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Resource Assessment of Methane Hydrate in the Eastern Nankai Trough, Japan

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Abstract

Resource assessment of methane hydrate (MH) in the eastern Nankai Trough was conducted through probabilistic approach using 2D/3D seismic data and drilling survey data from METI exploratory test wells “Tokai-oki to Kumano-nada”. We have extracted more than 10 prospective “MH concentrated zones” characterized by high resistivity in well log, strong seismic reflectors, seismic high velocity, and turbidite deposit delineated by sedimentary facies analysis.

The amount of methane gas contained in MH bearing layers was calculated using volumetric method for each zone. Each parameter, such as gross rock volume (GRV), net-to-gross ratio (N/G), MH pore saturation (Sh), porosity, cage occupancy, and volume ratio was given as probabilistic distribution for Monte Carlo simulation, considering the uncertainty of these evaluations.

The GRV for each hydrate bearing zones was calculated from both strong seismic amplitude anomaly and velocity anomaly. Time-to-depth conversion was conducted using interval velocity derived from Seismic Vision While Drilling (SVWD). Risk factor was applied for the estimation of the GRV in 2D seismic area considering the uncertainty of seismic interpretation. The N/G was determined based on the relationship between LWD resistivity and grain size in zones with existing wells. Seismic facies map created by sequence stratigraphic approach was also used for the determination of the N/G in zone without well controls. Porosity was estimated using density log, together with calibration by core analysis. The Sh was estimated by the combination of density log and NMR log, together with the calibration by observed gas volume from onboard MH dissociation tests using Pressure Temperature Core Sampler (PTCS). The Sh in zone without well control was estimated using relationship between seismic P-wave interval velocity and Sh from NMR log at well location.

Total amount of methane gas in place contained in MH within survey area in the eastern Nankai Trough was estimated to be 40 tcf as Pmean value. Total gas in place for MH concentrated zone was estimated to be 20 tcf (Half of total amount) as Pmean value. Sensitivity analysis indicated that the N/G and Sh have higher sensitivity than other parameters, and they are important for further detail analysis.

Introduction

Seismic data from the Nankai Trough, offshore central Japan, indicates widespread distribution of bottom simulating reflectors (BSR)¹ that are interpreted to represent lower boundary of methane hydrate (MH) bearing zones. MH in the Nankai Trough is a potential natural gas resource, however, the volume, distribution, and occurrence of MH in this area is poorly understood.

In 1999, MH-bearing sand-rich intervals in turbidite fan deposits were recognized from the eastern Nankai Trough based on results of MITI (Ministry of International Trade and Industry) “Nankai Trough” wells^{2, 3}. Based on this exploration result, the Japanese government inaugurated a 16-year MH exploration program in 2001. As a part of this program, the Ministry of Economy, Trade and Industry (METI), Japan, drilled the “Tokai-oki to Kumano-nada” exploratory test wells from January to May 2004, in order to obtain data for understanding the occurrence of MH and estimating resource potential^{4, 5}. In this campaign we carried out logging-while-drilling (LWD) at 16 sites, coring at four sites, wireline logging at two sites, and long-term monitoring of formation temperature at single site^{5, 6, 7} (Figure 1). Using following data set, we conducted MH resource assessment in the survey area in 2005 and 2006. Figure 2 shows the flow chart of the resource assessment.

- MITI Exploratory Test Well “Nankai Trough” in 1999 (6 wells)