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A study of Gas Hydrate with future Energy Perspective

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Introduction

As India moves towards the 21 century, the gigantic need of energy stares at her face slowing down the pace of industrialization and agricultural reforms. According to the recent statistics, India is currently the fourth largest consumer in the Asia Pacific region of crude oil, after Japan, China, and South Korea and this is likely to increase significantly in the next few decades, Considering the present status and trend in the energy scenario. It can be safely assumed that the energy needs, at least for the next three decades, would be sourced from fossil fuels. At present our country imports about 70% of its oil demand.

The exploitation of renewable energy sources is not up to the level of branching out to a major alternative solution. Traditional offshore hydrocarbon exploration may not fulfill the energy need in coming decades in-spite of the technology development and private participation. As the known resources are drying up, India is becoming more and more inclined in exploring more unconventional areas of energy sources. India is spending about Rs. 80,000 crores every year to import oil but the deeper ocean in the EEZ is still unexplored. It is strongly perceived that proper study of the deeper EEZ region would lead to new discoveries of oil, natural gas and new resources like gas hydrates, known to be the richest source of energy. Natural gas hydrates, which the potential of being an alternate energy resource, are known to occur worldwide in the sediments of outer continental margin and in permafrost region near Arctic pole. GH has attracted the attention of the scientific community because of their widespread distribution; potential as future energy resources; possible role in climate change and submarine geo-hazard.

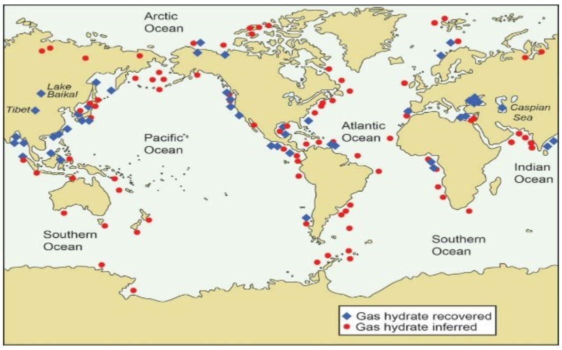

Fig-1(Global occurrences of Gas Hydrates)

Methodology

The passive margin of Indian peninsula and along the Andaman convergent margin (first expedition 2006 of NGHP) was aimed to study the gas hydrate occurrences both spatially and temporally in this two distinct geologic provinces with special emphasis to understand the geologic and geochemical controls on the occurrence of GH in two diverse setting .Coring/drilling/LWD/MWD in 39 holes in Indian offshore during the above expedition over Kerala-Konkan, Krishna- Godavari, Mahanadi and Deep offshore Andaman have indicated the presence of GH with the deep microbial gas accumulation and established the fact that this deposit of GH is controlled by Methane flux through fracture system, generated by the regional stress regime. The deep sea drilling project (DSDP), Ocean drilling program (ODP), and JNOC/JAPX/GSC Mallik program and more recently integrated ocean drilling program(IODP) have all opined that GH can definitely prove to be an alternate energy resources of our future.

Gas hydrates (GHs) are a vast energy resource with global distribution (Fig-1) in the permafrost and in the oceans.

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After a brief examination of GH accumulations that are well characterized and appear to be models to future development and gas production, scientists have analyzed the role of numerical simulation in the assessment of the hydrate production potential, identified the data needs for reliable predictions, evaluated the status of knowledge with regards to these needs, discussed knowledge gaps and their impact, and reached the conclusion that the numerical simulation capabilities are quite advanced and that the related gaps either are not significant or are being addressed .The past decade has seen a marked acceleration in GH R & D. Among the most important developments is the increasing focus of research on gas hydrate bearing sediments (HBS) rather than crystalline hydrate, the improvements in tools available for sample collection and analysis, the emergence of robust numerical simulation capabilities, and the transition of GH resource assessment from in-place estimates to potential recoverability (Boswel 2007).

