

CURRENT RESEARCH PROJECTS

Biogeochemical sulfur transformations in modern analogs of ancient aquatic systems

The early evolution of life on Earth was intimately coupled with the evolution of the chemical composition and redox conditions in the oceans. A conventional approach for elucidating the biogeochemical processes in the ancient oceans is the analysis of the chemical and isotopic compositions of sedimentary rocks. Chemical and isotope fractionation patterns formed in modern aquatic systems under conditions similar to those, which are believed to have existed in ancient oceans, are used as a reference. However, this approach does not provide complete understanding of the evolution of the global biogeochemical sulfur cycle. The present research project is intended to fill the missing gaps in knowledge of biogeochemical sulfur transformations in modern analogs of ancient aquatic systems by analysis of speciation and multiple isotope composition of sulfur species. Our main playground for this research is Lake Tiberias in northern Israel. Sub- and low- millimolar sulfate concentrations in the Paleoproterozoic Ocean were proposed to be based on low sulfur isotope fractionation between sulfate and sulfide by microbial sulfate reduction at low sulfate concentrations. We study distribution and quadruple isotope fractionation of sulfur species in warm monomictic Lake Tiberias, with 100-600 μM sulfate concentrations and zero-valent sulfur concentrations in the hypolimnion. This system may provide an analog for some post-Great Oxygenation Event environments where sulfidic conditions developed.

Cycling of the redox-sensitive elements in sediments of the Gulf of Aqaba

The Gulf of Aqaba is situated in southern Israel. It is the northeastern part of the Red Sea, which is an extension of the Indian Ocean. The Gulf of Aqaba is an oligotrophic water body, which is colonized by some of the northernmost coral reefs and tropical biota. The Gulf of Aqaba situated in an extremely arid region receives large eolian inputs of dust, which contain reactive iron minerals, from the Sahara and adjacent deserts. As oxygen is depleted in the upper 1-2 cm of the sediment, sulfate, iron (hydr)oxides and manganese oxide are the main electron acceptors in the anoxic sediment. These three elements are actively cycled in marine sediments and their redox reactions are utilized by microbial metabolic pathways. The main goals of our study are to understand an impact of eolian dust deposition on the biogeochemical cycling of redox-sensitive elements, and development of multiple proxies approach to characterization of marine systems situated in an arid areas in the past.

Kinetics of decomposition of organic polysulfanes in aqueous solutions

Dimethylpolysulfanes are the product of biological and abiotic methylation of intermediates of hydrogen sulfur oxidation. These compounds have an unpleasant odor, which compromises the quality of drinking water. Pathways for the production of these compounds in natural aquatic systems as well as their decomposition reactions in organic mediums are relatively well known. On the other hand, rates and mechanisms of dimethylpolysulfanes disproportionation in aqueous solutions are poorly studied. The goal of this research is to understand the factors controlling concentrations of dimethylpolysulfanes in natural aquatic systems, rates of their decomposition, and terminal products of their decomposition.