

## Pore space filling state of mud sediment in the gas hydrate area in the Japan Sea: assumption from oxygen isotopic composition of water fraction

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Gas hydrates in the Japan Sea occur massive, vein, and granular forms in fine-grained mud sediments. It is generally considered that the hydrate cannot be developed in micron-sized pore spaces in fine-grained sediments because of a reduced pore water activity and the capillary pressure in pores (Clennell et al., 1999). This appears a distinct contrast with pore-filling gas hydrates in sandy sediments, as observed in the Nankai Trough.

However, our analyses for the hydrate-bearing sediments recovered from Joetsu offshore imply that the gas hydrate at least partly fills the porosity of the mud sediments. Our analysis sequence consists three steps; the oxygen isotopes of the water fraction (porewater and hydrate) equilibrated with gaseous carbon dioxide, the methane/carbon dioxide ratio of headspace gas, and the porosity by measuring weight and volume of the dried sediments. We found that the difference in oxygen isotope between porewater and hydrate decreased down to <1.5 permil with increasing abundance of hydrate, which contradicts with theoretical calculation assuming fractionation in a closed system. Headspace gas of some mud sediments recorded extremely high methane/carbon dioxide ratio. These features imply the occurrence of hydrate in the porosity of the mud sediments. In addition, the porosity of the Joetsu sediments was clearly lower than the porosity of the other area (e.g., the Oki offshore). This can be explained by the pore-filling hydrate and/or free gas. Our findings improve the estimate of energy resource of the Japan Sea hydrate, and may contribute to future study for the hydrate recovery.

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Clennell et al., 1999. *Journal of Geophysical Research* 104, B10, 22,985–23,003.

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