Lifting the veil on speleothem sampling

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We provide insights on speleothem sampling and describe the fieldwork involved in the retrieval campaigns of two calcite speleothems in the framework of the Past4Future project.

During the last decade, speleothem studies have enhanced our understanding of the evolution of continental climate thanks to the acquisition of high-resolution well-dated time-series (Cruz et al. 2005; Drysdale et al. 2009; Fleitmann et al. 2009; Genty et al. 2003; Genty et al. this issue; Wang et al. 2008). Speleothems can be precisely dated to up to 600 ka BP with the Uranium-Thorium method and potentially even further back in time if datable with the Uranium-Lead method.

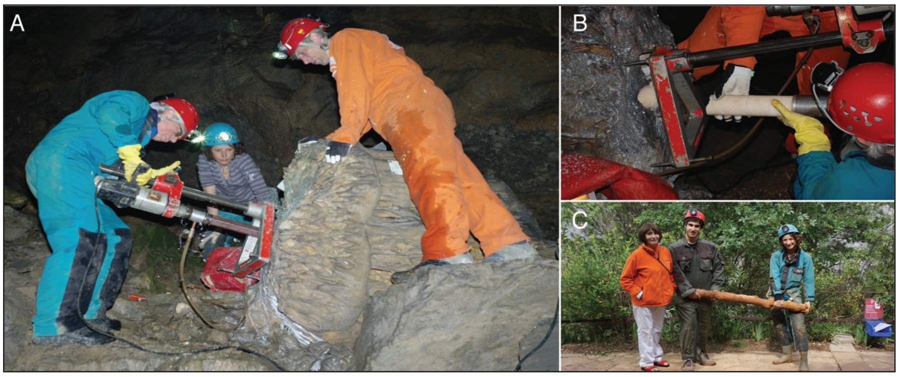

Figure 1: Speleothem samples taken in the framework of the Past4Future project. ***A)*** *Core drilling of the RSM 17 stalagmite in the Remouchamps Cave, Belgium. The photo shows the drilling device used and the base of the stalagmite.* ***B)*** *Retrieval of a speleothem core.* ***C)*** *The stalagmite taken from Clamouse Cave, France. Photos: E. Zaremba, S. Verheyden, and D. Genty.*

Preparing for speleothem retrieval

Access to a cave for sampling is generally the result of long collaborations and much investment of time in order to build a trusting relationship with local cavers, cave owners, and cave managers. Also, speleothem sampling raises ethical issues related to their environmental, esthetical, and economic (touristic) significance. For this reason, sampling is usually conducted with respect to the few existing codes of ethics that provide specific guidelines for scientific work (UIS 1997, 2001; SSS-SGH 2004) (see FFS 2005 for an overview of the existing codes of ethics). Since the number of speleothem studies - and thus sampling - are rapidly increasing (Fleitmann and Spötl 2008), an enhanced exchange of already sampled speleothems through published literature or via internationally referenced museum collections is increasingly needed. This will help minimize the impact of speleothem research on cave environments.

To select the most appropriate speleothems to sample, cave monitoring (e.g. Genty 2008; Mattey et al. 2008; Verheyden et al. 2008) and preliminary dating is performed (Spötl and Mattey 2012). These first steps provide basic information on both the climatic response and growth period enclosed in the selected sample before its removal from the cave. Ongoing technical developments using portable in-situ imagery (Favalli et al. 2011; Hajri et al. 2009) and in-situ chemical analyses (Cuñat et al. 2005; Dandurand et al. 2011) will provide, in the future, information on the Uranium content and internal structure of speleothems, ensuring that scientists select the most appropriate in-situ samples without the need for preliminary laboratory work.

Retrieving speleothems

In the framework of the Past4Future project, scientists have collected new speleothem data covering the last interglacial period (LIG) and the penultimate deglaciation (Termination II). Among the new samples is RSM17, a broken stalagmite approximately 3-m-long and 1-m in diameter, from the Remouchamps Cave in southeast Belgium (BiSpEem project, Belspo 2012-2016). Preliminary Uranium-series dates indicate that the stalagmite was deposited between 126 [-11, +14] and 95.3 [-8, +9] ka BP with an overall growth-rate of 0.1 mm yr^{-1} (Gewelt 1985). A team of seven people cored the stalagmite in May 2012. Since the stalagmite is located in a section of the cave open to tourists and close to the underground river, electricity and cooling water were available, facilitating the operation. However, the drilling was often interrupted by tourist visits. After six hours, 11 cores of ~30-cm -long and 8-cm-diameter were retrieved from the stalagmite (Fig. 1A-B). Sub-samples are currently at the University of Minnesota waiting to be Uranium dated.

In June 2012, a ~1.4-m-long and ~10-cm in diameter stalagmite was found broken on the floor of the Clamouse Cave (southern France), where other spelethems have already been sampled (McMillan et al. 2005; Plagnes et al. 2002; Quinif 1992) (Fig. 1C). The stalagmite was removed from the cave and ongoing dating is now needed to confirm that this stalagmite covers the LIG time period. The southern part of France benefits from optimal climate conditions enabling continuous speleothem growth during Termination periods, while speleothem growth further north generally only starts when full interglacial conditions are present.

Such a thin "take-away" stalagmite is ideal for studying the entire section, while drilled cores such as those from the Remouchamps Cave only reveal part of the internal section of the stalagmite. However, core drilling provides the possibility of sampling large stalagmites and flowstones. Importantly, drilling provides a unique opportunity to sample with minimal impact on the cave environment (Spötl and Mattey 2012).

Outlook

The speleothems sampled in the Remouchamps and Clamouse Caves in the framework of the Past4Future project are currently being analyzed. They will provide new chronological constraints on the onset of the LIG time period. They will also complement the existing speleothem dataset compiled by Genty et al. (this issue) with the aim of improving our understanding of the continental climate variability in Western Europe during Termination II and the LIG.

Acknowledgements

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Selected references

Full reference list online under:

http://www.pages-igbp.org/products/newsletters/ref2013_1.pdf

BiSpEem Project – Belspo (2012 2016). Available at: www.naturalsciences.be/geology/research/environment/bispeem

Drysdale, RN et al. (2009) *Science* 325: 1527 1531

Spötl C, Mattey D (2012) *Journal of Speleology* 41: 29 34

UIS (1997) Available at: http://www.uis-speleo.org/

Wang Y et al. (2008) *Nature* 451: 1090 1093