Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08712, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08712
EGU General Assembly 2008

One dimensional physico-chemical ecological modelling of sulfidic oceans: applications to Proterozoic ocean chemistry and euxinic photoic zones

C. Honeycutt (1), D. Canfield (1) and C. Bjerrum (2)

(1) Nordic Center for Earth Evolution, Institute of Biology, University of Southern Denmark, Denmark. (2) Nordic Center for Earth Evolution, Geology Institute, University of Copenhagen, Denmark

(honeycutt@biology.sdu.dk)

A quantitative understanding of the carbon cycling of Proterozoic ocean is essential to understanding distribution of biomarkers and organic matter, as well as the rise of oxygen in the prokaryote-dominated Proterozoic oceans.

Because the ecology of the Proterozoic oceans probably was dominated by small single-celled organisms, the distribution of carbon, sulfur, phosphorus, nitrogen, iron and other nutrients within the water column was different from that found within today's oceans. To better understand how the biogeochemistry of the Proterozoic and sulfidic oceans differed from today's ocean, we built a 3-part coupled upper ocean model which is forced by solar intensity, earth's reflectivity, wind strength and atmospheric composition. The model is 1-dimensional which allows vertical gradients to develop, driving ecological structures such as the deep chlorophyll maximum. In the model primary productivity is affected by light and physical mixing which brings nutrients such as nitrate and phosphate from ocean interior into the upper ocean environment and nutrients such as elemental nitrogen and carbon dioxide through Henry's Law dissolution of gases. These are transported within the photic zone via advection, diffusion, and density mixing.

The ecosystem model is based on a modern sulfidic analog, Lake Cadagno, a meromictic Alpine lake. Using this ecological model within the physical model framework, we have conducted a series of experiments to understand the role of vertical export of organic matter in a prokaryote-dominated, sulfidic ocean. This has allowed us to predict the vertical distribution of not only oxygenic phototrophs, but also purple and green sulphur bacteria. The paleoatmospheric experiments have confirmed that not only is the deep chlorophyll maximum a Michaelis-Menten process, but also that phytoplankton modify their own environment through uptake of nutrients, resulting in vertical variation of nutrient limitation in the upper ocean environment. Some important conclusions of our model are that organic aggregates resides longer in the upper water column; the distribution of certain picoplanktonic species may be due to light intensity; and a sulfidic ocean will lead to a deeper chlorophyll maximum and a deeper potential photic zone.