# Bioturbation and the Phanerozoic Sulfur Cycle: A Model Approach

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Bioturbation is the range of processes that occur when organisms burrow through sediments, flushing their burrows with overlying seawater and mixing sediment particles. It is an ecological innovation that evolved during the late Neoproterozoic and became subsequently more prevalent throughout the Phanerozoic. Bioturbation increases mixing across the sediment-water interface, influencing the redox state of the sediment and the cycling of redox-sensitive elements such as sulfur. Throughout Earth history, the fractionation between the sulfur isotopes of sulfate and sulfide has increased intermittently; the second significant increase occurred during the Precambrian-Cambrian transition. The impact of bioturbation on the sulfur isotope record during this second interval of change has been documented by previous studies, but there has been little consensus on what the exact mechanism for the change in the sulfur isotope record is at this time.

Using a simple two-box model, we modelled the concentrations and stable isotope compositions of sulfate and sulfide in bioturbated and non-bioturbated sediment, and the overlying water column. We used results from bioturbation experiments to guide our model results and obtain values for the fluxes of components into and out of the sediment, the sulfate reduction rate, and the sulfur isotope fractionation. We found that, rather than increasing the sulfate concentration of the overlying water due to enhanced sulfate recycling, bioturbation draws down sulfate from the water column and into the sediment, where it is then reduced. Additionally, we found that the fractionation between sulfate and sulfide is greater in the bioturbated sediment. These results support the conclusion that the evolution of bioturbation at the beginning of the Phanerozoic didn't necessarily change the sulfur cycle through the reoxidation of sulfide and subsequent recycling of sulfate back to the ocean, but rather opened up the system to allow for a continuous supply of sulfate to the sediment.