

Sedimentary sulfur cycling in oxygenated deep ocean settings

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The sulfur cycle plays a key role in regulating atmospheric and marine chemistry, particularly through its linkage to the carbon cycle via microbial sulfate reduction (MSR). However, our understanding of the modern sulfur cycle is heavily based on studies of shallow sediments along coasts and within anoxic basins, with less attention given to the oxygenated deep ocean settings that encompass most of the global seafloor by area. Here, we present the initial results of an expansive study of sedimentary sulfur cycling within deep ocean settings using a diverse set of sediment and interstitial water samples collected during International Ocean Discovery Program Expeditions 361 & 363. Our data capture aqueous sulfate and sulfide $\delta^{34}\text{S}$ profiles across deep (50+ mbsf) sulfate-methane transitions (SMTs) at Sites U1478, U1482, and U1483 as well as profiles collected at sites without a SMT in the upper 150+ mbsf (Sites U1474, U1486, and U1488). Closed-system modelling and sulfate-sulfide $\delta^{34}\text{S}$ offsets imply large ($\geq 50\text{‰}$ in magnitude) isotopic fractionations ($^{34}\epsilon$) during MSR at these sites. A decrease in the magnitude of $^{34}\epsilon$ with depth below the seafloor is also suggested by data from several sites and indicates a possible shift from open to closed system behavior as interstitial water sulfate concentrations decrease. Ongoing 1-D reactive transport modelling and solid-phase $\delta^{34}\text{S}$ measurements will place further constraints on sulfate reduction rates and MSR $^{34}\epsilon$ at these sites. Our results have significant implications for the values of key parameters commonly used in box models of the marine sulfur cycle, including the globally-integrated magnitude of isotopic fractionation during MSR and the $\delta^{34}\text{S}$ of the global pyrite burial flux.