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Speleothems as recorders of local climate variability and its implications for Maya cultural evolution from a unique cave site on the northern Yucatán Peninsula

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The unsteady cultural evolution and final collapse of Maya civilization in Mesoamerica are heavily debated issues and discussion includes the impact of both natural (e.g., droughts, hurricanes, volcanic eruptions) and social disasters (e.g., warfare and unsustainable economy). An increasing number of records point to recurrent multi-year droughts coinciding with hiatuses in construction, periods of temporary urban abandonment and population collapse. Previous reconstructions indicate that environmental conditions and precipitation on the Yucatán Peninsula were distributed very heterogeneously in space and time and the duration and chronology of events remains uncertain. High resolution environmental reconstructions are, however, mainly based on archives from sites on the southern Yucatán Peninsula.

We have now recovered several stalagmites from Estrella Cave, northern Yucatán Peninsula, spanning the entire Maya era and reaching even to historical times (–1100 to 1780 AD). The high precision ²³⁰Th/U ages obtained so far from these stalagmites indicate growth rates of up to 160 μm per year, thus offering the potential for annual to decadal climate proxy reconstruction. Here we present ²³⁰Th/U based preliminary age models for some of these stalagmites. Based on growth rates, petrographic observations, and trace element to calcium ratios we draw first conclusions on the timing of (recurrent) dry periods around key episodes of Maya cultural evolution, such as the Terminal Classic Period (~800–1000 AD). Furthermore, these first results show that the incorporation of certain trace elements (Mg, Sr, Ba, P, ...) in these speleothems is strongly related to recharge and hence precipitation above the cave. Moreover, the site also contains unique remains of the Mayan culture, such as paintings, pottery, constructions and even buried skeletons, thus highlighting its significance not only for regional climate reconstruction but also for local archaeology.