Hells Bells–underwater speleothems: A novel paleohydrological archive for the Yucatán Peninsula, Mexico

N. SCHORNDORF*[1], S.M. RITTER[1], N. FRANK[2,1], L. KLOSE[3] AND W. STINNESBECK[1]

[1]Inst. Earth Sci., Heidelberg Univ., Heidelberg, Germany (*correspondence: nils.schorndorf@iup.uni-heidelberg.de)
[2]Inst. Env. Physics, Heidelberg Univ., Heidelberg, Germany
[3]Jacobs Univ. Bremen gGmbH, Bremen, Germany

Downward expanding, bell-shaped underwater speleothems, termed as Hells Bells, were recently reported for the ~60 m deep meromictic El Zapote sinkhole (cenote) on the Yucatán Peninsula (YP), Mexico [1]. The water body of the cenote is stratified into a fresh water layer, a thick transition zone (halocline) and a salt water layer. Hells Bells (HBs) most likely form in the pelagic redoxcline, a narrow zone above the halocline, due to proton-consuming chemolithoautotrophic biogeochemical processes [2]. HBs formation also depends on the depth position of the halocline, which is a function of the fresh water layer thickness and the mean sealevel elevation [2].

In this study we conducted detailed geochemical analyses, including U-series dating and stable isotope analyses ($\delta^{18}O$, $\delta^{13}C$) of HBs speleothems of different water depths. The oldest samples analysed here date back to 120 ka BP while the youngest ages of HBs speleothems of different water depths indicate that its growth is still ongoing. A 56 cm long HBs specimen (ZPT4, illustrated in [1]) was studied in detail by taking 40 samples along its presumed growth axis. The specimen covers a period of ~12.5–1.4 ka BP and continuous net growth conditions are indicated since ~8 ka BP at a near linear net growth rate of 100 μm a^{-1}.

HBs growth records the minimum relative sea-level elevation because its growth depends on the halocline elevation and is restricted to 30–40 m present day water depth. Furthermore, a change from a relatively cold and dry Late Pleistocene climate, dominated by C4-plants, to a warmer more humid Early/Middle Holocene climate with increasing portions of C3-plants, is indicated by $\delta^{13}C$ of HBs.

Eventually, $\delta^{234}U_{initial}$ values together with Sr/Ca, Ba/Ca and Mg/Ca ratios of the investigated HBs, allow for a reconstruction of the development and variation of the thickness of the freshwater lens throughout the Holocene.

[1] Stinnesbeck et al. (2018) *Paleo3* **489**, 209–229.
[2] Ritter et al. (2019) *Biogeosciences Discuss. https://doi.org/10.5194/bg-2018-520.*