

Our Ref:



an agency of the
Department of Arts and Culture

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CaseID: 21120

Date: Wednesday May 17, 2023

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Letter

In terms of Section 32(19) of the National Heritage Resources Act (Act 25 of 1999)

Attention: Jenny Maccali
University of Bergen

1. Rationale and objectives The southern coast of South Africa is a key region to study the broader context of human evolution with sites such as Blombos cave and Klipdrift shelter. In order to better understand the links between climate and human evolution it is necessary to reconstruct past climate at high-resolution near archeological sites. Speleothems (e.g. stalagmites) are formed in caves and act as natural archives by recording past climate information such as temperature, hydroclimate and even vegetation. As part of the SapienCE research centre, we are analyzing speleothems collected in 2020 in Bloukrantz cave (Fig. 1; 34°27.557'S, 20°46.697'E) in the De Hoop Nature Reserve (SAHRA permit ID 3125). These speleothem samples have proven quite unique not only by the multitude of methods that can be applied, and hence the results that can be extracted (Maccali et al. 2023), but also by the climate results themselves. Indeed, the first results displayed a series of short and drier events with no associated changes in temperature. In addition, of the three thermometry methods applied, two agree remarkably well while the third one shows a variable offset (Fig. 2). This third method, namely TEX86, relies on the biochemical fingerprint left by microbial communities in the cave. Our objectives are twofold; our first objective is to explore West cave (34°27.049'S, 20°41.883'E) in the De Hoop Nature Reserve and subsample speleothems to potentially recover samples to i) replicate the specific climate signal recorded in Bloukrantz's samples and then confirm the regionality of this signal and ii) extend the time range of our research ranging actually from ~45 to 90 ka (Fig. 3). Our second objective is to characterize the TEX86 signal specifically for Bloukrantz cave. In order to identify the origin of the TEX86 signal in Bloukrantz cave speleothems, both cave sediments and soil samples above the cave will be analyzed.

2. Methods Speleothems can be accurately and precisely dated by the U-Th radiometric technique that relies on the measure of both the parent (Uranium) and daughter (Thorium) in samples. The method is destructive as the samples need to be dissolved in acid medium before being analyzed. U-Th dating requires radioactive material and trained staff to handle them. The samples will be prepared in the Uranium laboratory at the University of Bergen and analyzed in the ICP laboratory with a NuTM Plasma MC-ICP-MS. In order to minimize damages to the speleothem samples two cores were drilled (~2 cm wide, ~10 cm long) at the base of two speleothems. Similarly, when coring was not possible, the base and top of speleothems were carefully chipped off to limit damages to the samples. A total of 4 speleothems have hence been subsampled to determine the age

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period of their growth. Speleothems preserve small amounts of organic matter sourced either from the overlying soil or from the cave environment. A group of lipids derived from microorganisms, namely Glycerol Dialkyl Glycerol Tetraethers – GDGTs, have been measured in speleothems and have shown a strong correlation with surface air temperature. Although uncertainties on the source of the GDGTs exists, recent studies indicate that they could be derived from microbial communities in the cave itself (Baker et al., 2019). These microbial communities adapt to changing conditions (e.g. changes in cave temperature) leaving distinct biochemical signatures. Samples from Bloukrantz cave have recently been analyzed by colleagues at the Max Planck Institute for Chemistry (MPIC) in Mainz, including the topmost sample as part of a calibration study for the TEX86 paleothermometer in speleothems (Martinez-Garcia et al., 2022). The unusually high amounts of GDGTs in our samples could point to the presence of a rich speleothem archaeal community or transport of soil-derived bacterial signal into the cave, making this location distinct from others used in the calibration. Indeed, the estimated preliminary TEX86 temperature for the late Holocene sample is $\sim 3.5^{\circ}\text{C}$ lower than the other temperature methods, and the estimated TEX86 temperatures for the older samples are on average $\sim 7^{\circ}\text{C}$ lower, with apparent systematic variations over time (Fig. 3). By analyzing the cave sediment and overlying soil, we aim to further investigate the origin of the TEX86 signal in Bloukrantz cave speleothem. The method is destructive as it necessitates a chemical extraction of the bacteria from the soil/sediment. Samples will be prepared and analyzed at the MPIC facility in Mainz. 3. Duration and expected results Results are expected within a year. The U-Th dating will be performed by the end of the summer 2023. Based on the age range calculated, the speleothem could be collected for further paleoclimate investigations in the coming years. TEX86 analyses will be performed within a year and the results will further trace the origin of the TEX86 signal in Bloukrantz cave speleothems and hence refine the TEX86 thermometry method.

Dear Ms Samantha Mienies and Dr Jenny Maccali,

Thank you for your application to permanently export eight speleothem samples and two sediment samples from Bloukrantz Cave, De Hoop Nature Reserve, for U-Th radiometric analysis at the Uranium laboratory at the University of Bergen (sample preparation) and the Max Planck Institute, University of Mainz, Germany (analysis).

SAHRA has reviewed the application and has decided to approve it.

We wish you every success with this project.

Paleoclimate reconstructions from speleothems from the De Hoop Nature Reserve, South Africa.

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Should you have any further queries, please contact the designated official using the case number quoted above in the case header.

Yours faithfully

Ragna Redelstorff, PhD
Heritage Officer
South African Heritage Resources Agency

Phillip Hine
Manager: Archaeology, Palaeontology and Meteorites Unit
South African Heritage Resources Agency

ADMIN:

Direct URL to case: <https://sahris.sahra.org.za/node/616442>

Terms & Conditions:

1. This approval does not exonerate the applicant from obtaining local authority approval or any other necessary approval for proposed work.
2. If any heritage resources, including graves or human remains, are encountered they must be reported to SAHRA immediately.
3. SAHRA reserves the right to request additional information as required.