EGU24-18793, updated on 20 May 2024
https://doi.org/10.5194/egusphere-egu24-18793
EGU General Assembly 2024

Fluid Inclusion Microthermometry in Borneo stalagmites: Investigating the role of fabric and open porosity on temperature reconstructions

Marit H. Løland[1,2], Yves Krüger[1], Leonardo Pasqualetto[1], Silvia Frisia[3], Andrea Borsato[3], Judson W. Partin[4], Jess F. Adkins[5], Kim M. Cobb[6], and Anna N. Meckler[1,2]
[1]University of Bergen, Departement of Earth Sciences, Norway
[2]Bjerknes Centre for Climate Research, Bergen, Norway
[3]School of Environmental and Life Sciences, The University of Newcastle, Newcastle, Australia
[4]Institute for Geophysics, Jackson School of Geosciences, University of Texas at Austin, Austin, USA
[5]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, USA
[6]School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, USA

Fluid inclusion microthermometry has emerged as a powerful tool for reconstructing past land temperatures from speleothems. An implicit assumption of the method is that the closing age of the fluid inclusions is equal to the age of the surrounding calcite, and thus, that the reconstructed temperatures are representative of the cave temperature at which the calcite layers formed. The present study, however, demonstrates that this assumption does not hold true for all stalagmites.

Here we show as an example our results obtained from stalagmite SSC01 from Snail Shell Cave (Northern Borneo), that spans the last ~27,000 years, and that was previously investigated for hydroclimate reconstructions (Partin et al., 2007). A temperature record was reconstructed by means of nucleation-assisted microthermometry (Krüger et al., 2011) by analysing ~20 – 70 individual fluid inclusions in each of the 34 growth bands along the growth axis of SSC01. The Holocene part of the record yields near Gaussian-shaped distributions within coeval fluid inclusion assemblages, while the glacial and early deglacial part shows a considerable spread among seemingly co-eval inclusions, with bimodal distributions. When applying a Gaussian deconvolution routine, we find that the warmer part of these distributions consistently yields temperatures resembling late deglacial or Holocene temperatures. Temperatures of the colder mode of the distributions, in contrast, reflect glacial and deglacial conditions showing a clear deglacial warming trend that closely follows atmospheric CO_2 and Southern Hemisphere warming.

We hypothesize that the warmer mode of these bimodal distributions is a result of open porosity, networks of interconnected cavities that sealed off from the environment towards the end of the glacial Termination, i.e., at a temperature that was significantly higher than the formation temperature of the surrounding calcite host. This interpretation is further supported by petrographic observations, revealing that the glacial and deglacial part of the stalagmite is characterized by frequent alterations of columnar open fabrics (Frisia et al., 2015) and organic-rich

micritic layers with high porosity. We suppose that open porosity in stalagmites can occur both vertically along the columnar crystal boundaries and also laterally along specific growth layers.

Bimodal temperature distributions in seemingly coeval fluid inclusions can arise due to temporary open porosity, provided that the temperature difference between the different closing ages of the inclusions is large enough. Our findings emphasize the need for careful consideration of fabric-related factors that can affect the temperatures derived from fluid inclusions.

References:

Frisia, S (2015). Microstratigraphic logging of calcite fabrics in speleothems as tool for palaeoclimate studies. *Int. J. Speleol.* **44**, 1–16.

Krüger, Y. et al. (2011). Liquid–vapour homogenisation of fluid inclusions in stalagmites: Evaluation of a new thermometer for palaeoclimate research. *Chem. Geol.* **289**, 39–47.

Partin, J.W., et al (2007). Millennial-scale trends in west Pacific warm pool hydrology since the Last Glacial Maximum. *Nature* **449**, 452.