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The behaviour of U, V, As and Mo in a carbonate-rich, anoxic lake

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The incorporation of the trace metals U, V, As and Mo into sediments is influenced by the redox conditions under which a sediment is formed. These elements are therefore useful tracers of the palaeoenvironment. Studying late Hauterivian – early Barremian (hemi-) pelagic sections from the northern Tethyan margin we found different degrees of enrichment of these four metals in different horizons known to have been deposited under anoxic or suboxic conditions.

In order to better understand the sedimentary geochemistry of the four elements we studied a small carbonate-rich anoxic lake (Lake Loclat, Neuchâtel, Switzerland). We found co-variation of As and Mo in short sediment cores. Furthermore, the concentrations of both elements is roughly corresponding to the TOC content of these black to gray micritic calcite (75%) muds.

In the water column, however, their behaviour is different. Looking from top of the water column (10 m depth) the concentration of total As decreases from 0.7 ppb in the epilimnion to 0.5 ppb in the thermocline and the underlying sulfide oxidation zone and become again higher (up to 1 ppb) in the lower hypolimnion. In contrast Mo concentrations are constant (0.5 ppb) through the epilimnion and the thermocline but decrease in the lower hypolimnion. Vanadium behaves much like As, while U shows a profile similar to Mo.

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Hydrogeochemical Modeling of Tracer-Tests at Cape Cod, USA

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Introduction

At the Cape Cod test site, Massachussetts, USA, a sewage plume in the aquifer can be subdivided into an oxic, suboxic and anoxic zone by lots of multilevel wells. In the different zones tracer tests were carried out in the year 2000 in the frame of a DFG-project in cooperation with scientists of the USGS. Bromide as conservative and As(III) as reactive tracer were injected into the oxic and suboxic zones [1], while bromide and As(V) were injected continuously into the anoxic zone [2]. Recently the breakthrough curves and spatial distributions resulting from the oxic and suboxic field data have been modeled with PHREEQC. Target of this hydrogeochemical model is the validation of the hypothesis, that supposes surfaces of manganese and iron to be the main reaction partners within the redox reactions of arsenic [3].

Modeling procedure and results

For the modelling procedure a model area with a length of 10.5 m was subdivided into 105 cells with a length of 0.1 m each. The tracers were injected into the first cells and the breakthrough curves were evaluated in those cells according to the distances of the observation wells in the field. Hydrodynamic data were calibrated with the bromide breakthrough curves.

Simulating the geochemical reactions of arsenic, sorption processes and redox reactions have to be considered. The oxidation of As(III) to As(V) was considered using birnessite as oxidant. Sorption processes were modeled with surface complexation at manganese and iron surfaces. Modeling the oxic breakthrough curves of As(III) and As(V) measured amounts of iron surfaces could be used as input parameters. In the suboxic model it had to be considered, that the reactive surfaces are covered by phosphate from the sewage plume.

Further modeling work will focus on the anoxic tracer test, in which the reduction of As(V) to As(III) by H_2S could be observed. In the moment laboratory experiments are carried out to quantify rates of As(V) reduction by H_2S and will provide input data for the anoxic model.

References

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