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Leveraging Stable Isotope and Trace element Geochemistry From Continuous Cave Monitoring to Discern Tropical Hydroclimate Variability in the Philippines

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Speleothem growth is sensitive to multiple in-cave specific factors in addition to regional hydroclimate variability. Using speleothem geochemical variability to ascertain robust trends in hydroclimate relies on a detailed understanding of modern cave systematics. Continuous and long-term monitoring of cave systems aids in developing the empirical relationship between the hydroclimate, the karst aquifer hydrology, and the cave microclimate. This is currently lacking in the Philippines, a region impacted by variable hydroclimate systems on a sub-annual to an interannual temporal scale.

This paper reports the first seasonal monitoring effort across multiple cave systems across an approximately 10° latitudinal spread in the Philippines. Bangalau (18.2158° N, 121.8762° E); Maningning Cave (MC, 15.1071° N, 121.0773° E) in Biak-na-Bato National Park; Puerto Princesa Underground River (PPUR, 10.1926° N, 118.9266° E) in Puerto Princesa Subterranean River National Park were monitored for (1) monthly or bimonthly drip water pH, total dissolved solids, electrical conductivity, temperature, drip rate, water $\delta^{18}O$, water $\delta^{2}H$, and elemental (cations and anions) composition, (2) monthly or bimonthly modern cave calcite $\delta^{18}O$, $\delta^{13}C$, and elemental (Ca, Mg, Sr) composition, and (3) continuous cave atmosphere pCO_2, relative humidity and temperature. Our dripwater sites in each cave system covered at least one diffuse and one conduit drip site to understand the end-member response in the cave system to regional climatological variability.

Our preliminary cave atmosphere pCO_2 range of 600 ppm (PPUR) to 40,000 ppm (MC) suggests seasonal stagnation of calcite precipitation, which is corroborated by other, albeit limited, tropical cave monitoring studies. Further, the modern cave calcite $\delta^{18}O$ range between -8.9 to -14.5 ‰ V-PDB. The results of our monitoring endeavor will be of significance for those aiming to reconstruct paleoclimate records using speleothems from the Philippines and within the broader Western Pacific Warm Pool region in the tropics. The results also provide insight into how climate variations in the tropics, a region vastly under-monitored, impact speleothem growth and geochemical records derived from speleothems.