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Anaerobic oxidation of Methane and Sulfate reduction in the Nile Deep Sea Fan

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Rates of anaerobic oxidation methane (AOM) and sulfate reduction (SR) were investigated in sediments of several different cold seeps at the Nile Deep Sea Fan. Microbial methane and sulfate turnover rates determined by radiotracer incubations, revealed strong differences between investigated sites. AOM rates ranged from 5 nmol CH4 $ml^{-1}d^{-1}$ to over 1000 nmol CH4 $ml^{-1}d^{-1}$. SR activity ranged from 0 to over 3000 nmole SO4 $ml^{-1}d^{-1}$. Such high rates of AOM and SR are similar to rates observed at gas hydrate bearing, highly active methane seep systems, such as at the Cascadia margin and in the Gulf of Mexico. High AOM activity was also correlated with sediments overlain with white films reminiscent of sulfide oxidizing bacteria. High SR activity correlated with mud breccia sediment, but often without white films. At present, AOM is believed to be coupled to SR by a syntrophic consortium of methane-oxidizing archaea and sulfate reducing bacteria. The molar ratios of sulfate reduced to methane oxidized were close to 1:1 in several samples, such as the Amon mud volcano, indicating a strong coupling between SR and AOM. However, at some sites such as in the Menes caldera SR exceeded AOM by over an order of magnitude, indicating a loose coupling between the two processes. In these cases, the electron donor for sulfate reduction was probably higher hydrocarbons. Methanotrophic archaea (ANME) and sulfate reducing bacteria, previously shown to be involved in AOM, were detected in several samples with AOM and SR activity. Our results indicate that several cold seeps in the Nile Deep Sea Fan are sites of high microbial turnover, fueled by methane and other seepage compounds. One of the future goals of the project MEDIFLUX (ESF EUROMARGIN program) is to investigate the relation between microbial diversity, activity and the geological/geochemical structure of the different seep systems.