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Noble gases in paleoclimate archives

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Noble gases dissolved in groundwaters provide accurate absolute paleotemperatures, which can directly be related to stable isotope ratios obtained from the same archive. A recent example is a study conducted in China, where the influence of temperature and precipitation (monsoon) on the stable isotopes could be separated. The combination of noble gases and stable isotopes has been applied in many groundwater studies, but a synthesis of what we can learn from this approach is still missing. However, it cannot be denied that groundwater is not an ideal paleoclimate archive in terms of time resolution and age control. Therefore, it is interesting to explore new applications of noble gases in high-resolution archives such as ice or speleothems.

In polar ice cores, the isotopic and elemental composition of trapped air is valuable to study abrupt temperature changes and processes at bubble close-off, as well as for dating. Noble gases have played only a limited role in this research so far, but recent studies demonstrate their potential. Our group has mainly focused on using radiogenic He diffusing into the base of ice sheets as a tracer to study ice dynamics. A major difficulty of this approach is the He loss by diffusion during sampling, which we have studied in detail. An exciting new development is the application of the noble gas thermometer to fluid inclusions in speleothems. The major challenge for this method is not so much the tiny amount of trapped water, but rather the often overwhelming presence of trapped air. Although stepwise crushing can reduce the air/water ratio, the best results have been achieved with certain stalagmites that naturally contain low air amounts. Reasonable paleotemperatures could be obtained from a cave in Germany, demonstrating the validity of the method. If the noble gas thermometer can be applied to a wider range of speleothems, this approch promises to become a powerful

proxy/archive combination for future paleoclimate research.