Measuring seasonal hydroclimate dynamics in speleothems

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Speleothems (cave carbonates) provide critical records of past changes in continental hydroclimate. In combination with U-Th geochronology, oxygen isotope ($\delta^{18}O$) time-series from speleothems around the globe are used to illustrate local hydrological responses to regional and global paleoclimate changes. The temporal resolution of these $\delta^{18}O$ records is typically multi-annual to decadal, allowing workers to identify abrupt, decadal-scale climate changes. Analytical methods developed at the WiscSIMS lab allow for seasonal resolution $\delta^{18}O$ records, which enables interrogation of hydrological responses to climate change on a human timescale. Here, we present seasonal $\delta^{18}O$ records measured in Late Quaternary speleothems from two regions, China and Israel, that are key to understanding global hydroclimate and its link to cultural evolution.

The modern hydroclimates of both China and Israel are strikingly seasonal, and seasonal-resolution $\delta^{18}O$ records from both localities indicate that these seasonal patterns persisted in the Holocene. Prior to the Holocene, however, we observe variations in seasonal $\delta^{18}O$ patterns through both time and space. We characterize these changes by emperically modeling the seasonal resolution $\delta^{18}O$ data and quantitatively assessing growth bands imaged by confocal laser fluorescent microscope.

At both sites, the changes in seasonal speleothem $\delta^{18}O$ patterns observed across deglacial intervals are interpreted as regional atmospheric reorganization. In the Chinese samples, summer monsoon rainfall intensifies across deglaciations. Concurrently, westerly storm tracks vacate central Israel. Both results suggest a northward shift of seasonal hydroclimate regimes during deglaciation. The seasonal resolution data indicate large, rapid (<20 yr) hydroclimate changes at the Younger Dryas/Holocene transition in both localities.