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Advances in noble gas paleothermometry on speleothems

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The application of the noble gas paleothermometer on speleothem fluid inclusions promises to provide absolute paleotemperatures from stalagmites. These noble gas temperatures (NGTs) are based on the temperature dependent solubility of gases in water and could help to interpret other speleothem proxies. In particular NGTs may help to better understand oxygen isotope records.

In summer and autumn 2009 a measurement run with 26 (sub-)samples from 9 different caves was performed. The water and the noble gases were released using a stepwise extraction technique by online in vacuo crushing and thermal heating. Depending on the sample water amount about three extraction steps were performed for each sample, so that the total number of speleothem measurements exceeded 80 in this run.

NGTs were determined from noble gas concentrations by inverse modeling. Only the equilibrium solubility component, which contains the temperature information, and an atmospheric air component from air-filled inclusions are included in the calculations. Plots of two noble gas concentrations against each other (Xe-Ne, Kr-Ar) show that the measured concentrations are in general agreement with this simple model.

Unfortunately the combined mass spectrometric measurement of Ar, Kr and Xe turned out to be slightly problematic. A separated measurement should solve the corresponding problems. Furthermore, a lab water standard for noble gases will be prepared to further examine the measurements in the future.

In this measurement run samples from not only Bunker Cave (Germany) showed suitable properties for NGT determination but also samples from Katerloch Cave (Austria) where the water concentration varies between 0.4 to 4 μl per g calcite which is comparable to the Bunker Cave stalagmites. The air to water volume ratio is below 0.1 which in principle allows the determination of NGTs with errors in the range of 1 °C. The calculated NGTs are in the range of the modern cave air temperature.