Methanogenesis and methane consumption within the gas chimney structure in Hidaka Trough, offshore Hokkaido: implications from pore water and gas geochemistry

*Mamata Tsuyoshi[1], Ryosuke Nakajima[1], Hitoshi Tomaru[1], Ryo Matsumoto[2]

1. Department of Earth Sciences, Chiba University, 2. Gas Hydrate Laboratory, Meiji University

Hidaka Trough, offshore Hokkaido, is characterized by gas chimney structures, methane plume, and degassing structures that indicate gas migration from deep sediments to the surface area. This methane is strongly associated with microbial mediated chemical reactions in shallow sediments. This study aims to figure out the microbial processes such as methanogenesis and methane consumption, characterizing geochemical environment in shallow sediments, by analyzing concentrations of dissolved ions and hydrocarbons, and stable isotopic composition ($\delta^{13}C$) of dissolved carbons collected from mounds with gas chimney structures in Hidaka Trough.

Sulfate is depleted strongly near the seafloor at the sulfate-methane interface (SMI), indicating the domination of reductive environment near the seafloor. Sharp negative peak of $\delta^{13}C$ of dissolved inorganic carbon (DIC) locates at the SMI, indicating the anaerobic methane oxidation predominates for the sulfate consumption at this interval. We examined $\delta^{13}C$ of methane and dissolved hydrocarbon composition to distinguish the gas source. Although the biogenic methane is transported from deep sediments, it receives a certain amount of methane of thermogenic origin. In addition, by comparing $\delta^{13}C$ of methane with DIC, biogenic methane produced by microbial mediated CO_2 reduction pathway is also significant. Methane produced by microbial mediated CO_2 reduction within upper methanogenesis zone and biogenic and/or thermogenic methane derived from deep sediments contributes to the shallow reductive environment within gas chimney structures in Hidaka Trough.

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