

Lithology, biochemistry and micropaleontology of mud volcanoes and high-intensity cold seeps on the bottom of the Black Sea and Sea of Azov

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The study is focused on lithology, geochemistry, and foraminifera related to mud volcanoes and high-intensity cold seeps in the northern Black Sea and the Sea of Azov to hindcast ecosystem development since the LGM.

The sampling was completed in the areas of mud volcanoes and high intensity cold seeps ~~in~~ during the course of several scientific cruises on R/Vs “Professor Vodiansky” and “Vladimir Parshin”. Regional and local assessment of the subsurface characteristics of mud volcanoes and mapping of high intensity gas seeps occurrences in test areas, and characterization of sources of gas seeps has been performed by high-resolution geo- and physical measurements to define the processes of gas and fluid formation and migration in the subsurface. Numerous profiles have been carried out by dredging in selected area across the northern Black Sea; the SE part of the Sea of Azov; and the Kerch Strait where mud volcanoes and high intensity cold seeps are clearly expressed. Based on these data, 150 stations were selected and sampled by gravity core.

Our results to date are as follows. Mud volcanoes and high-intensity cold seeps are located in the Kerch-Taman folded zone of the Alpine fold system, Sorokin depression, Abikh and Subbotin structures, as well as Odessa-Sinop deep fault. Especially intensive seeps occur in the area of the Phoros uplift and Lomonosov massif. As a rule, the mud volcanoes and high-intensity gas seeps are related to the Maikopian (Oligocene-Early Miocene) geological sequence represented by thick (up to 3000 m) clayey sediments with layers and lenses of water enriched sands and alevrites folded by neotectonic activity in small folds (clayey diapirs). The Maikopian age of sediments is indicated by foraminifera *Nodosaria spinescens* (Rss.), *Robulus aff. crassus* (Orb.), and others. Mud volcanoes are often located in the top of geanticlines. Their height ~~is~~ ranges between a few meters and a few tens of meters, and their diameter varies from a few m² to 500 m². Wide areas of the sea bottom are covered by muddy volcanic sediments. They are present not only on the bottom surface but in geological sequences as well where volcanic clays and breccia overlie each other since the LGM (ca 27 ky BP-present), reflecting the periodicity of volcanic eruptions for a quite long time-interval. Taxonomic content, abundance and density of microfauna vary significantly depending on concentration of chemical parameters of cold seeps as well as lithological content of the sediments.

The high intensity cold seeps are often related to mud volcanoes or the ruptures in neotectonic uplifts on the sea bottom. The height of high intensity cold seeps varies from 70 m to 850 m, and can reach a diameter 400 m. The concentration of methane varies from 0 to 89.9%, while CO₂ ranges between 0.0 and 15.5%. Concentrations of hydrogen and are below chromatographic detection limits, i.e., their concentrations were below 0.001%.

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