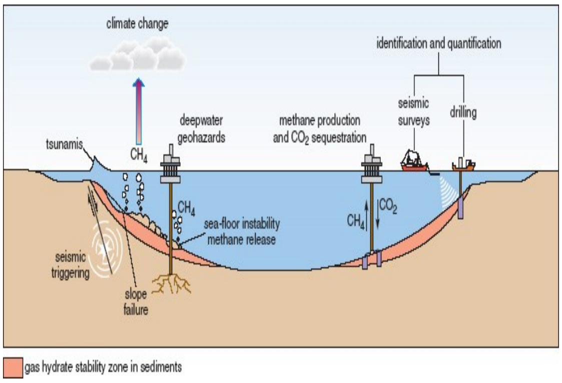
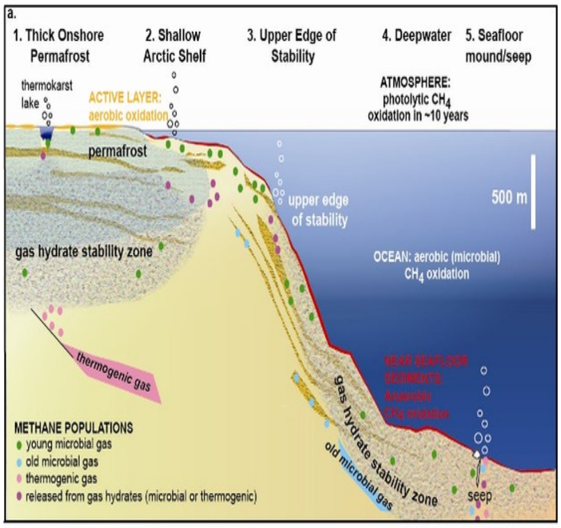


Fig-2

A fuller understanding of complexities of GH geological system has emerged, including the new insights into the effects of solubility, salinity and heat flow, reservoir litho logy, and rates and migration pathways of both gas and H_2O (Rupppel et,al 2005; Paul et,al 2005).These new data led to a GH resource assessment in the gulf of Mexico (currently underway) by the US mineral management service of the US department of interior (Ray2005;Frye et,al2008). Addionallly, critical data gaps, such as information on the mechanical and hydraulic properties of HBS needs to be addressed. Significant inroads have been made into our understanding of hydrate response under different production scenarios.



Ruppel, Nature Knowledge, Hydrates/Climate, April 2011

Fig-3 schematic-continental slope

Example

In natural setting, such as the ocean bottom, when buried organic matter decomposes to methane and dissolves in water, clathrates form at temperature greater than 277 K (4^O C or 39^o F). Biogenecally produced methane, in dissolved water, forms hydrates very slowly because of mass- transfer limitations. Over geologic time, the total enclatharated methane in the oceans has been estimated 2.1 $*10^6$ standard cubic meters (SCM)- twice the energy total of all other fossil fuels on earth. The amount of hydrated methane in the northern latitude permafrost is relatively small (7.4 * 10^{14} SCM), within the error margin of ocean hydrate estimates.

Because the atmosphere warned by 4^o F with shallow oceans in the late Paleocene (55 million years ago), there is evidence for the hypothesis of Dickens *et al* that ocean methane hydrate dissociation caused a large green house gas warming of 14^o F, significantly impacting evolutionary process. Atmospheric-induced changes in the ocean floor temperature are not likely to occur in current times because deeper oceans effectively constrain temperature changes. Such factor as geologic techtonism and warm –ocean-current circulation may contribute to modern ocean hydrate disruption.

Unfortunately, because hydrates in ocean sediments are dispersed (typically <305 vol %), substantial ingenuity is required for economic energy recovery. A recent workshop concluded that most critical in-situ issues arise because hydrates are ill-defined in four respects in the geophysical/chemistry domain: detection, distribution, sediment properties and, and hydrate controls. For example, sonic waves are the principal detection tool for ocean hydrate deposit, but some quantification and frequently qualitative detection of hydrate is inaqurate, as suggested with BSRS in the Gulf of Mexico (Fig-4). Field tests are required to bind the problem in the field, which will be verified by laboratory experiments.

