



The impact of methane on biogeochemical processes at the Hakon Mosby Mud Volcano

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The turnover of methane plays a major role in the biogeochemistry of gas-bearing sediments. It has influence on the carbon, sulfur and iron cycles and affects both chemical and microbiological processes. Cold seep ecosystems like the Håkon Mosby Mud Volcano (HMMV) show signatures of aerobic and anaerobic oxidation of methane at the seafloor. At the HMMV the anaerobic pathway (AOM), which is coupled to sulfate reduction, often dominates because of limited oxygen penetration. A consortium of methane oxidizing archaea and sulfate reducing bacteria performs this process, resulting in CO₂ and H₂S production. The transformation of the sulfide can either be carried out by thiotrophic bacteria to sulfur or sulfate, or chemically by precipitation with iron, resulting in FeS or pyrite formation.

One major characteristic of the HMMV is the clear division in different habitats, which are all fueled by varying methane discharges from the volcano source. Our investigations in the framework of the project HERMES with the French research vessel "Pourquoi pas ?" and the ROV "Victor 6000" in June/July 2006 concentrated on the centre as well as the surrounding area covered by microbial mats. In the center high advection rate seems to limit sulfate penetration and therefore restrains anaerobic oxidation of methane (AOM). In this habitat sporadic gas ebullition into the overlaying water can be detected. For the first time we investigated sulfate reduction (SR) by in situ incubation with a new instrument called INSINC. INSINC incubates sediment cores at in situ temperature and pressure at the seafloor to obtain realistic rates of methane-fueled sulfate reduction.

In the bacterial habitat our investigation also concentrated on the fate of the sulfide,

which is produced through sulfate reduction. To assess if the biological or the geochemical pathway of sulfide oxidation dominates, precise information about the involved components is crucial. An important in situ tool for this is the microprofiler (MIC), on which up to 10 microsensors can be deployed. With the help of the MIC the characterization of habitats in terms of oxygen penetration, sulfide production, pH and small scale temperature changes can be assessed. In addition to this, porewater and solid phase iron and sulfur geochemistry was performed on retrieved pushcores and multicores.

This study shows that only through the combination of different in situ devices as well as ex situ techniques, the role of the methane and its effect on for example the iron and the sulfur cycle at the HMMV can be estimated.