Active methane cycling studied by molecular biomarkers and stable isotope in the sediment of Sakhalin continental slope

DONG-HUN LEE[1], YOUNG-KEUN JIN[2], HIROTSUGU MINAMI[3], AKIHIRO HACHIKUBO[3], JONG-KU GAL[1], BOHYUNG CHOI[1], KYUNG-HOON SHIN[1]*

[1]Department of Marine Sciences and convergent technology, Hanyang University
55, Hanyangdaehak-ro, Sangnok-gu, Ansan, 425-791, South Korea
[2]Division of Polar Earth-system Sciences, Korea Polar Research Institute
26, Songdomirae-ro, Yeonsu-gu, Incheon 406-840, South Korea
[3] Environmental and Energy Resources Research Center, Kitami Institute of Technology, 090-8507 Hokkaido, Japan

Active methane (CH_4) releases from gas seepages bearing gas hydrate (GH) to water column have been widely observed on the Sakhalin continental slope. However biogeochemical processes about methane-related archaea communities in this region is poorly understood. Hence, we analyzed the distribution of the intact polar lipid (IPL) and core lipid (CL)-glycerol dibiphytanyl glycerol tetraethers (GDGTs) in order to assess its utility as a proxy for *in situ* CH_4 production/consumption in geological systems associated with shallower GH accumulation. In shallow sediments, the most depleted-carbon isotopic values of CH_4 and CO_2 ($\delta^{13}C_{CH4}$: –46.3‰ and $\delta^{13}C_{CO2}$: –26.6‰) indicate that thermogenic CH_4 is mainly oxidized by methanotrophic activities. $\delta^{13}C$ values of biphytanes ($\delta^{13}C_{BP1}$ as low as –69.3‰) derived from IPL-GDGTs, in particular BP-1 as probable methane-related biomarker, are distinctively lighter than those of CH_4, suggesting that methanotrophic archaea is potentially indicative for living biomass performs *in situ* anaerobic oxidation of methane (AOM) in this depth range. Previous 16S rRNA surveys of the microbal populations in this vent deposit have shown predominant ANME-1 among phylogenetically *Euryarchaeota* and appear to be controlled by geochemical and geological processes that drive biogeochemical CH_4 cycle. Overall, IPL results are similar with gene-based survey. We conclude that upward CH_4 sources from thermogenic origin can be continuously reduced by methanotrophic activities in surface seafloor. This study provides the first biogeochemical data set of active CH_4 vent deposits at the Sakhalin continental slope, which help to better understand modern and past CH_4 cycle in this setting.