Seasonal and high-frequency CO_2 fluctuations in central Texas Caves

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Executive Summary

The growth rate and chemical composition of cave calcite deposits (speleothems) are important proxies for past environmental and hydrologic changes. Understanding the timing and driving mechanisms of calcite growth is therefore important for interpreting these proxies. One driving mechanism is the concentration of carbon dioxide in cave air. A previous study in tourist caves located on the Edwards plateau found speleothem growth rate to be correlated with the concentration of carbon dioxide in Cave air (Banner et al., 2007). In the summertime, when carbon dioxide concentrations are elevated, calcite growth rate decreased; conversely, in the wintertime, when carbon dioxide concentrations were relatively low, calcite growth rate increased. These findings suggest that some speleothems may not grow continually; thus their chemical and isotopic composition may only be reflective of the composition of dripwaters throughout the year. As well, speleothem growth rate is also used as a climate proxy and may be interpretations made based on growth rate may be biased due to seasonal hiatuses in growth caused by high cave-air CO_2 concentrations.

To assess if this is a phenomenon unique to tourist caves, which are modified from their natural state and are subject to intense visitation, we began a monitoring program in several BCP-owned wild caves in South Austin. Initial findings show that cave-air carbon dioxide concentrations are strongly seasonal, with peak concentrations occurring in late summer to early fall, and lower concentrations occurring from late fall to early spring (Cowan et al., 2009). These findings suggest that seasonal fluctuation in cave-air carbon dioxide concentration is a naturally occurring phenomenon and is regional in extent.

Our monitoring also shows that significant, high frequency cave air CO_2 fluctuations occur in all tourist and BCP caves monitored. High temporal resolution monitoring suggests that these fluctuations are a result of barometric pressure and surface temperature fluctuations (Cowan et al., 2009).

Methods and Study Caves

The following BCP – managed caves were monitored beginning in July, 2006: Blowing Sink, Seibert Sink, Maple Run Cave, Whirlpool Cave , District Park Cave and Cave Y. During each visit carbon dioxide concentrations were measured at several stations located throughout each cave using a hand-held, infrared carbon dioxide meter. Maple Run Cave, Whirlpool Cave and District Park Cave were each

approximately every two weeks. Blowing Sink, Seibert Sink, and Cave Y were visited less frequently. Soil thickness was also measured at Maple Run Cave, Whirlpool Cave and District Park Cave by driving a 1/8-inch diameter Rebar stake into the ground until refusal.

Preliminary Results

Because Blowing Sink, Seibert Sink, and Cave Y were visited less frequently, it is unclear if the carbon dioxide concentration in these caves exhibits a strong seasonal fluctuation. Maple Run Cave, Whirlpool Cave and District Park Cave Each exhibited strong seasonal fluctuations in the concentration of cave air carbon dioxide. For clarity, we will present a representative summertime and wintertime transects of these frequently visited caves (Figures 1-3).

Preliminary Conclusions

Multiple transects of each Maple Run Cave, Whirlpool Cave and District Park Cave shows that cave-air CO_2 varies seasonally, with peak concentrations in late August to early October and lower concentrations in December through late March. The timing of seasonal CO_2 fluctuations is consistent in all three caves. These results indicate that 1) the seasonality of calcite deposition observed in the tourist caves (as controlled by the concentration of cave-air CO_2) is not due to human alteration of the caves, 2) the concentration of cave-air CO2 varies significantly on the seasonal timescale and 3) the seasonal fluctuation of cave-air CO_2 is regional in extent. These findings have important implications on the use of speleothems in paleoclimate studies.

Multiple talks on this ongoing research have been given at professional meetings and are detailed below. A manuscript detailing this study is currently in preparation and will be submitted for publication in a peer-reviewed journal. A copy of the accepted manuscript will be provided to BCP staff. As well, a short paper on seasonal and higher-frequency CO_2 fluctuations was published in the Proceedings of the 15th International Congress of Speleology (attached).

