

Active sulfur cycling in oxic sediments along a crustal gradient in the South Atlantic

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Microbial sulfate reduction of sedimentary organic matter or methane in marine sediments is a biotic process that influences the global carbon cycle and regulates the concentration of oxygen in the ocean and atmosphere on geologic timescales. Sampling younger (6.6 Ma) to older crust (61.2 Ma) along the South Atlantic Transect (SAT) during Expeditions 390 and 393 provided a unique opportunity to study sulfur cycling in the deep biosphere along a crustal gradient that extends westward from the Mid-Atlantic Ridge (MAR). The modest amount of organic carbon (0.35 ± 0.32 wt.%) along the SAT is considerably higher than other mid-ocean sites, such as the South Pacific Gyre (Exp. 329) or North Pond (Exp. 336), where reductive nitrogen cycling was documented, and sulfur cycling is possible. This work focuses on pore water and sediments collected during Expedition 390 from site U1559, located closest to the MAR, and U1556 located furthest from the ridge. Radioisotope rate measurements and porewater chemistry were used to assess reductive and oxidative sulfur cycling. The porewater chemistry for U1556 and U1559 does not follow the canonical sequence of organic matter degradation coupled to different electron acceptors – oxygen, nitrate, metal, sulfate, methanogenesis. Porewater sulfate concentrations decrease relative to normal seawater either above the zone of manganese reduction (U1559) or within (U1556) this redox zone. Porewater oxygen concentrations also reveal sulfate concentrations decrease where oxygen is present. The in-situ sulfate reduction rates coupled with the chemical data reveal sulfur redox cycling within oxygenated porewaters. Furthermore, porewater profiles reveal a bi-directional sulfate gradient decreasing downwards from the sediment-water-interface and upwards from the underlying crust. The bottom-up transport of sulfate suggests the sediment biogeochemistry is influenced by circulation through the crust.