

Gas-hydrates in Krishna-Godavari and Mahanadi Basins: New Data

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Background

Gas-hydrates are crystalline substances consisting of mainly methane and water, and occur in shallow sediments of outer continental margins and permafrost regions. They are formed at high pressure and low temperature regime when supply of methane gas exceeds the solubility limit. Unlike natural gas, oil and minerals, gas-hydrates are not stable at standard temperature and pressure (STP). One volume of gas-hydrates, when dissociated, releases 164 volumes of methane at STP. Since methane is the lowest molecular weight hydrocarbon, use of gas-hydrates as fuel will cause less pollution to the environment. These have attracted the global attention due to their natural occurrences in abundance and huge energy potential. The methane locked as gas-hydrates is envisaged as $1-120 \times 10^{15} \text{ m}^3$ (Boswell and Collett, 2011). Only 15% recovery from this gigantic reserve may be sufficient to meet the global energy requirement for about 200 years (Makogon et al. 2007). Thus, gas-hydrates seem to be a viable major energy resource of future, and have been identified globally either by geophysical, geochemical and geological surveys or by drilling and coring (Boswell and Saeki, 2011; Ruppel, 2011; Sain and Gupta, 2012). Besides having the energy potential, the study of gas-hydrates is also important from natural hazards point of view related to seafloor subsidence, slumps and slides (Gupta and Sain, 2011).

The bathymetry, seafloor temperature, total organic carbon (TOC) content, sedimentary thickness, rate of sedimentation, geothermal gradient indicate good prospects of gas-hydrates along the Indian margin (Sain and Gupta, 2008). A total volume of ~1900 trillion cubic meter of methane gas, stored in the form of gas-hydrates, has been prognosticated (Collett et al. 2008) within the Indian exclusive economic zone (EEZ). This volume of gas is more

than 1500 times of India's present natural gas reserve, and it is envisaged that 10% recovery from this huge cache of energy can meet India's overwhelming energy requirement for about a century. Therefore, the identification and quantitative assessment of gas-hydrates along the Indian margin has been very essential.

MoES Program

Under the aegis of the Ministry of Earth Sciences (MoES), GoI, a comprehensive research-oriented gas-hydrates program has been launched emphasizing the scientific and technology development for identifying promising sites on regional scale and estimating the resource potential, studying the impact of dissociation of gas-hydrates on environment, and developing environment-safe technology for production. The National Geophysical Research Institute (NGRI) and National Institute of Oceanography (NIO) are pursuing the scientific objectives for the identification, delineation and evaluation of gas-hydrates in various offshore basins. While the National Institute of Ocean Technology (NIOT) is developing remotely-operated vehicles and autonomous coring systems for validating the ground truth, and viable technologies for producing gas from gas-hydrates. The National Gas Hydrate Program (NGHP), under the auspices of the Ministry of Petroleum & Natural Gas (MoP&NG), GoI, has also been formulated in which the Oil & Natural Gas Corporation Limited, Oil India Limited, Gas Authority of India Limited, Directorate General of Hydrocarbons, NGRI, NIO, NIOT, Indian Institute of Technology at Kharagpur and Kanpur, and Indian School of Mines are carrying out research for geo-scientific investigation of gas-hydrates along the Indian shelf followed by technology development for production of gas from gas-hydrates.

Gas-hydrates are mainly recognized by seismic experiment with the identification of an anomalous seismic reflector, known as the bottom simulating reflector or BSR, based on its characteristic features (Sain and Gupta, 2008). The BSR is a physical boundary between sediments containing gas-hydrates above and free gas-saturated sediments below, and is often associated with the base of gas-hydrate stability field. Hence, theoretical map of gas-hydrate stability zone plays an important role in identifying BSRs on seismic sections. By analyzing available multi-channel seismic (MCS) data, the BSRs were identified earlier in the Mahanadi (Mn) and Andaman (Am) regions (Sain and Gupta, 2008). The first scientific expedition using a remotely operated vehicle, recently developed by NIOT, brings out chemosynthetic habitats at a depth of 1017 m and implies the surface expression of gas-hydrates in KG basin (Ramadass et al. 2010). The drilling and coring by NGHP Expedition-01 (Collett et al. 2008) have validated the ground truth where gas-hydrates were predicted from surface seismic data in the Bay of Bengal. This has boosted to advance further research for the detection, delineation, and quantification of gas-hydrates along the Indian margin followed by a strong initiative for production in an environmental-safe manner.

