SAPIENCE

CENTRE FOR EARLY SAPIENS BEHAVIOUR

UNIVERSITY OF BERGEN

ANNUAL REPORT 2022

Norwegian Centre of Excellence

STATEMENT
FROM THE CHAIR OF THE BOARD

It is with great pleasure and much enthusiasm that we can announce that SapienCE has now entered its second phase.

SapienCE has been a tremendous success since the opening of the Centre in 2017 in terms of delivering what is expected from such a Centre of Research Excellence, namely, to generate innovative, ground-breaking results that advance the international research frontier. Continued funding for the Centres of Research Excellence, has relied on passing the Norwegian Research Councils midterm evaluation. Since Autumn 2021, Team SapienCE has worked continuously towards preparing for the midterm evaluation. Just before Christmas last year, we received the expected – but still very happy news - that the funding for the Centre has been prolonged for the entirety of its planned lifespan, i.e. through to 2027.

On behalf of the Board of SapienCE, I would like to extend our heartfelt thanks to the Norwegian Research Council for their continued support and for their invaluable efforts of ensuring that we as local, national, and global communities will know more in the future, than we do today. Team SapienCE is ready to do our part towards this endeavour.

Mobilising and preparing for the midterm evaluation has proven to be both highly creative and constructive. I would like to highlight three processes that have proved to be particularly important. First, it has been incredibly useful to fully assess existing achievements as well as the direction the research has been taking. The recognition of how for instance cognitive research has, more than initially anticipated, come to the forefront of SapienCE research aims. Our internal evaluation has been vital in spelling out our academic coordinates that will assist in navigating the Centre through its second, and final phase. Second, this assessment also has opened further strengthening of the academic superstructure of the Centre in terms of common denominators across the different work packages. Third, as these processes coincided with a team change amongst the early career researchers, particular emphasis has been placed on learning from the experiences from phase one and to carry on the SapienCE spirit and continue to nurture this team feeling.

There has also been a change of crew when it comes to the Deputy Director of the Centre. Professor Eystein Jansen is now stepping down, and the Board would like to thank him for his relentless efforts and steadfast commitment towards ensuring the continued success of SapienCE. The Board has decided to promote two of the PIs to the role as new Deputy Directors. It is with great pleasure that we announce that Karen van Niekerk and Simon Armitage will be the new Sapience Deputy Directors for Field Research and Early Career Researchers, respectively.

The University of Bergen (UiB) has just launched a new strategy – "Knowledge that shapes society". UiB aims to be amongst the best universities in Europe and continue its international reputation for excellence in research, education, and dissemination. SapienCE is assisting UiB in delivering on all these ambitions. In 2023 we are especially excited to be opening an exhibition featuring SapienCE research at the University Museum of Bergen, an award-winning museum located at the very heart of our campus and the city of Bergen. Please come and join us in May to learn more about the work of SapienCE and to celebrate their achievements so far!

Camilla Brautaset

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STATEMENT
FROM THE DIRECTOR

It is with pride that I present the 2022 SapienCE Director's Report reflecting on our Centre of Excellence turning 5 years old in October last year. In 2017 - 2019 we cut our teeth on getting to grips with our innovative, broad ranging research projects and combining the diversity of our researchers in archaeology, climate and psychology. This approach would pay considerable dividends in later years and result in numerous top-level publications in international journals.

It is with some regret then that we look back to March 2020 when our excavation team at Blombos Cave, South Africa, was recalled, almost overnight, to return to Norway. This marked the start of a difficult 2 years during which the Covid-19 pandemic resulted in many, and at times, all of us working from home. Not being able to go to our laboratories or interact with our colleagues on a one-to-one basis was clearly going to influence our productivity and our mental health. Despite these challenges there was a remarkable capacity and willingness shown by our SapienCE scientists to keep up their research programmes. The back-up provided by SapienCE administrators was admirable, especially in organising regular contact with our researchers via Zoom and Teams meetings and lunchtime talks. Our bi-monthly Leader Group meetings via Zoom kept us in good contact and, on more limited occasions, it was positive when all our scientists could join in a group chat. Supervision meetings with PhDs and mentorship of Postdocs continued via Zoom until mid-2021 with some limited opportunities for direct meetings. It is worth briefly reflecting that even in the final weeks of 2021, we still faced Covid-related challenges, with some SapienCE members still being confined to home offices, and a primarily digital reality with all fieldwork cancelled.

As we entered the new year in 2022, opportunities for the re-opening of research and field opportunities became apparent and SapienCE members rapidly mobilised to commence with various fieldwork plans in South Africa. Simultaneously we opened the Centre in Bergen again to 'live' interactions. As a celebration of returning to fieldwork I highlight below some key field events. Swift plans were

implemented to commence with excavation of the 90-85 ka levels at Blombos Cave, southern Cape, South Africa from 12th February – 27th March. Directed by PI Karen van Niekerk, with support from an excellent team drawn from Master students, Early Career Researchers (ECRs) and PIs from SapienCE, the University of Bergen (UiB), the Department of Archaeology, History, Cultural Studies and Religion (AHKR) and the University of the Witwatersrand (Wits), the excavations were highly successful with several significant discoveries. Importantly, being in the field again generated a palpable excitement within our team, new friendships were made, and new collaborations planned. A crucial element of SapienCE, namely creating opportunities for inspiring our researchers and creating a sense of 'togetherness' was restored. Analysis of the recovered materials, and those from previous excavations was carried out in our Cape Town satellite laboratory in March-April 2022 led by Karen van Niekerk and Francesco d'Errico, with Master, PhD and Postdoc involvement. This work will result in several publications in leading journals. Additional fieldwork included a geological survey of the Blombos coastline in March 2022 led by Simon Armitage and Christopher Miller. Surveys for archaeological sites in the inland Karoo, and in the mountains and along the coastline of the southern Cape were completed in March by Henshilwood, Tankosic and Armitage with interesting results in a somewhat physically challenging landscape. Successful excavations from July 28- September 5 at Klasies River in the 120 ka levels was led by Sarah Wurz, with exciting discoveries.

Public outreach on a person-person basis also recommenced in late 2021/2022 with palpable results. The 'live' opening in November 2021 of the SapienCE/ Wits 'Origins of Early Sapiens Behaviour' exhibition at the Origins Centre, University of the Witwatersrand paved the way for its success in 2022. This exhibition will now move to the South Africa National Park Cape Point Reserve, near Cape Town, and open in March 2023. Cape Point is visited by more than 1 million visitors a year and this SapienCE exhibition will ensure we extend and exceed our outreach activities in the next 3 years. A SapienCE team-building outing was held at Øystese, Hardanger, June 13-15, 2022, with 25 (out of 31) SapienCE members present, including most consortium partners. The focus was on SapienCE scientists' research providing the first post-Covid formal and informal in-person meeting opportunity. It was enhanced by two workshops, one on strategies for group cohesion and improved collaboration organized by UiB's Human Resources department, and one on the upcoming SapienCE exhibition at the University of Bergen Museum organized by the museum's curators. This was followed up by a visit to the Origins Centre at Wits University, Johannesburg by the UiB museum curators to see the SapienCE exhibition 'live' and to visit the new premises for the exhibition at Cape Point. The UiB Museum will open their SapienCE exhibition in Bergen in May 2023.

There are 31 scientists in our SapienCE team, including 19 researchers/PIs, 5 PhDs, 7 Postdocs, and 13 administrative staff. In 2022 we have one SEAS (Co-Fund mechanism of Horizon 2020) postdoc, Dr Asia Alsgaard, working on South African coastal adaptation based on archaeological findings. A further 3 SEAS posts are currently advertised, 2 in Climate and 1 in Archaeology. A Research Council of Norway (RCN) funded Postdoc, Dr Aliki Papa, has been appointed in our Cognition section to study fungi (mycology) in southern African prehistory. Several Postdoc and PhD posts will be advertised in 2022/23. Our SapienCE project (administrative) manager, Dr Zarko Tankosic, who holds a PhD in archaeology from Indiana University, is making excellent progress as a senior member of the SapienCE team.

In 2022 SapienCE again made its mark scientifically and our swift mitigatory actions from early in the year resulted in several positive outcomes and top-tier publications. We continue to attract world class collaborators and are held in high regard by leading international institutions. I present below our research for 2022.

SAPIENCE RESEARCH 2022

CLIMATE 2021 – 2022

- Downscaled global model data was used to identify the role of regional sea level on South African climate. The work indicates major local impacts of sea level change on seasonality in the present coastal regions when sea levels dropped during glacial periods. This paper has been published in Quaternary Science Reviews. A second paper comparing the results with climate proxy data and archaeological records has been submitted to PLOS One.

- A publication of the global model simulations for the 120-50 thousand year ago (ka) interval analysing the impact of sea level on global climate dynamics has been published by Nature Geoscience.

- Sediment Cores: Terrestrial climate reconstructions and a preliminary age model for cores derived from X-ray fluorescence data has been submitted for publication. Luminescence dating of the sediment cores was conducted in May-July 2022. Further analyses of onshore hydroclimate is ongoing at UiB.

- Follow-up of the tephra work from Blombos Cave and sediment cores. The Blombos Cave Tephra is not from the Toba eruption. Analyses of the geochemistry of the tephra from the marine cores is underway in Edinburgh to identify if this is the same tephra found in Blombos Cave.

- Initiatives for vegetation modelling and Agent Based modelling in SapienCE Archaeology, Climate Studies and Cognition sections. Plans are laid for this to be a key aspect of SapienCE Phase 2 in collaboration with Prof. Axel Timmermann at IBS Center for Climate Physics, Busan, South Korea.

- Continuing analysis of speleothems recovered from Bloukrans Cave, De Hoop Nature Reserve are expected to yield significant climate data for the southern Cape after 100 ka. Chronology has been clarified using U/Th and a pilot study shows that the carbonate and interstitial water proxies work in the material.

COGNITION 2021-2022

- Across three sub-projects, we continued our work on the origins of religious belief and symbolism, which combines philosophical theory, insights from anthropology and psychology on human culture and cognition, and archaeological models and data on prehistoric artifacts.

A first joint publication on this work (to be published in a special issue on the origin of religion) sketches a plausible scenario for when and how symbolic practices emerged and why they increased in complexity. A second paper (submitted for publication) illustrates how early sapiens cognition (including religious beliefs) can be reconstructed by more seriously taking into consideration the dual role of culture, as both a scaffold of innovations and a driving force in diversification.

- Intersection with the ERC Synergy Grant funded project "QUANTA": Two SapienCE teams (at UiB and in Bordeaux) have begun to collect data and to develop and refine methodological protocols for investigating the emergence and evolution of symbolic tools for quantification and numerical cognition. One paper discussing the potential encoding of numerical content in pebbles has been submitted for publication.

- A large-scale interdisciplinary effort aimed at proposing a new scenario for the origin of language – seen, in short, as the consequence of a gradual eco-cultural niche expansion – has emerged from a workshop organised in 2022 by Larissa M Straffon and is currently being prepared for publication.

- Empirical testing of an evolutionary, archaeologically grounded scenario for the complexification of cultural transmission and teaching in our lineage is ongoing. A first study combining transmission-chain design with brain-imaging has been completed, the data is currently analysed, and a follow-up study is underway.

- Collaborative research to identify, via functional magnetic resonance imaging (fMRI) experiments, the neural bases of the perception of the culturalized body with a focus on painting and beadwork on human faces is ongoing.

- An initiative for 'unearthing' invisible food has been taken, envisioned as a new direction and key focus in the second phase, with the potential to cross-cut work in the three major clusters of SapienCE. We are developing a multidisciplinary approach to investigate the role of mushrooms as a key ecological component in the environment, as valuable source of food, and as a potential driver of both cultural and cognitive evolution. Two publications on how knowledge about mushroom edibility evolves over time, conducted in collaboration with Åge Oterhals from the Norwegian Institute of Food, Fisheries and Aquaculture Research have been submitted for publication.

ARCHAEOLOGY 2021-2022

- Six-week excavation season at Blombos Cave (February-March 2022) of the M3 (ca 85 ka) layers with the assistance of MA (UiB and Wits) students and SapienCE ECRs.

- C. Miller and S. Armitage conducted geoarchaeological field survey and sampling around Blombos Cave from the 21st to the 25th of February.

- A field season at Klasies River main site was undertaken by Sarah Wurz from 28 May to 6 September 2022.

- New U-Th dates on ostrich eggshell from Klipdrift Shelter HP and younger layers (Elizabeth Niespolo, Princeton; Warren Sharp, Berkeley; Armitage). Dates are similar to those obtained by luminescence dating, but this method produces ages with smaller uncertainties, thus potentially narrowing down the duration of the Howiesons Poort techno-tradition.

- New radiocarbon dates for the upper layers of Klipdrift Shelter (surface deposit about 12 500, layer below 33 000).

- Dating of the MIS 4-3 deposits at Klasies River with PI Prof. Simon Armitage is ongoing.

- U-Th dating results of the speleothem material from Klasies River were published in Frontiers in Earth Science.

- A comparative perspective on MIS 5 shellfish exploitation at Klasies River main site and Blombos Cave. Paper to be submitted shortly.

- Demonstrated the feasibility of zooarchaeology by mass spectrometry (ZooMS) for identifying small mammal remains from the Middle Stone Age (MSA) levels of Klipdrift Shelter.

