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Quantifying the role of bioturbation in the geologic carbon cycle

BRIAN BEATY, PHD[1], LIDYA G. TARHAN[2], KATE PIPPENGER[2], ERIK A. SPERLING[1] AND JONATHAN PAYNE[1]

[1]Stanford University
[2]Yale University

The Phanerozoic spread of bioturbating animals across global seafloor environments has been hypothesized to have altered Earth's carbon cycle through its impact on sedimentary organic matter processing and burial. However, bioturbation's impact on sediment chemistry varies widely across modern seafloor environments, hampering efforts to determine its net impact on the global carbon cycle. Here we quantify the effect of bioturbation on organic matter burial efficiency by combining observations from global geochemical datasets with mechanistic predictions from diagenetic modeling. We explore relationships between bioturbation intensity and total organic carbon content in International Ocean Discovery Program cores and continental stratigraphic sections spanning Paleozoic to Recent time. The effects of bioturbation are undetectable in globally aggregated data but emerge when comparing data within stratigraphic sections and across similar depositional settings. We use diagenetic models to predict which environments should show the strongest bioturbation effects, running simulations under boundary conditions representative of a range of major marine depositional environments (e.g., epicontinental seas, continental shelves, and abyssal plains). We further consider differences between extrinsic environmental forcings (e.g., oxygen availability, food supply) and intrinsic ecological processes (e.g., feeding and dwelling behaviors) in controlling bioturbation-geochemical relationships, to test whether evolutionary changes in how bioturbators interact with sediment amplified their impact on Earth's carbon cycle over the Phanerozoic.