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Response of drip water elments/Ca ratios in ventilated caves to hydroclimate

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The examination of spatial and temporal variability in Critical Zone processes is facilitated by karst systems, which offer a unique perspective into the subsurface realm where water has interacted with rainfall, CO_2 concentration, and bedrock across various lengths and timescales. The hydrological processes include the deposition of speleothem. Speleothem Mg/Ca and Sr/Ca can be valuable proxies for recording past variations in rainfall and cave air pCO_2. However, most studies neglect the controlling of the combination effect in rainfall and cave air pCO_2 on the seasonal in drip water Mg/Ca and Sr/Ca values. Furthermore, the extent of our understanding regarding the impact of seasonal rainfall and cave air pCO_2 on seasonal variations in drip water Mg/Ca and Sr/Ca remains restricted in caves with diverse regions and ventilation types. In this study, five-year monitoring was implemented from 2017 to 2021 at Shawan Cave in Southwest China. It was found that the irregular seasonal oscillation in drip water Mg/Ca and Sr/Ca is influenced by the inverse-phase seasonal changes between rainfall and cave air pCO_2. The interannual variation in drip water Mg/Ca could be affected by rainfall amount, while that of drip water Mg/Ca most like be controlled by cave air pCO_2. Moreover, we compared cave drip water Mg/Ca and Sr/Ca in different regions to investigate how the elements/Ca of drip water respond to hydroclimate conditions. We found that, no matter what ventilation types are in the different regions, the range of cave air pCO_2 is a key factor controlling the seasonal variation in elements/Ca ratios, which affects the response of elements/Ca ratios on hydroclimate. The ratios respond well to local hydroclimate associated with rainfall variation if the range is narrow. While the seasonal amplitude of the ratios may be amplified or irregularly oscillated controlled by the combination of rainfall amount and cave air pCO_2, when the range of cave air pCO_2 is considerably large. Therefore, this implies that the seasonal distribution of rainfall, annual mean rainfall, range and seasonal pattern of cave air pCO_2, and cave air temperature are investigated before using speleothem Mg/Ca and Sr/Ca for reconstructing the paleoenvironment.