Goldschmidt 2026 Abstract
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Sulfur transformations in the water columns of low-sulfate lakes: What controls triple sulfur isotopic composition of hydrogen sulfide and sulfate?

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Stratified lakes with sub-millimolar sulfate concentrations, in addition to being environmentally important systems, have long been applied as the modern analogs of the Precambrian ocean. This study employs analysis of triple sulfur isotope (^{32}S, ^{33}S, ^{34}S) composition of sulfur species, to the study of sulfur cycling in the water columns of two lakes: Lake Kinneret (Israel) and Lake Sihailongwan (China) [1] with sulfate concentrations in the epilimnions 550 μM and 80 μM, respectively.

Microbial sulfate reduction in Lake Kinneret is characterized by an increase in 15 ‰ to 34 ‰, while $\lambda^{33}S$ values increase from 0.510 to 0.513. Also, the highest $\varepsilon^{34}S$ values were observed at the chemocline or within 2 m below it. These fractionation patterns may be attributed to two primary factors: (1) reduced sulfate reduction rates resulting from the enhanced transport of organic matter to the hypolimnion during spring; and (2) an increased extent of hydrogen sulfide reoxidation and the disproportionation of sulfide oxidation intermediates at the chemocline and during the late stages of lake stratification.

In Lake Sihailongwan, the increase in $\varepsilon^{34}S$ between spring and autumn is less pronounced than that observed in Lake Kinneret. However, similar to Lake Kinneret, both $\varepsilon^{34}S$ and $\lambda^{33}S$ values are higher in the upper hypolimnion compared to the lower hypolimnion. Given that the water column of Lake Sihailongwan is supersaturated with respect to FeS, the continuous removal of isotopically light hydrogen sulfide may be an additional factor contributing to the decrease in apparent $\varepsilon^{34}S$ values within the lower hypolimnion.

In Lake Kinneret a difference between the $\delta^{34}S$ values of epilimnetic sulfate and sedimentary pyrite is 7 ‰, which is 9 ‰ lower than the value predicted from compilation published by Gomes and Hurtgen [2]. In Lake Sihailongwan, there is no significant difference between the isotopic compositions of epilimnetic sulfate and sedimentary pyrite; this aligns with the predicted value of 1‰ calculated from the work of Gomes and Hurtgen [2].

[1] Boyko, V., et al. (2021) Geochim. Cosmochim. Acta, 296, 56–74.

[2] Gomes M.L., Hurtgen M.T. (2015) Geochim. Cosmochim. Acta, 157, 39–55.