Environmental divers of decoupled marine sulfate oxygen and sulfur isotope trends during the Toarcian Oceanic Anoxic Event

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The Toarcian Oceanic Anoxic Event was a major carbon cycle perturbation associated with two pulses of extinction and widespread environmental change. Studies of the biogeochemical sulfur cycle provide insight into the evolution of bottom-water redox conditions, which influence elemental cycling and habitability in the ocean. In particular, a ~6‰ positive excursion in the sulfur isotope composition of marine sulfate ($\delta^{34}S_{SO4}$) has been interpreted to reflect enhanced pyrite burial due to the expansion of anoxic and euxinic sedimentary environments and/or changes in sulfur isotope fractionation associated with sulfate reduction. Similarly, the T-OAE preserves a 6‰ positive oxygen isotope ($\delta^{18}O_{SO4}$) excursion that precedes the $\delta^{34}S_{SO4}$ excursion at Monte Sorgenza. Using these observations, we model the behaviour of marine sulfate reservoir using both classic box models and a new flux balance approach to address the question of expanding euxinia and the role of biology. This study highlights how coupled $^{34}S_{SO4}$ and $\delta^{18}O_{SO}$ approaches can provide insight into environmental changes associated with major perturbations to the carbon cycle.