Identification of hydrological extreme events from high-resolution trace element distributions in speleothems

P. HOLZ[1*], A. HARTMANN[1], E. EICHE[1], T. NEUMANN[1], T. KLUGE[2], G. MEYER[3], M. SCHUH[3]

[1]Karlsruhe Institute of Technology, Institute of Applied Geosciences, philipp.holz@kit.edu ([*]presenting author)
[2]Heidelberg University, Institute of Environmental Physics
[3]Heidelberg University, Historisches Seminar

Hydrological extreme events can be recorded in geological archives such as stalagmites in terms of specific trace element distributions, as well as in historical archives based on written records. The innovative approach of the project CheckExtrema is the combination of both archive types in order to cross-validate both archives and to identify hydrological extreme events in the past. Therefore, we have investigated stalagmites from the Bavarian Alps (Stal-Höl-1) and the Franconian Alb (Stal-KTH-2) and administrative records in the historical archives of Nuremberg in Germany.

The distribution of multiple trace elements in Stal-Höl-1 was determined with synchrotron based X-ray fluorescence (µSyXRF) at ANKA (KIT) and by µXRF with spatial resolutions of 5 µm and 30 µm, respectively. Both analytical methods will be applied to Stal-KTH-2 in the near future.

The µSyXRF analysis yielded distinctive peaks of certain element ratios, e.g. high Fe/Ca and Zn/Ca ratios along the stalagmite`s central growth axis. In contrast, the corresponding trace element variations in the µXRF data are of much lower intensity. These observations are consistent with a certain smoothing effect that results from the slightly lower spatial resolution of the µXRF data. The peak positions from both analyses, however, are often virtually identical which suggests that both methods are suited for high-resolution trace element mapping.

Pronounced peaks in Fe/Ca and Zn/Ca ratios may reflect detrital particle inclusions during flooding or heavy precipitation events that disturbed the stalagmites`s growth. With accurate age models, based on U/Th- and ^{14}C-datings, these layers can be related to hydrological extreme events identified in the historical archive. After calibration, the flood chronology from written documents can be extended substantially using the geological record.