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Relationship between recent cave temperatures and noble gas temperatures derived from fluid inclusions of modern soda straw stalactites

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Recently, strong effort is devoted to establish a new method to derive palaeotemperatures from noble gas (Ne, Ar, Kr, Xe) concentrations dissolved in fluid inclusions of speleothems [1-2]. It has been already shown that the water content of the speleothems can be determined via the water vapour pressure after the water has been released from the carbonate samples and collected in a cold finger and then heated up to room temperature. Additionally, the noble gas contents can be precisely measured with noble gas mass spectrometers. Based on these noble gas concentration data sets, a so-called noble gas temperature (NGT) can be calculated meaning a temperature at which the noble gases have been dissolved in water. To use these NGT's as a palaeoclimate proxy, one of the main questions is how these noble gas temperatures reflect the prevailing cave temperature in which the carbonate has grown. We studied noble gas significances in recent soda straw stalactites from more than ten Central European caves covering a temperature range of 1 to 14 °C. Kluge et al. (2008) has shown the soda straw stalactites might contain less excess air, hence they are more suitable samples to derive NGT's, because noble gas abundances from large air inclusions can mask the temperature information. The 14C ages of these soda straw dripstones were obtained to be recent or at least Holocene ages. Thus one can assume that the cave temperatures during carbonate formation were as same as at present. We measured the water and noble gas contents of numerous carbonate samples from soda straw stalactites and calculated noble gas temperatures by a precision of 1 °C or better. Comparing these temperatures with cave temperatures we obtained that they agree well within the uncertainty of the noble gas temperature determination. Therefore, we can conclude if diffusion of noble gas isotopes does not play a significant role in the carbonate lattice this new tool helps the palaeoclimate community to gain reliable palaeotemperature information on the time range from present back to hundred thousand years.

[1] Kluge T., Marx T., Scholz D., Niggermann S., Mangini A., Aeschbach-Hertig W., 2008. A new tool for palaeoclimate reconstruction: Noble gas temperatures from fluid inclusions in speleothems. Earth and Planetary Science Letters 269, 408-415.
[2] Brennwald M.S., Scheidegger Y., Tomonaga Y., Holzner C.P., Wieler R., Kipfer R., 2006. New applications of noble gases as environmental proxies in unusual aquatic environments. Geochimica et Csomochimica Acta 70, Supplement, A66.