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Holocene rapid climate changes investigated in alpine speleothems, Michbach cave, Switzerland.

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Distinct periods of rapid climate change are known to have occurred repeatedly during the Holocene and are particularly well marked by successive advances and retreats of alpine glaciers. Although stratigraphic observations of moraine sequences allow dating of glacier advances, little information is available on former retreats due to subsequent erosion. Subsurface sediment sequences associated with glacial runoff in alpine cave systems offer an alternative way to reconstruct glacier fluctuations. However, such fluctuations could also be interpreted from relative changes in speleothem growth rates.

Milchbach cave is an extensive multilevel karst system developing along the Upper Grindelwald Glacier, Switzerland (Boeke & Stettler, 2005). It was discovered in 1997 following a substantial glacier retreat unclogging several cave entrances. The cave comprises 4 major phreatic levels intersected by a vadose shaft system. Consequent to the recent glacier retreat the 2 uppermost levels are now open to the external atmosphere leading to a temporarily highly ventilated system subject to forced convection ($>1 m^3 sec^{-1}$). Speleothems are observed in several parts of the cave and 2 stalagmites were sampled for further investigations.

Preliminary U/Th dating confirms that speleothem growth phases are in agreement with known periods of reduced glacier extension during the Holocene (Joerin et al., 2006). Growth rates range 17 and 26 μm year^{-1}, suggesting that the selected samples are suitable for the investigation of environmental changes with a decadal resolution. Morphological evidence suggests the presence of several well marked hiatuses which are likely to be associated with Holocene glacier advances. From periglacial karst en-

vironments it is well known that freezing temperatures could prevent the percolation of seepage water limiting by the way the precipitation of calcite. However, further mechanisms associated with changes of the ΔpCO_2 between the cave atmosphere and the drip water need also to be considered. Therefore, our study focuses particularly on changes in the external soil cover and modifications in the subsurface ventilation regime. Further insight is expected from the interpretation of trace elements and stable isotope analyses, both closely related to the hydrological behaviour of the system. Multi-elemental trace analyses (up to 16 selected TEs) were conducted using x-ray microfluorescence (XRMF) on a 50 μm scale along the sample growth axis. Preliminary results show simultaneous spatial and temporal concentration changes for some TEs which are attributed to climate-related processes. Therefore, Milchbach stalagmites are assumed to offer an excellent opportunity for the study of climatically controlled changes of the hydrological and ventilation regime in a cave system.

References

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