Recent Data

Major portions of the deep-water regions along the Indian shelf are not fully explored. Most of the MCS data examined so far were acquired for the exploration of conventional hydrocarbons and may not be adequate for evaluating the resource potential and understanding the genesis of gas-hydrates. Under the sponsorship of the

MoES, very recently, NGRI has acquired 7500 lkm of 2-D MCS data, using a modern ship equipped with the state-of-the-art acquisition system, between 500 to 1500 m water depth in the KG and Mn basins (Fig.1) with a view to identifying new prospective zones, and evaluating the resource potential. The data are of high quality that has produced very good image of shallow sediments in both basins. Figure 2 shows seismic sections along representative lines (shown by red and green in Fig.1).

Preliminary Findings

The preliminary analysis of recently acquired seismic data delineates widespread occurrences of distinct BSRs over a large area (shown by white lines in Fig.1) in both KG and Mn basins. Figure 2 exhibits distinct BSRs identified along representative seismic lines in these two basins. The gas-hydrates stability thickness map (Sain et al. 2011) that has been computed theoretically using the available bathymetry, seafloor temperature and geothermal gradient data has helped in identifying the BSRs from seismic sections. As the energy potential of gas-hydrates is tremendous, the recent investigation provides great hopes to overcome the present energy crisis of India.

Future Work

By employing a suite of approaches for the qualification and quantification of gas-hydrates (Sain and Gupta, 2012 and references therein) to the new data, we will be able to provide information with regard to (i) understanding the petroleum system associated with gas-hydrates; (ii) delineating the extension of sediments containing gas-

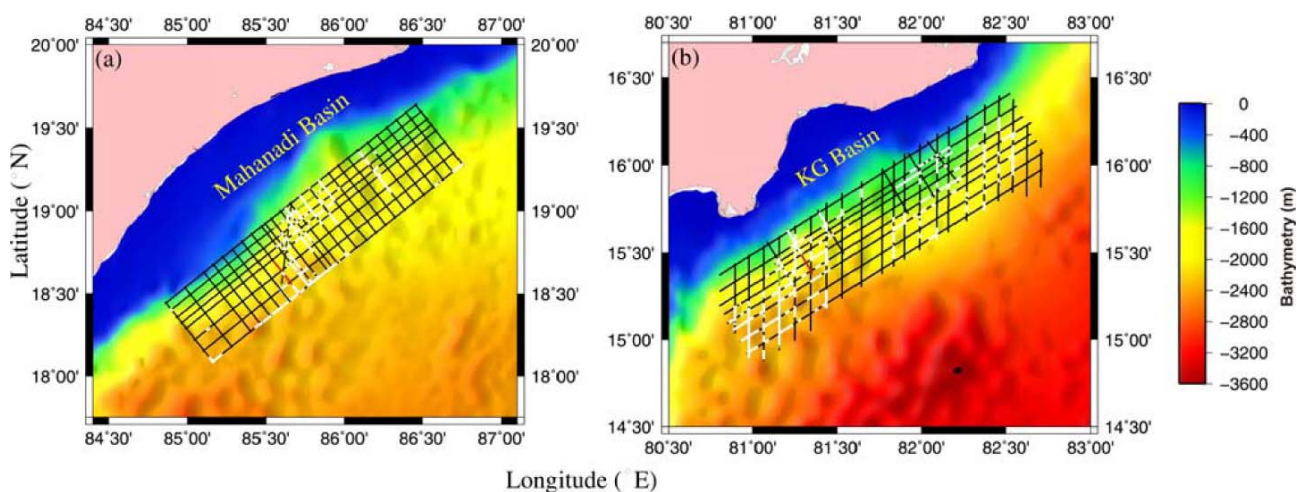


Fig.1. Locations of seismic profiles (black lines) along which MCS data have been acquired recently in (a) Mn and (b) KG basins along the eastern Indian margin. The identified BSRs have been marked by white. Red and green lines show the locations of seismic sections that exhibit representative BSRs in Fig.2.

