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Potential for hydroclimate reconstruction using speleothem trace element, stable isotope and U-series proxies from the SISALv3 speleothem database

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The PAGES-SISAL WG (Past Global Changes-Speleothem Isotope Synthesis and AnaLysis Working Group) has created the latest version of the global speleothem database SISAL version 3 (SISALv3), which updates the oxygen and carbon isotope records together with linked uranium-thorium data, standardised chronologies and extensive metadata information [1]. The database also for the first time includes elemental proxy records of Mg/Ca, Sr/Ca, Ba/Ca, U/Ca, P/Ca and Sr-isotope ratios. We present initial results from projects using these data to improve proxy interpretations.

Preliminary results show that the main control on inter-cave differences in elemental abundances is speleothem mineralogy. However, no clear trends can be deduced for different bedrock types, lithologies or host rock ages. In particular, speleothems from dolomite or limestone lithologies show similar ranges, suggesting that other processes, potentially related to climatic or environmental changes, may act simultaneously.

High pCO2 infiltrating water can degas in air cavities in the karst, precipitating calcium carbonate long before the water reaches the cave. During changing hydroclimatic conditions, the extent of this process impacts the trace element to calcium ratios of Mg/Ca and Sr/Ca, as well as carbon isotopes in measurable ways, thus forming a multi-proxy mechanism of semi-quantitatively reconstructing multi-annual droughts. Initial data exploration of SISALv3 suggests that the interpretation of bulk average or whole speleothem datasets in terms of such prior precipitation needs to be supported by additional data and metadata constraints including timescales and trace element sources, transport and incorporation.

Another application of the SISALv3 database is assessing the controls on the initial (234U/238U) activity ratio, which is an emerging new proxy for detecting changes in the fluid residence time in karst aquifers. In a preliminary global analysis, we find no simple trends for late Holocene bulk average (234U/238U)0 activity ratios with mean climate conditions. The strongest control appears to be the age of the host carbonate lithology with the highest (234U/238U)0 activity ratios found in Mesozoic and older lithologies.

[1] Kaushal, N, Lechleitner, FA, Wilhelm, M. SISALv3: A global speleothem stable isotope and trace element database. *Earth System Science Data Discussions*, *2023*.