Methanogen diversity and methanogenic potential in natural gas fields in Japan

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Methane accumulated in the subsurface has recently attracted considerable interest as a cleaner energy source. Methane is found as a natural gas and as methane hydrates. This study focuses on methane gas deposits in interstitial water, classified as a natural gas of the dissolved-in-water type in Japan. Gas-dissolved formation water has been found in reservoir rocks that originate from the marine sediments of the Miocene to Quaternary periods. Based on geochemical analysis, the methane produced in these geological settings was shown to be predominantly microbial. However, little is known of the microbial community structure in natural gas fields where biogenic methane has accumulated, while a number of studies on microbial ecology in oil reservoirs have been conducted. To better understand the formation process of the gas deposit and to evaluate the current state of the reservoir, we performed microbial community analysis together with determination of the methanogenic potential. We report the phylogenetic diversity of *Archaea* (primarily methanogens) based on 16S rRNA gene analysis, and methanogenic activities in the formation water in a gas field in Chiba and Niigata, Japan.

Two formation water samples (of 25 degrees C in temperature) were obtained from a depth of 350 to 1150 m in Chiba (1). This region is the largest gas field that produces natural gases of dissolved-in-water type in Japan. In addition, two formation water samples (of 46 and 53 degrees C in temperature) were obtained from a depth of 700 to 800 m in Niigata (2). Each formation water sample was derived from different reservoir layer, which deposited in the 1-4 Ma in bathyal environments. Based on 16S rRNA gene cloning analysis, the dominant archaeal sequences were related to the hydrogenotrophic methanogens in the genus *Methanobacterium* or *Methanothermobacter* in each sample. Of the methanogenic substrates tested using the formation water-based medium, H_2-CO_2 gave rise to methane formation in all samples.

These results suggest that the formation water in the gas fields harbor viable hydrogenotrophic methanogens and have possibly been making a contribution to ongoing methanogenesis.

(1) Mochimaru, H. et al. Geomicrobiology Journal (in press)

(2) Mochimaru, H. et al. Extremophiles (in press)