Vertical distributions in the level and sulfur isotope ratio of sulfide in sediment of the Lake Biwa during stratification period

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The biogeochemical processes of sulfur in sediments have been well studied in the marine environments, whereas in freshwater environments they have received less attention due to the low sulfate concentration in lake water. Recently, however, it has been suggested that microbial sulfate reduction and subsequent primary production by sulfur oxidation support organisms on the bottoms. In this study, we investigated the microbial sulfur cycle in lake sediments in Lake Biwa using stable sulfur isotope.
Sediment cores were obtained from the central part of the northern lake in Lake Biwa (St. 1; ca. 90 m water depth) and from the off Hikone (St. 2; ca. 50 m water depth) in September 2021, when the stratified structure of the lake water was developing. The cores were sliced at intervals of 3 to 5 cm and measured concentrations of acid volatile sulfide (AVS) and total sulfur (TS) and their isotope ratios. Sulfate concentrations in pore water were also measured.
The vertical profile of AVS concentrations in the sediments showed a maximum at the surface and a decrease with depth. The maximum values were comparable to those observed in reductive marine sediments. Sulfate concentrations in the pore water were almost undetectable, suggesting that the AVS is produced by microbial sulfate reduction. However, the observed AVS concentrations were higher than expected from the water content and sulfate concentration of the sediments, suggesting that there may be a large amount of AVS originating from the decomposition of organic sulfur. The δ34S value of AVS increased with depth, and its maximum value was higher than that of lake water sulfate. The isotopic fractionation value (-3.4‰) calculated from the change of concentration and δ34S value of AVS was within the range of the isotopic fractionation value (-4~+2‰) by sulfur-oxidizing bacteria. This suggests that AVS produced by microbial sulfate reduction and organic matter degradation is consumed by sulfur-oxidizing bacteria. These results may indicate that the sulfur cycle of AVS production and consumption by microbes is driven in the lake sediments of Lake Biwa.

Keywords: Lake sediment, Microbial sulfate reduction, Acid volatile sulfide

