Factors controlling the efficiency of microbial methane oxidation at cold seeps

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The anaerobic and aerobic consumption of methane by seafloor communities — before it is emitted to the hydrosphere — is termed 'the benthic filter for methane'. The efficiency of this filter can be quantified as the proportion of total methane oxidized anaerobically and aerobically to total methane flux. Generally, at continental slopes, methane flux to the hydrosphere is almost fully controlled by benthic microbes in the diffusion-dominated sulphate–methane transition zones. Also, at cold seeps, the majority of the dissolved methane transported to the sea floor by upward fluid flow is used by benthic biota, including animal-microbe symbioses. However, the efficiency of the benthic methane filter at cold seeps is reduced from around 80% in systems with low fluid flow, to around 20% in systems with intermediate flow, and even less at high flux seeps with vents emitting free gas to the hydrosphere. Furthemore, at active mud volcanoes impacted by gas eruptions and sediment mixing, microbial communities may be displaced and their ability to oxidize methane reduced. Here we present and discuss a few case studies from deep-sea cold seeps, where environmental disturbances limit the efficiency of the benthic filter in removing the potential greenhouse gas methane. Repeated time-series sampling has allowed us to quantify fluid flow rate, methane and oxygen consumption, microbial community composition, and to constrain the temporal and spatial scales of community disturbance and recovery at cold seeps such as the Amon Mud Volcano of the Nile Deep Sea Fan (Eastern Mediterranean) and the Haakon Mosby Mud Volcano of the Barents Sea. This work was supported by the Deep Carbon Observatory project.