Mechanism of methane gas flow at shallow type methane hydrate areas using wave field simulation

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In this study, we have been investigated the features of the subseafloor structure beneath some surface methane hydrate (hereinafter referred to as MH) based on various geoscience survey data and seismic features using wavefield simulations, in order to evaluate the extend and quantity of MH.

It is well known there are remarkable acoustic blanking zone and geologic gas chimney beneath surface MH areas.

It is necessary to determine both a process of MH formation and a relation between methane seeps and its submarine structure, as well as to investigate the potential for MH regeneration.

We therefore tried to understand the seismic features for the subseafloor structure with a gas-chimney beneath surface MH area, such as Umitaka Spur, off-Joetsu, Niigata, by simulating seismic wavefield. We calculated some structure models with surface MH, free-gas reservoir, and/or fault systems, referring to some seismic data, heat flow distribution data, and methane isotope ratio data. We assumed that the methane gas, which is caused by thermal decomposition, have been moved by groundwater from deep layer through some fault system/networks to subseafloor.

Based on the result of the waveform data for various types of subseafloor structure models, we found that the acoustic blanking zone on the seismic profile may be caused by a structure which included the relatively lower velocity zone at a low-saturated gas layer beneath the relatively higher velocity zone at the surface MH. We assumed that the underground water network could be horizontal spreading due to faults and fractures inside the gas chimney.

We therefore concluded that the acoustic blanking was caused by scattering and attenuation of seismic waves which traveled through lower-velocity zones such as underground water inside some fault system/network and low saturated gas layers under MH stability zones.

It is also found that some gas chimneys and methane seeps may be shown above the cross-area of normal fault group existing near seafloor to shallow depth and North-northeast - South-southwest reverse fault system existing at the large depth in this study area. So, we considered that large/ gashing-out seeps could carry out with warm groundwater upwelling through such fault system/networks.

Keywords: Methane hydrate, Gas chimney, Methane seeps

