ID: W2140105159

TITLE: Interaction between hydrocarbon seepage, chemosynthetic communities, and bottom water redox at cold seeps of the Makran accretionary prism: insights from habitat-specific pore water sampling and modeling

AUTHOR: ['David Fischer', 'Heiko Sahling', 'Kerstin Nöthen', 'Gerhard Bohrmann', 'Matthias Zabel', 'Sabine Kasten']

ABSTRACT:

Abstract. The interaction between fluid seepage, bottom water redox, and chemosynthetic communities was studied at cold seeps across one of the world's largest oxygen minimum zones (OMZ) located at the Makran convergent continental margin. Push cores were obtained from seeps within and below the core-OMZ with a remotely operated vehicle. Extracted sediment pore water was analyzed for sulfide and sulfate concentrations. Depending on oxygen availability in the bottom water, seeps were either colonized by microbial mats or by mats and macrofauna. The latter, including ampharetid polychaetes and vesicomyid clams, occurred in distinct benthic habitats, which were arranged in a concentric fashion around gas orifices. At most sites colonized by microbial mats, hydrogen sulfide was exported into the bottom water. Where macrofauna was widely abundant, hydrogen sulfide was retained within the sediment. Numerical modeling of pore water profiles was performed in order to assess rates of fluid advection and bioirrigation. While the magnitude of upward fluid flow decreased from 11 cm yr?1 to <1 cm yr?1 and the sulfate/methane transition (SMT) deepened with increasing distance from the central gas orifice, the fluxes of sulfate into the SMT did not significantly differ (6.6?9.3 mol m?2 yr?1). Depth-integrated rates of bioirrigation increased from 120 cm yr?1 in the central habitat, characterized by microbial mats and sparse macrofauna, to 297 cm yr?1 in the habitat of large and few small vesicomyid clams. These results reveal that chemosynthetic macrofauna inhabiting the outer seep habitats below the core-OMZ efficiently bioirrigate and thus transport sulfate down into the upper 10 to 15 cm of the sediment. In this way the animals deal with the lower upward flux of methane in outer habitats by stimulating rates of anaerobic oxidation of methane (AOM) with sulfate high enough to provide hydrogen sulfide for chemosynthesis. Through bioirrigation, macrofauna engineer their geochemical environment and fuel upward sulfide flux via AOM. Furthermore, due to the introduction of oxygenated bottom water into the sediment via bioirrigation, the depth of the sulfide sink gradually deepens towards outer habitats. We therefore suggest that ? in addition to the oxygen levels in the water column, which determine whether macrofaunal communities can develop or not ? it is the depth of the SMT and thus of sulfide production that determines which chemosynthetic communities are able to exploit the sulfide at depth. We hypothesize that large vesicomyid clams, by efficiently expanding the sulfate zone down into the sediment, could cut off smaller or less mobile organisms, as e.g. small clams and sulfur bacteria, from the sulfide source.

SOURCE: Biogeosciences

PDF URL: https://bg.copernicus.org/articles/9/2013/2012/bg-9-2013-2012.pdf

PUBLICATION YEAR: 2012

TYPE: article

CONCEPTS: ['Chemosynthesis', 'Geology', 'Benthic zone', 'Oceanography', 'Bottom water', 'Cold seep', 'Microbial mat', 'Sediment', 'Petroleum seep', 'Continental shelf', 'Pore water pressure', 'Water column', 'Environmental science', 'Hydrothermal vent', 'Ecology', 'Methane', 'Geomorphology', 'Biology', 'Paleontology', 'Hydrothermal circulation', 'Cyanobacteria', 'Geotechnical engineering', 'Bacteria']