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Succession of novel methanotrophic guilds on mud flows at Håkon Mosby Mud Volcano, Barents Sea - evidence of biomarker and DNA analyses

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Ocean margin research of the last decade has provided evidence for distinct microbial habitats fuelled by methane. Such microbial ecosystems are found near gas hydrate environments, at mud volcanoes, and other methane-driven cold seep systems; yet we know little on how these communities develop over time and shape their environment. Active mud volcanoes provide an in situ laboratory to study the temporal succession of chemosynthetic communities on recent mud flows. One such example is the Håkon Mosby Mud Volcano (HMMV). In the youngest parts at the centre, high concentrations of specific bacterial fatty acids and their associated, low delta 13C-signature gives evidence that aerobic methanotrophy (MOx) is the primary biomass-generating process mediated by a type I methanotroph. In surface sediments of the central area, mean MOx rates are as high as 115 nmol cm-3 d-1 while sulphate reduction rates (SRR) remain close to detection limit. An onset of anaerobic oxidation of methane (AOM) below the MOx horizon is indicated by low amounts of 13C-depleted, archaeal lipids. In patches of reduced sediment, covered by greyish, thiotrophic microbial mats at the boundary of the centre, a four-fold increase in specific, archaeal lipid concentrations that is accompanied by further depletions in 13C, gives evidence that AOM communities have propagated. These patches are very heterogeneous as indicated by highly variable AOM and SRR with mean values as high as 500 nmol cm-3 d-1. Further expansion of AOM communities results in a belt of reduced sediments adjacent to the centre. Here, anaerobic methanotrophy is the predominant microbial biomass-

generating process below white thiotrophic mats consisting of Beggiatoa. AOM communities are restricted to a narrow surface horizon of no more than 4 cm as indicated by sharp, vertical gradients of 13C-depleted archaeal and bacterial lipids as well as a distinct peak in AOM and SR rates with values <500 nmol cm-3 d-1 in the uppermost sediment horizon. A combination of molecular techniques (DAPI, FISH, gene libraries), as well as biomarker fingerprints of 13C-depleted archaeal and bacterial lipids provide evidence that AOM communities comprise a novel strain of archaea (termed ANME 3) and sulphate reducing bacteria (SRB) of the Desulfobulbus cluster. The outer rim of HMMV is densely colonised by pogonophoran worms, which harbour symbiotic MOx-bacteria and extend down to 60 cm into the sea floor. At 70 cm bsf, elevated lipid biomarker concentrations together with a distinct maximum in AOM and SR rates give evidence that bio-ventilation of the worms relocates the AOM horizon to the sub surface where both, AOM communities and the worms compete for methane.