

OXYGEN ISOTOPES IN CAVE STALAGMITES AS A PROXY RECORD
OF PAST TROPICAL CYCLONE ACTIVITYDavid L. Malmquist^{*}
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1. INTRODUCTION

Rain generated by tropical cyclones has significantly lighter $\delta^{18}\text{O}$ values than rain produced by normal tropical, subtropical, and mid-latitude summer storms. Lawrence and Gedzelman (1996) observed that 42 rain samples from 4 tropical storms and one Category 1 hurricane that made landfall in Texas had a mean $\delta^{18}\text{O}$ value of -9.35‰ , whereas the mean $\delta^{18}\text{O}$ value for 161 samples of normal summer rain from southeast Texas was -2.93‰ .

In cavernous regions, the isotopic signature of rainfall may be incorporated within calcium carbonate deposits precipitated via groundwater seepage into caves (Hendy, 1971). Thus speleothem deposits such as stalagmites potentially contain a millennial record of past tropical cyclone activity (Lawrence and Gedzelman, 1995), at a resolution of years to decades (Li et al., 1989; Baker et al., 1993).

Such a record would significantly extend the current ~100-year instrumental record of tropical cyclone activity. The brevity of this instrumental record currently limits our understanding, analysis, and prediction of tropical cyclone variability.

2. MATERIALS AND METHODS

Samples were taken from caves in Bermuda using a gas-powered drill to extract cores and a chisel to remove two small specimens. Selection of the sampled stalagmites was based on external morphology and location within the cave.

Specimens were subsequently thin-sectioned and probed using a device capable of collecting microgram samples along digitally defined paths. Samples were then subjected to mass

spectroscopic analysis for $\delta^{18}\text{O}$, with an analytical precision of 0.1‰ .

A path width corresponding to annual growth bands was estimated by assigning a date to an apparent soot layer in the stalagmite and dividing the sampled interval by the number of years between that date and present. Anecdotal evidence suggests that the soot layer was deposited by a forest fire that occurred in Bermuda in 1617.

Data on the frequency of tropical cyclones in Bermuda was taken from NOAA Historical Climatology Series 6-2 (1992) and Tucker (1982).

3. RESULTS

Preliminary data indicate that $\delta^{18}\text{O}$ values incorporated in a Bermuda stalagmite during the last 244 years range from -2.178‰ to -4.635‰ (mean = -3.5 , SD = 0.5), with decadal-scale variations up to 1.87‰ (Figure 1).

Figure 1 also shows the annual number of tropical cyclones affecting Bermuda between 1741 and 1985.

4. DISCUSSION

The $\delta^{18}\text{O}$ values in Figure 1 suggest that the oxygen isotopes incorporated within the calcium carbonate of the sampled stalagmite record decadal-scale tropical cyclone variability in Bermuda. Exact calibration of this isotopic variability against Bermuda's nearly 400-year documentary record of tropical cyclones awaits ^{14}C dating of a soot layer in the sampled stalagmite.

The absence of event-scale resolution within the stalagmite is most likely due to the slow growth rates of Bermuda stalagmites. As *annual* growth rates of Bermuda stalagmites are a few tens of

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micrometers, isotopic resolution of an individual storm event within a stalagmite would require a higher sampling resolution than currently available.

Planned analysis of $\delta^{18}\text{O}$ values of normal and tropical cyclone rains from Bermuda, as well as analysis of $\delta^{18}\text{O}$ values from drip waters in Bermudian caves, will provide additional baseline data for further testing the feasibility of using oxygen isotopes as a proxy record of tropical cyclone activity in Bermuda and elsewhere.

5. REFERENCES

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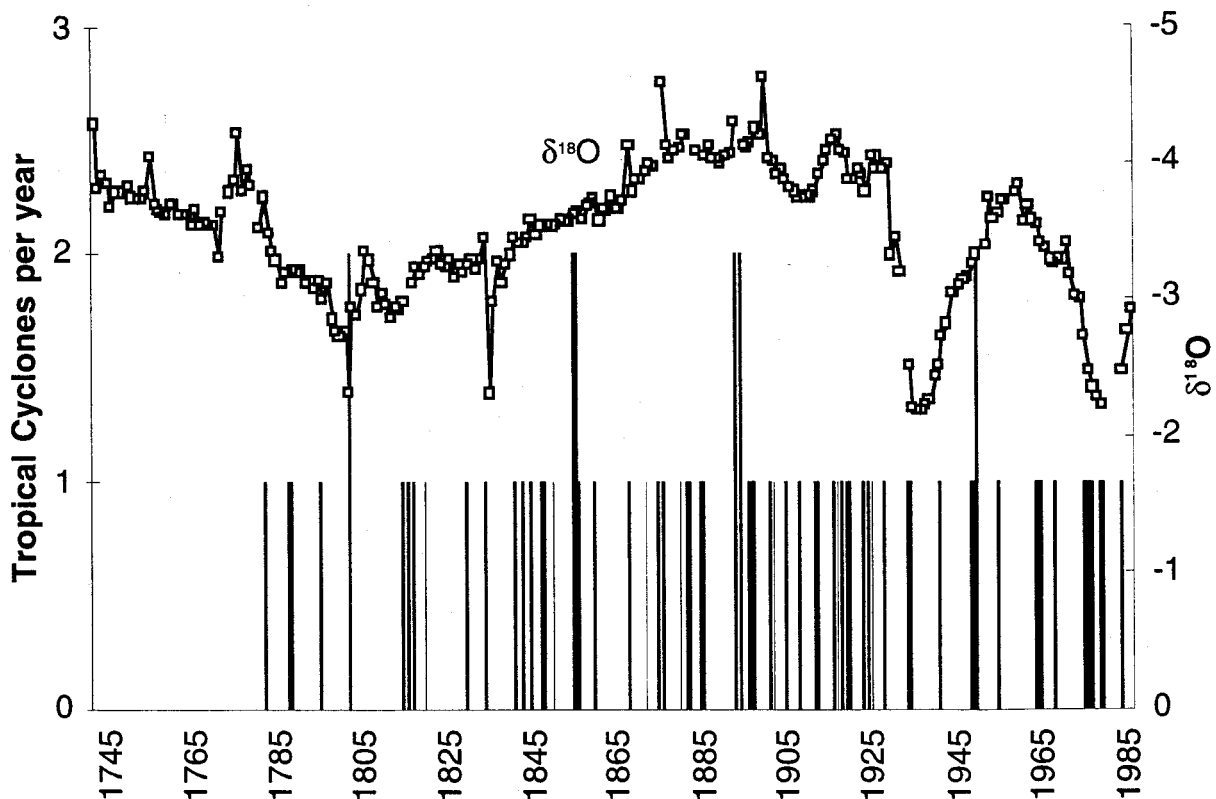


Figure 1: $\delta^{18}\text{O}$ values for portion of Bermuda stalagmite analyzed to date in this study, plotted against annual number of tropical cyclones affecting the island between 1741 and 1985.