Work Cited

Banner, J., Guilfoyle, A., James, E., Stern, L., Musgrove, M., 2007, Seasonal variations in modern speleothem calcite growth in Central Texas, U.S.A.: Journal of Sedimentary Research, v. 7, p. 615-622

Cowan, B. D., Osborne, M.C. and Banner, J.L., 2009, Temporal variability of cave-air CO_2 in central Texas, Proceedings of the 15th International Congress of Speleology, Kerrville, Texas, July 19-26, 2009, Volume 2, Symposia, Part 2

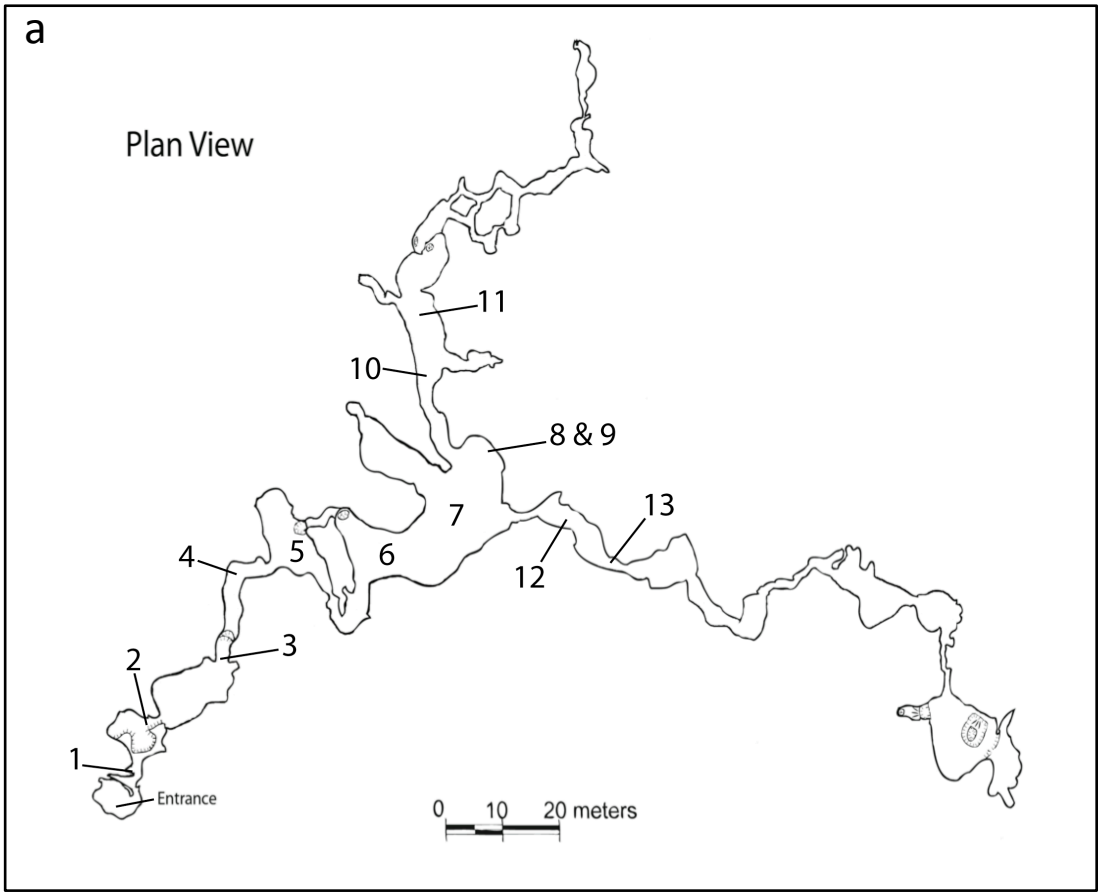
Professional Presentations

Cowan, B. D., Osborne, M.C. and Banner, J.L., 2009, Temporal variability of cave-air CO_2 in central Texas, Technical Sessions, University of Texas at Austin, Department of Geological Sciences, October 2008

Temporal variability of cave-air CO_2 in central Texas, Abstracts with Programs - Geological Society of America Annual Meeting, Houston, Texas, October 2008, 40(6):197

Cowan, B. D., Osborne, M.C. and Banner, J.L., 2009, Temporal variability of cave-air CO_2 in central Texas, Proceedings of the 15th International Congress of Speleology, Kerrville, Texas, July 19-26, 2009, Volume 2, Symposia, Part 2

Figure 1: (a) Map of carbon dioxide monitoring stations within Whirlpool Cave.
(b) Representative summer and winter transects of Whirlpool Cave.