- Identifying the sources for ochre found in Blombos Cave by analysing samples collected during the 2020 geological survey season and by using the chemical and mineral composition of different ochres alongside microscope analysis of thin-sections to produce unique "fingerprints" for each ochre source near Blombos.

- Compiling a comprehensive 3D model of the Blombos Cave excavations, using the photographic archive extending back to 1998.

- The first results from the experimental field season (2020) were published in the EXARC Journal, emphasizing a strong role of our ECRs in developing research goals and seeing them through to publication.

- Conducting detailed geochemical analysis of archaeological and experimentally heated *Turbo sarmaticus* (a type of sea snail) shells to determine the environmental conditions under which MSA people lived.

- Finished isotope analyses on modern and archaeological microfaunal material from Klipdrift Shelter and Klasies River (with Patrick Roberts)

- Collaborative Cape Town lab-based analysis of Blombos Cave shell beads March-April 2022.

- Collaborative Cape Town lab-based analysis of Blombos Cave ochre retouchers March-April 2022.

- Technological and chemical analysis of Blombos Cave ochre tool kits in the SapienCE Cape Town lab - March-April 2022.

- Completed the documentation of 597 ochre artefacts from Klipdrift Shelter years 2011-2013, 2018.

- The discovery of 23 double-bevelled bone tools ('wedges') from ~80,000–60,000-year-old layers at Sibudu Shelter (d'Errico) – this has direct relevance to future analyses of bone tools from Blombos Cave, Klipdrift Shelter and Klasies River.

CONCLUSION

SapienCE started 2022 with vigour and positivity as we were finally able to get together 'physically' as a group, work in our labs and in our centre in Bergen together, and to travel once again to conduct fieldwork in South Africa. We had a highly successful excavation and analysis season in South Africa from January – April 2022 and achieved most of our goals and exceeded others. Our team building in Norway also brought us back together as a group, allowing us to discuss 'live' our ongoing and planned research and to look forward to new opportunities in the future. We are now involved in active discussions to plan for our next 4 years. What new avenues of research would be best for our SapienCE goals of continuing to understand early human behaviour in South Africa? How successful have we been at addressing the initial questions we set for SapienCE in 2017? We are looking forward to continuing this debate in coming months. Our multi-disciplinary scientists are proceeding apace with their planned research targets, and we can expect some excellent outputs in 2023.

I would like to thank all our SapienCE members for the enormous efforts they have made in 2022 to ensure the ongoing success of our centre. I pay special credit to our respective Deans and Heads of Departments, the RCN, our Project Manager, researchers and our administrative staff for their ongoing support of our ECRs, students and staff and for helping to create a centre that once again is a live hub for our activities and ground-breaking research. To those members of SapienCE who have moved on to new posts, or who will be retiring, thank you so much for your invaluable contributions and we will miss you.

I conclude by reiterating the pride we have in seeing that SapienCE continues to evolve as a strong, unified team and I have full confidence that all members, scientific and administrative, will respond to the best of their abilities in continuing our research and pursuing excellent science in 2023 and beyond. As we have done since 2017, SapienCE will continue over the next 4 years to establish Norway and UiB's position as world leaders in early human origins research.

Christopher Stuart Henshilwood

SCOPE

The SapienCE Centre of Excellence is built around a carefully selected interdisciplinary team of archaeologists, climatologists and psychologists. The team aims to increase our understanding of how and when *Homo sapiens* behaviour changed, making us who we are today.
Within the next decade, the SapienCE team will investigate Middle Stone Age (MSA) archaeological sites by looking in detail at the evidence, layer by layer, site by site.

HIGH-RESOLUTION RECORDS

SapienCE researchers will produce an exceptional range of securely dated, high-resolution records of early human cultural, social, technological and subsistence behaviours, alongside global, regional and site-based palaeoenvironmental information. The centre's aim is to integrate these records, allowing a holistic analysis which will provide groundbreaking insight into the diverse aspects of what it means to be human.

ACCESS TO UNLOCK THE PAST

The SapienCE team has exclusive access to Blombos Cave, Klasies River main site and the Klipdrift Complex; sites that contain the key for unlocking the past. Blombos Cave is known as the cradle of human culture. Engraved ochre, shell beads and world's earliest drawing are amongst the significant finds from this cave. Early modern humans occupied the cave between 100 000 - 70 000 years ago.

Klasies River main site is famous for its numerous human fossils and the extensive 20-meter archaeological archive of early human behaviour. Early modern humans occupied the site between 120 000 - 59 000 years ago. The Klipdrift Complex covers both the Middle and Later Stone Age. The site is particularly associated with the Howiesons Poort techno-complex dating to approximately 65 000 - 59 000 years ago.

KEY RESEARCH QUESTIONS

1. When, why and how did humans first become behaviourally modern and how is this defined?
2. Did cognitive changes accelerate behavioural variability?
3. How were these groups of hunter gatherers socially organised?
4. Was social cohesion enhanced by the adoption of symbolic material culture and did it lead to innovation?
5. What cognitive skills had to be in place in order for other skills to develop?
6. How adaptable were humans to environmental change and did climate impacts act as drivers for technological innovation and subsistence adaptations?
7. Can we determine, from our planned genetic research, the relationship of these early *H. sapiens* to extant human populations?

ACTIVITIES

ARCHAEOLOGY

2022 marked a return to near-normal conditions for the archaeology group in SapienCE, with the threat of Covid-19 waning and international mobility becoming possible once again. This allowed the centre to recommence in-person research collaborations, both in Bergen and at partner institutions, and a much-anticipated return to fieldwork.

Excavations at Blombos Cave, led by PI Karen van Niekerk, began in early February and continued for six weeks. An all-female team composed of SapienCE researchers and masters/PhD students from the University of Bergen and the University of the Witwatersrand (Wits) excavated the 85-90 thousand-year-old deposits. They were joined by our ECRs Larissa Mendoza Straffon, Ozan Mert Göktürk and Zahra Haghighi, who visited for two weeks each. Excavations focussed on an area of the cave that is relatively understudied, so the aim of the 2022 season was to recover sufficient material to allow useful comparison with both younger deposits at Blombos and contemporaneous levels at other sites. The excavations met this aim, but as usual Blombos also threw up a few surprises, including a hippo tusk lying on top of a hearth. Often archaeologists require considerable imagination to interpret the meaning of the material they excavate, but occasionally our ancestor's behaviour is immediately recognisable and hauntingly human. The team's discovery of limpet shells, neatly stacked next to the fire 90 thousand years ago, is a touching example of the latter. In August, SapienCE PI Sarah Wurz renewed excavations at Klasies River, accompanied by masters and PhD students from Wits and Oxford University. Faunal remains and a number of hearths were excavated. A large and obstructive speleothem was removed from the Witness Baulk, revealing material very different from the overlying layers. In particular, the layers excavated in 2022 were much richer in shellfish and contained lithic technology reminiscent of the MSA1 (Klasies River) techno complex. Uranium-series dating of speleothems from these levels were published in Frontiers in Earth Science and put Klasies River amongst the handful of sites with shell-bearing deposits older than 110 thousand years in South Africa.

Alongside the excavations at Blombos, SapienCE researchers Chris Miller (Tübingen) and Simon Armitage (Royal Holloway) conducted a week-long survey of the area surrounding Blombos, collecting samples which will allow them to understand the landscape evolution around the cave during the Middle Stone Age. The centre Director and Administrator, Christopher

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Henshilwood and Zarko Tankosic, also conducted a number of surveys for new archaeological sites, accompanied by various colleagues. These surveys included the Molteno site 8 km east of Blombos, Romanskraal farm in the Riversdale Mountains and preliminary visits to Karoo sites in the Gouritz Cluster Biosphere Reserve.

Laboratory-based research and training within the archaeology group also continued to gather momentum in 2022. PI Sarah Wurz's PhD student Peter Morrissey visited Chris Miller and Susan Mentzer in Tübingen to receive theoretical and practical training in geoarchaeology, allowing him to complete a micromorphological study of deposits from Klasies River. SapienCE PhD student Zahra Haghighi visited the laboratory in Cape Town and worked with PI Francesco d'Errico to take samples from previously excavated Blombos Cave ochre tool kits. She also completed her second research secondment at the University of Copenhagen to conduct analyses on protein residues contained within the tool kits and other samples. Postdoc Elizabeth Velliky returned from parental leave in March and subsequently completed the mammoth task of documenting all ochre artefacts from four excavation seasons at Klipdrift Shelter. She plans a visit to the Cape Town laboratory early in 2023 to complete the same task for Blombos Cave. In March, Karen van Niekerk and Francesco d'Errico worked in the Cape Town laboratory on new shell beads from Blombos, producing a manuscript by the end of the year. Our long-term collaborations also produced new results, with Elizabeth Niespolo and Warren Sharp (Berkeley Geochronology Centre) producing a number of uranium-series dates on ostrich eggshell from the Howiesons Poort levels of Klipdrift Shelter. These ages are in excellent agreement with published luminescence dates and offer the possibility of building a more precise chronology for the site. Lastly, the end of the pandemic allowed SapienCE to recommence scientific workshops, including a particularly productive day discussing the potential role of agent-based modelling in our research with Axel Timmermann (Busan National University).

If 2022 was notable for a return to normal activities, it also represents a moment of change for the archaeology group. Postdoc Turid Hillestad Nel completed her time with SapienCE and took up a permanent Senior Adviser role at the Western Norway University of Applied Sciences, while PhDs Ole Unhammer and Jovana Milic are currently working hard to complete the write-up of their doctorates. Ole used his experience of photogrammetry within SapienCE to gain a permanent position in the Norwegian Institute for Cultural Heritage Research (NIKU). Postdoc Magnus Haaland transitioned to a new post as Manager of Department of Collections at the UiS Archaeological Museum, while still keeping a 20% affiliation with SapienCE. In April we welcomed Asia Alsgaard to the centre as part of SapienCE's contribution to the Shaping European Research Leaders for Marine Sustainability (SEAS) Programme. Asia is using stable isotope analysis to assess how changes in the coastal environment during the Middle and Late Stone Age impacted foraging practices. We also have a PhD and two postdoc positions at various stages of the recruitment process. 2023 looks likely to be as exciting and productive as 2022!

CLIMATE - RECONSTRUCTIONS AND MODELLING REVEAL SURPRISING RESULTS

A key objective of SapienCE is to find out what environments the people who occupied the archaeological sites lived under. The 100.000-50.000 year interval when major cultural evolution took place in the southern Cape as evidenced by archaeological findings, is embedded in the initial phases of the last glacial, which lasted from about 115.000 to about 12.000 years ago. One well-known aspect of a glaciation is that sea levels dropped by several tens of meters as water was stored on land in the growing ice sheets, to become as low as 70m below present at around 70.000 years ago, and furthermore as low as 130m at the Last Glacial Maximum around 20.000 years ago. We also know that the now submerged Agulhas Plateau off the Southern Cape emerged above sea level during low sea level stands, exposing a large plain with rivers and various forms of vegetation. Hence when sea levels dropped, the distance from the archaeological sites to the coastline increased. The archaeological evidence shows this through changes in the food sources utilised by the people who occupied the coastal caves.

Less has been known of the impact these changes of the coastline had on weather and climate. In SapienCE we now have interesting results, indicating that the sea level changes had a larger impact on important climate parameters.

What was done? First, we used a global climate model of the same type as used in the IPCC reports to simulate future climates. This was used to simulate climates 5000 years through the SapienCE interval. The simulations were forced by changes in the parameters of the Earth´s orbit (Eccentricity, Axial tilt and Precession), which we know were key to driving the glacial cycles through redistribution of solar irradiation. Ambient atmospheric CO^2 was adjusted according to data from Antarctic ice cores, and sea level was lowered according to global sea level reconstructions. These simulations gave a coarse picture of the climate changes, but not in enough detail to identify changes of a scale in which SapienCE is interested. We therefore ran simulations of selected times with a model which simulates climates on a few km scale over southern Africa, using the global model simulations as input. In this downscaling led by SapienCE postdoc Ozan Mert Göktürk, we could investigate the specific effects of the lowered sea level and movements of the local coastline. It appears that when sea level was low and the coastline furthest away from Blombos Cave and our other sites, the local climate around the caves changed significantly, with overall drier climate in what is now the coast, but then was several tens of kms away from the sites. The seasonal range in temperature became larger. Overall, the climate became more continental in a surprisingly strong and coherent way. This has cast new light on the living conditions of ancient humans during the important period of emerging modernity.

Climate proxy reconstructions from cave deposits appear to confirm this drying tendency with lowered sea levels. The magnitude of the climate changes is further explored in ongoing investigations of speleothems and ocean sediment cores offshore the coast. We now have firm evidence that such reconstructions are possible and that we can acquire robust climate signals from cores and speleothems in the region. Results are forthcoming early in 2023.

The climate model results have now been published in the journal Quaternary Science Reviews (1). Other papers further exploring these results compared to the archaeological data are close to submission.

Another unexpected result also came out of this work. This was found through analyses of the global model simulations. The new results have more to do with climate dynamics, than the specific objectives of the SapienCE project. It appears that changes in sea level on the scales that happened in the past and in future projected sea level apparently on their own could lead to significant and systematic changes in the climate system, such as the ocean heat transport in the global ocean. This is a surprising result, that has not been seen before. The results are under final review in a leading journal.

