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Paleotemperatures derived from fluid inclusion in stalagmites using noble gas mass spectrometry

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Dissolved atmospheric noble gases in groundwater are used to reconstruct paleotemperatures based on their temperature dependent solubilities. The disadvantage of the groundwater archive is its limited temporal resolution. In contrast, the speleothem archive offers precise absolute dating and high-resolution records. Noble gases dissolved in microscopic water inclusions in speleothems are expected to reflect the cave temperature and thus potentially are a new tool for paleotemperature reconstruction.

Noble gases extracted from speleothem samples consist of two components: The noble gases corresponding to the air-equilibrated water and additionally gases from air-filled inclusions. Too large contributions of air can mask the temperature information contained in the water and are a major challenge for the method. In case of samples with an air-water-volume ratio A lower than 0.1 a simple crushing technique can be applied. Otherwise a stepwise procedure can be used to reduce A to favourable values.

Multiple measurements on an 11 kyr old stalagmite from Northwest-Germany revealed a temperature of about 3 ˚C, which is not unreasonable for the investigated cave (recent cave temperature 10 ˚C). First test series on two other stalagmites from the same cave showed also reasonable temperatures for the according climate periods. Furthermore, the stepwise extraction procedure yields encouraging results. For a holocene stalagmite sample from Oman (recent cave temperature about 25 ˚C) with an A of 1 using simple crushing, the air-water volume ratio could be reduced to about 0.1 by a stepwise technique and a temperature of about 24 ˚C was obtained in the final separation steps.