Unexpected Biogeochemical Controls from the Santa Monica Basin Revealed in Carbon, Sulfur, and Trace Metal Cycling

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Continental margin sediments play a key role in marine and global biogeochemical cycles, as organic matter degradation is controlled by the availability of electron acceptors used within a well-known sequence of microbially mediated redox reactions. This study investigates the complex biogeochemical processes that prevail in the bathymetrically isolated Santa Monica Basin (SMB). We explore the solid-phase and pore fluid profiles along a transect from 71 to 907 meters water depth that includes oxygenated (>60 μM O_2) bottom waters near the coast and oxygen deficient (~4 μM O_2) bottom waters at the depocenter.

Results indicate unexpectedly low concentrations of pyrite in the suboxic section (0.04 - 0.35 wt.% FeS_2) that cannot be explained by low TOC contents (~ 5 wt.%) nor deficiencies in reactive Fe (up to 2.3 wt.%). This lack of formation of pyrite and weak production/accumulation of hydrogen sulfide, both major sinks for several trace elements, has resulted in a relatively minor change in chalcophile and siderophile trace elements with depth, potentially leaving biologically important trace elements available longer compared to other marginal marine localities.

We offer new perspectives on C_{org} recycling at this site as our extensive geochemical data reveals the extents and causes of refractory organic matter distributions and how those patterns dictate the accumulation, speciation, and isotope composition of solid-phase sulfur constituents in the SMB sediments. Ongoing work on the cycling of organic matter, including C/N ratios and C and N isotope relationships, and the trace element contents of sedimentary pyrite will shed light on the biogeochemical conditions present in the SMB and analogous settings in the modern and ancient ocean.