Trace metal variability in Puerto Rican speleothems and drip waters: Indicators for (past) tropical cyclone activity?

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In the tropical Americas, extreme precipitation events such as hurricanes are responsible for enormous damage and numerous fatalities each year. However, projections of hydro-climatic change and tropical cyclone (TC) activity in Central America and the Caribbean for the next decades are still challenging, requiring more reconstructions of past precipitation and TC activity. In tropical speleothems, stable oxygen isotope values (δ18O) are an often used proxy for precipitation amount, and in some cases TC activity, but may be masked by various effects such as evaporation or kinetic effects inside the cave, temperature, or variable moisture sources and trajectories.

Here we investigate the potential of trace metals in speleothems and drip waters from Larga Cave, Puerto Rico, as complementary proxies for past effective infiltration, and hence precipitation amount. The analysis of transition metal ratios in drip waters from 2014 to 2019 reveal a seasonal variation, with peaks in the Cu/Ni (and Cu/Co) ratios potentially reflecting the intensity of the prior wet season. The suggested imprint of Hurricanes Bertha (2014) and Maria (2017) in the drip water suggests that transition metal ratios might be even indicators of (past) tropical cyclone activity.

Laser ablation ICPMS analyses of speleothems from the same cave support the interpretation of a potential climate signal in the transition metal ratios. Both higher Cu/Ni and Cu/Co values are found during presumably warmer and wetter phases, such as e.g. during the late Holocene, as well as at the onsets of Dansgaard/Oeschger interstadials including the Bolling/Allerod (14.6-12.8 ka BP). Replicated records of the past 400 years combined with stable isotope values of oxygen and carbon (δ13C) will provide a test of the underlying mechanisms driving the observed variability on different timescales. Comparison with other reconstructions highlights the potential of Cu/Ni (and Cu/Co) ratios in speleothems for hydro-climate and past precipitation variability reconstruction.