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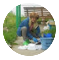
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A possible long-term CO_2 sink through submarine weathering of detrital silicates

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The weathering of silicate minerals exposed on the continents is the largest sink of atmospheric CO_2 on time scales of millions of years. The rate of this process is positively correlated with global mean temperature and atmospheric CO_2 concentration, resulting in a negative feedback that stabilizes Earths' climate (Berner, 2004). Detrital silicates derived from the physical denudation of the continents are a major component of marine sediments (Li and Schoonmaker, 2003). However, their geochemical behaviour is poorly understood and they are considered to be unimportant to the long-term carbon cycle. We show that in organic matter-rich sediments of the Sea of Okhotsk detrital silicates undergo intense weathering. This process is likely favoured by microbial activity, which lowers pore water pH and releases dissolved humic substances, and by the freshness of detrital silicates which originate from the cold, poorly weathered Amur River basin. Numerical simulations of early diagenesis show that submarine weathering rates in our study area are comparable to average continental weathering rates (Gaillardet et al., 1999). Furthermore, silicate weathering seems to be widespread in organic matter-rich sediments of continental margins, suggesting the existence of a significant CO_2 sink there. These findings imply a greater efficiency of the silicate weathering engine also at low surface temperatures, resulting in a weakening of the negative feedback between pCO_2, climate evolution and silicate weathering.

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Reactive transport simulations of lateral hydrothermal circulation in oceanic hydrothermal systems

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Circulation of seawater through the oceanic crust and the chemical reactions that occur along the flowpath are the most important processes leading to the formation of submarine hydrothermal systems and associated mineral deposits. We use variably coupled reactive transport models to explore the evolution of fluid flow, heat transport and chemical reactions in the oceanic crust and the implications for the formation of mineral deposits at the seafloor.

Permeability measurements in the upper crust suggest that the permeability distribution is heterogeneous and stratified so that fluid flow is essentially lateral and confined to high-permeability layers. We approximate hydrological and geochemical conditions in the oceanic crust with different model designs. The first model consists of a horizontal, 1D flow system that is bounded at the top and bottom by conductive layers. We use a range of heat flow values and flow velocities that are consistent with those measured or estimated for ridge crest or ridge flank settings. This model is aimed at reproducing the alteration processes that have been observed in the reaction zone at mid-ocean ridges and at assessing the hydrological implications of these processes and the rates at which they occur. The hydrological simplicity of this model allows us to increase the complexity of the chemical system, check for the consistency of thermodynamic data and define a minimum set of species to be used in more complex simulations.

In a second set of simulations we use a 2D model domain with recharge, discharge and reaction zones and assign a heterogeneous, anisotropic permeability distribution to the oceanic basement aquifer. Fluid flow is still dominantly lateral along high-permeability pathways but we account for macro-dispersion and localized cellular convection as a result of the heterogeneous permeability. In this fully coupled simulation, we examine the evolution of the system with regard to the nature and distribution of alteration processes, the flow pattern and thermal conditions. We focus on processes within the discharge zone and how these affect the fluxes and the chemical composition of vent fluids and associated mineral deposits.

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