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Trace Element Variation in Modern Speleothem Growth

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Speleothems are cave calcite deposits and are common paleoclimate proxies. Whereas previous analysis of cave drip waters from many settings has led to a detailed understanding of the mechanisms that control geochemical evolution of the drip waters, factors affecting the partitioning of trace elements into speleothem calcite are not well understood. To understand how dripwater and speleothem compositions are related, this study will measure the Mg/Ca, Sr/Ca, Ba/Ca and $^{87}Sr/^{86}Sr$ ratios in dripwater and calcite grown on artificial substrates from Natural Bridge Caverns New Braunfels, Texas.

Previous research has focused on understanding the controls on cave dripwater compositions from which speleothems form. As meteoric water percolates through the vadose zone, the Mg/Ca, Sr/Ca, Ba/Ca and $^{87}Sr/^{86}Sr$ ratios can be modified by water-rock interaction (i.e. calcite and/or dolomite dissolution and reprecipitation) along a flow path from the surface to the cave. The ratios can also be influenced by prior calcite precipitation (PCP) (i.e., calcite precipitation in the vadose zone above the cave or on the cave ceiling). The amount of PCP that occurs can be controlled by the level of CO_2 in the cave and vadose zone and/or antecedent moisture conditions that influence the relative saturation state of the vadose zone above the cave and the relative water travel times. The co-variation of Mg/Ca (and Sr/Ca) and $^{87}Sr/^{86}Sr$ values is useful for identifying if dripwater is controlled by water-rock interaction, PCP, or a combination of both. Water-rock interaction results in higher Mg/Ca (and Sr/Ca) and lower $^{87}Sr/^{86}Sr$ values, and PCP results in higher Mg/Ca (and Sr/Ca) with constant $^{87}Sr/^{86}Sr$ values.

For this research, monthly dripwater and calcite samples will be collected to assess how calcite growth rate and geochemistry relate to drip rate and dripwater geochemistry and characterize seasonal variations in this relationship and in calcite geochemistry. The substrates will be placed under drip sites that have previously been identified to be controlled by distinct combinations of water-rock interaction and PCP: i) dripwater dominantly controlled by PCP; ii) dripwater dominantly controlled by water-rock interaction and iii) dripwater controlled by a combination of both. The results will be used to improve upon quantitative transfer functions that relate climate with drip water and speleothem geochemistry, and will be used to forward model synthetic speleothem records.

Keywords: Trace elements, paleoclimate, speleothems