

Hells Bells – underwater speleothems

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Spectacular bell-shaped underwater speleothems, termed as Hells Bells, were recently reported from several deep meromictic sinkholes (cenotes) on the Yucatán Peninsula (YP), Mexico [1] (Fig. 1). Hells Bells (HBs) consist of granular and micritic layers of calcite often forming downward divergent hollow cones. HBs appear to grow in the freshwater body above a sulfidic halocline and seem to prefer a dark environment. Age-dating showed that HBs grow under water from modern to at least ~4.5 ka BP [1].



Figure 1: Hells Bells speleothems at El Zapote cenote. The redoxcline is indicated by the white cloudy layer.

The mystery of the subaqueous growth of HBs, however, remained unresolved. Therefore, we conducted detailed geochemical analyses of the water column and HBs speleothems of El Zapote cenote including carbon isotope analyses [2]. Based on these results we propose a biogeochemical mechanism in which chemolithoautotrophy, in particular the proton consuming nitrate-driven anaerobic sulfide oxidation, favors calcite precipitation in the redoxcline and hence, HBs formation. Furthermore, a dynamic elevation of the halocline as a hydraulic response to droughts and recharge events, e.g. hurricanes, might explain the shape of HBs as well as their occurrence over a range of 10 m water depth. Additional investigations of three cenotes with HBs and one cenote devoid of HBs indicate that stagnancy is the most important prerequisite for HBs formation, which might explain the exclusivity of HBs to only a few cenotes in a restricted area of the northeastern YP.

Eventually, HBs are prospected as paleohydrological archive, especially in reconstructing the thickness of the freshwater lens of the YP karst aquifer.

[1] Stinnesbeck et al. (2018) *Paleo3* **489**, 209–229.

[2] Ritter et al. (2019) *Biogeosciences Discuss.*

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