While we are continuing our analysis of the model simulations, our eyes are now on finishing the climate proxy reconstructions and integrating these and model results with the archaeological evidence thus providing a basis for our plans in the 2nd phase of our centre, where we also aim to introduce humans into the models.

1) OM Göktürk, SP Sobolowski, MH Simon, Z Zhang, E Jansen, 2023, Sensitivity of coastal southern African climate to changes in coastline position and associated land extent over the last glacial. Quaterary Science Reviews https://doi.org/10.1016/j.quascirev.2022.107893

COGNITION
- GROUP SUMMARY

Members of the SapienCE cognition group had a thriving year. Altogether, we produced a dozen published papers, gave more than 15 academic talks, participated in several renowned scientific conferences, organised three workshops, and took part in two archaeological excavations. In addition, we were joined by a new postdoctoral fellow.

We have two ongoing projects in collaboration with the Brain Imaging Group at the University of Bergen (UiB). After the setbacks brought about by the pandemic, a project on the Neuroarchaeology of MSA tools, led by Torill-Christine Lindstrøm and Kenneth Hugdahl, has now managed to test three participants with promising results. The Brain Activation in Cultural Evolution (BRACE) project, has also made significant advances, and will soon be concluding its pilot study. PhD student Heidi Øhrn and MSc student Emilie Pettersen Sjursen have recruited and tested 24 participants, resulting in an extensive dataset that will be analysed in early 2023. Related to these studies, the neuroimaging group at the University of Bordeaux has continued to develop a study on the neural correlates of the culturalised body, led by Francesco d'Errico.

The European Research Council project *QUANTA: Evolution of cognitive tools for quantification*, which includes SapienCE PIs Andrea Bender and Francesco d'Errico, and, since September, Postdoc Larissa Mendoza Straffon, is now in full swing. There were two project workshops in 2022. The first was hosted by the University of Bordeaux team on June 21st and 22nd, and included a visit to important cave art sites and the National Prehistory Museum at Les Eyzies. The second meeting was in Berlin on December 5th and 6th, organized by the Leipzig Max Planck Institute group. The project has various intersections with SapienCE, regarding the evolution of modern human cognition and culture.

The project of our new Postdoctoral Research Fellow, Aliki Papa, started in October. Supervised by Andrea Bender, she will look into the role of mushrooms during the Middle Stone Age. Drawing from cumulative cultural evolution theory, this interdisciplinary project will look at cross-cultural data on mushroom exploitation from archaeology, anthropology, and biology and has potential implications for advancing our knowledge on the evolution of our species' diet, information transmission strategies, and cognitive skills.

Members of the Cognition group were also involved in many academic activities throughout 2022, some of which deserve special mention. In addition to her involvement in SapienCE and QUANTA, back in May Andrea Bender participated in the workshop *Cultural Model Theory: Shaping a New Anthropology* in Illinois, USA. Francesco d'Errico, beside leading multiple projects and co-editing two monographs, visited the SapienCE Cape Town Laboratory in March to examine material from Blombos Cave and Klipdrift Shelter. Later in the year, he resumed the excavation of Border Cave. Within the framework of 'Matter, Gesture and Soul' Torill-Christine Lindstrøm is now participating in the project Tracing Rhythm which held an exhibition at UiB's Faculty of Art, Music and Design (KMD) in November and December. In February, Larissa Straffon visited the Zooarchaeology Lab at the Catalonian Institute of Palaeoecology and Social Evolution (IPHES) in Tarragona, and the Microscopy Lab at the National Centre for the Study of Human Evolution (CENIEH) in Burgos, where she analysed animal bones with cutmarks made by 3 different hominin species. In March, she participated in the excavation season at Blombos Cave, and in the Fall, she coordinated a comparative eye-tracking study on humans and chimpanzees, in collaboration with Leiden University. Heidi Øhrn has been trained in brain imaging techniques and has followed an intensive PhD course program. She also has been collaborating closely with the University Museum for the upcoming SapienCE exhibition.

Finally, we presented our work at several meetings, among others, the World Archaeology Congress, the meeting of the European Association of Archaeologists, the conference of the Cognitive Science Society, the European Society for Human Evolution, and several public events and media outlets. Our publications were featured in *The Journal of Human Evolution, PLOS One, Psychology of Aesthetics, Creativity* and *the Arts, and Behavioral and Brain Sciences,* among others.

SAPIENCE SCIENTIFIC HIGHLIGHTS
THE FIRST 5 YEARS

Since our establishment in October 2017, the first five years of the SapienCE Centre of Excellence (CoE), have been eventful. A strong start in 2017 led to several years of exciting innovative research within our CoE and we rapidly established ourselves as a force within the international scientific community. A rapid obligatory change in our operational methods and approaches in early 2020 was to have a major effect. First, the recall of our fieldwork team from Blombos Cave, South Africa at the start of the COVID-19 pandemic in March 2020 signalled the commencement of a new phase in the daily operations and long-term planning of our centre. Second, most SapienCE researchers were confined to home offices and a primarily digital reality. Laboratory work was curtailed, and contact was limited to online meetings. SapienCE Early Career Researchers (ECRs) frequently felt isolated due to the lack of 'in person' contact with fellow researchers and their supervisors. Our SapienCE leaders instituted swift mitigatory actions resulting in several positive outcomes by assisting our ECRs and continuing with our research using alternative approaches. One positive is that we continued producing top-tier publications and strengthened global collaborations and by the final weeks of 2021 we commenced returning to our 'normal' pre-COVID operations. Our gratitude is expressed to all SapienCE members and administrators for their considerable efforts during these two most challenging of years. A highlight of 2022 was when we could return to the field in South Africa, collect new data and build once again on team camaraderie. By the end of 2022 we managed to return to almost full pre-Covid capacity, and our CoE was settling into its usual productive rhythm. Several scientific and team-building events in 2022 enabled us to improve our team's spirit of cohesion and to zero-in on the plans for the second phase of SapienCE, where a multilateral focus will be, among others, on new data collection, synthesis, integration and on the expansion of innovative ways to understand our human past. We are currently in the process of hiring new scientists and ECRs that will assist with implementing these novel, exciting plans.

The focus of SapienCE centres on understanding the evolutionary history and ecological dynamics of the human species, with a particular emphasis on the past 100,000 years. Since its establishment our CoE has had a significant impact on international research themes and research methods. Concrete results, produced over the past five years, show that SapienCE researchers have made a substantial contribution to international research on cognitive modernity, its archaeological/material correlates, and the climatic context in which this occurred in South Africa.

SapienCE scientists have expanded their own research using the experience they have obtained while working on CoE -related topics. A key resultant outcome of the research excellence of SapienCE scientists is that our CoE, Norway, and the University of Bergen are now regarded as one of the world's leading research centres on the earliest development of behavioural modernity of our own species in Africa from 120,000 years ago (120 ka).

We list here some of the key impacts of SapienCE since 2017:

The world's oldest drawing is 73 000 year old and made on a silcrete stone flake displaying a red cross-hatched pattern. The finding was discovered during excavation in Blombos Cave by Karen van Niekerk and Christopher Henshilwood.

ARCHAEOLOGY

1. Developing new methods for analysing archaeological data: SapienCE has developed highly innovative methods for analysing archaeological data, including the use of high-resolution 3D imaging and potentially in the future machine learning techniques. This has enabled researchers to better understand the material culture of past societies and how it changed over time.

2. Collaborating with international partners: SapienCE has established collaborations with leading international research institutions, among others the University of Bordeaux, the Max Planck Institute for the Science of Human History, University of the Witwatersrand, Royal Holloway University of London, University of Tübingen, and the University of Cambridge. This has led to the exchange of ideas, data, and expertise, and has helped to foster a more global approach to the study of human evolution.

3. Contributing to public understanding of science: SapienCE has engaged in extensive outreach and public engagement activities, including organizing public lectures, exhibitions, and media appearances. This has helped to raise public awareness of the importance of understanding our evolutionary history and has inspired a new generation of researchers.
Overall, SapienCE has made a significant impact on the study and understanding of human behavioural evolution and has contributed to the development of new research themes and methods in this field. Its collaborative and interdisciplinary approach has helped to break down barriers between different academic disciplines and has paved the way for new discoveries and insights into our species' past.

4. Of global significance was the discovery and publication of the world's oldest known drawing found at Blombos Cave, southern Cape, South Africa (Henshilwood et al., 2018). The artefact with intentionally applied ochre lines is dated at 73,000 years. This find further demonstrated the ability of early *Homo sapiens* in southern Africa to produce graphic designs on different media using various techniques, indicating high levels of cognitive development and adds to evidence of engraving abstract designs on ochre.

5. Advancing the field of palaeogenomics: SapienCE has contributed significantly to the field of palaeogenomics by contributing, to leading palaeogeneticists, samples from Blombos Cave, Klipdrift Shelter and Vaalkrans Shelter with the potential to develope new methods for extracting and analysing DNA from these ancient human remains. The samples from Blombos Cave and Klipdrift Shelter did not produce results but those from Vaalkrans were highly informative on Khoisan movements in the 19th century (Coutinho et al., 2021). Further collaboration with SapienCE can provide new insights into the evolutionary history of our species.

6. The discovery of the earliest known formal bone tools at Sibudu Cave, in southern Africa, dated to 80-60 ka further supports this assertion (d'Errico et al., 2022).

7. The oldest recorded use of bow and arrow has been found by SapienCE-affiliated researchers in Sibudu Cave (Backwell et al. 2018) and at our SapienCE site, Klipdrift Shelter in the southern Cape (Douze et al. 2018).

8. SapienCE researchers have discovered innovative subsistence strategies, including utilising and processing of plant foods, at the sites of Blombos Cave, Klasies River and Border Cave (Larbey et al., 2019 and Wadley et al., 2020) and the use of grass and ash bedding at Border Cave 200,000 years ago, to inhibit tick infestation (Wadley et al., 2020).

9. The earliest deliberate burial in Africa was co-published with SapienCE researchers (Martinon-Torres et al., 2021) and adds new information on the potentially advanced behaviours of early modern humans in southern Africa.

10. We have added scientific value to the archive of research materials from SapienCE sites via the innovative application of new techniques, notably microanalytical study of engraved ochre (Haaland et al., 2021a) and uranium-series dating of ostrich eggshells including the ongoing work at Klipdrift Shelter (Sharp & Niespolo, in prep.).

11. Six SapienCE ECRs successfully conducted 3 weeks of burning experiments in South Africa prior to being recalled to Norway due to the pandemic. The first publication resulting from these experiments has recently been published (Bentsen et al. 2022)

An international team of researchers, including scientists from SapienCE, were able to isolate ancient DNA from solid blocks of sediment embedded in plastic resin commonly used for micromorphological analyses.

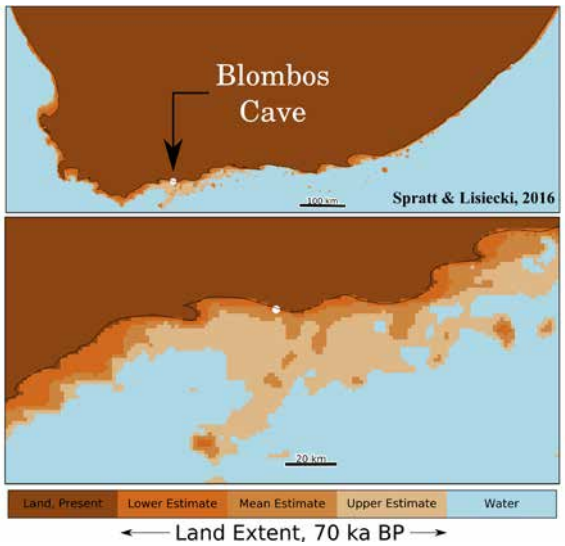
Shipboard scientist with one of the retrieved a sediment cores on a research expedition on board the French research vessel R/V Marion Dufresne 2020.

Scientists from SapienCE are investigating when, why, and how humans developed number systems, and why those vary so massively across cultures.

Dr. Haaland studying tiny fragments in the cultural layers of Blombos Cave through a microscope.

SapienCE scientists researching the neural basis for social learning processes by using functional magnetic resonance imaging (fMRI) to record brain activation while participants learn how to tie simple knots to explore human cognitive evolution.

Jovana Milic and Ole-Fredrik Unhammer documenting the fire experiments during fieldwork in South Africa 2020.



Estimates of land extent in southern Africa at around 70 000 years before present (70 ka BP)

SapienCE event with open discussions at the Bergen Lirbrary in 2019: A day in the life: Homo Sapiens 100 000 years ago.

CLIMATE

Climate modelling, since our inception, has been an integral and important part of SapienCE. This helps us achieve a better understanding of changing climate, landscapes and how these may have impacted early human behaviour.

1. We have an increased understanding of local environmental (as opposed to purely climatic) changes from climate modelling (Göktürk et al., 2023), landscape analysis (Jacobs et al., 2019) and an array of different proxies from our archaeological sites including micromammals (Nel and Henshilwood, 2016, 2021) and larger mammals (Reynard and Henshilwood, 2018). The impact of these changes on human behaviour is now better understood due to reconstructions of site use intensity changes at an individual location (Haaland et al., 2021b) and via the construction of ecological niches associated with different archaeological periods based on a landscape scale analysis of site locations (d'Errico et al., 2017).