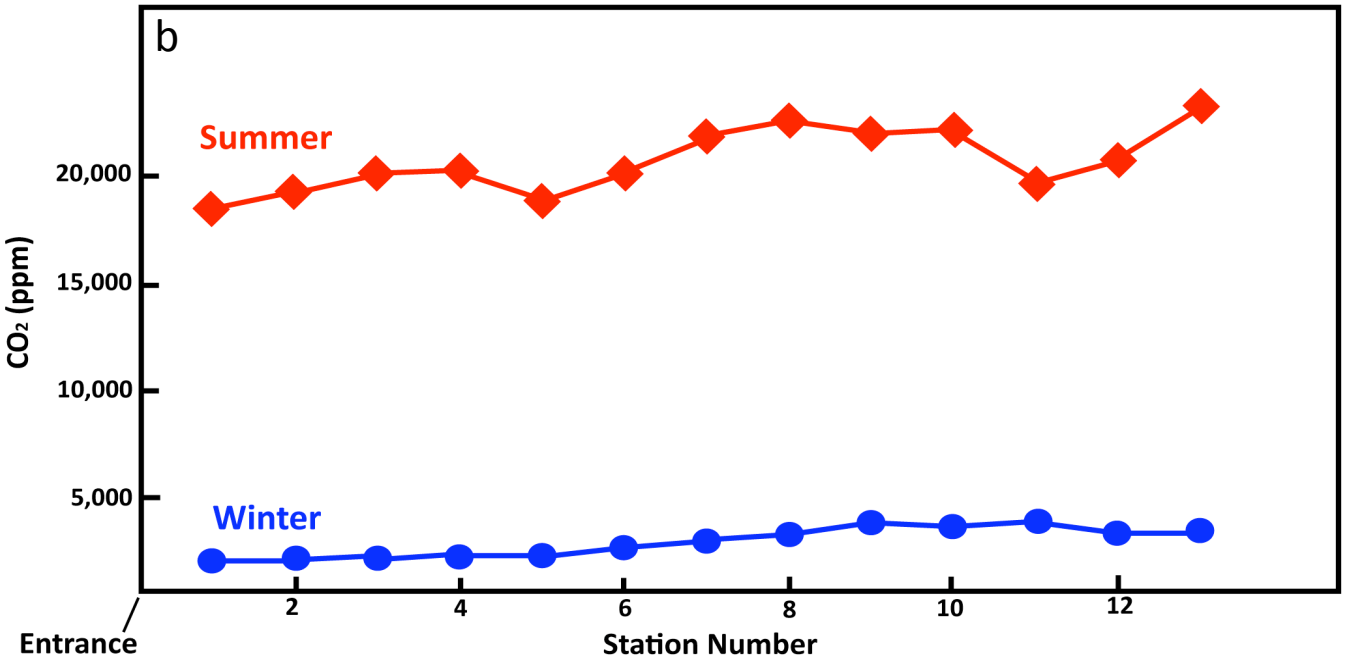
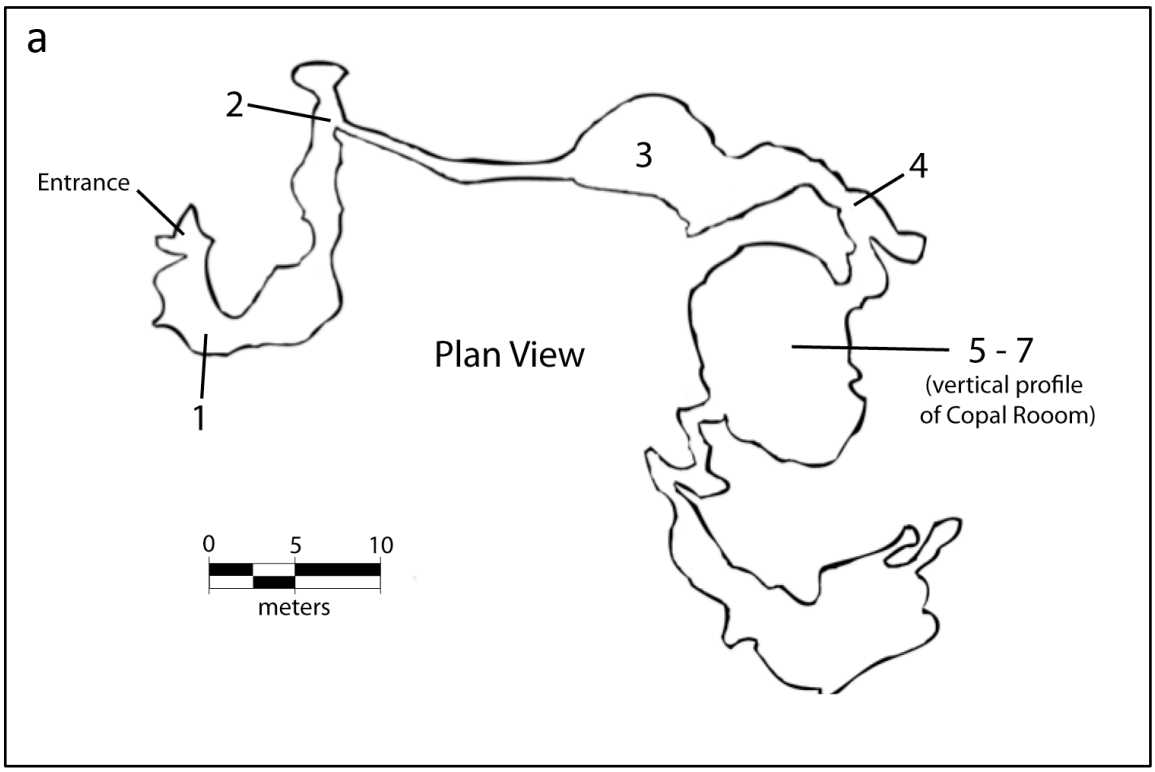


