Depositional and Facies Constrols on the Abundance, Speciation, and δ^{34}S Records in Paleozoic Carbonates

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Our understanding of the long-term evolution of biogeochemical sulfur cycling comes in large part from the isotope record (δ^{34}S) of sulfur-bearing phases from bulk rock samples in the sedimentary record. These data have been used to provide a framework for reconstructing both global redox budgets and microbial metabolic activity over Earth history. Here, we highlight stratigraphic δ^{34}S records that show large variability that is inconsistent with their reflecting a record of global sulfur cycling. Instead, these records of both carbonate-associated sulfate and pyrite δ^{34}S are controlled by the conditions in the local depositional environment. Here, we specifically look at the spatial distribution of carbonate-associated sulfate (CAS) and pyrite within complex sedimentary carbonates, examining their abundance and isotopic composition as a function of depositional (and diagenetic) facies. By pairing bulk isotopic data and depositional and diagenetic facies with high-resolution techniques (using synchrotron and secondary ion mass spectrometry (SIMS) approaches), we gain new insights into the mechanisms by which isotopic signatures get generated, initially encoded in sediments, modified during deposition and diagenesis, and ultimately preserved in the geologic record. The results can help us deconvolve local controls on δ^{34}S records from changes in the global S cycle, enabling us both to better understand the suite of diagenetic processes impacting these rocks and to improve long-term reconstructions of the sulfur cycle over geological timescales.