Biogeochemical processes at the redox boundary: A window for understanding the oceanic environments in deep time

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In the modern aquatic environments, an O2/H2S interface is buried in the sediments except for some unusual environments like fjords, meromictic lakes, and closed ocean basins. However, in the early Earth when atmospheric O2 level was substantially lower than the present, it should have been widespread in the shallow portion of the open ocean. Therefore, modern anoxic water columns are putative analogues for understanding the biogeochemical processes in the Archaean ocean and euphotic zone anoxia during the Cretaceous oceanic anoxic events. In this study we investigated the biogeochemical processes at the redox boundary in a saline meromictic Lake Kaiike, Japan. The Lake Kaiike is characterized by the O2/H2S interface at 5 m depth in the water column throughout the year and microbial mats in the surface sediments (Oguri et al., 2002). Around the O2/H2S interface several types of microbes including purple sulfur bacteria, green sulfur bacteria, and cyanobacteria form a dense population with a cell number of each bacterium being up to 107 cell mL-1 (Nakajima et al., 2003). We have determined many properties of the lake water including nutrients, light intensity, DIC, stable carbon and nitrogen isotopic compositions of lipid biomarkers and photosynthetic pigments, etc. In conjunction with 16S rDNA evidence reported previously (Koizumi et al., 2004), compositions of photosynthetic pigments suggested that brown-colored green sulfur bacteria (Pelodyctyon luteolum) inhabited and photosynthesized in the dark (less than 0.1 microphoton m-2 s-1), anoxic monimolimnion and benthic microbial mats. However, although DNA fragments of cyanobacteria were observed in the benthic microbial mats, isotopic compositions of chlorophyll a suggested that the cyanobacterial activity is negligibly small in the mats. Nitrogen isotopic compositions of bacteriochlorophyll e homologues from the redox boundary suggested that the green sulfur bacteria (Chlorobium phaeovibrioides) would conduct nitrogen fixation in the chemocline, whereas purple sulfur bacteria (Halochromatium sp.) and cyanobacteria (Synechococcus sp.) may assimilate nitrite (Ohkouchi et al., 2005). In this presentation, we will report geochemical and microbiological evidences in this anoxic lake and discuss the biogeochemical processes in the redox boundary of the aquatic environments, which potentially provides some hints for understanding the oceanic environments in deep time.