



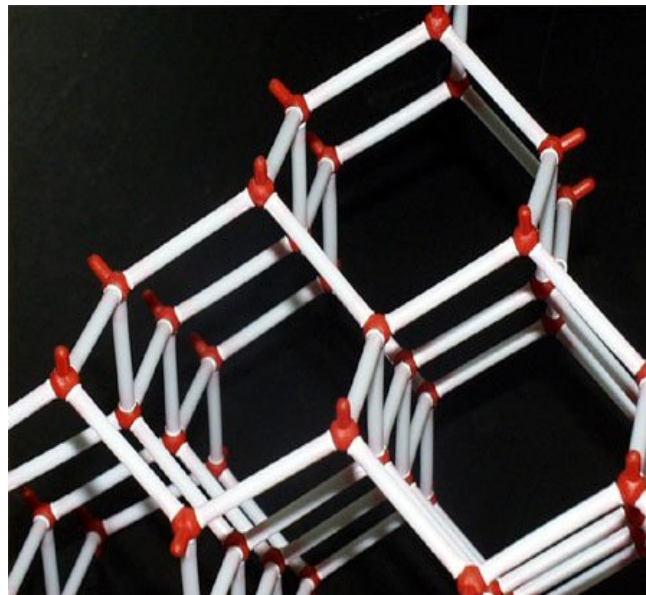
P - 06

Geophysical Methods of Prospecting of Gas Hydrates, A Qualitative Approach

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The worldwide amount of carbon, bound in gas hydrates, is conservatively estimated to be a total of twice the amount of carbon found in all known fossil fuel on earth. The extraction of methane from hydrates could provide an enormous energy and feedstock resource. Moreover conventional gas resources are believed to be trapped beneath methane layers in ocean sediments. So gas hydrates can be considered for an unconventional energy resource for our future.

Gas hydrates are the cages of water molecules which envelope and trap, i, e, mainly methane (CH_4) molecules. They are crystalline solids. The Crystal is arranged in a compressed latticework, which in appearance, looks like water ice. Since they are encaged within a lattice, they are called "Clathrates", (the Latin terminology, means encaged). The structure of crystalline ice is shown in this figure.





Crystalline Structure of Ice

The crystalline solids of clathrates are formed under moderate pressure and temperature, but above freezing point of water in nature. These solids are very hard and ice like, and may contain molecules of substances

other than methane. Listed is the comparison of the properties of pure hydrates with other water saturated sediments.

<u>Property</u>	<u>Hydrates</u>	<u>Water saturated Sediments (average)</u>
<i>Acoustic Vel.(km/sec)</i>	3.6	1.5-2.0
<i>Transit Time (m sec/ft.)</i>	84.7	203-152
<i>App. Resistivity in ohm-mt.</i>	150	1-3
<i>App. Bulk density in gms/cm³</i>	104-1.06	1.75
<i>Neutron porosity in %(limestone)</i>	50-60	70

Ocean hydrates of continental margin are categorized in two. First one is of the organic origin, called the Biogenic hydrate and the other one is called Venting or the Thermogenic hydrates. Other than those, there are Parma-frost hydrates and last in the category is free methane.

There are different methods of locating the gas hydrates.

- By Seismic method of prospecting:- The BSR (Bottom simulating reflector level) represents the gas hydrates stability zone (GHS) or the interface boundary.
- By Coring:- Core sampling has revealed the presence of Hydrate where no free methane is present.
- Synthesis of hydrate in lab:- Hydrates can be manufactured in laboratory by evaluating the properties and subsequently their potential can be explored.
- Computer modeling and simulation:-This is useful in studying the presence of hydrate formation on continental margin.

Study revealed that an estimated 25 quadrillion cube meters 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 rocks contain a greater concentration of methane. For instance, in a reservoir with 30% porosity at a depth of less than 5000 ft, one c.ft. of rock generally contain 50 c.ft. of gas in the form of methane hydrate.

