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Revisiting the sulfur cycling in a modern euxinic system: short-term $\delta^{34}S$ variability of dissolved sulfide in Lake Cadagno, Switzerland

JULIETTE DUPEYRON[1,2], MR. VIRGIL PASQUIER, PHD[2], LAETITIA GUIBOURDENCHE[3], VINCENT BUSIGNY[4], PIERRE CARTIGNY[1], DIDIER JÉZÉQUEL[5], STEFANO M BERNASCONI[6] AND JOHANNA MARIN-CARBONNE[7]

[1]Institut de Physique du Globe de Paris
[2]University of Lausanne
[3]UCLA
[4]Institut de Physique du Globe de Paris, Université Paris Cité
[5]Institut de Physique du Globe de Paris /CNRS UMR 7154
[6]ETH Zürich
[7]UNIL Institute of Earth Sciences

The sulfur isotopic composition ($\delta^{34}S$) of sedimentary pyrite is widely used to reconstruct past marine environments on a global scale. However, local sedimentary conditions may have a greater influence than previously recognized. In this study, we present new multi-isotopic sulfur data from dissolved H_2S, alongside microscale sulfur isotopic analyses of sedimentary pyrite from the redox-stratified Lake Cadagno (Switzerland) and compare them with previously published data (Canfield et al., 2010).

Canfield et al. (2010) performed surface sediment incubations and observed large, near-equilibrium isotopic fractionation during microbial sulfate reduction, hinting to slow cell-specific sulfate reduction rates despite abundant organic carbon. In the present work, 37 grain-specific isotopic analyses of pyrite grains from surface sediments deposited over the past 20 years are reported. One of them recorded the maximum fractionation value as observed from previous incubations while the rest of the pyrite $\delta^{34}S$ distribution reflects the evolution of water column H_2S over the same time period, ranging from -19.6‰ in 2006 to -4.4‰ in 2022. This ^{34}S enrichment in water column H_2S resulted from the diffusion of highly ^{34}S-enriched H_2S from porewaters.

These results challenge the conventional model used for paleoenvironmental reconstructions of euxinic systems, which assumes that H_2S production primarily occurs in the water column. Instead, we emphasize the role of sedimentary processes and local conditions in controlling sulfur cycling and pyrite $\delta^{34}S$ values. Our results also highlight the need for caution when using pyrite $\delta^{34}S$ as a proxy for past SO_4^{2-} dynamics.

Reference

Canfield, D.E., Farquhar, J., and Zerkle, A.L. High isotope fractionations during sulfate reduction in a low-sulfate euxinic ocean analog. *Geology*, 38(5):415–418, 2010. doi: 10.1130/G30723.1.