Impacts of natural gas developments on methanogenic diversity and activity in natural gas field

HIDEYOSHI YOSHIOKA[1*], TAIKI KATAYAMA[1], SUSUMU SAKATA[1], YOSHIYUKI MURAMOTO[2] AND JUN USAMI[2]

[1]Research Institute for Geo-Resources and Environment, Geological Survey of Japan, AIST, Tsukuba, Ibaraki, Japan

[2]Kanto Natural Gas Development Co., Ltd., Mobara, Japan
(*correspondence: hi-yoshioka@aist.go.jp)

Despite the important contribution of biogenic methane to natural gas resources worldwide, little is known about microbial methanogenesis in deep subsurface environments. We investigated methanogenic diversity and activity in the formation waters collected from confined sand aquifers through production wells in natural gas field in Japan. Methanogenic activity measurements using radiotracers, culturing experiments and molecular analysis of formation water samples indicated the predominance of hydrogenotrophic methanogenesis. The results were consistent with the geochemical interpretation of the stable isotopic compositions of methane in this gas field that their origin was biogenic via carbonate reduction pathway. The cultivation of water samples amended only with methanogenic substrates resulted in significant increases in microbial cells along with high-yield methane production, indicating the restricted availability of substrates in the aquifers. Hydrogenotrophic methanogenic activity increased with increasing natural gas production from the corresponding wells, suggesting that the flux of substrates from organic-rich mudstone to adjacent sand aquifers is enhanced by the decrease in fluid pressure in sand layers associated with natural gas production. The transient predominance of methylotrophic methanogens, observed for a few years after well drilling, also suggested the stimulation of the methanogens by the exposure of unutilized organic matter through well drilling. These results would provide an insight into the physicochemical impacts on the methanogenic activity in biogenic gas deposits.

[1] Katayama et al. (2015) *ISME J.* **9**, 436–446.