Figure 2: (a) Map of carbon dioxide monitoring stations within Maple Run Cave.
(b) Representative summer and winter transects of Maple Run Cave.



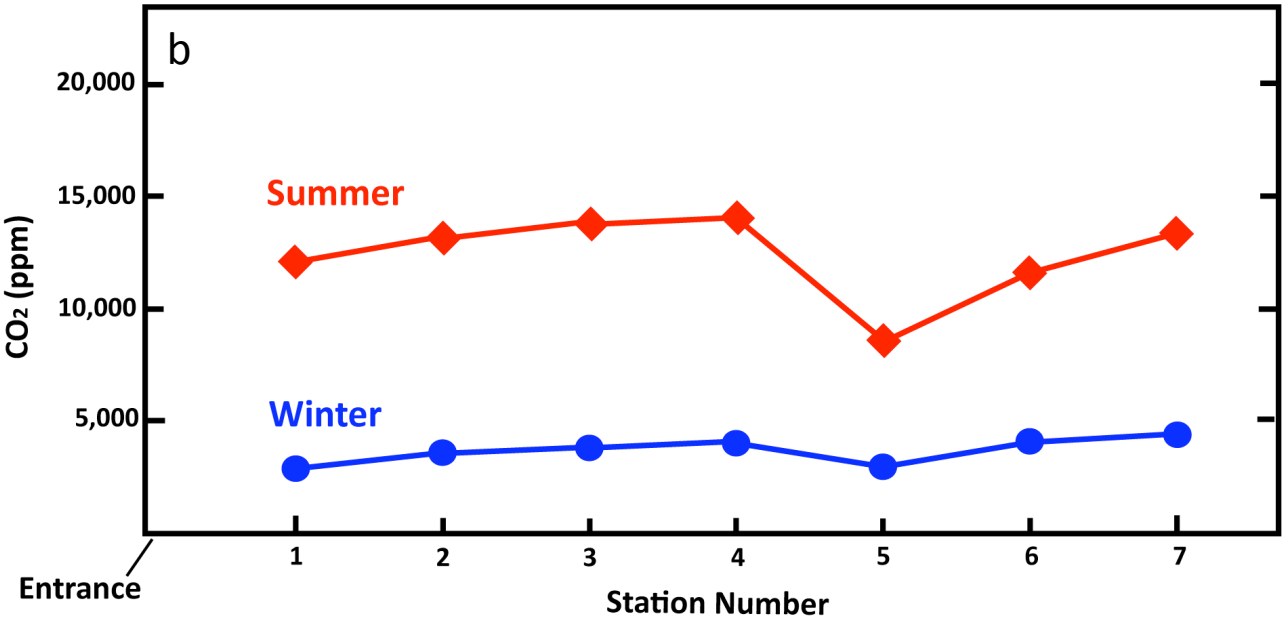


Figure 3: (a) Map of carbon dioxide monitoring stations within District Park Cave.
(b) All carbon dioxide measurements taken in District Park Cave from July, 2006 to October, 2007.

