

A Preliminary Study of Hydrate and Free Gas Saturation in a Gas Hydrate reserve

N. Satyavani, Uma Shankar, B. Ashalatha, S. I. Reddi & N. K. Thakur

National Geophysical Research Institute, Hyderabad

ABSTRACT: Multi-channel seismic data acquired in the western offshore region of India has shown some prominent reflections beneath the seafloor. Preliminary seismic data processing and the AVO studies in the region point to the presence of BSRs in some of the seismic lines. A BSR is the primary indicator of the presence of gas hydrate, and is supposed to represent the base of gas hydrate stability zone. Further studies have been taken up in this region to characterize the hydrate reservoir and estimate the amount of hydrate present. In the study, we use the multi-channel seismic data with a visible BSR in offshore Western Continental Margin of India. The study is based on the work done by Ecker et. Al., 2000 and the resource estimates are presented in terms of hydrate and free gas saturations.

INTRODUCTION

Gas hydrates, are naturally occurring solids comprised of water molecules forming a rigid lattice of cages, with most of the cages containing molecules of natural gas, mainly methane, hence, the name, methane hydrates. A primary indication of the presence of gas hydrate/free gas is the occurrence of BSR, observed as a negative polarity reflector, approximately parallel to the sea floor (Andreassen et al, 1995; Hyndmann & Spence, 1992; Miller et al, 1991). Natural submarine gas hydrates are inferred, mainly from BSRs in the sediments of outer continental margins. BSR also represents the base of the gas hydrate stability field and its presence in the seismic data points to accumulation of gas beneath the hydrate stability field and/or presence of hydrate above the stability field. Though qualitatively, the presence of hydrate can be inferred from the BSR, the quantitative aspect of the hydrate reserves still remains an unanswered question in many of the cases world wide, unless there is a well/sonic log drilled in the region. However, in most of the regions the well-log data is not available and inferences have to be derived from surface seismic data.

Multi-channel seismic data shows presence of some BSRs in the Offshore region of Western Continental Margin of India (Gupta et al, 1998; Rao et al, 2001; Reddi et al, 1998; Veerayya et al, 1998). Following the procedure adopted by Ecker et al (2000), we attempt to estimate the gas hydrate reserves in terms of hydrate and free gas saturations.

METHODOLOGY

The fundamental aspect for the estimation of gas hydrate reserves is to obtain porosity and saturation from the single velocity input. In the presence of well log data the saturation and porosity can be directly derived from the well data, but in the present case there are no research wells drilled in the area and initial assumption has to be made either for saturation or porosity. As first step, we assume the entire section to be 100% brine saturated i.e., depicting a case of “no-hydrate” situation. Then, we calculate the baseline porosity curve (Fig.1) which is nothing but a vertical porosity profile depicting monotonous decrease in porosities with depth, owing to over-burden pressure. Using 100% brine, we change the porosity until the rock physics model can reproduce the seismic interval velocities. This results in anomalies in the regions where the sediment is not 100% saturated. The porosity is underestimated in areas of hydrate saturation, while it is overestimated when free gas is present. When such a deviation is noticed, a second order polynomial is used to fit the curve with the baseline porosity curve and we arrive at “true” porosities. Having known the true porosities and the interval velocities, we can now calculate the actual saturation of hydrate.

RESULTS

In the present study we find that the porosity values slowly decrease from 0.9 to 0.2 with increasing depth in the absence of Hydrate reserves. But in the presence of hydrate

