Universität Basel

Research Project

Microbial methane consumption in contrasting ocean environments: effects of elevated seepage and geochemical boundary conditions

Third-party funded project

Project title Microbial methane consumption in contrasting ocean environments: effects of elevated seepage and geochemical boundary conditions
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Large quantities of the green house gas methane (CH_4) are stored in sediments of continental margins, most importantly in the form of clathrate hydrate, which forms naturally when CH_4 and water are subjected to low temperature (T) and high pressure (p). Typically, these conditions are met below 300 to 600 m water depth. An increase in bottom water T thus shifts the upper P/T boundary at which CH_4 hydrates are stable towards greater water depth. Consequently, hydrate layers could then be exposed to P/T conditions where they become unstable. This leads to a liberation of CH_4 into surface sediments, the overlying water column and, potentially, into the atmosphere where it further contributes to global warming. However, microbial CH_4 oxidation may counteract this development. At present, most methane is retained in anoxic ocean sediments because it is oxidised by specialised archaea in consortium with sulphate reducing bacteria. In addition, aerobic bacteria in the water column consume CH_4 that has by passed the benthic, microbial filter. Nevertheless, at so-called cold seeps where large quantities of $CH_4$are transported into surface sediments, significant amounts of CH_4 may escape both, the sedimentary as well as the water column part of the microbial filter and are then released into the atmosphere. Yet, the efficiency of the microbial filter is not well constrained as are environmental factors controlling abundance and activity of methanotrophs, or selecting for specific phylogenetic groups. To close this knowledge gap, we propose to investigate microbial activity, abundance and identity at two contrasting cold seep settings. (i) The recently discovered seeps on the West Spitsbergen margin emit CH_4into the water column and potentially into the atmosphere. These seeps are putatively driven by recent hydrate melting. This study site therefore offers the unique possibility to investigate the benthic and water column part of the microbial CH_4 filter at a potentially newly created seep habitat in a temperature sensitive environment. (ii) Deep sea basins in the eastern Mediterranean Sea feature anoxic, CH_4-rich brine lakes. The different environmental conditions associated with the brine lakes such as ion composition and CH_4 contents will allow us to investigate limits of anaerobic and aerobic methanotrophy and could permit to identify key environmental factors controlling activity, abundance and identity of the methanotrophic community. The study sites will be sampled within the frame work of sea going expeditions that have already been approved and funded. The data gained during the proposed project (mainly microbial activity, abundance and identity) will be integrated with geochemical and geochronological investigations as well as model approaches carried out by our colleagues. We will measure microbial activity in the sediment and the water column by *ex situ* incubations with radio-isotope techniques. High resolution activity measurements will be interpolated to determine CH_4 budgets, which, in combination with emission estimates, will be used to assess the efficiency of the microbial CH_4 filter. Additionally, microbial

activities will be assessed indirectly using stable isotope signatures. The known as well as potentially novel methanotrophic communities will be identified and quantified using lipid biomarker assays in combination with molecular approaches (FISH, clone libraries). Together with activity measurements and geochemical parameters, these will be used to determine key environmentală factors controlling activity and selecting for specific groups of methanotrophs.

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