

Reconstructing Depositional and Diagenetic Conditions from Bulk and Microscale Sulfur Isotope Records of Sedimentary Pyrite

DAVID A. FIKE¹, JENNIFER HOUGHTON² AND CLIVE JONES¹

¹Washington University in St Louis

²Washington University in St. Louis

Presenting Author: dfike@levee.wustl.edu

Stable isotopic data (e.g., $d^{13}\text{C}$ or $d^{34}\text{S}$) provide a framework for understanding biogeochemical cycling today and for reconstructing both global redox budgets and environmental change over Earth history. These reconstructions often rely on bulk sediment measurements and the assumption that the average values measured using ~ 1 g of rock from a given stratigraphic section provide information about global biogeochemistry. Here we demonstrate that bulk $d^{34}\text{S}$ signatures spanning a range of $> 70\%$ in Pleistocene marine sedimentary pyrites are controlled by variations in ambient depositional conditions that affect both the porewater $d^{34}\text{S}_{\text{H}_2\text{S}}$ composition, particularly sedimentation rate and organic carbon loading, and the subsequent formation of pyrite (e.g., iron availability). Grain-specific (~ 1 - 100 μm) isotope analysis of pyrites by secondary ion mass spectrometry (SIMS) reveals that this isotopic variability primarily results from how these depositional conditions modulate diagenetic pyrite formation in the sediment column. Depositional controls on this diagenetic signal has a much greater impact on bulk $d^{34}\text{S}_{\text{pyr}}$ than variations in the inherent isotopic fractionation by sulfur cycling metabolisms. Moreover, these results demonstrate that we can reconstruct original biological fractionation and resolve the relative order of pyrite formation within a sediment, extracting additional information about the evolving porewater environment. We show that local depositional variations in these systems give rise to stratigraphically coherent $d^{34}\text{S}$ trends that are not representative of any changes in global S cycling. This requires that we revisit the interpretation of bulk pyrite $d^{34}\text{S}$ records preserved in ancient strata.