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88Sr/86Sr fractionation and calcite accumulation rate in the Sea of Galilee

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This study uses Lake Kinneret (Sea of Galilee, northern Israel) as a natural laboratory to investigate the fractionation of the stable Sr isotope ratio (88Sr/86Sr) during precipitation of authigenic calcite in the water column, and evaluates the dependence of the fractionation 87Sr/86Sr and 88Sr/86Sr ratios in the freshwater and brines that enter the lake are used to calculate the relative contributions of these sources to the Sr budget of the modern lake. The 87Sr/86Sr and 88Sr/86Sr ratios were measured in authigenic calcite, living Melanopsis shells, lake water and various water sources to the lake. While the lake's 87Sr/86Sr ratios are determined by the mixture of freshwater supplied mainly by the Jordan River and saline springs, the 88Sr/86Sr ratios of the lake reflect a more complex mass balance that includes the effect of isotopic fractionation during the precipitation of authigenic calcite. The data show a significant long-term effect of calcite accumulation on the stable Sr isotope ratio of the lake, increasing the 88Sr/86Sr of the water by 0.04 ‰İn contrast to the authigenic calcite, biogenic aragonite shells are shown to have a rather constant 88Sr/86Sr water-$CaCO_3$ fractionation of precipitation of coralline and chemical aragonite from seawater and the precipitation of authigenic calcite from various continental waters. The field data of the present study suggests that the fractionation of 88Sr/86Sr in authigenic calcite represents a kinetic fractionation that varies with precipitation rate, in addition to the constant thermodynamic property. Massive precipitation of authigenic calcite occurs in Lake Kinneret during the spring phytoplankton bloom as the latter increases considerably the degree of calcite saturation. The correlation between accumulation rate can be therefore used as a tool to reconstruct paleo-environmental variations by analyzing the 88Sr/86Sr ratio in authigenic $CaCO_3$ in core sections.