Three Dimensional Investigation on BSR Developed in the Accretional Prism Off Muroto, Western Nankai Trough

室戸岬沖、南海トラフ付加体中に発達する BSR の三次元的調査

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ABSTRACT

[Introduction]

Natural gas hydrate is believed to become a future alternative energy. Preliminary estimation of resources of this gas in the earth is about $10^{15} - 10^{17}$ m^3. This volume is two times bigger than recoverable and non recoverable fossil fuels. Gas hydrate can be detected primarily by the occurrence of a bottom simulating reflector (BSR) in the seismic image.

Japan as one of the largest industrial country, imported 4.0 million barrels of oil a day and 7.0 billion cubic feet of LNG a year (2002 data, Tsuji et al, 2004). This condition encourages the government to find domestic energy. Japan National Oil Company, presently the Japan Oil, Gas and Metals National Corporation (JOGMEC) was given the task by Minister of International trade and Industry (MITI) of coordinating domestic

exploratory work (Max, 2000).

Preliminary methane hydrate research and development studies were carried out in the late 1980s by government institutions. The objective of this research was to examine the occurrence of methane hydrate around Japan. In June 1994 the Minister of International trade and Industry (MITI) initiated a project to evaluate methane hydrate around Japan. The result of this investigation mentions that methane hydrate, as an unconventional natural gas resource, might be the most important indigenous energy resources remaining to Japan. It is expected that in the near future, during the first decade of 21st century, the term "Recoverable Reserves" may be applied to hydrate deposits rather than the initial "Expected Resources" (Tono, 1998). Now, Japan is the one of the most active country for gas hydrate study.

The Nankai Trough, where my study is located, is a geologically important area for investigation of accretionary tectonics and earthquake prediction. There for, many seismic investigations were carried out in this area. The recent seismic study have revealed extensive Bottom Simulating Reflectors (BSRs), which are believed as base of gas hydrate layer, or top of free gas layer. After that, The Nankai trough has become the

focus of gas hydrate studies. The amount of resources of natural gas hydrates and associated free gas with hydrated layer in the Nankai Trough offshore Shikoku region was estimated from 1.6 trillion m^3 to 2.7 trillion m^3 (Tsuji et al., 1998).

Since gas hydrate is believed as important energy, research activities in gas hydrate study have been increase. Many technical and scientific papers related to methane hydrate, including those dealing with the likelihood of hydrate adjacent to Japan, have now been published. Multidiscipline study is needed to understand gas hydrate properties, occurrence, distribution, detection and recovery. Part A of this thesis will review some important issues on gas hydrate studies, while part B will explain my PhD thesis with a title "A STUDY OF GAS HYDRATE DISTRIBUTION USING 3-D SEISMIC DATA IN THE MUROTO AREA – JAPAN".

[Muroto 3-D]

Muroto area is a one of the well imaged area of gas hydrate related BSRs in the Western Nankai subduction margin. Collaborative project between UTIG, University of Hawaii, University of California, Santa Cruz, University of Tokyo, Japanese Geological Survey and STA JAMSTEC was conduct a 3-D seismic investigation using a research vessel "Ewing" in 1999.

122 lines were acquired with total 150.000 shots. It was covered and imaged an 8 x 80 km area. This survey was divided into two legs, EW9907 and WE9908. During EW9908, 8 OBS instruments were also deployed and recorded 3-component reflection and refraction arrivals from Ewing shots.

The primary objective of this investigation was to image the plate boundary fault that forms at the toe of the accretionary wedge near the Nankai Trough and extends beneath Shikoku Island. However, post-stack time migrated profile, which was processed previously, also showed clear and interesting BSR distribution phenomena.

3-D seismic image is very useful to study BSR distribution. Earth structure can be deeply analyzed in various points of view. It reveals detail information of BSR distribution and its relation to stratigraphy. We did 3D velocity modeling using vertical velocity analysis and horizontal velocity analysis to get good velocity model. These models are based on 3D pre-stack migration methods with iteration method, which can produce relatively accurate depth interval velocity model. This model is finally used to create 3-D depth migrated volume. Depth image can provide better understanding about relation between BSR appearances to gas hydrate stability zone that is controlled by interrelation between temperature and depth/pressure.

BSR is not distributed uniformly in all entire area. More over, there are some areas where BSRs are shown very clear and strong. In contrast, some areas show no BSR. BSR also tends to disappear or appear just in some small areas. The Amplitude of BSR

layer is also varied depends on geological structure. BSR distribution was finally characterized by divided the volume into 5 zones. The zones determination was based on BSR development relates to tectonic/sedimentary process where different zones have different characteristics.

The existence of young sediment, fault, sea floor slope, and sedimentation process are main factors, which control BSR distribution. However, every zone is controlled by different dominant factor. Interpretations about fluid flow process and gas production source were also made by using the advantage of 3D data.