# Bioturbation—past, future and biogeochemical feedbacks

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Bioturbation—sediment mixing by burrowing animals—critically shapes seafloor ecology and sediment properties, as well as global marine biogeochemical cycling. Geologic archives indicate that the appearance of intensively and deeply mixed sediments lagged significantly behind relatively early advances in the colonization of the seafloor. However, the biogeochemical impact of early bioturbation has remained extensively debated. Similarly, understanding of how both bioturbation and bioturbation-biogeochemical feedbacks will respond to ongoing and future climatic change is severely limited.

The majority of sulfide produced in modern seafloor sediments is reoxidized, in large part as a direct consequence of bioturbation-mediated sediment aeration. To address the question of to what extent this feedback may have been important in ancient seafloor settings, we present a new diagenetic model framework and data exploring the relationship between bioturbation and sulfur cycling. This approach indicates that these relationships are complex and non-linear, and that differences in both intensity and style of bioturbation—in conjunction with changes in environmental boundary conditions—can promote highly variable responses in terms of sulfur burial. Bioturbation in early Paleozoic shallow marine systems was likely bioirrigation-dominated and biodiffusion-limited, and may therefore, relative to modern bioturbation, have less substantially modified the magnitude of benthic sulfide reoxidation.

Ongoing and future climatic change—particularly increasing marine temperatures—will likely substantially impact feedbacks between bioturbation- and microbially mediated sulfur cycling. In order to develop a more quantitative predictive framework for the extent to which these interactions will shift under future warming, we explore feedbacks between benthic sulfide production and oxidation under varying temperature regimes. Shifts in the balance between bioturbation-mediated oxidation and microbial production of hydrogen sulfide may result in enhanced sulfide diffusion from seafloor sediments into overying bottom waters, with potentially dire consequences for benthic animal communities, including species critical for fishery-based economies.