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Formation of methane fields in the Golubaya bay of the Black Sea

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Study of formation of methane fields in water environments is essential for search of oil and gas in bottom sediments of the aquatories [Egorov et al., 2008]. Methane acts as a tracer of various biogeochemical processes in freshwater and marine waters as well. Moreover, in recent years estimation of methane emission is one of tasks of current climate research because of high contribution of methane in the greenhouse effect [Bazhin, 2000].
The Black Sea is the largest methane reservoir in the world [Lein, Ivanov, 2005]. The Golubaya Bay of the Black Sea acts as a peculiar model of formation and variability of methane fields in the marine environment. The main purpose of our study is to identify factors that influence the high methane saturation in the aerobic coastal waters.
Data collection took place in the Golubaya and the Gelendzhikskaya bays and in the Ashamba River since 1999 to 2013.
Water samples were analyzed by the head-space method with further gas chromatographic determination of methane concentrations [Bolshakov, Egorov, 1987].
Methane saturation in the Golubaya Bay waters exceeds the equilibrium with the atmosphere value 10-100 times. According to the simultaneous measurements of methane in two bays in different seasons, methane saturation in the Golubaya Bay is higher than in the Gelendzhikskaya Bay. The smaller bottom depth and accordingly the larger biological productivity in the Golubaya Bay may be the reason of it. Microbial production of methane in aerobic waters of the bay is associated with zone of zooplankton concentration and products of its vital activity [Lein, Ivanov, 2009].
It is known that formation of methane is intense in periodically flooded soils where anaerobic conditions are formed. That causes development of methanogenic bacteria [Alekseev et al., 1978]. Distribution of methane in marine and river waters illustrates that the river runoff and groundwater supply are some of the sources of high methane saturation in the Golubaya Bay.
Local increase of methane concentration in the bottom waters of the Golubaya Bay is associated with accumulation of reduced sediment. Origin of that sediment related to the material of the Ashamba River runoff. The process of diagenesis begins in the upper layer of the sediment [Reeburg, 1989; Vershinin, Rozanov, 2002]. Formed by chemical reactions of this process methane then enters to the bottom water due to action of waves. This situation was very strong after disastrous flood in the summer of 2012.
Also we consider the seasonal fluctuations of methane concentrations in the Golubaya Bay.
The result of our work is determination of factors that affect formation of methane fields in the Golubaya Bay. They are terrestrial runoff, groundwater infiltration, the development of diagenetic process in the upper layer of sediment. The high saturation of methane in the river is caused by the influence of groundwater supply and stagnant conditions in the river widening near the mouth. We determined that average methane saturation in summer is 10 times as large as in winter due to the variability of bioproductivity.