Now the question is, is it feasible to extract hydrates economically? In places like USA and Russia, conventional gases are cheaper. But place 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 gas from deep marine structure is very problematic at present. So the following possibilities may be explored.

- Horizontal drilling f of low permeability layer.
- Depressurization.
- Thermal process, such as hot water steam flooding.
- 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. It is important to mention the breaking of the huge iceberg in the Canadian coast recently and is presumed to be the result of the energy released by hydrate. So the following environmental hazard has to be assessed for the safer mankind before any exploration activity is planned.

- Safety and sea floor stability.
- Possibility of land slides during breaking of hydrates.
- The top hydrate layer, covered by sediments, may melt; causing land slides.
- Earthquake may cause the breaking of hydrates; resulting in land slides.

The gas hydrate activities in India are as follows.



"HYDERABAD 2008"

- a) DGH survey in deep water of Andaman revealed the gas hydrate prospect in ST-1 to ST-7 at a depth of 800-2000 mtr.
- b) ONGC:-Seismic prospecting of 1400 kms. In Krishna-Godavari deep offshore revealed the vital information on interval velocity, Polarity, amplitude variation with offset at bottom simulating reflector (BSR) level and other Geo-scientific information like Bathymetry, structure, thickness of hydrate stability zone (HSX), rate of sedimentation etc.
- c) GAIL-NGHP:- NGHP(National gas hydrate project) through CSIR institutes prepared GHSZ (gas hydrate stability zone) thickness map in off-shore GOA.
- d) NGRI:- Sponsored by GAIL for western and eastern region acquired expertise through wave form inversion of multichannel seismic data.
- e) NIO:- In western continental margin of India surveyed and observed the presence of acoustic signatures in continental slope and rise region off Goa.

Well log analysis and core studies at Mallik gas hydrate field in Mackenzie delta shows that high P and S- wave velocities characterize sediments with high concentration of gas hydrates.

The seismic profiles (VSP) acquired in two intervals were used to improve the confidence in the seismic-to-well correlation approach. Sonic and density logs acquired in the above two intervals were used to access the seismic ties at well locations. Synthetic

traces of well logs were compared with seismic 3-D data whereas logs in the well were the basis for comparison with VSP-CDP of walia et al. For all cases the time to depth conversion curve were obtained from direct arrival travel time, measured on a zero offset VSP, acquired in the above well 2L-38 (Sakai-1999). Synthetic seismic traces for vertical incidence were calculated by convolving the reflection coefficient obtained from the Sonic and density logs with a wavelet, extracted from 3-SD and VSP data sets, using frequency matching.

Another technique for hydrate detection includes electrical resistivity measurements. Electrical resistivity measurements made in well logs, characterize a region, containing hydrate as more resistive when compared to background sediment without hydrate. However, well logs can only give a qualitative idea of the occurrence of gas hydrate, not its lateral extent.

A large consortium was established that included ONGC,GAIL,GeoforschungsZentrum of Germany and the Chevron/ British petroleum joint venture group in 2002.Two observation wells and a production well was drilled on the Mallik structure in Mackenzie delta. They recovered 48 ft.high quality core comprising fine grained sand and no shale or silt. This core was depressurized and heated, that yielded very high quality data, which was integrated to reservoir simulation models. In particular, the flow tests demonstrated that gas production from hydrate bearing sand is technically feasible. Burning gas hydrate in a lab. is shown in this figure.



Burning of Gas Hydrate



Finally we conclude that Gas hydrate can definitely offer an alternative energy resource for our future. Much research is still necessary to determine the methodology to extract gas hydrates economically. Following state-of-the-art Geophysical tools can be used for studying the subject .

- Density and Sonic Log
- High resolution multi-channel seismic profiling.
- Super resolution sismo-acoustic profiling.
- High resolution seismic reflection – refraction tomography(sounding).
- Electro-magnetic sounding.
- Deep ocean geophysical penetrometry.
- Geological coring (preferably with onboard determination of core physical properties)

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