Paleo-temperature and hydrological signal from water and noble gas amounts of Swiss stalagmite

E. GHADIRI [1,2], M. S. BRENNWALD[1] AND R. KIPFER1 [1,2]

[1]Eawag, Swiss Federal Institute of Aquatic Science and Technology, Water Resources and Drinking Water, 8600 Dübendorf, Switzerland. (elaheh.ghadiri@eawag.ch)

[2]ETH Zurich, Institute of Biogeochemistry and Pollutant Dynamics and Institute of Isotope Geology and Mineral Resources, 8092 Zurich, Switzerland

The results of dissolved atmospheric noble gases in fluid inclusions of stalagmites were used to reconstruct past ambient cave temperatures and hydrological conditions when the water was trapped. To reconstruct temperatures from noble gases (noble gas temperature: NGT) in water-filled inclusions, we processed samples from Swiss stalagmites M6 from Milandre cave (400 m.a.s.l) and GEF1 from Grotte aux Fees cave (895 m.a.s.l) covering the climatic transitions Allerød–Younger Dryas–Holocene.

Water content. The amount of water extracted per unit mass of calcite fabric (e.g., 'water yield': WT) was shown to be a measure of the total water content. The data shows that the WT systematically changes with $\delta^{18}O_{calcite}$. We therefore conclude that WT records can be linked on changes in drip rates and thus can be used to track changes of past precipitation even in cold regions.

Noble gases. Noble gas analysis shows that the annual mean temperatures in Milandre cave were 2.2±2.0°C during the late Allerød and dropped to 0±2°C at the Younger Dryas. Such temperatures indicate conditions near to the freezing point of water during the first part of the Younger Dryas. However, one late Holocene sample gave a cave temperature of 8.7±1.4°C agreeing generally with present day annual mean temperature. The annual mean temperature of 5.7±1.3 °C from GEF1 was determined from the early Holocene. The observed data show systematic variations with sample elevation, e.g., higher temperature from lower altitude and vice versa. Combining the NGTs and elevation allows determining the laps rate in the past as T scales with altitude. This calibration is key as paleo-temperatures are often implicitly assumed that the modern laps rate is also valid for the past. Our study makes an argument that noble gas analysis in stalagmites can also be a new route to address this fundamental hypothesis of past climate reconstruction.