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Microbial consumption of methane and methane emission at the Haakon Mosby Mud Volcano, Barents Sea

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The Haakon Mosby Mud Volcano (HMMV) is an active methane seeping mud volcano of ca. 1 km in diameter at 1250 m water depth on the Norwegian margin of the Barents Sea (72˚00'N, 14˚45' E). Previous and recent videographic mapping of the seafloor indicates three distinct habitats: (1) a central area of 0.11 km^2 covered by greyish muds; concentrically enclosed by (2) a belt of 0.22 km^2 of blackish, highly reduced sediments covered with white mats of the thiotrophic bacterium *Beggiatoa sp.*; (3) and an outer rim of 0.41 km^2 of brownish sediments, which are densely populated by siboglinid tubeworms. These habitats were sampled with the ROV Victor 6000 (IFREMER) by push cores, a video-guided multiple corer and gravity cores for *ex situ* measurements of aerobic and anaerobic methane oxidation as well as sulphate reduction rates. Methane oxidation rates and *in situ* fluxes of oxygen and sulphide as well as methane emission, were used to calculate a conservative methane budget for HMMV. Aerobic or anaerobic oxidation of methane dominates biogeochemical processes in the HMMV sediments and is carried out by different microbial communities in distinct zones of the mud volcano. Chloride and bromide concentration profiles provide

evidence that differences in advective flow of pore water is a main factor determining this zonation. In the centre, a high upward flow of sulphate-free subsurface fluids strongly limits the penetration depth of sulphate and oxygen. Here, aerobic oxidation of methane (MOx) is restricted to the top cm sediment layer with rates of 3.8 mol m^{-2} yr^{-1} and anaerobic oxidation of methane (AOM) is absent. Adjacent to the centre at the *Beggiatoa* site, decreased upward fluid flow and the activity of the *Beggiatoa* filaments allows for an AOM zone of ca 5 cm at the sediment surface with rates of 8.2 mol m^{-2} yr^{-1}. At the outer rim of the HMMV, bioventilation of the tubeworms irrigates a much deeper zone with oxygen- and sulphate-rich seawater. MOx activity of the free-living methanotrophic community in the oxygenated surface sediments was comparably low with 0.2 mol m^{-2} yr^{-1}. A defined methane-sulphate transition zone was found just beneath the roots of the tubeworms at 67 to 77 cm sediment depth. Here, AOM activity was high with 7.1 mol m^{-2} yr^{-1}. Microbial consumption reduces the methane efflux of HMMV by 5×10^6 mol yr^{-1}. In comparison to the total methane flux of 13-40 $\times$ 10^6 mol yr^{-1}, this is $<$40%.

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