2. A central component of SapienCE research on climate focuses on two deep sea cores obtained in 2020 by SapienCE scientists on board the French research vessel Marion Dufresne. Current analysis is establishing the sensitivity of the southern Agulhas Current to climatic changes during the Late Pleistocene. These cores will also be used to determine the influence of the Agulhas Current on southern African terrestrial climate, as part of SapienCE's ongoing research into understanding factors influencing human behavioural evolution in this region.

COGNITION

1. Understanding how cultural innovations may have affected human brain development (and vice versa) is a focus of SapienCE researchers affiliated with our cognition group (e.g. d'Errico et al. 2018). They include fMRI applications, at Haukeland University Hospital, Bergen, where in two studies we observed which parts of the brain activate during stone tool production and during learning and teaching processes, respectively.

2. SapienCE scientists have also pioneered the application of neuroimaging techniques to the perception of the earliest abstract engravings (e.g. Salagnon et al. 2020, Mellet et al. 2019 and others).

3. Our scientists have developed novel approaches to exploring the role of quantification in human cognitive evolution (Bender and Beller, 2018; d'Errico et al. 2018). This research has resulted in a new project, "QUANTA: The cognitive evolution of tools for quantification", which is funded with an ERC Synergy Grant and headed by SapienCE scientists Andrea Bender and Francesco d'Errico.

OTHER MAJOR SAPIENCE ACHIEVEMENTS SINCE 2017

1. Two SapienCE scientists, Christopher Henshilwood and Anna Nele Meckler, were inducted into the Norwegian Academy of Sciences and Letters.

2. Andrea Bender was elected a fellow of Academia Europea in 2022.

3. Our erstwhile collaborator Svante Pääbö, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany received the Nobel prize in 2022.

4. Francesco d'Errico has been included in the Clarivate List of the Highly cited researchers for 2017-2021 and in 2021 received funding from the University of Bordeaux of 7.5 million euros for the SapienCE sister project 'Human Past'

5. For the 'The Origins of Early Sapiens Behaviour' exhibition Henshilwood and team were finalists in the South African NSTF-South32 Awards – National Science and Technology Forum Communication Award for 2019/2020.

6. Henshilwood was awarded the Hjernekraftprisen (Brain Power Award) 2020 from the Norwegian Association of Researchers (Forskerforbundet) for research, development, and outreach.

7. The University of the Witwatersrand Vice Chancellors Impact and Innovation Award was awarded to Henshilwood and team on 6th October 2022.

8. Henshilwood was rated an A1-rated Scientist by National Research Foundation, South Africa, 2021-2025. A researcher in this group is recognised by all reviewers as a leading scholar in her/his field internationally for the high quality and wide impact of her/his recent research outputs.

9. In 2021 Henshilwood was appointed as Archaeology Ambassador -UNESCO Gouritz Cluster Biosphere Reserve, Riversdale, southern Cape, South Africa.

10. SapienCE Deputy Director, Eystein Jansen, was appointed as Vice-Chair of the European Research Council in 2022.

11. The "San Elders Speak" book is a result of a 2009 visit to the McGregor Museum in Kimberley, South Africa by co-authors, Lucinda Backwell and Francesco d'Errico, a SapienCE senior scientist. Ancient organic artefacts from Border Cave looked remarkably like items of historical San material culture to them and a study of the Fourie Collection of Kalahari San material culture at the Museum of Africa in Johannesburg commenced with four San elders invited for consultation. The result is the book and 29 video archives available online and an article (Colagè and d'Errico, 2020).

12. The University of the Witwatersrand/SapienCE 'The Origins of Early Sapiens Behaviour—Mother Africa Welcome Home!' exhibition was first displayed at the Iziko Museum, Cape Town in 2017, then the Origins Centre Museum, Wits in 2019. It has been viewed by more than 150,000 visitors. In 2023 the exhibition will open at the SAN Parks Cape Point Nature Reserve in Cape Town with more than 1m annual park visitors.

13. Our human capital development is considered one of SapienCE's most significant achievements. This is demonstrated by our ability to attract researchers from fifteen different nationalities, multiple countries, institutions, and variable scientific fields. All these scientists are collaborating on understanding the common origins of the behaviour of our own species. SapienCE continues to serve as a training hub for a new generation of Norwegian and South African researchers.

Overall, SapienCE has made a significant impact on the study of human evolution and has contributed to the development of new research themes and methods in this field. Its collaborative and interdisciplinary approach has helped to break down barriers between different academic disciplines and has paved the way for new discoveries and insights into our species' past. Over the next five years, the SapienCE Centre of Excellence will continue to consolidate the University of Bergen and Norway's position as a world leader in early human origins research.

LIST OF SIGNIFICANT PUBLICATIONS FROM THE FIRST 5 YEARS OF SAPIENCE (SELECTION)

1. Backwell, L. and d'Errico, F., 2021. San Elders Speak: Ancestral Knowledge of the Kalahari San. NYU Press.

2. Backwell, L., Bradfield, J., Carlson, K., Jashashvili, T., Wadley, L., & D'Errico, F. 2018. The antiquity of bow-and-arrow technology: Evidence from Middle Stone Age layers at Sibudu Cave. Antiquity, 92(362), 289-303. doi:10.15184/aqy.2018.11

3. Bender, A. (2020). The role of culture and evolution for human cognition. Topics in Cognitive Science, 12, 1403-1420.

4. Bender, A. (2020). What early sapience cognition can teach us: Untangling cultural influences on human cognition across time. Frontiers in Psychology, 11:99, 1-6.

5. Bender, A., Beller, S., & Jordan, F. (Eds.) (2020). The cultural evolution of cognition [special issue]. Topics in Cognitive Science, 12(2), 644-783.

6. Bender, A., & Beller, S. (2019). The cultural fabric of human causal cognition. Perspectives on Psychological Science, 14, 922–940.

7. Bentsen, Silje, Magnus Haaland, Jovana Milic, Turid Hillestad Nel, Ole F. Unhammer, and Elizabeth Velliky. "Pilot fires: Preliminary Report from Interdisciplinary Actualistic Fire Experiments." EXARC Journal EXARC Journal Issue 2022/1 (2022).

8. Bradfield, J., Lombard, M., Reynard, J. and Wurz, S., 2020. Further evidence for bow hunting and its implications more than 60 000 years ago: Results of a use-trace analysis of the bone point from Klasies River Main site, South Africa. Quaternary Science Reviews, 236, p.106295.

9. Colagè, I., d'Errico, F., 2020. Culture: The driving force of human cognition. Topics in cognitive science, 12(2), 654-672.

10. Coutinho, A, Malmström, H, Edlund, H, et al. Later Stone Age human hair from Vaalkrans Shelter, Cape Floristic Region of South Africa, reveals genetic affinity to Khoe groups. American Journal of Physical Anthropology. 2021; 174: 701–713. https://doi.org/10.1002/ajpa.24236

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13. d'Errico, F., Doyon, L., Colagé, I., Queffelec, A., Le Vraux, E., Giacobini, G., Vandermeersch, B. and Maureille, B., 2018. From number sense to number symbols. An archaeological perspective. Philosophical Transactions of the Royal Society B: Biological Sciences, 373(1740), p.20160518.

14. Douze, K., Delagnes, A., Wurz, S., Henshilwood, C.S. 2018.The Howiesons Poort lithic sequence of Klipdrift Shelter, southern Cape, South Africa. PlosOne. https://doi.org/10.1371/journal.pone.0206238

15. Göktürk, O.M., Sobolowski, S.P., Simon, M.H., Zhang, Z., Jansen, E. 2023 'Sensitivity of coastal southern African climate to changes in coastline position and associated land extent over the last glacial.' Quaternary Science Reviews 300, 1-11.

16. Haaland, M. M., Strauss, A. M., Velliky, E. C., Mentzer, S. M., Miller, C. E., van Niekerk, K. L., & Henshilwood, C. S. 2021a. Hidden in plain sight: A microanalytical study of a Middle Stone Age ochre piece trapped inside a micromorphological block sample. Geoarchaeology, 36(2), 283-313. doi:https://doi.org/10.1002/gea.21830

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20. Larbey, C., Mentzer, S.M., Ligouis, B., Wurz, S. and Jones, M.K., 2019. Cooked starchy food in hearths ca. 120 kya and 65 kya (MIS 5e and MIS 4) from Klasies River Cave, South Africa. Journal of Human Evolution, 131, pp.210-227.

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24. Nel, T.H., Wurz, S., Henshilwood, C.S. 2018. Small mammals from Marine Isotope Stage 5 at Klasies River, South Africa–Reconstructing the local palaeoenvironment. Quaternary International 471: 6-20. https://doi.org/10.1016/j.quaint.2017.08.074.

25. Nel, T.H. and Henshilwood, C.S., 2016. The small mammal sequence from the c. 76–72 ka Still Bay levels at Blombos Cave, South Africa–taphonomic and palaeoecological implications for human behaviour. PloS one, 11(8), p.e0159817
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26. Nel, T.H. and Henshilwood, C.S., 2021. The 100,000–77,000-Year-Old Middle Stone Age Micromammal Sequence from Blombos Cave, South Africa: Local Climatic Stability or a Tale of Predator Bias? African Archaeological Review, 38, pp.443-476.

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31. Wadley, L. Backwell, L. d'Errico, F., Sievers Ch., 2020. Cooked starchy rhizomes in Africa 170 thousand years ago. Science 367(6473): 87-91. doi: 10.1126/science.aaz5926

32. Wadley, L., Backwell, L., d'Errico, F. and Sievers, C., 2020. Cooked starchy rhizomes in Africa 170 thousand years ago. Science, 367(6473), pp.87-91.

33. Wadley, L., Esteban, I., De La Peña, P., Wojcieszak, M., Stratford, D., Lennox, S., d'Errico, F., Rosso, D.E., Orange, F., Backwell, L. and Sievers, C., 2020. Fire and grass-bedding construction 200 thousand years ago at Border Cave, South Africa. Science, 369(6505), pp.863-866.

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STORIES

HOW WARM WAS THE OCEAN AROUND SOUTH AFRICA IN THE PAST?

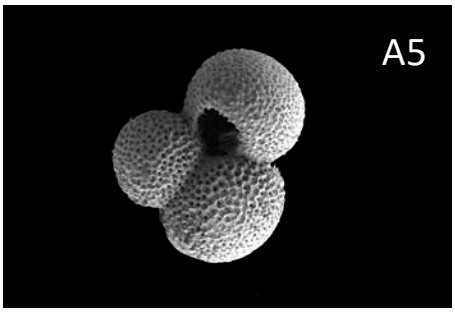
Master student Alan Kvindesland investigated surface ocean temperatures across the last 140,000 years off the coast of South Africa. He used a sediment core that was retrieved by the SapienCE team in 2018 (called MD20-3591) and compared different ways in which the temperatures can be reconstructed. The reason is that each method (or "proxy") has advantages and disadvantages, and combining several proxies allows for cross-checking and yields more robust information.

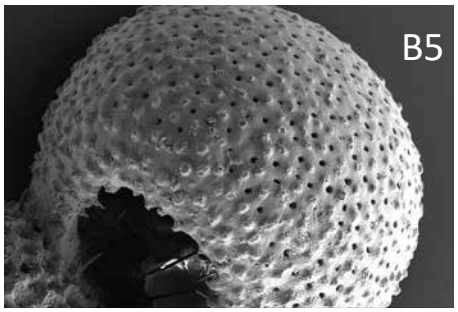
Alan used microfossils of foraminifera, sand-sized unicellular organisms that live in the surface ocean and produce carbonate shells that are preserved in the sediments once the organisms have died. The properties of these shells reflect the conditions of the ocean water at the time the shells were built.

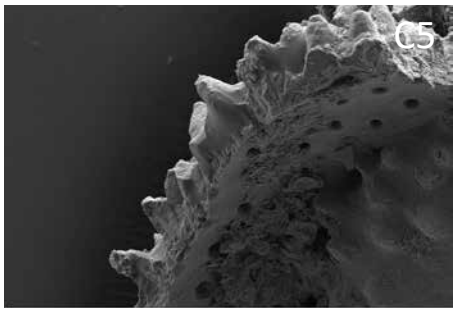
In this master thesis, Alan calculated temperatures from the ratio of Mg/Ca in the shells (data had previously been obtained by Margit Simon), which is known to reflect ocean temperature, but can also be affected by other ocean properties such as salinity and pH. In addition, there are different proposed calibrations (i.e., translations of the Mg/Ca signal into temperature) that can be used. The advantage of this proxy is that the measurements are relatively quick, and one can obtain detailed timeseries with many data points.

Alan compared the Mg/Ca-based temperatures with another proxy, called clumped isotope thermometry, which is based on the same type of shells but this time one measures the distribution of isotopes of oxygen and carbon. The occurrence of bonds between two rare isotopes of O and C is directly related to formation temperature of the carbonate, without other influences. The downsides are that the analytical uncertainty of this method is larger compared to Mg/Ca, and that the measurements take a long time and use a lot of material, so one can only obtain a few data points within the timeframe of a master thesis.

