Geophysical Research Abstracts
Vol. 15, EGU2013-13190-1, 2013
EGU General Assembly 2013
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Multi-isotope (C - O - S - H - B - Mg - Ca - Ba) and trace element variations along a vertical pore water profile across a brackish-fresh water transition, Baltic Sea

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The Holocene Baltic Sea has been switched several times between fresh water and brackish water modes. Modern linear sedimentation rates, based on 210-Pb, 137-Cs, and Hg dating of surface sediments, are between 0.1 and 0.2 mm per year. The change in paleo-environmental conditions caused downcore gradients in the concentrations of dissolved species from modern brackish waters towards fresh paleo-pore waters, interrupted by the brief brackish Yoldia stage. These strong physico-chemical changes had consequences for e.g., microbial activity and further physical and chemical water-solid interactions associated with multiple stable isotope fractionation processes, and, in turn, have strong implications for isotope and trace element partitioning upon early diagenetic mineral (trans)formations. In this communication, we present the results from the first integrated multi-isotope and trace element investigation conducted in this type of salinity-gradient system.

It is found that concentrations of conservative elements (e.g., Na, Cl) decrease with depth due to diffusion of ions from brackish waters into underlying fresh waters. This is associated with pronounced depletions in H-2 and O-18 of pore water with depth. Covariations of both isotope systems are close to the meteoric water line as defined by modern Baltic Sea surface waters. A downward increase and decrease of Ca and Mg concentrations, respectively, is associated with decreasing Ca-44 and Mg-26 isotope values. B-11 isotope values decrease in the limnic part of the sediments, too. On the other hand, an increase in Ba concentrations with depth is associated with an increase in Ba-137/134 isotope values. Microbial sulfate reduction and organic matter oxidation lead to an increase in DIC, but a decrease in sulfate concentrations and in C-13 contents of DIC with depth. Suess (1981) was probably the first to propose, that desorption of Ca and Ba from glacial sediments due to downward diffusing ions may be responsible for a downcore increase in pore water concentrations of earth alkaline ions and the formation of authigenic barites. Coupled S-34 and O-18 isotope signals in authigenic barites suggest that they were formed in pre-Yoldia sediments from pore waters strongly depleted in O-18 (as low as -20 per mil vs. VSMOW).
In the present communication, we will discuss possible impacts of diagenetic processes on multi-isotope signals in pore waters and authigenic phases. A combination of mixing between brackish and fresh water, ion exchange, precipitation/dissolution, and transport reactions is considered to explain most of the observed isotope variations along the vertical pore water profile.

This work was supported by the Leibniz IOW, BONUS+ program, the Universities of Bern, Geneva, Bochum, Münster, and Oldenburg, and the Natural Museum of History, Berlin.