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Iron reduction in profundal sediments of ultra-oligotrophic Lake Tahoe under oxygen-limited conditions

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In deep temperate lakes, the frequency and depth of water column mixing is expected to decrease over the coming decades due to stronger thermal stratification in a warming climate, potentially leading to increased periods of bottom water anoxia. The associated shifts in biogeochemical redox processes in the sediment may result in reductive dissolution of iron minerals and an increased flux of ferrous iron and other nutrients from the sediment into the water column. Here, we study the sediment properties and reactivities under depleted oxygen concentrations of Lake Tahoe, a deep ultra-oligotrophic lake in the Sierra Nevada mountain range. In whole-core incubation experiments, we found that a decrease in dissolved oxygen concentration in the top 2 cm of the sediment resulted in an extension of the microbial iron reduction zone from 3 - 6 cm to 1.5 - 6 cm depth. In addition, rates of ferrous iron release from the sediments into overlaying water increased with decreasing dissolved oxygen concentration. Our findings suggest that large amounts of ferrous iron and potentially mineral-associated phosphorus may be released from Lake Tahoe sediment if bottom water were to go anoxic in the coming decades. If mixed into surface waters, these nutrients could contribute to alleviating nutrient limitations on phytoplankton productivity and decreasing lake clarity with serious consequences for the ecology of Lake Tahoe.