Through the comparison of the two proxies, Alan was able to find out which calibration works best for calculating the Mg/Ca temperatures. A surprising result was that both proxies revealed similar or even warmer ocean temperatures during glacial times (ice ages) than during the subsequent interglacials – which is opposite than expected and suggests major changes in the current system off South Africa.





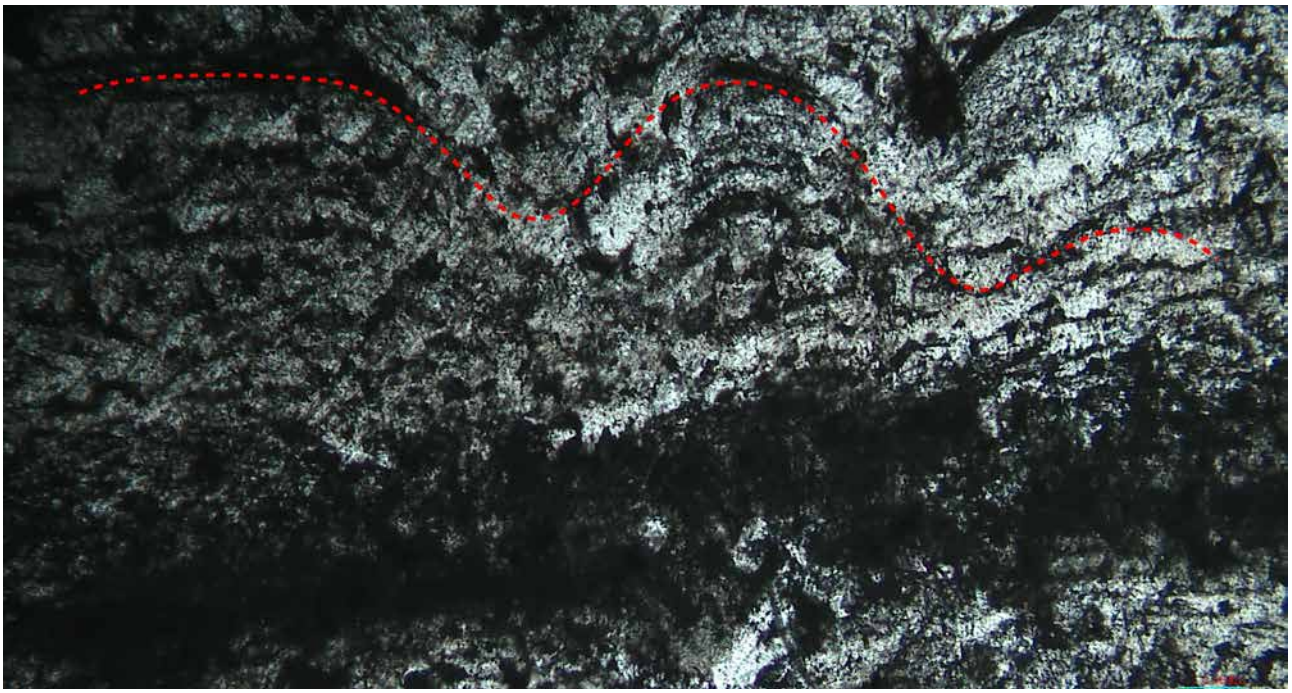


THROUGH THE LENS

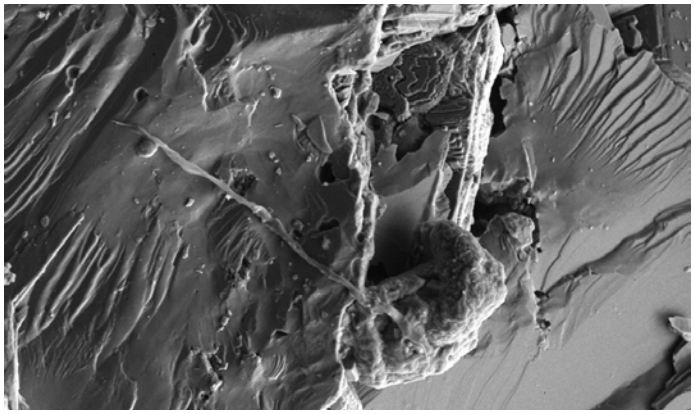
Looking at speleothem samples through a microscope can be quite exciting and surprising. For the inexperienced eye, looking at speleothem thin sections can seem boring at first, a bit like looking at static "snow" on an analogue television - a series of blurry lines in shades of grey. But sit with an expert and a whole different story starts to unfold, these wavy layers become stromatolite-like structures, likely the results of colonization of the speleothem surface by bacterial communities during periods of low drip-rate.

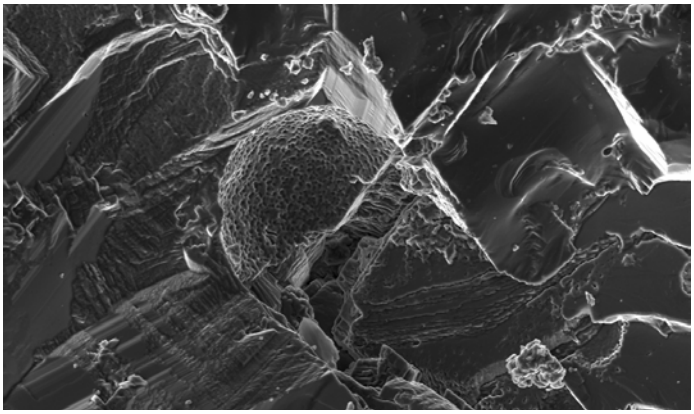
In June this year, I had the opportunity to look at thin sections with Prof. Silvia Frisia, the author of the reference paper in speleothem petrography. From her observations, she concluded that our sample contained a lot of organic matter and showed signs of the activity of microorganisms. Her conclusions were confirmed by the recent geochemical analysis (TEX86) of some of our samples by Dr. Alfredo Martínez García, a colleague at the Max Planck Institute for Chemistry in Mainz, who concluded that our samples contain an unusually high amount of organic material. This offers exciting new research avenues. For instance, we can now analyse organic proxies, which potentially host a wealth of information, not only about past climate but also about the past ecosystem in and around the cave.

Back to the microscope, a lot of exciting structures have been discovered in our samples. The exact information that they can reveal about the environmental context in which our speleothems formed remains to be investigated.

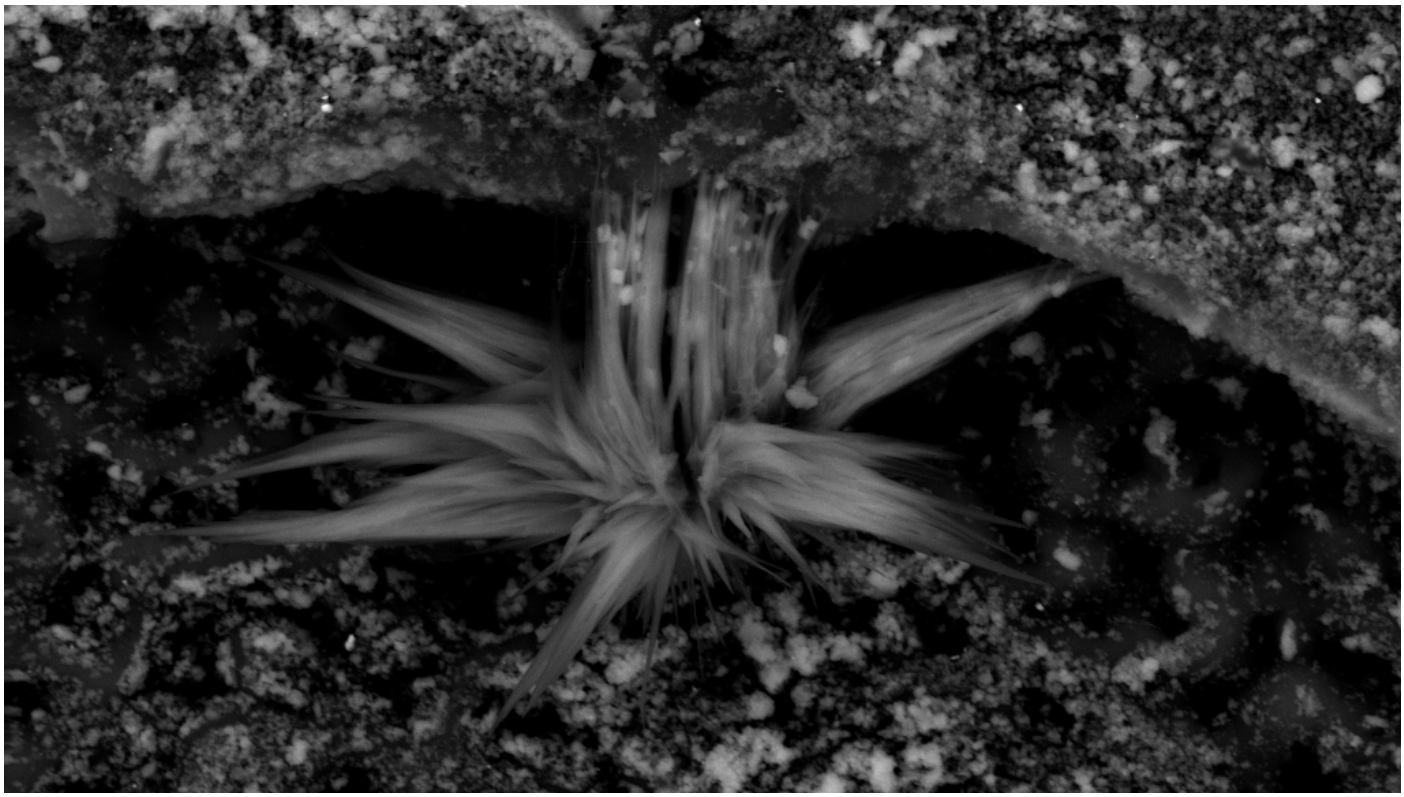


Thin section of a speleothem from Bloukrantz Cave, viewed under a microscope.
The red dashed line indicates the wavy, stromatolite-like structure, which is likely the result of bacterial activity.

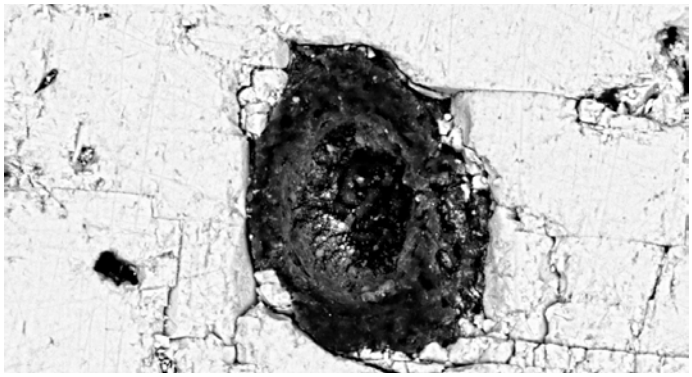


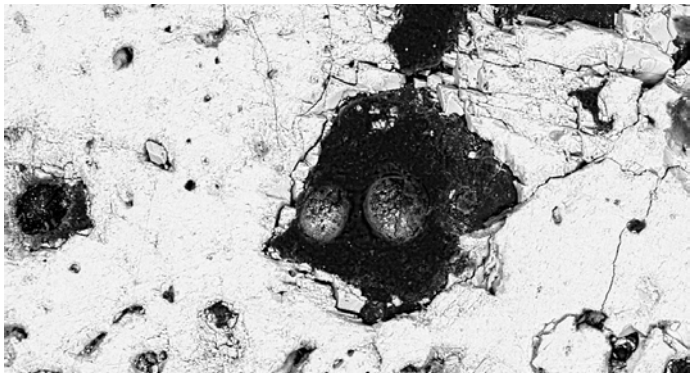


Structures observed under an SEM (scanning electron microscope) on a freshly broken speleothem surface.



Flower-like structure observed from a thin section using an SEM. This could be a salt crystal.





Rounded structures observed from a thin section viewed using an SEM. Could this indicate the past presence of micro-organisms that were degraded and/or later covered by further calcite precipitation?

