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Sulfate reduction and methane oxidation at different habitat scales: implications for oxygen and methane budgets of the Håkon Mosby Mud Volcano (HMMV)

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The HMMV is one of the best investigated mud volcanoes worldwide and has now been studied in high resolution with ROV systems and in situ biogeochemical payloads during several cruises within the last years. Based on first diffusive flux and rate measurements the HMMV has been subdivided into three main habitats indicating aerobic methane oxidation in the center, anaerobic oxidation coupled to sulfate reduction in surface sediments of the bacterial mat zone, and subsurface AOM below siboglinid tubeworms (Niemann et al. 2006). A comparative analysis of in situ biogeochemical measurements from 4 different expeditions serves to address variations in microbial activities within and between the various habitats. Additionally, we estimated total fluxes of dissolved methane and oxygen between seafloor and water column, improving the methane and oxygen budgets of the HMMV.

For our investigations we used a combination of different in situ devices and ex situ techniques to quantify the dominant biogeochemical processes. Using a ROV operated benthic chamber module we measured total oxygen consumption and methane emission rates. The new in situ tool INSINC was applied to incubate sediment cores at in situ temperature and pressure at the seafloor for measuring sulfate reduction (6^{th} FP EU project EXOCET). Additionally, incubations with radiolabeled $^{14}CH_4$ and $^{35}SO_4^{2-}$ tracer were performed to determine ex situ methane oxidation and sulfate reduction rates.

The data indicate that on average similar and high turnover rates of methane and sulfate are associated with Beggiatoa mats from different areas of the HMMV. Therefore, we assume that comparable fluxes of fluids and gases are responsible for the formation of Beggiatoa mats. However, on a smaller scale within one Beggiatoa mat small heterogeneities are measurable, reflected also in the bacterial coverage of the sediment surface. The total oxygen consumption rates show a similar trend but are significantly higher than the previously reported diffusive uptake rates, indicating an active benthic community. Also the dissolved methane emissions in the various areas are higher than reported from other seep systems (Boetius and Suess 2004). This presentation compares sulfate and methane turnover as well as in situ oxygen consumption rates on various spatial scales, providing a better understanding of the mechanistics and coupling of biogeochemical processes at cold seeps. The research was carried out in the framework of the BMBF-DFG Geotechnologies program “MUMM” as well as of the EU 6^{th} FP HERMES.