

Mineralization of organic matter in surface sediments of temporarily euxinic basins, Baltic Sea

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Organic matter is mineralized in marine sediments by microbial activity using predominantly oxygen, sulfate, and metal oxides as electron acceptors. Modern euxinic basins as found in the Baltic Sea or the Black Sea are of particular importance because they may serve as type systems for anoxia in Earth's history.

We present here first results from biogeochemical investigations carried out in the Baltic deeps (Gotland Basin, Landsort Deep) during the first scientific cruise of the new German RV M.S. MERIAN in 2006. Short sediment cores were obtained with a multi-corer and analyzed for particulate and dissolved main, minor and trace elements besides stable carbon isotopes in dissolved inorganic carbon (DIC). Microsensors were applied to analyze steep gradients of oxygen, sulphide and sulphate. Pore water profiles were evaluated in terms of process rates and associated element fluxes. Gross and net anaerobic mineralization rates were additionally obtained from core incubations with ³⁵S or bag incubations of sediment sections. Highest SRR were found in the top 5-10 cm. Element fluxes across the sediment-water interface were compared with re-evaluated literature data and show for the Baltic Sea a dependence from bottom water redox conditions, and sediment compositions and formation conditions (e.g., accumulation rates).

Acknowledgements

The research is supported by Leibniz IO Warnemünde, DFG, and MPG. Thanks to F. Pollehne and S. Lage for support.

Interaction of fluid flow, heat and mass transport, and chemical reactions in oceanic hydrothermal systems: New insights from fully coupled reactive transport simulations

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Circulation of seawater through the oceanic crust and the chemical reactions that occur along the flowpath control the composition of vent fluids. We use 1D and 2D fully coupled reactive transport models to explore the evolution of fluid flow, heat transport and chemical reactions in the oceanic crust and the implications for mineral alteration patterns and vent fluid composition.

Fully coupled models are required to assess the complex interaction between chemical alteration, fluid flow and thermal conditions in the oceanic crust. The recharge of seawater into the basaltic crust causes the precipitation of significant volumes of anhydrite and chlorite which reduces the porosity and thus the permeability of the recharge zone. Similarly, cooling of the hydrothermal fluid as it ascends to the seafloor below hydrothermal vents may lead to the precipitation of minerals such as quartz and a reduction in permeability. Alteration reactions in the high-temperature reaction zone also introduce some heterogeneity of the permeability distribution which are, however, somewhat less pronounced than the permeability reduction in the recharge and discharge zones due to lower thermal and/or compositional gradients and closer to equilibrium conditions. Therefore, over time chemical reactions have the potential to modify the flow field and the thermal conditions in oceanic hydrothermal systems which could lead to observable changes in discharge rate, temperature and/or chemical composition of seafloor hydrothermal vents.

It is interesting that, despite this potential for temporal evolution, the composition of vent fluids in oceanic hydrothermal systems (e.g. 21°N, East Pacific Rise) are observed to remain constant on a decadal time scale. The fluid composition at these vents is consistent with rock buffering at greenschist metamorphic conditions. Our simulations are therefore aimed at incorporating this observational constraint and quantifying the magnitude, spatial distribution, time scales and rates of chemically induced permeability changes and the associated effect on flow and thermal conditions and the impact on the evolution of the vent fluid composition. Critical parameters and aspects that are explored in these simulations are water/rock ratios (which are dependent on the permeability and the reactivity) and the formulation of the porosity / permeability coupling used in the reactive transport code.