

Rethinking secular $\delta^{34}\text{S}$ records: Depositional, petrographic, and diagenetic controls on $\delta^{34}\text{S}$

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Sulfur isotope ratio data ($\delta^{34}\text{S}$) can yield significant insights into global biogeochemical cycling over Earth history, providing a framework for reconstructing both global redox budgets and microbial metabolic activity. However, as these records become better resolved, coeval but divergent isotopic records are becoming increasingly common. These sulfur isotope records are characterized not just by divergent $\delta^{34}\text{S}$ values, but also by differences in the spatial signature and magnitude of isotopic variability. Such discordant data suggest that we do not fully understand how isotopic signatures are incorporated and eventually preserved in the rock record. Putting these data into a detailed depositional, petrographic, and diagenetic context can provide insights into the origin of this spatial variation. Here, we specifically look at the partitioning of carbonate-associated sulfate (CAS) within complex sedimentary carbonates and examine its abundance and isotopic composition as a function of depositional (and diagenetic) facies. By pairing bulk records with high-resolution synchrotron and secondary ion mass spectrometry (SIMS) approaches, we can increase our understanding of how isotopic signatures get encoded in sediments and modified during deposition and diagenesis. The results enable us to reflect on and refine our interpretations of chemostratigraphic $\delta^{34}\text{S}$ data that have the potential to constrain the behavior of the sulfur cycle over geological timescales.