Quaternary Research (2024), **118**, 1
doi:10.1017/qua.2024.12

Introduction

Introduction to special issue: new developments in speleothem paleoclimate and paleoenvironmental science

Yassine Ait Brahim[a] and Andrea Columbu[b]

[a]International Water Research Institute, University Mohammed VI Polytechnic, Benguerir, Morocco and [b]Department of Earth Sciences, Pisa University, Pisa, Italy

Over the last two decades, speleothems have increasingly been exploited in past climatic and environmental reconstructions of the last ca. 500 ka using the U-Th absolute dating method. However, recent improvements in the U-Pb dating methodology have already demonstrated that speleothem paleoclimate time series can be extended further back in time. Oxygen and carbon stable isotopes ($\delta^{18}O$ and $\delta^{13}C$) are the most exploited measurements, allowing the investigation of an array of past climate and environmental variables such as temperature, rainfall amount, moisture provenance, and seasonality. Trace elements, clumped isotopes, and fluid inclusions are among the newest climate proxies being progressively applied to refine the speleothem-based paleoclimatic interpretations and to gain novel insights into past climatic and environmental dynamics.

This special issue of articles is derived from a topical session that took place in 2022 during the PAGES Open Science Meeting. With the aim of presenting the most recent findings and advancements, the topical session welcomed speleothem-based paleoclimate and paleoenvironmental studies. We gave special attention to records from underrepresented regions and/or time periods, as well as to novel approaches and/or techniques.

Johnston et al. present the first measurement of $^{36}Cl/Cl$ in speleothems, pioneering exploring the mechanisms of its incorporation into the calcite lattice and highlighting the mechanism for other trace elements. Mg, Na, Sr, P, U, and Y trace elements are used in Faraji et al. to reconstruct hydroclimate variability in the Southern Cook Islands, showing the role of the South Pacific Convergence Zone and El Niño Southern Oscillation in controlling rainfall in the South Pacific. Endres et al. investigate the poorly understood formation of fluorescent laminations in stalagmites, indicating that fluorescence variability in La Vallina Cave (Spain) is mainly influenced by changes in overlying vegetation, water reservoir time, and respiration rates and challenging the prevailing views relating the increase in drip-water fluorescence during rainy conditions. Dickson et al. examine the distribution of pollen and microscopic charcoal within several stalagmites from southwest Australia, finding that these allochthonous particles are located preferentially on the stalagmites' flanks, knowledge that will allow future sampling campaigns to be more tightly focused. Cisneros et al. apply nondestructive micro-CT and XRF core scanning to a stalagmite from Mallorca (Spain), demonstrating the validity of this technique to detect major flooding events. For the first time, Lončar et al. date phreatic overgrowth speleothems from the Croatian Adriatic coast, discovering a sea-level still stand at ca. 2.8 ka. Borsato et al. contribute a data set from a high-precision monitoring program at Lamalunga Cave (Italy), providing key information about the relationship between microclimate parameters and speleothem growth. The remaining contributions to this special issue construct novel $\delta^{18}O$ and/or $\delta^{13}C$ time series from speleothems from key locations spread over three continents to investigate several interesting aspects of the climate system. Cui et al. define time and structure of the penultimate deglaciation in China with special attention to the changes of the Asian summer monsoon around the 134 ka event, while the record proposed by Krause et al. focuses on the relationship between tropical vegetation productivity and atmospheric methane concentrations in Sulawesi over the last 40 ka. Braun et al. present a composite $\delta^{18}O$-$\delta^{13}C$ record from South Africa spanning from 104 to 17 ka to constrain rainfall dynamics and soil activity over this exceptionally long time frame, while Gürbüz et al. use the same proxies to uncover rainfall variation in central Turkey at the MIS 5e/5d transition. Holocene climate features are investigated by Nehme et al. and Demeny et al. The first article provides insights into climate variability during the Holocene optimum in the Qadisha mountainous area (Lebanon), while the second studies in detail the climate variability during the 8.2 ka event in Hungary by coupling petrographic observations, ^{14}C activities, Sr concentrations to stable isotope compositions of calcite and inclusion-hosted water. Finally, Hatvani et al. present the SISAL webApp—a web-based tool to query the Speleothem Isotope Synthesis and AnaLysis (SISAL) database. As the SISAL database currently hosts 691 speleothem records from 294 sites and is routinely updated, this novel, user-friendly app aims to increase the accessibility of the database while also functioning as a learning tool enabling more advanced ways of querying.

To summarize, these articles collectively enhance our understanding of paleoclimate using speleothems. They cover diverse topics, including the incorporation mechanisms of $^{36}Cl/Cl$, stalagmite formations, hydroclimate variability in the Southern Cook Islands, penultimate deglaciation in China, tropical vegetation and methane concentrations in Sulawesi, rainfall dynamics in South Africa and central Turkey, and Holocene climate features in Lebanon and Hungary. Finally, the SISAL webApp will enhance database accessibility. Together, these studies contribute to a comprehensive global perspective on past climate variations.

Corresponding author: Yassine Ait Brahim; Email: yassine.aitbrahim@um6p.ma

Cite this article: Ait Brahim Y, Columbu A (2024). Introduction to special issue: new developments in speleothem paleoclimate and paleoenvironmental science. *Quaternary Research* **118**, 1–1. https://doi.org/10.1017/qua.2024.12

Acknowledgments. We thank the editors for hosting this topical session and the reviewers who provided comments and suggestions on the articles.