

Evaluation of calcite precipitation on stable Sr isotopic fractionation in the carbonate-dominated environment: hints from a cavern river system

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There were only a few attempts available for studying stable Sr isotope fractionation in the terrestrial environment. This study aims at understanding the controls of water $\delta^{88/86}\text{Sr}$ ratios responsible for bedrock lithologies and fractionation processes at carbonate-dominated catchments under various climatic conditions. We represent a monthly monitoring data of major ion concentrations, $^{87}\text{Sr}/^{86}\text{Sr}$ and $\delta^{88/86}\text{Sr}$ ratios for a karst river at the Luofang Cave in the Central China. Our results showed seasonal variations in the water Sr isotopic compositions characterized by radiogenic $^{87}\text{Sr}/^{86}\text{Sr}$ and heavier $\delta^{88/86}\text{Sr}$ ratios in the warm and rainy season, and vice versa in the dry period. The markedly heavier $\delta^{88/86}\text{Sr}$ (0.30 to 0.42‰) related to the bedrock (~0.24‰) cannot be interpreted solely by lithologies. Laboratory leaching of the local soils suggested limited $\delta^{88/86}\text{Sr}$ fractionation during incongruent silicate weathering. The absent or low density of local vegetations imply that plant utilization and biological activities may not be the primary control on water $\delta^{88/86}\text{Sr}$. Thermodynamic calculation of the calcite saturation states, water pHs, and the decreased Sr/Na ratios refer the favorable for calcite precipitation in that time. Stable Sr isotope fractionation during the calcite formation was evaluated in the freshwater system by the calcite precipitate and drip waters, and the $\Delta^{88/86}\text{Sr}_{\text{Car-Aq}}$ was estimated $-0.15 \pm 0.07\text{‰}$ (2SD). Thus, if the calcite precipitation is the only process controlling the cave water $\delta^{88/86}\text{Sr}$, the enrichment of the heavily Sr isotopes in waters relative to the bedrocks equal to ~30 to 70% of Sr removed from the water. Our results indicate that secondary calcite precipitation in the carbonate-dominated environments could be of significance and play an important role controlling water $\delta^{88/86}\text{Sr}$ compositions.