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Microbes at the Beach – Microbial Populations and Activities at Shallow Gas Seeps in the Kattegat, Denmark

M. Basen (1), A. Eppelin (1), M. Krüger (1,2)

(1) MPI for Marine Microbiology, Bremen, Germany (2) Federal Institute for Geosciences and Resources (BGR), Hannover, Germany (M.Krueger@bgr.de / Phone: 0049-(0)511-6433102)

Large reservoirs of methane are located beneath the Kattegat area between Denmark and Sweden. Continuous gas seeping led to the formation of up to several metres high carbonate structures at the sea bottom. Interestingly, seeps with associated carbonates are also found in less than 1 m water water depth close to the beach. Gas bubbles contained 80-95% methane, with a presumably mixed biogenic and thermogenic origin. No higher alkanes were found. The sediment is sandy with a relatively high organic carbon content. Rates of sulfate-dependent methane oxidation in cores collected close to the seeps were relatively low. This was confirmed by FISH analysis which revealed only few ANME-cells in the sediment. A parallel clone library based on archaeal 16S rRNA showed only a limited diversity and no ANME-related sequences. In contrast, rates of sulfate reduction without substrate addition were high throughout the sediment depth. Also, cell numbers of sulfate-reducing microorganisms determined by FISH with probes for the different phylogenetic groups were high, with a clear dominance of Desulfosarcinales. Clone libraries for sulfate reducers based on the apsA-gene additionally contained high numbers of sequences for sulfur-oxidising microorganisms. Taken together this indicates a highly active sulfur cycle in this habitat. Futhermore, substantial rates were measured for aerobic methane oxidation as well as methane production. However, the phylogenetic analysis revealed only a limited diversity of methanotrophic bacteria and methanogenic archaea.