006-2007. Budget figures for other nations are not available.

4. Kinds of research are taking place and those is doing it

In the U.S., the DOE supports three primary research areas: Arctic Field Operations, Marine Field Operations, and Laboratory/Modeling Efforts. The goal of the Arctic program is a long-term production test of a hydrate-bearing reservoir. The primary participants are BP-Alaska and the USGS. The goals of the marine program are drilling safety, understanding geologic systems, and establishing the scope and productivity of the marine resource. The primary participants are members of a joint industry program led by Chevron. The goals of the laboratory and modeling efforts are to improve exploration tools and numerical simulation capability, and to provide basic science data. This effort is undertaken by a partnership of 12 universities and 6 national labs.

The hydrate resource potential of the U.S. is being assessed by the USGS and MMS.

Japan is conducting extensive research into exploration tools, resource assessment, reservoir modeling, drilling, and operational/environmental safety. The Japanese effort is coordinated through the "Research Consortium for Methane Hydrate Resources in Japan" (designated MH21). MH21 utilizes the combined efforts of numerous universities, government agencies, and companies and is led by the Japan Oil, Gas and Metals National Corporation (JOGMEC), the National Institute of Advanced Industrial Science and Technology (AIST), and the Engineering Advancement Association of Japan (ENAA). JAPEX has operated the MH21 drilling programs.

5. Leading companies

BP-Alaska has undertaken the most comprehensive assessment of gas hydrate resource potential, including prospect identification and computer modeling of production. BP-Alaska drilled a hydrate well in February 2007 that could lead to a production test as early as 2008. The BP-Alaska focus has been on Arctic hydrate rather than marine. Chevron and ConocoPhillips are the only two majors in the Gulf of Mexico JIP, and Schlumberger/WesternGeco is a prominent service company in the JIP. ConocoPhillips is engaged in research that could lead to a method of producing gas hydrates while simultaneously sequestering carbon dioxide. Other majors and independents have personnel investigating gas hydrate either for resource potential or geohazards, but these internal programs are not well documented. In addition, many service companies have committed resources to gas hydrate evaluations, with specific emphases related to the services they currently provide.

As noted in item #4, Japanese and Indian companies are also involved in gas hydrate efforts.

6. Focus of recent activity

As noted in item #1, the focus of activities in the U.S. has been the North Slope of Alaska and the Gulf of Mexico. International areas of significant recent and planned activities include deepwater marine areas offshore from Japan, India, Canada, Korea, and Japan. Canada is also involved in research on the Mackenzie Delta.

7. Estimated U.S. and international resources/reserves and their strategic impact

The volume of gas hydrate in sediment is extremely large, estimated at 200,000 tcf for the U.S. and 700,000 tcf globally. These large numbers are widely reported yet are misleading because the commercialization will be limited to areas where hydrate is concentrated in porous, permeable strata. In addition, production of gas from hydrate-bearing sands is most feasible in

areas of existing infrastructure. For the U.S., Arctic hydrate-bearing sandstones under existing infrastructure are estimated to contain 10's of tcf (in place). For Arctic sandstones away from existing infrastructure, the estimate rises to 100's of tcf. For deepwater sandstones, the estimate is in the 1000's of tcf.

8. Critical technology needs and how they are being addressed

A number of technical hurdles need to be overcome in order for gas hydrate to become a viable commercial resource. A critical need is the development of tools for consistent, reliable prospect identification and evaluation. The development of these tools requires a better understanding of the modes of occurrence of gas hydrate in nature and the impact of gas hydrate on sediment properties. Commercial production necessitates the adaptation of existing completion technology to the specific requirements of gas hydrate reservoirs.

These needs are being addressed by the integration of field and laboratory investigations. Major progress has been derived from comprehensive logging and from the recovery and analysis of cores that are maintained at *in situ* conditions. Extensive production testing is now planned for selected locations and will lead to improved reservoir models. Significant progress in the identification of prospects appears to have been made by the BP-Alaska program

9. Critical environmental or geohazard issues and how they are being addressed

The greatest potential geohazard that may be attributed to hydrate-bearing sediment is the effect of rapid, uncontrolled hydrate dissociation (reversion to gas and water). An industry consortium led by Chevron and largely funded by the DOE is investigating this issue in a collaborative effort with university programs. Preliminary results indicate that low concentrations of hydrate in sediment are not a significant geohazard. The impact of hydrate dissociation during the dedicated production of gas from hydrate is currently being assessed through research funded by the DOE.

10. EMD technical sessions, publications, and workshops that exist or are planned

Past AAPG conventions have included poster and oral gas hydrate sessions although the convention in Long Beach contains only two papers. The 2008 convention has the potential for at least one hydrate-specific session as a result of the 2006 drilling in India and the 2007 drilling in Alaska, China, and Korea. The results of the current Canadian drilling are being held confidential. A Hedberg Research Conference was held in 2004, and a proceedings volume is currently being edited. A gas hydrate short course is planned for the 2008 AAPG annual convention, and it is being organized by Tim Collett and Art Johnson