THE BLACK SEA AS NATURAL LABORATORY FOR BIOGEOCHEMISTRY AND MICROBIOLOGY OF ANOXIC HABITATS

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Abstract

The Black Sea is the largest anoxic basin on earth and provides unique conditions for the study of microbial habitats and controls on key anaerobic microbial processes in the element cycles. Recent studies of European research programs carried out *in situ* measurements of fluxes and turnover of methane and sulfur at seep systems of the Black Sea, and investigated the microbial diversity in permanently anoxic settings, especially those associated with fluid flow and gas seepage. This presentation will summarize recent work on shallow and deep continental margin settings northwest of Crimea and in the Sorokin Trough and present first results of the expedition MICROHAB with RV METEOR (HERMES project).

Keywords : Bacteria, Biodiversity, Black Sea, Mud Volcanoes.

Currently, the global inventory of fluid seeps at passive continental margins is growing rapidly, but geological, chemical and biological processes operating at those fluid seeps remain poorly understood. In the Northern Black Sea, a variety of active methane seeps have been identified at depths from 100-3000 m, including actively gas emitting mud volcanoes, and unique microbial reefs. The total area influenced by gas seepage and hydrate deposition is currently not known, but it is likely that a significant part of the methane released into the Black Sea hydrosphere comes from methane release from subsurface sediments [1]. The main objectives of the recent expedition METEOR M72/2 “MICROHAB”was to map specific methane-driven microbial habitats at high resolution, to quantify the composition, distribution and development of microbial communities in the anoxic Black Sea, and to obtain insight in element cycling and export at different types of fluid seeps in the Black Sea. This expedition carried out in Feb. and Mar. 2007 contributes to the GEOTECHNOLOGIEN program MUMM II studying the microbiology and biogeochemistry of methane and sulfur turnover by in situ technologies, as well as to the EU FP6 Integrated Project HERMES which deals with the biodiversity of hot spot ecosystems at Europe’s continental margins.

Methane is produced in ocean margin sediments as a consequence of the microbiological degradation of organic matter buried below the zone of sulfate penetration. As methane builds up, it migrates upwards and may reach the sediment surface, where it leads to the formation of complex geostructures such as pockmarks or carbonate chimneys and platforms, caused by methane ebullition and oxidation, or of large scale topographies on the deep sea floor such as mud volcanoes and carbonate mounds. The microbiological key process of sub-surface methane oxidation accounts for perhaps 90% of the entire methane flux in the sea floor and, therefore, plays a critical role as a barrier against methane emission to the sea and atmosphere [1].

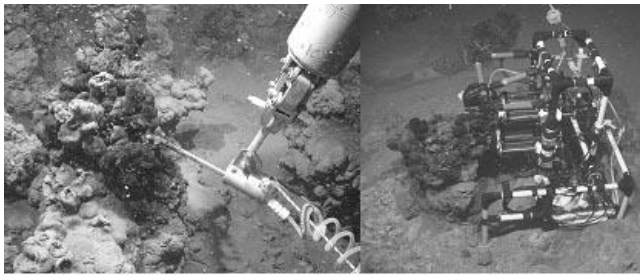

Fig. 1. Methanotrophic reefs of the NW Crimea margin. Left: Sampling of escaping gas. Right: Measurement of microbial methane turnover in the microbial mat. Source: MARUM, Exp. MICROHAB M72/2.

The formation of carbonate nodules, chimneys and crusts can be related to methane oxidation at fluid seeps, and the responsible methanotrophic communities can be traced via analysis of biomarker isotope signatures even in fossil carbonates. Key players in this process are some enigmatic archaeal/bacterial communities, which use sulfate for the anaerobic oxidation of methane (AOM) or for the oxidation of higher hydrocarbons. In the Black Sea, unique microbial habitats of previously unknown biomass accumulations form above gas seeps, because oxygen is absent and thus any higher life [2]. This affects the biogeochemistry of methane and sulfur turnover considerably, making the Black Sea an interesting natural laboratory to study anoxic microbial processes and their signatures in the geosystem.

For the research during the expedition with RV METEOR M72/2 "MICROHAB" with the remotely operating vehicle QUEST (MARUM) the following target areas have been selected (Fig. 1): 1) In the northwestern Black Sea, hundreds of active gas seeps occur along the shelf edge west of the Crimea peninsula at water depths between 35 and 800 m. At some of the shallow Crimean seeps, microbial mats were found associated with isotopically light carbonates. Aspects of the microbiology, sedimentology, mineralogy, and selected biomarker properties of these deposits were recently described [2,3]. 2) Abundant mud volcanoes and near surface gas hydrate occurrences were found in the Sorokin Trough (Fig. 2; [1]). The mud volcanoes have diameters of up to 2.5 km and heights of up to 120 m above the surrounding sea floor. We have focussed on the Dvurechenskii mud volcano, a flat-topped and very active mud volcano in the Sorokin Trough with a highly interesting geochemistry

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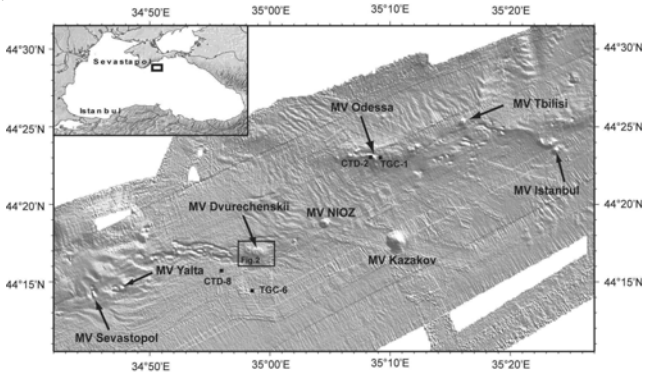

Fig. 2. Mud volcanoes of the Sorokin Trough. Source: after [4]

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