EGU General Assembly 2021

EGU21-627
https://doi.org/10.5194/egusphere-egu21-627
EGU General Assembly 2021

Mineral protection regulates the long-term global preservation of natural organic carbon

Jordon Hemingway[1], Daniel Rothman[2], Katherine Grant[3], Sarah Rosengard[4], Timothy Eglinton[5], Louis Derry[3], and Valier Galy[6]

[1]Harvard University, Earth and Planetary Sciences, United States of America (jordon_hemingway@fas.harvard.edu)
[2]Lorenz Center, Department of Earth, Atmospheric, and Planetary Science, Massachusetts Institute of Technology
[3]Department of Earth and Atmospheric Sciences, Cornell University
[4]Departments of Geography and Earth, Ocean, and Atmospheric Sciences, University of British Columbia
[5]Geological Institute, Department of Earth Sciences, ETH Zürich
[6]Department of Marine Chemistry and Geochemistry, Woods Hole Oceanographic Institution

The vast majority of organic carbon (OC) produced by life is respired back to carbon dioxide (CO_2), but roughly 0.1% escapes and is preserved over geologic timescales. By sequestering reduced carbon from Earth's surface, this "slow OC leak" contributes to CO_2 removal and promotes the accumulation of atmospheric oxygen and oxidized minerals. Countering this, OC contained within sedimentary rocks is oxidized during exhumation and erosion of mountain ranges. By respiring previously sequestered reduced carbon, erosion consumes atmospheric oxygen and produces CO_2. The balance between these two processes—preservation and respiration—regulates atmospheric composition, Earth-surface redox state, and global climate. Despite this importance, the governing mechanisms remain poorly constrained. To provide new insight, we developed a method that investigates OC composition using bond-strength distributions coupled with radiocarbon ages. Here I highlight a suite of recent results using this approach, and I show that biospheric OC interacts with particles and becomes physiochemically protected during aging, thus promoting preservation. I will discuss how this mechanistic framework can help elucidate why OC preservation—and thus atmospheric composition, Earth-surface redox state, and climate—has varied throughout Earth history.