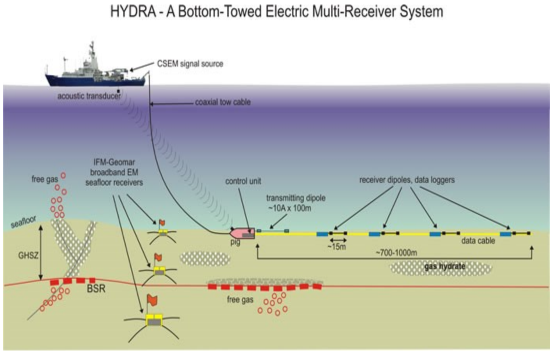


Fig-4

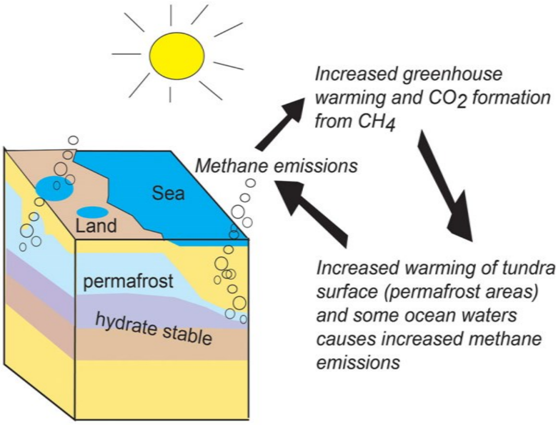


Fig-5 we have reserves, but how to control the huge energy when released?

Study revealed that an estimated 25 quadrillion cubic meter of Methane is available in Hydrates globally. Theoretically one cubic meter of pure methane hydrate should yield 164 cc of methane and 8cc of water.

Reservoir rock contains a greater concentration of methane. For instance, in a reservoir with 30% porosity at a depth of less than 5000ft.one cubic feet of rock generally contains 50 c.ft of gas in the form of methane hydrate.

Conclusion

Now the question is , is it feasible to extract hydrates economically? In places like USA and Russia, conventional gases are cheaper. But places like Japan, where import cost for conventional gases become costly, the gas hydrates may prove to be economical; and so is true for India too. Recoverability of GHas from deep marine structure is very problematic at present. So the following possibilities need to be explored.

a) Horizontal drilling of low permeability layer.
b) Depressurization.
c) Thermal process, such as hot water steam flooding.
d) Solvent/ Chemical injection to decrease the stability of the hydrate lattice.

The fate of methane in sea water is not clear. So one has to understand the dynamics and the distribution of Methane Hydrate-First, followed by quantifying its role in the global carbon cycle and the climate change (fig-2,3,5). It is important to mention the breaking of huge iceberg in the Canadian coast (consequent flooding) is the result of energy released by gas hydrate. So the following environmental issues (Hazard) have to be addressed for the safer mankind before any such exploration activity is envisaged.

a) Safety and Sea floor stability.
b) Possibility of landslides during breaking of hydrates.
c) The top hydrate layer, covered by sediments, may melt, causing Tsunamis.
d) Earthquake may cause the breaking the hydrates, resulting in landslides.

Finally it is concluded that Gas Hydrate can definitely offer an alternative energy resources for our future. Much research is still necessary to determine the methodology to extract gas hydrate economically with the following State of the art technology and techniques.

a) High resolution multichannel Seismic Profiling.
b) Remotely operated vehicle (ROV) rated for 6000 mt.water depth and above with scientific pay-load and with high resolution multi beam sonar, heavy robotic manipulator for sampling, scientific sensor to measure dissolved Methane, dissolved oxygen, and Salinity along with the Imaging devices.

c) Remotely operated Autonomous Coring System.

d) Wire-Line:-
   - i) Tri-Axial Induction Log-for resolution of thin laminated bed.
   - ii) Dielectric Log- for estimation of Hydrate Saturation, Water Salinity.
   - iii) Bore hole Sonic Imager- For estimation of In-Situ Stress phenomenon.
   - iv) Geo-Chemical Logs-For estimation of Volume, IN-Situ permeability, Neutron-Density porosity, Matrix properties.

e) LWD:-
   - i) Pulse Neutron-for measuring Density-Neutron porosity in situ.
   - ii) Source less Neutron Porosty and Source less Density Porosity measurement.
   - iii) Quadra pole Sonic:-Measuring Compressional and Shear Slowness.
   - iv) Deep resistivity reading measurements-for Horizontal well placement.
   - v) Resistivity Anisotropy.

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