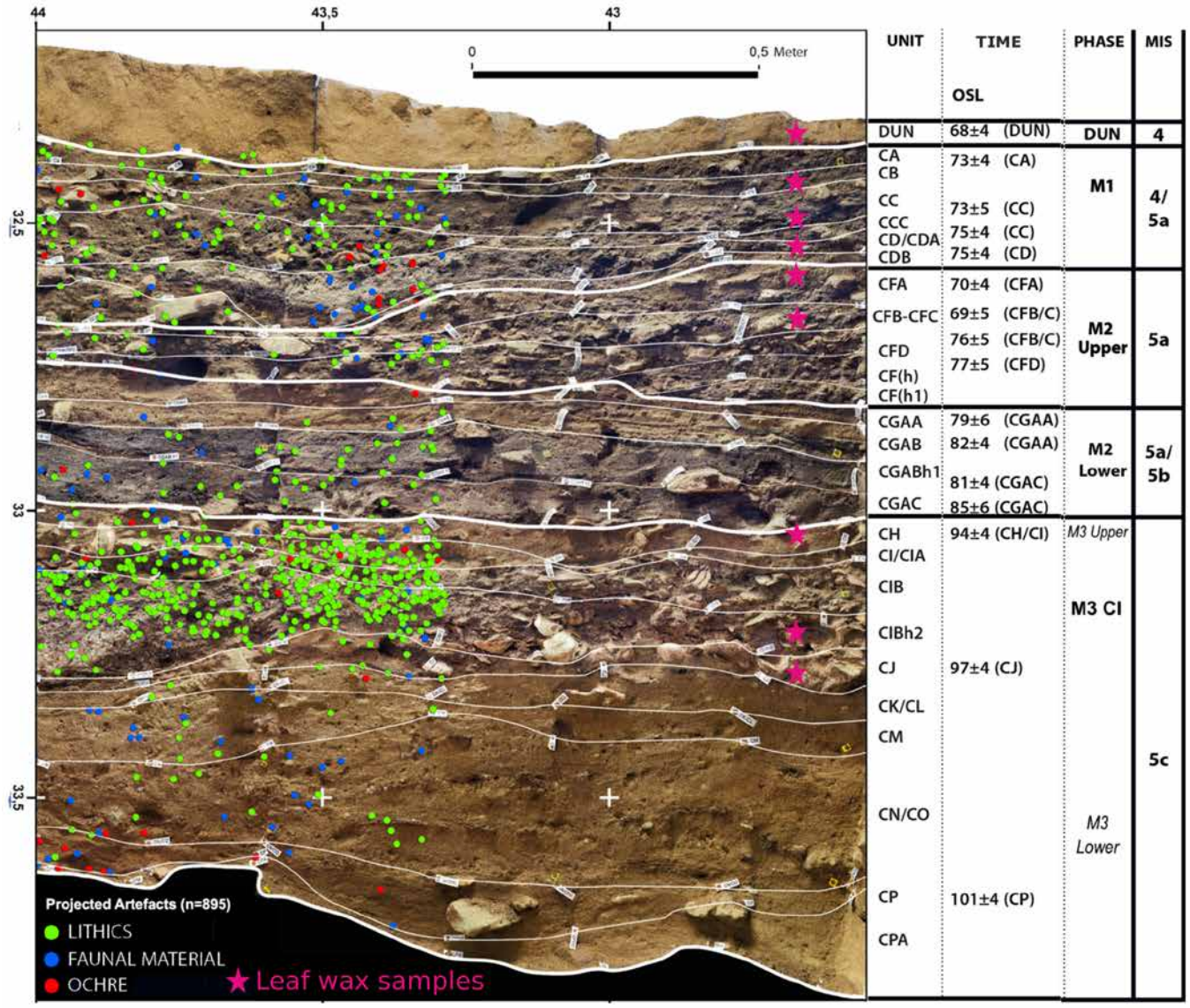
Blombos Cave archaeological sequence with leaf wax sample locations shown (upper panel, adapted from Haaland et al. 2021) and a couple of regional modelling results (lower panel).

COMBINING PROXY CLIMATE DATA AND MODELLING RESULTS

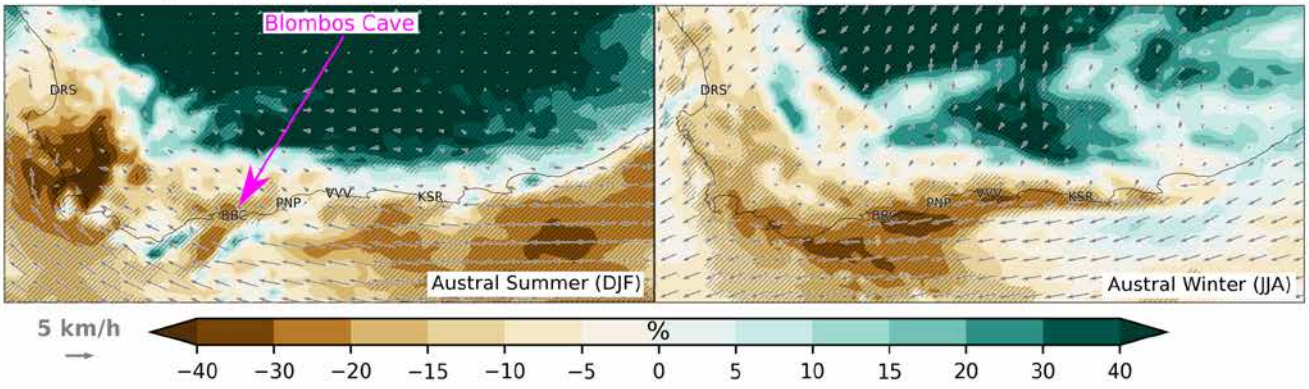
Reconstruction of past climate through mathematical modelling or natural proxies are both exciting, but how useful or reliable is each of these methods on their own? A good way to avoid this tough question is to test and interpret the findings of one technique using those of the other, by employing the two together. A SapienCE study led by Ozan Göktürk and Margit Simon (and recently submitted to PLoS ONE) has done exactly this to investigate how local climate near key SapienCE sites changed between 82 and 70 thousand years ago (ka). This is an important period of transition with documented, substantial shifts in large-scale climate, regional environment and early human behaviour. Leaf waxes, obtained from sediments within Blombos Cave's archaeological sequence, contain information about vegetation types and water availability at the time that they were formed. This information can be used to infer how wet or dry the area surrounding the cave was. High-resolution regional climate modelling generates its own, independent line of evidence, while helping put both the simulated and reconstructed changes into perspective.

Margit's leaf waxe data tell us that the environs of Blombos Cave became increasingly drier from roughly 90 to 65 ka. But wait: How can we be really confident of this result, while some other proxy-based work shows the exact opposite climate change signal for the same interval, for the interior areas of southern Africa that are not so far away from the coast where Blombos is located? At this point Ozan's model output solves the paradox by revealing the spatial pattern of change from 82 to 70 ka: Modelling shows that the story on the coast was remarkably different from that in the interior, supporting the story told by Blombos leaf waxes. It also tells us the factors that contribute to the coastal-inland contrast. For instance, while enhanced solar radiation during summer is known to increase rainfall in the interior regions of Africa, which did happen from 82 to 70 ka, cooler sea surface temperatures at 70 ka produced the opposite effect near the coast, as revealed by regional climate modelling. In addition, falling sea-levels between 82 and 70 ka cause the coastline to migrate further away from Blombos Cave, reducing the moisture in the Cave's vicinity.

We plan to do more interdisciplinary collaboration like this one - which will surely add to the existing high-calibre SapienCE science.



Change in **precipitation (%) and surface wind** (from 82 to 70 ka, with coastline shift)



PILOT FIRES:

THE FINAL OUTPUT OF AN ECR INITIATIVE AT SAPIENCE

THE SPARK OF PILOT FIRES

In the Spring of 2020, six SapienCE early career researchers (ECRs) organized and executed an ambitious experimental field season in Jongensfontein, South Africa. The goal: to conduct realistic fire experiments on materials commonly found in southern African Middle Stone Age (MSA) archaeological sites, and document any changes in their characteristics in-situ. This included measuring the heat-induced effects on materials such as ostrich eggshell, micromammal bones, owl pellets, seashells and ochre. The results of this project were presented at a dedicated session at an international conference as well a publication in EXARC Journal, entitled "Pilot fires: Preliminary Report from Interdisciplinary Actualistic Fire Experiments."

THE IMPORTANCE OF THE HEARTH

Fire was central to prehistoric life as the source of heat and light, and was used to cook food, dry clothes, and produce tools. The hearth was a communal space where people met, worked, and socialised, as well as a private space for a household or small group. Fire affects the space at a campsite, as a fire should be in a suitable location (e.g. a dry spot with good air circulation) but limits movement since you cannot move too close to it. Furthermore, fire produces waste material such as ashes, generating the need for refuse and space management to keep litter contained and out of living areas. Waste from fires can also impact and transform materials that underlies it. Thus, fire is key to both our understanding of the everyday life at a prehistoric campsite, and out interpretation of the archaeological deposits that these activities produced.

Practical experiments can aid in replicating prehistoric processes and events, providing new knowledge and perspectives on archaeological sites and excavated material. Previous fire experiments in MSA contexts have examined how fire affects materials and deposits at a site (e.g. layers in hearths), how hearths and other combustion features are formed (e.g. temperatures and wood analyses), and how heat and fire could contribute to the production of tools (e.g. producing glue to fasten points to shafts). These experiments were usually conducted by a small number of participants and designed to address narrowly defined research questions by limiting the number of variables and allowing strict experimental control. Such precision is vital to the scientific value of these experiments, but can restrict comprehensive analyses of the combined effects of fire-related behaviours.

Dr Silje Evjenth Bentsen, the main organiser of the Jongensfontein experiments and lead author of the paper, had conducted various fire experiments through her PhD and postdoctoral research before moving to SapienCE. She planned an additional series of experiments in South Africa, to examine the effects of heating ostrich eggshell, which is commonly found in MSA archaeological levels. However, other ECRs in archaeology at SapienCE also had projects that could benefit from experimental heating work. The ECR group thus decided to form an experimental team to conduct a comprehensive series of fire experiments. These experiments examined the effects of heating on a range of different materials as well as testing new documentation techniques. In the process they also created reference collections for future research.

ARCHAEOLOGY EXPERIMENTS AND 3D DOCUMENTATION

The experimental fires were constructed within standardised containers measuring 100 x 100 x 30 cm. Within each box, four stratigraphic layers were constructed at a depth of 15, 10, 5 and 0 cm below the surface. The basal layer was sterile, while modern analogues of archaeological materials were placed in overlying layers along with temperature probes where necessary. To obtain spatial control over the different components of each fire, 3D recordings at pre-defined stages of each experiment were produced, from construction to burning and excavation. Positions of the temperature probes and experimental artefacts were also recorded.

This recording strategy allowed for the 3D reconstruction of spatial relationships between, and the visible changes in, elements within a particular experiment over time. Furthermore, the use of standardised containers and fire construction techniques allowed the spatial and visual changes occurring in repeated/related experiments to be compared.

Several types of experimental artefact were used during the experiments: ostrich eggshell, micromammal bones, owl pellets, seashells, and ochre, which were related to the research of Silje Bentsen (postdoc), Turid Hillestad Nel (postdoc), Jovana Milic (PhD), and Elizabeth Velliky (postdoc). In addition, Magnus Haaland (postdoc) took micromorphological block samples at the end of the experiments to study the effects of heat on sediments in-situ. Lastly, Ole Unhammer (PhD) focused on creating 4-Dimensional (4D) spatial and visual records using digital photogrammetry of the fire experiments before, during and after each firing experiment. Overall, each ECR contributed a different component to the experimental season which created a completely new dynamic for conducting archaeological experiments.

THE IMPACT

The planning stage of the experiments was crucial and included both team meetings and discussions as well as individual design of the subproject of each ECR involved. Logistics were another important part of the planning stage, because the experiments were to be conducted in South Africa but were planned from Norway. Several days were set aside to plan and map the equipment required and to ensure that significant tools were collected or bought and brought to the experimental camp site. Customised boxes were produced to contain each experimental fire. Due to time constraints, two experiments (four fires) were burning simultaneously during most of the 3-week experimental season. Duty rosters ensured that the experiments were always monitored, to minimise the risk of unintended fires.
The experimental team convened their own session during the EXARC experimental conference of 2021. This was a virtual conference, consisting of prerecorded presentations, which remained online after the meeting. By December 2022, our session had attracted approximately 1000 views, making it one of the more popular of the conference.
Experimental archaeology publications rarely have space to describe the details of the experimental planning process and methods chosen. The ECR experimental team recognised this gap in the literature and published a co-authored paper on the methods used in their experimental season at Jongensfontein. The paper was published in EXARC Journal, a Level 1 online journal in the Norwegian system. The paper was well received by other experimental researchers and proved so popular that the journal decided to print an abridged version in their hard-copy publication EXARC Journal Digest.

70 000-YEAR-OLD ARTEFACT

– TRAPPED IN A BLOCK OF SEDIMENT REVEALS HIDDEN INFORMATION ABOUT EARLY HUMANS

A SapienCE paper describing the investigation of a Middle Stone Age ochre block trapped inside a plastic-hardened micromorphology sample became one of the top ten most downloaded articles in the journal Geoarchaeology this year. The study demonstrates how the creative use of unconventional research methods turned an unfortunate archaeological sampling event into a scientific success story. However, the journey from accidentally (and irrevocably) incorporating a rare archaeological artefact into a micromorphology sample to producing an important scientific publication was not straightforward. Here is the story behind the trapped ochre piece.

A feeling of disbelief, and a rush of adrenalin ran through Magnus Haaland as he realized what had just happened. He was working on a plastic-hardened block of sediment collected during fieldwork in South Africa. As he was slicing it up, he realised that he had cut through a large piece of ochre which had been accidentally trapped in the sample. The block he was working on had been collected in Blombos Cave in South Africa. This meant that the artefact, which he had permanently encased in plastic and now sliced through with a saw, could potentially be packed with important information about our ancestors who once lived in this cave 100,000 years ago.

However, help was at hand in the form of Magnus's colleague, André Strauss, who specialised in using micro computed tomography (Micro CT) scanning for reconstructing an otherwise destroyed material. André suggested that Magnus should investigate Micro CT scanning of the block with him. In addition, Magnus decided to contact Elizabeth Velliky – who he knew specialises in prehistoric ochre use. Maybe she knew how to find out whether the ochre pieces were used by humans. She was immediately interested.

