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Stalagmite Dead Carbon Proportion Records Hydroclimate Variability in Central Vietnam

KATHLEEN R JOHNSON[1], TIA CHUNG-SWANSON[1], ELIZABETH W PATTERSON[2], MICHAEL L GRIFFITHS[3], GUACIARA DOS SANTOS[1], JOHN SOUTHON[1], ZICHENG WANG[1] AND HECTOR MARTINEZ DE LA TORRE[1]

[1]University of California Irvine
[2]Lafayette College
[3]William Paterson University

Radiocarbon (^{14}C) dating is rarely used for development of speleothem age-depth models due to the variable incorporation of ^{14}C-free "dead" carbon from carbonate bedrock and aged organic matter in the soil and epikarst. However, speleothem ^{14}C measurements have been increasingly used to investigate hydroclimate and carbon cycle processes in karst environments through determination of the dead carbon proportion (DCP) and its variability through time. Higher DCP values are thought to reflect increased closed-system dissolution during wetter periods and vice-versa [1], though it is unclear whether factors such as exchange with modern cave air CO_2, variable soil organic matter dynamics, and/or sulfuric acid-driven dissolution may play a role. To further investigate DCP as a proxy for hydroclimate, we conducted new ^{14}C measurements on a well-studied stalagmite (HH-1) from Central Vietnam that formed between 45-4 ka [2] . We measured ^{14}C and calculated DCP in 35 subsamples of HH-1 calcite spanning the full range of hydroclimate states. Our results show agreement between DCP and other hydrologically-sensitive proxies ($\delta^{13}C$, Mg/Ca, $\delta^{18}O$), with high DCP during wet periods and low DCP during dry periods, including the last glacial maximum and Heinrich stadial (HS) events. Notably, we observe extremely low near-zero DCP values during HS 1, 2, and 3, which we hypothesize may reflect exchange of dripwater dissolved inorganic carbon with in-cave atmospheric CO_2 during periods with extremely slow growth rates. Finally, we apply a simple geochemical model to evaluate the influence of DCP on speleothem stable carbon isotopes ($\delta^{13}C$), and find that prior calcite precipitation remains the dominant control on HH-1 $\delta^{13}C$ variability.

References

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