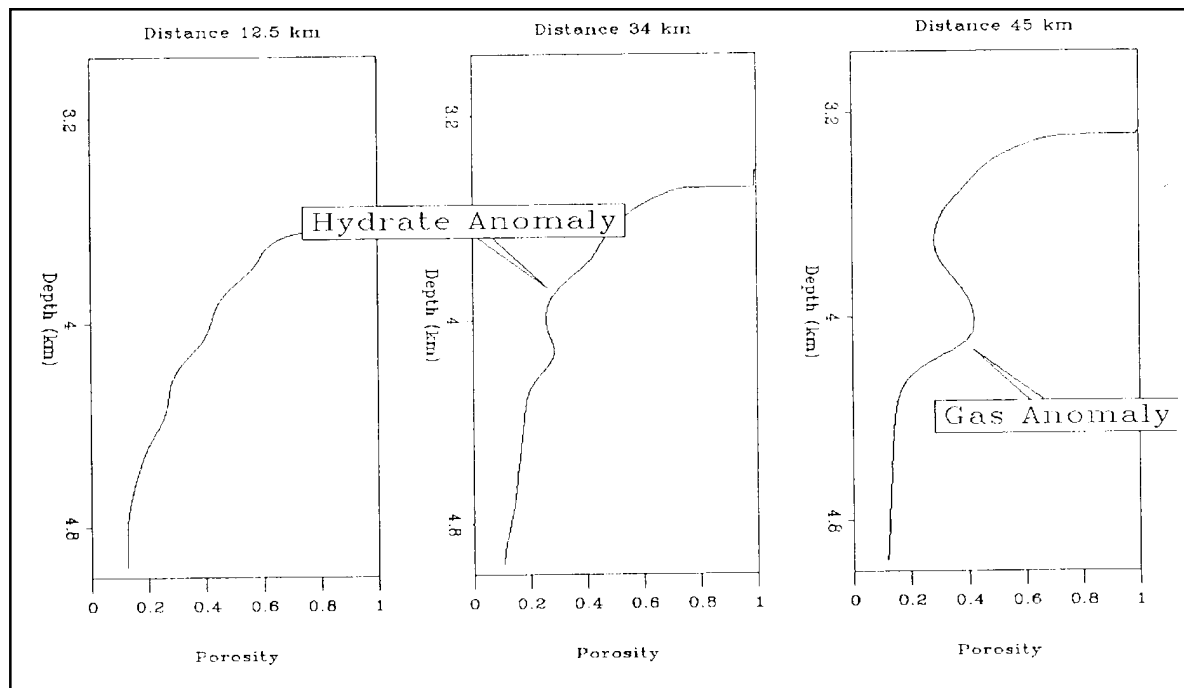


Fig. 1 : Baseline porosity curves taken from Ecker et al., 2000

reserve, they sharply fall from 0.9 to 0.4 at the BSR and rise from there to about 1.2 and again fall to 0.2. The saturation estimates are derived from porosities and vary between 8-10% of the pore space.

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REFERENCES

- Andreassen, K., Hart, P. E., Grantz, A., 1995, Seismic Studies of a bottom simulating reflection related to gas hydrate beneath the continental margin of the Beaufort Sea, *J. Geophys. Res.*, 100, 12659 – 12673.
- Ecker, C., Dvorkin, J., Nur, A. M., 2000 Estimating the amount of gas hydrate and free gas from marine seismic data. *Geophysics*, 65, 563-575.
- Gupta, H.K., Subramanyam, C., Rao, H. Y., Thakur, N.K., Rao, T.G, Ashalatha, B., Khanna, R., Reddi S.I., Drolia, R.K., 1998, Analysis of single channel seismic data along the continental margin of India for Gas Hydrates, National Geophysical Research Institute (NGRI) Tech Rep. No. – 98-Lithos-221.
- Hyndmann, R.D., and Spence, G.D., 1992, A Seismic study of methane hydrate marine bottom simulating reflectors. *J. Geophys. Res.*, 97, 6683 – 6698.
- Miller, J.J., Lee, M.W., and Huene, R., 1991, An analysis of a seismic reflection from the base of a Gas Hydrate Zone, Offshore Peru, *Amer. Assoc. Petrol. Geol. Bull.*, 75. 910-924.
- Rao, Y.H., Subramanyam, C., Rastogi, A., Deka, B., 2001, Anomalous features related to Gas / Gas hydrate occurrences along the western continental margins of India, *Geo-Marine Lett.* 21, 1-8.
- Reddi S.I., Thakur, N.K., Ashalatha, B., Kalachand Sain, 2001, Reprocessing of Multi-channel seismic data of ONGCL for gas hydrate exploration in offshore Goa, National Geophysical Research Institute (NGRI) Tech Rep. Np. – 2001-EXP-307.
- Verayya, M., Karisiddaiah, S.M., Vora, K.H., Wagle, B.G., Almeida, F., 1998, Detection of Gas Charged sediments of Gas hydrate horizons along the WCMI, in *Gas Hydrate: relevance to world margin stability and climate change*, Eds. J.P., Henriot and Mienert, *J. Geol. Soc. India Sp. Pub.* 137: 239-253