Marine Methane Biogeochemistry of the Black Sea

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Dissolved methane in the Black Sea is assumed to be primarily sourced by hydrocarbon seepage and decomposing gas hydrates. While the majority of seep sites were found on the continental shelves and slopes, some sites of free gas emission were discovered even in deep-waters well beyond the upper hydrate stability limit in about 725 m below sea level (mbsl). The molecular and stable C- and H isotopic characteristics of hydrocarbons from deep reservoirs can be altered during migration through the sediment by diverse abiotic and biotic processes. These include preferential biological degradation of individual compounds, molecular fractionation during incorporation into gas hydrates, and methane consumption mediated by the anaerobic oxidation of methane (AOM).
In order to evaluate processes affecting the fate of methane during ascend from the deep subsurface towards shallow waters, we surveyed submarine high-flux hydrocarbon seep sites (e.g. mud volcanoes, cold gas and oil seeps) in the northwestern and eastern Black Sea in recent years. Investigations were targeted on hydrocarbon sources, gas hydrate abundances, seafloor features, microbial communities, and properties of the hydrocarbon plumes in the overlying water body. For this, hydroacoustic measurements, dives with underwater vehicles, precise seafloor sampling including pressure coring, and water sampling were performed.
On the Ukrainian shelf carbonaceous structures emerge up to 4 m from the seafloor in an area at 230 mbsl in the anoxic water body. A combined lipid biomarker and microscopy approach demonstrated that different AOM-performing consortia dominated microbial mats involved in carbonate precipitation.
The continental slope offshore Georgia harbors a number of gas and oil seeps. At the Batumi seep area in 840-mbsl gas hydrates filled extraordinary high fractions of up to 43% of the pore space in sediments deeper than 0.9 m below seafloor. $^{14}C\text{-}CH_4$ analyses indicated de novo methanogenesis in top sediments.

Key words: *Black Sea, methane, gas hydrates, pressure coring, isotopes, methanotrophy*