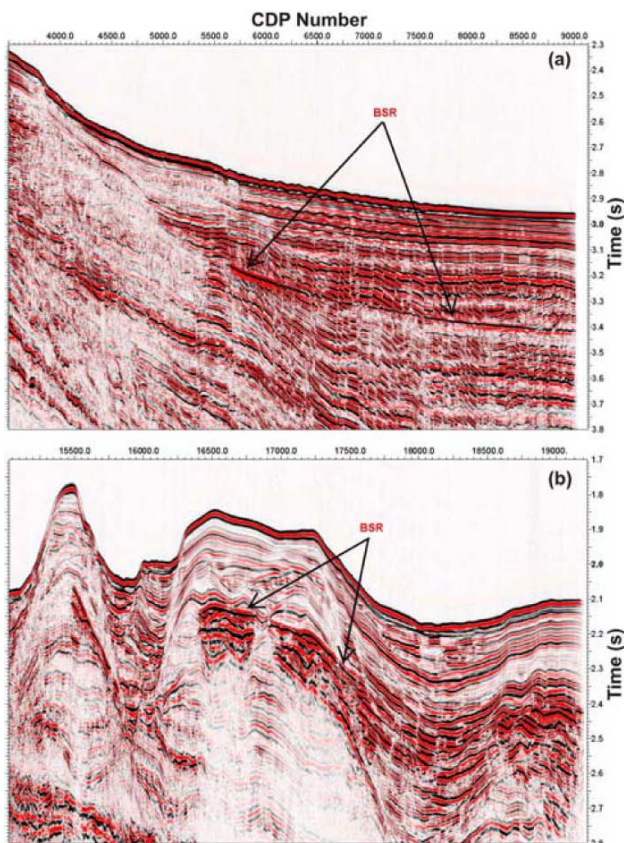


Fig.2.1. Distinct BSR on specimen seismic sections along the (a) red and (b) green lines, shown in Fig.1 in Mn basin. The CDP interval is 12.5 m.

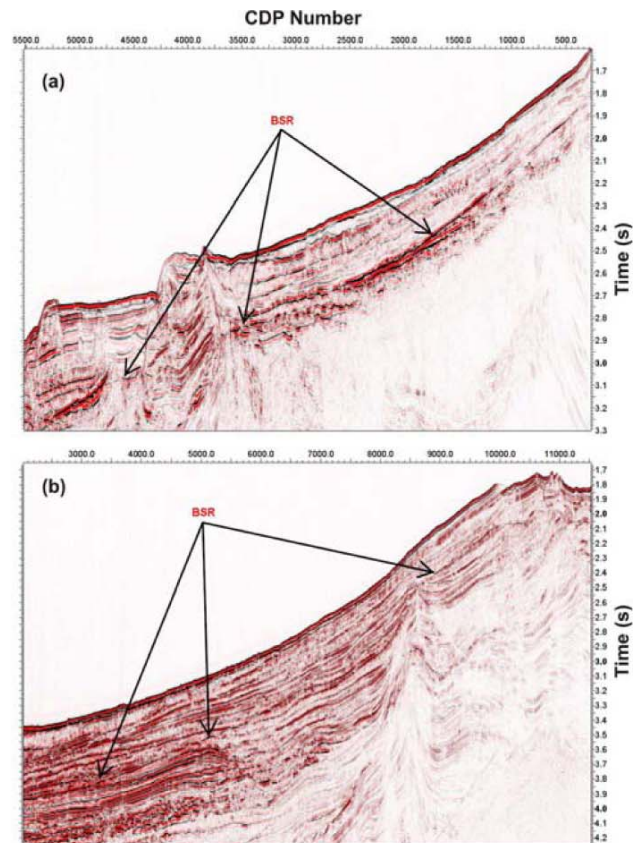


Fig.2.2. Distinct BSR on specimen seismic sections along the (a) red and (b) green lines, shown in Fig.1 in KG basin. The CDP interval is 12.5 m.

hydrates; and (iii) quantifying the amount of gas-hydrates in these two basins. The information derived from geological, geochemical, and biological data collected by NIO will be assimilated, and the ground truth will be validated by NIOT.

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