Rapid organic matter sulfurization and enhanced organic matter burial across Ocean Anoxic Event 2

MORGAN REED RAVEN[1], DAVID A. FIKE[2], MAYA L. GOMES[3], SAMUEL L. WEBB[4]

[1]Dept. of Earth Science, University of California Santa Barbara, USA; raven@ucsb.edu
[2]Dept. of Earth and Planetary Sciences, Washington University in St Louis, MO, USA; dfike@wustl.edu
[3]Dept. of Earth and Planetary Sciences, Johns Hopkins University, MD, USA; mgomes@jhu.edu
[4]Stanford Synchrotron Radiation Lightsource, Menlo Park, CA, USA; webb@slac.stanford.edu

Large swaths of the southern North Atlantic and Tethys Oceans experienced enhanced organic matter (OM) burial associated with Ocean Anoxic Event 2 (OAE-2, 94 Mya). Although the changes in productivity and preservation that permitted this massive flux of OM burial and resulting atmospheric CO_2 drawdown have been debated for decades, it is clear that widespread sulfidic conditions contributed to the accumulation of both pyrite (FeS_2) and organic sulfur in many of these sections. Here, we systematically investigate these sulfur pools from a collection of well-characterized sites with diverse local redox conditions. To assess changes in sulfur biogeochemistry across OAE-2 and their effects on OM preservation, we generated profiles of the sulfur-isotopic composition, molar S content, and chemical speciation (by X-ray absorption spectroscopy) of OM, along with the S-isotope composition of pyrite.

Globally, we find a generalizable correlation between OM sulfurization intensity and total OM burial that spans several orders of magnitude. By comparing our results with modern sites and laboratory experiments, we argue that OM sulfurization was a central process facilitating enhanced OM burial during OAE-2. Especially in OM burial hotspots like Tarfaya Basin, extensive OM sulfurization likely occurred rapidly in sinking particles, where sulfurization reactions could impact a relatively large pool of fresh algal biomass. Rapid, particle-hosted sulfurization thus provides a mechanism for understanding the link between anoxia and enhanced OM burial throughout the geologic record. Additionally, the existence of critical redox thresholds for rapid sulfurization in the environment helps to explain how relatively modest changes in local redox state might lead to relatively dramatic changes in OM burial, as indicated by the sudden, sharp shift in global C-isotope records at the onset of OAE-2.