" The tricky part was that we only had thin slices of this piece, so any marks that we see might either be from humans or natural causes. Without having the entire piece to look at, it was a real challenge! Thankfully, Magnus had several thin sections made from the ochre piece - imagine taking a few slices from a loaf of bread - so we could piece together the story when we combined all those sections together", Velliky explained.

Magnus Haaland, André Strauss and Elizabeth Velliky worked together on restoring the piece of ochre, along with fellow SapienCE scientists Christopher Miller, Karen van Niekerk and Christopher Henshilwood. The scientific project produced several important findings which are presented in the in the international journal Geoarchaeology. When asked what the most important findings from this study were, Velliky responded:

"I suppose it depends on which author you talk to. I think Magnus would say that the major finding is that archaeologists shouldn't be afraid of taking micromorphological block samples from their sites, because even if artefacts are caught in these blocks, there is still a lot of information that you can get from it, and it even opens some research avenues that otherwise wouldn't be available - such as destructive analyses".

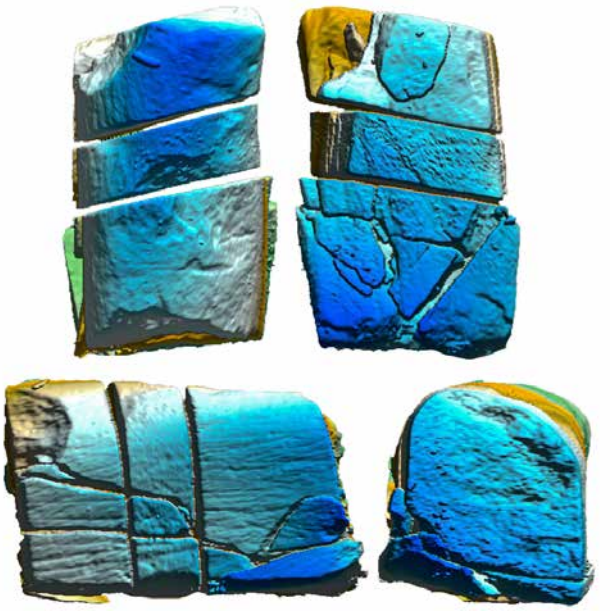
However, for Velliky the major finding of this work is that it has created a new way to study human-made markings on ochre pieces.

"Before our study, these interpretations were highly subjective – as they depended on the site, the type of ochre, and the person looking at them. Now we know that there are a lot more subtleties to these marks, and that previously we may have been looking at and analysing

them the wrong way. Then André might tell you that he was particularly excited about the use of Micro CT scanning for reconstructing an otherwise destroyed material".

Velliky says that the research on the trapped ochre piece has been the most unique project she has been part of. She hopes that the paper can inspire more people to pay attention to micro-ochre fragments at their sites, and perhaps be encouraged to collect more samples.
"Often people see patches of red and dig through them, but I hope our study would encourage people to save these features so we can understand more about how people used ochre in the past. I think we need to create a universal way of talking about how humans used ochre and from there we can really start to discuss what that means for human cultural and symbolic evolution".

According to Velliky, ochre is crucial to understand early symbolic behaviour in humans, because it isn't a biological necessity for humans to survive, so the need for it is different from tools used for hunting. She also thinks that 3D morphometric work, like that published in Geoarchaeology, provides a new and better way of studying human made marks on ochre.
"Often, we just know that ochre was collected and used, but there is sort of a gap during the actual production phase, or at least very superficial knowledge. If we can understand more about how humans interacted with this material and manipulated it, it could highlight more information that we previously missed or overlooked. By using 3D morphometrics, we can gather more information about the marks, their size, features, and nuances, and therefore better understand people who were making them. If we can understand more about how humans interacted with this material and manipulated it, it could highlight information that we previously missed or overlooked," Velliky says.



Putting this philosophy into practice, Velliky is working on a new article about the microscopic ochre fragments, or ochre crumbs, found in the sediments at several cave sites in southern Africa. She is using a range of thin sections from Blombos Cave as a case study. As a result of analysing the trapped ochre piece, she has created a good technical workflow for easily and quickly identifying these micro-ochre pieces in thin section, whereas previously have needed to visually find each little piece. She then uses several analytical techniques to see whether they are different types of ochre, and if so, how many types are present. Her goal is ultimately to compare these micro-ochre fragments with the larger ochre pieces excavated at the site.

CUTTING-EDGE TECHNOLOGY

UNLOCKS THE GATEWAY TO ANCIENT HUMAN DNA

The analysis of ancient DNA from sediments is an emerging technology that detects the past presence of humans and other animals at archaeological sites. However, little is known about the mechanisms by which DNA is preserved in sediments for long periods of time. A study, recently published in PNAS (the Proceedings of the National Academy of Sciences of the United States of America), has shed new light on the matter. By isolating DNA from solid blocks of undisturbed sediment embedded in plastic resin, the scientists discovered that ancient human and animal DNA is concentrated in small 'hot spots', particularly in microscopic particles of bone or faeces.

"With this approach it will become possible to analyse the DNA of many different ancient human individuals from just a small cube of solidified sediment", says the lead author of the new study, Diyendo Massilani, from the Max Planck Institute for Evolutionary Anthropology, a collaborating partner of SapienCE in several projects.

Working on sediments from Denisova Cave in the Altai Mountains, Massilani was able to recover substantial amounts of Neanderthal DNA from only a few milligrams of sample. Because these sediments were embedded in plastic resin as part of the process of making micromorphology samples, he was able to drill very small, precisely located samples. This approach allowed him to identify DNA from two individual males, who were related to a Neanderthal whose genome was previously reconstructed from a toe bone discovered in the cave.

"The Neanderthal DNA in these small samples of plastic-embedded sediment was far more concentrated than that typically found in loose material. It is amusing to think that this is presumably so because they used the cave as a toilet, tens of thousands of years ago", Massilani says.
SapienCE has contributed to the research with samples from its main archaeological sites: Blombos Cave, Klasies River and Klipdrift Shelter. Some of the blocks were made

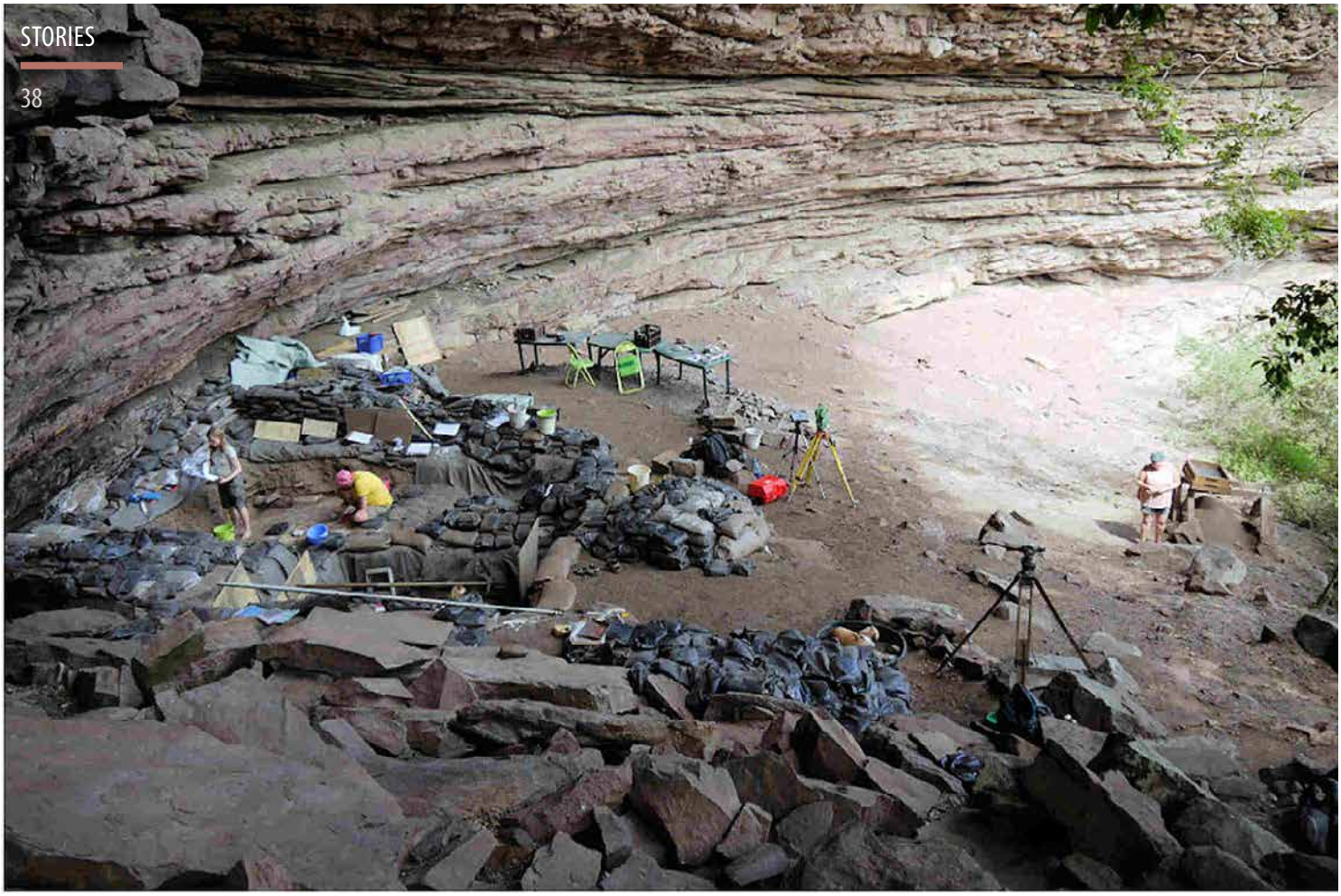
from sediments recovered years ago. SapienCE scientists Christopher Miller and Magnus Haaland, along with their colleague Susan Mentzer from the University of Tübingen, Germany, have been leading the field of microscopic study of sediments, known as micromorphology.

"We have been collecting these blocks so that we can study how the sediments - and the artifacts found within them - accumulated over time. The blocks are hardened in plastic so that they can be more easily studied in a laboratory, where we can cut and grind them very thin so that they can be analysed under a microscope, explains Miller. He says this recent study fits in well with the multidisciplinary and innovative approach that SapienCE is taking to understand Middle Stone Age humans in South Africa. Unfortunately, none of the samples from SapienCE sites yielded any DNA.
"Although the results from these sites were not what we had hoped for, the development of this technique - thanks to the help of the SapienCE team- marks a major advance in the field of ancient DNA studies and geoarchaeology" says Miller.

Christopher Henshilwood, director of SapienCE, was also disappointed that that the SapienCE samples contained no ancient DNA. However, he is adamant that this is an important study for the Centre, since it shows that, in some circumstances, DNA is preserved for very long periods of time.

"This study brings us a step closer to understanding where and under what conditions ancient DNA is preserved in sediments. It is possible that DNA from SapienCE caves did not show up in this study because preservation conditions in southern Africa are not ideal for DNA survival due to temperature, humidity, and other factors".

Many of the samples included in this study that were successful came from the Geoarchaeology Collection at the University of Tübingen, which is an external partner in the SapienCE project. Henshilwood says that the SapienCE will continue to collaborate with the University of Tübingen and Max Planck Institute in the hope that DNA may be recovered from bone or teeth from the Centre's sites.
"I think it is a good opportunity to be a part of a much larger study in which we can compare conditions at our sites with other sites in Africa with those elsewhere. It may not have worked in this round, but the DNA research will continue and hopefully we will get results in the future" says Henshilwood.



80,000-YEAR-OLD BONE TOOLS
FROM SOUTH AFRICA AND THEIR PROBABLE FUNCTION

Our ancestors used bone fragments as tools as early as two million years ago. From 1.8 million years ago they learned to modify bone with the same techniques used to knap stone and, from 1.4 million years ago, they were able to produce bone bifacial tools similar to those made of stone. But when did bone tools shaped with techniques adapted to bone material, such as abrasion, scraping, grooving and gouging appear? The application of these techniques allows the final shape and size of objects to be determined with a high degree of precision, facilitating their hafting, imposing a style and making them emblematic of a particular human group. What was the function of these first elaborate tools? Until the beginning of this century, the application of these techniques was considered to be an innovation introduced into Europe around 40,000 years ago by modern humans. Research carried out over the last two decades, often by researchers affiliated with SapienCE, has led to the discovery of fully worked bone tools in several regions of Africa, some of which could date back 100,000 years. But those found so far are rare or non-standardized in shape. A new discovery, published this year by SapienCE senior scientist Francesco d'Errico and his colleagues, changes the picture. He and his team documented 23 ancient bone tools found at Sibudu, a large rock shelter located close to Ballito, Kwa Zulu-Natal, South Africa, all with a flattened ogival-shaped end. They come from archaeological layers dated to between 80,000 and 60,000 years ago. Using a confocal microscope they studied in three dimensions the wear found on these ancient tools and compared them to similar features found on modern bone tools used experimentally for debarking trees, processing skins with and without ochre, digging in sediments inside and outside caves, and on ethnographic tools used for debarking trees. By applying a discriminant statistical analysis to the roughness of the worn areas the team concluded that tree debarking and digging in humus-rich soil were the activities that most closely match the use wear recorded on the majority of Sibudu tools. Interestingly, this type of tool continued to be used at Sibudu for 20,000 years, despite the fact that the occupants radically changed the way they produced stone tools during this period. These results support a scenario in which some modern human groups in southern Africa developed and maintained specific, highly standardised cultural traits locally, while sharing others across the subcontinent.

