EGU21-3322, updated on 17 Oct 2021
https://doi.org/10.5194/egusphere-egu21-3322
EGU General Assembly 2021

Using Micro-CT and petrographic analysis to select optimal U-Th samples from challenging stalagmites.

Jessica Oster[1], Cameron de Wet[1], Kate Neal[1], and Warren Sharp[2]
[1]Vanderbilt University, Earth and Environmental Sciences, Nashville, United States of America
(jessica.l.oster@vanderbilt.edu)
[2]Berkeley Geochronology Center, Berkeley, United States of America

Speleothem deposits can provide a wealth of critical, detailed paleoclimate information from low and mid-latitude terrestrial environments. A key strength of these archives is that they may be dated precisely using U-Th techniques. Yet, depending on the cave environment, overlying geology, seepage water flow characteristics, and speleothem growth habit, accurate, precise dating of speleothems can be challenging. For example, contamination by Th-bearing detritus degrades precision and accuracy when model-based corrections for initial ^{230}Th are applied, and partial dissolution or secondary infilling of porosity can also lead to inaccurate ages, thereby confounding interpretations of paleoclimatic change. Here we present a new chronology from a Holocene stalagmite, WMC2, from White Moon Cave in the Santa Cruz Mountains of California, USA, that exhibits multiple challenges. Stalagmite WMC2 was not active at the time of collection, but it was in situ, with a top age of 3267 ± 28 yrs BP 1950. WMC2 calcite has relatively high U (3-7 ppm), however, the stalagmite contains sporadically distributed sub-millimeter pockets of silicate detritus, leading to 100-fold differences in common Th (^{232}Th) concentrations in dating samples (i.e., >80 to <1ppb). Additionally, ages that appear to be anomalously young are associated with zones containing high densities of fluid inclusions, suggesting possible secondary calcite growth. We overcome these challenges using a combination of micro-CT imaging, transmitted-light microscopy and assessing replicate samples. Micro-CT provides a non-destructive method for imaging the internal structure of the stalagmite, allowing for the sampling of dense, pure calcite. Using this approach, we are able to avoid sub-millimeter pockets of silicate detritus that are not visible from the cut surface of the sample, thereby reducing ^{232}Th concentrations and associated initial ^{230}Th corrections, and obtaining more precise and accurate ages. Dating replicate samples from individual growth bands can confirm or refute whether diagenesis suspected from petrographic study has measurably affected U-Th ages since corrupt ages should scatter more than expected from analytical errors alone. We use our carefully screened ages for WMC2 to evaluate various age modeling approaches typically used for stalagmite proxy records, including those that apply Monte Carlo methods and Bayesian approaches. By employing multiple techniques to optimize stalagmite dating samples, reliable, precise U-Th ages (median 2s ~30 yr) may be obtained from stalagmites previously deemed too flawed for accurate dating, thereby broadening our ability to develop accurately dated speleothem paleoclimate records.