Holocene climate variability revealed by high-resolution speleothem records from eastcentral North America

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## Background



# $\delta^{13}C$ in Speleothems

- Interpreted as changes in the type or density of vegetation overlying the cave (Dorale et al., 1998).
- Higher biogenic activity and/or a higher proportion of C3 vegetation (i.e. more precipitation) results in more negative  $\delta^{13}$ C values.
- More depleted when the climate is in a moist state and are comparatively enriched during times of drought due to the influence of moisture on soil respiration rates (McDermott, 2004).

# δ<sup>18</sup>O in WV Speleothems

- Overall, interpreted as variations in cave temperature and properties/sources of meteoric water (McDermott, 2004).
- Hardt et al., (2010): enriched δ<sup>18</sup>O as representative of an increase in relative contribution of summer precipitation, due to variation in Bermuda High circulation intensity.



#### **Moisture Transport in North America**



Correlation maps of winter season (DJFM, 1948–2000) PNA index and climate parameters: A) zonal wind (u) at the 500 hPa level, B) meridional wind (v) at the 500 hPa level, C) surface air temperature for PNA+ and D) precipitation for PNA+.

Liu et al., 2011

## **Trace elements as proxies**

- Used to interpret the hydrogeochemical processes in the epikarst zone as well as the partitioning that occurs at the calcite-water interface.
- During periods of low rainfall, trace element ratios generally increase as a result of the longer residence time of water in the soil and epikarst zones.
- A coupling between δ<sup>13</sup>C values and Sr/Ca ratios can exist due to the occurrence of prior calcite precipitation in the vadose zone in times of low moisture availability, which will leave the remaining solution enriched in both δ<sup>13</sup>C and Sr in relation to Ca (Springer et al, 2008).

## Setting

#### Mississippian Greenbrier Formation



#### Methods

<sup>18</sup>O & <sup>13</sup>C : IRMS (VPDB) Th<sup>230</sup> : MC-ICP-MS Sr : ARTAX μ-XRF



#### HC2-02

## HC2-03

#### **Bruker Artax μ-XRF**







#### Results









#### HC2-02 & 03 Growth Curves



#### BCC-002 Record Springer et al., 2008

 Coincident Sr & δ<sup>13</sup>C enrichment
interpreted as
drought events in
eastern N. America

 6 of the 7 events coincide with N. Atlantic IRD events





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yr BP







## Conclusions

- More **Th<sup>230</sup> age dates** needed
- Slow growth rate during the early to mid Holocene of HC2-03 hinders proxy interpretation
- δ<sup>13</sup>C & Sr time series are linked through the effects of precipitation
- δ<sup>18</sup>O variability attributed to changes in the relative proportion of summer precipitation, a function of the Bermuda High and PNA+/-
- Drought events from BCC-002 not comparable in HC2-02 or HC2-03, but whether it is due to poor age control or a localized climate signal remains to be determined

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