Organic Matter Sulfurization during Ocean Anoxic Event 2: Evidence from Pont d’Issole, France

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Organic matter burial is a fundamental control on marine redox evolution. During the Cretaceous, a series of carbon-cycle perturbations, termed Ocean Anoxic Events (OAEs), are marked by widespread deposition of organic-rich shales. OAE2, at the Cenomanian–Turonian boundary, is also associated with changes in the global sulfur cycle that are typically attributed to enhanced pyrite formation in anoxic environments. However, if sulfide is present in the water column or shallow sediments, it can also react abiotically with labile organic matter and increase its preservation potential. This sulfurization process could represent a key mechanism driving the general observation that higher concentrations of organic matter are buried in O_2-limited environments. Currently, however, we have very little information about the relationship between sulfurization and rates of organic carbon burial.

In this study, we test whether organic matter sulfurization contributed to enhanced organic carbon burial during OAE2 using a previously characterized section from Pont d’Issole, France. We find strong correlations among the concentration, sulfur content, and $\delta^{34}S$ value of organic matter in these rocks, suggesting that organic sulfur represents a mixture of lightly degraded biomass and a pool of sulfide with a remarkably consistent $\delta^{34}S$ value. We characterize the bonding environment and redox state of organic sulfur using x-ray absorption spectroscopy, which allows us to track changes in the contributions of biogenic and abiogenic sulfur and to identify the chemical form of sulfurization products. Overall, these results suggest that sulfurization played a dominant role in controlling organic matter preservation and burial at Pont d’Issole – a conclusion that may be relevant to many O_2-limited environments. Organic sulfur concentration and $\delta^{34}S$ records thus contain valuable information about sulfur cycling in the sedimentary paleoenvironment and have the potential to improve interpretations of pyrite $\delta^{34}S$ records.