

Submarine weathering of detrital silicates simulated in the laboratory

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Silicate detritus is transported from the continents to the oceans by rivers. Although it is a major component of marine sediments, its reactivity in the oceanic environment has only been scarcely investigated. Wallmann et al. (2008) [1] propose that significant weathering of detrital silicates takes place in the anoxic sediments of the Sakhalin Slope, Sea of Okhotsk.

We carried out batch experiments with these sediments to further test this idea. In our experiment the sediments reacted with the artificial seawater in a matter of minutes to days, releasing dissolved compounds, such as TA (total alkalinity), Ca, K, Si, B, Sr, Li, Mn, Fe, and Ba. Applying a numerical biogeochemical model, we show that organic matter degradation and dissolution of carbonates can account for only a part of the observed TA increase. Detailed mineralogical analyses suggest that the only alternative source for TA is the weathering of primary silicates and clay minerals which are abundant in Sakhalin Slope sediments. Thermodynamic modeling of silicate solubilities shows that the experimental fluids are undersaturated with respect to a wide range of chemically diverse silicates which potentially contribute to the TA build-up. The weathering rate in our experiment is only one order of magnitude larger than in the natural setting, suggesting that in-situ dissolution of silicates takes place at a high degree of undersaturation.

Since the ocean is also highly undersaturated with respect to a wide variety of primary silicates and clay minerals, weathering of detrital silicates in oceanic and sedimentary environments could be a widespread process.

[1] Wallmann, Aloisi, Haeckel, Tishchenko, Pavlova, Greinert, Kutterolf, Eisenhauer (2008) *Geochim. Cosmochim. Acta* **72**, 3067-3090.

Methane biogeochemistry in anoxic marine sediments: insights from reaction-transport models applied to $\delta^{13}\text{C}\text{-CH}_4$ and $\delta^{13}\text{C}\text{-}\Sigma\text{CO}_2$ depth distributions

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Three fundamental questions regarding the methane cycle in anoxic marine sediments are: (1) what are the pathways of methane production; (2) how are methane production, methane oxidation, and sulfate reduction zoned within the sediment column; and (3) how much of the sulfate reduction is coupled to methane oxidation? Stable carbon isotopes in CH_4 and ΣCO_2 have been used to address each of these questions. However, simple isotope mass-balance calculations that ignore the effect of diffusive transport on isotope distributions can be misleading. I will present an advection-diffusion-reaction model that is suited for quantitative interpretation of stable isotope depth distributions in marine sediments where molecular diffusion is the dominant transport process. The model is driven by organic matter remineralization via sulfate reduction and methane production and can reproduce the features in $\delta^{13}\text{C}\text{-CH}_4$ and $\delta^{13}\text{C}\text{-}\Sigma\text{CO}_2$ profiles that are characteristic of marine sediments. A detailed comparison of predicted stable isotope distributions with methane production pathways and rates of processes illustrates the insights into the sedimentary methane cycle that can be derived from $\delta^{13}\text{C}\text{-CH}_4$ and $\delta^{13}\text{C}\text{-}\Sigma\text{CO}_2$ profiles.