In situ fluxes and zonation of microbial activity in surface sediments of the Håkon Mosby Mud Volcano

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ABSTRACT: From the Hakon Mosby Mud Volcano (HMMV) on the southwest Barents Sea shelf, gas and fluids are expelled by active mud volcanism. We studied the mass transfer phenomena and microbial conversions in the surface layers using in situ microsensor measurements and on retrieved cores. The HMMV consists of three concentric habitats: a central area with gray mud, a surrounding area covered by white mats of big sulfide oxidizing filamentous bacteria (*Beggiatoa*), and a peripheral area colonized by symbiontic tube worms (*Pogonophora*). A fourth habitat comprised gray microbial mats near gas seeps. The differences between these four methane-fueled habitats are best explained by different transport rates of sulfate into the sediments and porewater upflow rates. The upflow velocities were estimated by two independent methods at 3-6 m yr^{-1} in the central area and 0.3-1 m yr^{-1} in *Beggiatoa* mats. In the central area no sulfide was found, indicating that the rapidly rising sulfate-free fluids caused sulfate limitation that inhibited anaerobic oxidation of methane (AOM). Under *Beggiatoa* mats a steep sulfide peak was found at 2 to 3 cm below the seafloor (bsf), most likely due to AOM. All sulfide was oxidized anaerobically, possibly through nitrate reduction by *Beggiatoa*. The *Beggiatoa* mats were dominated by a single filamentous morphotype with a diameter of 10 mm and abundant sulfur inclusions. A high diversity of sulfide oxidizer morphotypes was observed in a grayish microbial mat near gas vents, where aerobic sulfide oxidation was important. The sediments colonized by *Pogonophora* were influenced by bioventilation, allowing sulfate penetration and AOM to 70 cm bsf. The HMMV is a unique and diverse ecosystem, the structure and functioning of which is mainly controlled by pore-water flow.