



## High-resolution dripwater sampling and ion microprobe $\delta^{18}\text{O}$ analysis – Relationship between modern surface climate signals and speleothem records

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The variability of speleothem  $\delta^{18}\text{O}$  records is mostly interpreted relative to the variability of the isotopic composition of precipitation. However, during percolation through the karst system, dripwater formation and dripping, multiple processes influence the initial rainfall  $\delta^{18}\text{O}$  value before the signal is captured in the speleothem calcite. This relationship between modern surface climate signals, dripwater and speleothems  $\delta^{18}\text{O}$  is investigated within the project “CheckExtrema”, where we combine stable isotope ratios and specific trace element patterns in dripwaters and stalagmite laminae of Stal-KTC-2 (Kleine Teufels Cave) from the Franconian Alb, to identify hydrological extreme events in the last 600 years.

Stal-KTC-2 was dated using U/Th series and radiocarbon dating.  $\delta^{18}\text{O}$  analysis of thin stalagmite laminae was performed after micromilling with a spatial sampling resolution of  $90\ \mu\text{m}$  using an Isotope Ratio Mass Spectrometer (IR-MS). To interpret this  $\delta^{18}\text{O}$ -dataset and to calibrate it to the modern rainfall  $\delta^{18}\text{O}$  input-signal and the isotopic composition of the dripwater, a cave monitoring program was set up in Kleine Teufels Cave: Dripwater collectors were installed at the three dripsites DS 3 (sampling location of Stal-KTC-2), DS 4 & 5. A rainwater collector was installed above the nearby Zoolithen Cave. Rainwater was sampled weekly while dripwater was sampled at intervals of up to two weeks over a period of 20 months.

The  $\delta^{18}\text{O}$  values of the rainwater show a seasonal trend with more positive values in summer, which reflects the temperature dependence of the rainfall isotopic signal. The obtained Local Meteoric Water Line (LMWL) is in good agreement with the LMWL of the nearest GNIP-station at the city of Erlangen. The  $\delta^{18}\text{O}$  values of the dripwater, however, only show a small variability with a weak trend towards more positive values in winter. For investigating mixing and damping effects in the karst aquifer and to improve the understanding of the dripwater  $\delta^{18}\text{O}$  variations, an autosampler with daily sampling resolution was placed at DS 4.

Stal-KTC-2 shows recent growth until 2004 AD. Due to very low growth rates of  $7\text{-}15\ \mu\text{m}/\text{yr}$  in the upper part of the stalagmite (approx. the last 1000 years BP), the sampling resolution of  $90\ \mu\text{m}$  represents 6-13 years. To identify hydrological extremes, annual resolution or better would be desirable. Therefore, an annually resolved  $\delta^{18}\text{O}$  analysis was carried out, using an ion microprobe with a sampling resolution of  $7\text{-}15\ \mu\text{m}$ . The IR-MS analysis revealed long-term climatic anomalies like the Medieval Warm Period (MWP) or the Little Ice Age (LIA). The higher resolved ion microprobe analysis confirmed and clarified these interpretations. However, additional distinctive peaks in the ion microprobe data indicate further events, which may be related to extreme weather conditions in certain years, for whose interpretation the autosampler data are indispensable.

Our research shows the great potential of combined ion microprobe analyses for speleothems with slow growth rates and the use and importance of autosampler systems as an additional high-resolution sampling option, if annual or sub-annual changes in speleothem  $\delta^{18}\text{O}$  records have to be considered.