Figure 1. Sibudu rock shelter during excavation

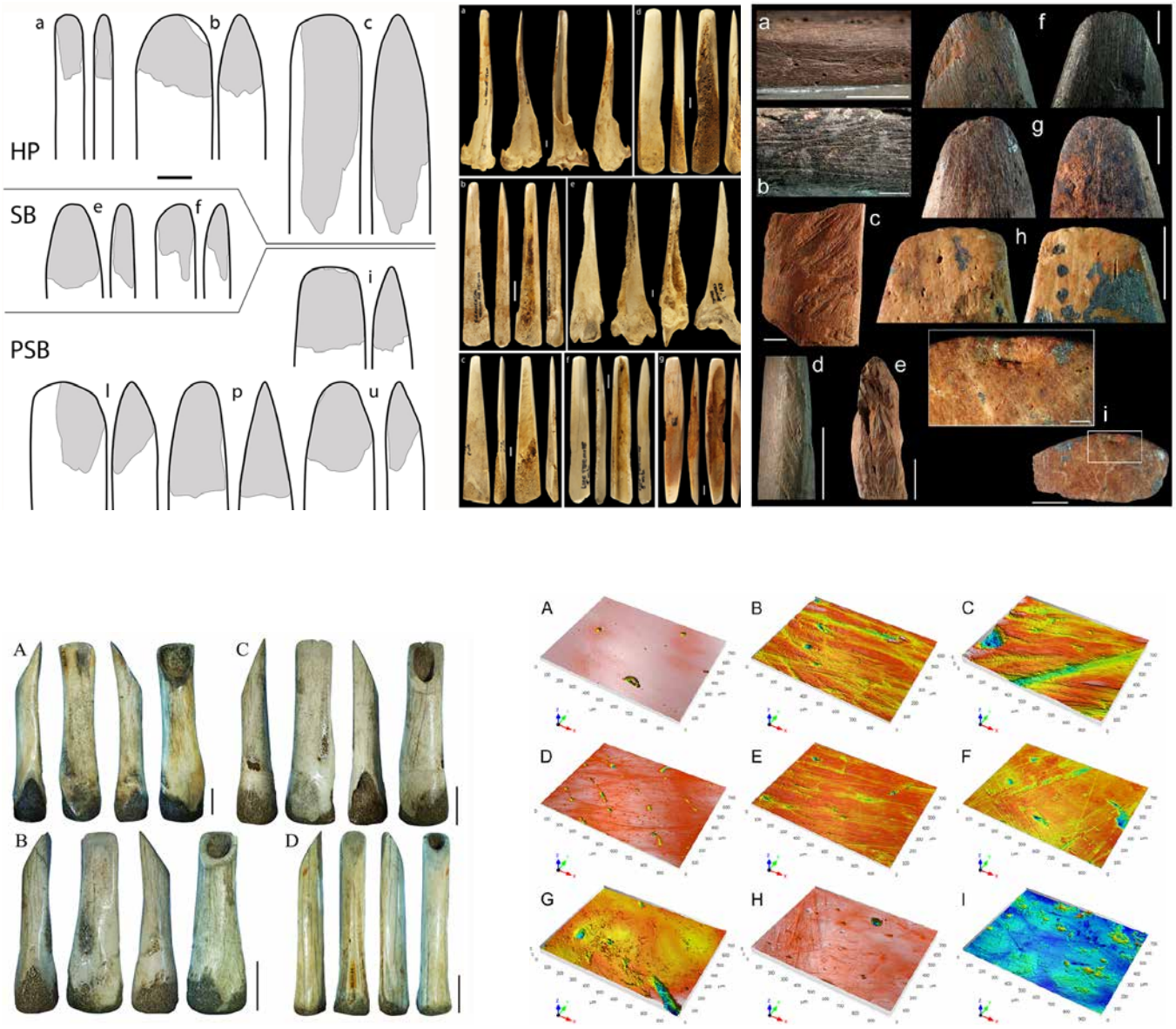


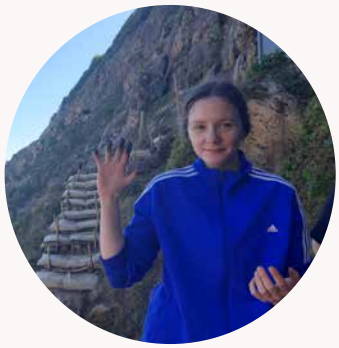
Figure 2. Top right: manufacturing and wear traces on bone tools from Sibudu Cave; top middle: reconstruction of the morphology of the tools tips from different archaeological layers; top left: experimental bone tools used in different tasks; bottom left: ethnographic tools used for debarking trees; bottom right: comparison of surface conditions between archaeological and experimental tools shows variations in the type and intensity of wear: no wear (A), digging of dry (B) or humus-rich (C) sediments for 20 minutes, treatment of rabbit skin without (D) and with (E) ochre for 20 minutes, and debarking of oak trees (F) over an extended period. The experimental (B-E) and ethnographic (F) data are compared with three archaeological specimens found at Sibudu (G-H).

MA STUDENTS IN BLOMBOS

Prior to the Blombos 2022 field season, Irene had no experience with South African archaeological material, while Åshild had no field experience whatsoever. We both attend the University of Bergen's master's program in archaeology, and we share a passion for the stone age. We were therefore thrilled (and a little bit nervous) when we received the news that we had been given the opportunity to be a part of this year's Blombos Cave excavation team.

Before leaving for the field, we received thorough training in the equipment we were going to use, which included a Trimble total station (for plotting the location of finds), photogrammetry software and database recording. While working in the cave, we had a comfortable learning environment where we were able to learn about the archaeological material as it was gradually uncovered, and simultaneously increase our abilities and confidence with the use of the specialist equipment and software. Blombos Cave is a dynamic and complex site, and we were able to observe and experience for ourselves how rich and diverse the material is, and we found ourselves stunned by the excellent preservation of ancient materals.

Working at the site, surrounded by the most spectacular landscape, often sparked our curiosity and reflections.
We are immensely grateful for having been able to participate in this field season, and to contribute to the work of further expanding our knowledge of the human past. We are also honoured to have met and worked with the other equally passionate team members. Conversations with them have provided us with valuable insights regarding our own research interests, as well as sparked new thoughts and ideas. It has truly been a unique learning experience.



ÅSHILD STUEN JENSEN

My interest and passion lie with osteology. I am studying tortoise remains from Klipdrift Cave in South Africa for my thesis. Tortoises are not a feature of the Norwegian fauna, and my time at Blombos has therefore been crucial to my understanding of their unique anatomy. It was also a good opportunity for me to experience how osteological material appears in an archaeological context, contrary to the often stylised drawings and images of pristine specimens found in a book. One of the more touching and thought-provoking experiences for me was when we uncovered a piece of striated ochre, as this was the moment it properly dawned upon me that a group of real, breathing people once handled and worked with these artefacts."

IRENE EKREN

"I specialise in prehistoric fishing tools, techniques and subsistence strategies, as well as coastal resource adaptations of the past. At Blombos, ancient layers of soil and sand, in themselves consequential and containing information, peeled back to reveal a delicate tapestry conveying a tale of early human behaviour. Among the many threads interwoven into this tapestry, I found myself particularly drawn to shellfish and stone tools, speaking of interaction with and adaptations to an ancient landscape and its resources. As I helped with recording our finds and using the total station, I would often listen to the sea just below the cave. You cannot be at the site without noticing the timeless sound of waves crashing against the cliffs. The climate and environment have changed throughout the millennia, and the shoreline has moved, but perhaps the echo of those waves still lingered in the shells collected by these peoples, all those years ago."

Figure 1: a) Stratigraphy of KDS showing layers and OSL dates; b) Location of excavated quadrates within KDS; c) excavated layers in section; figure by M.M.Haaland.

Figure 2: Title screen of the podium presentation given at the annual meeting of the ESHE society held in Tübingen, Germany.

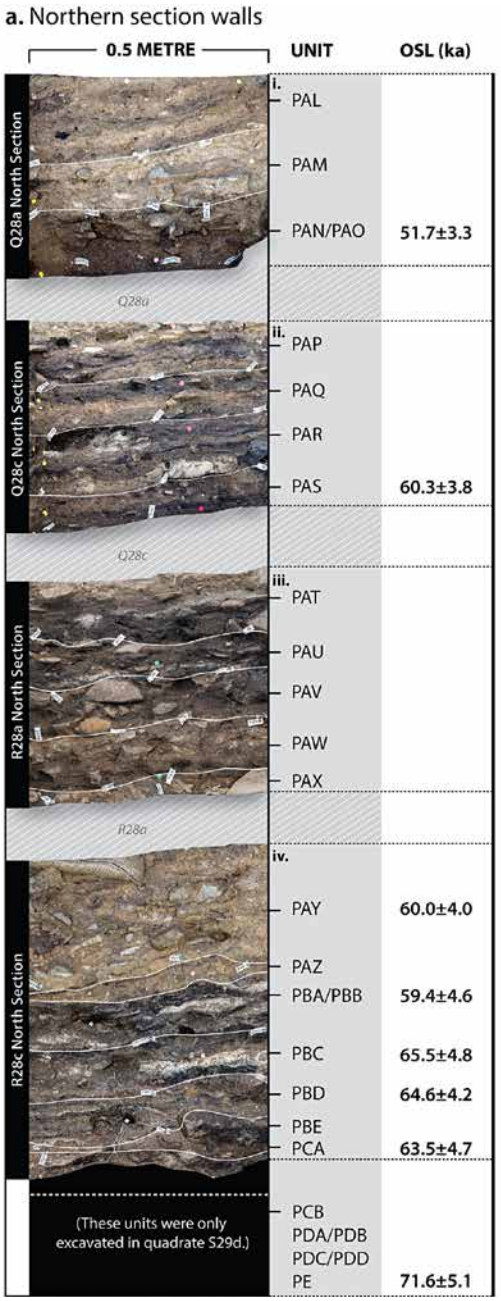
NEW INSIGHTS INTO OCHRE ARTEFACTS AND FEATURES FROM KLIPDRIFT SHELTER

The emergence of symbolism is a crucial aspect of investigating when, why and how ancient hominins adopted modern behaviour. Within this discussion, the use of mineral pigments is arguably one of the oldest mediums for abstract or symbolic communication. Iron-rich rocks, referred to as ochre, are the first pigments known to be used by prehistoric humans. Ochre has been used since at least 300 thousand years ago in South-Central Africa, as well as by European Neanderthals, and appears on lithics, bones, stones, shells, beads and cave and rock walls. Ochre is a frequently encountered archaeological material at two of SapienCE's flagship sites; Blombos Cave (BBC) and Klipdrift Shelter (KDS).

KDS is a 7 m deep rock shelter situated in a coastal cliff, ~12-15 m from the Indian Ocean and ~19 m above sea-level. KDS was first excavated in 2011, with subsequent seasons in 2012, 2013, and 2018. The stratigraphy bears 20 layers and lenses, and there are still intact sediments at the site. Optically stimulated luminescence (OSL) dates the uppermost layer to ~52 thousand years ago (ka), the middle layers from ~66-59 ka, and the current lowermost layers (which are anthropogenically sterile) give an age of ~72 ka (Figure 1). The middle layers are associated with the Howieson's Poort technocomplex, beginning with layer PAY and ending with layer PCA, and are of particular research importance given the density of anthropogenic material that they contain.

An initial assessment of the ochre assemblage at KDS was conducted by Riaan Rifkin and published in 2014. A new reassessment of the ochre assemblage, including materials from the 2018 excavation season, was undertaken by SapienCE postdoc Elizabeth Velliky as part of her postdoctoral research and is currently being written for publication. Both specialists report a few hundred ochre pieces, including pieces that have been modified by humans at the site to create pigment powder. Pigment powder was likely used in several different ways, including as a body paint, sunscreen, insect repellent, medicine, and hafting adhesive, to name a few. Ochre was thus a multi-purpose tool and formed an integral part of life for MSA peoples along the southern Cape.

This topic was the focus of a podium presentation given by Elizabeth Velliky along with co-authors Magnus Haaland, Susan Mentzer, Karen van Niekerk, and Christopher Henshilwood at the European Society for the study of Human Evolution (ESHE) annual meeting held from September 21-25, 2022, in Tübingen, Germany (Figure 2). Here, she presented the results of the recent analyses of the KDS ochre assemblage, including new ochre artefacts, new types of pigment found at the site, and in-situ microscopic ochre features that have only recently garnered the interest of geo/archaeologists in South Africa. These microscopic ochre particles are poorly studied and as such, little information exists on their origin and their potential implications for Middle Stone Age (MSA) behaviour. However, microscopic ochre is present at both KDS and BBC, and is currently being studied by SapienCE scientists Elizabeth Velliky, Magnus Haaland, and Christopher Miller, along with other international collaborators. Understanding more about the types of behaviour that created such features, or any other possible taphonomic processes impacting their preservation, is key to gaining new insights into MSA ochre practices along the southern Cape.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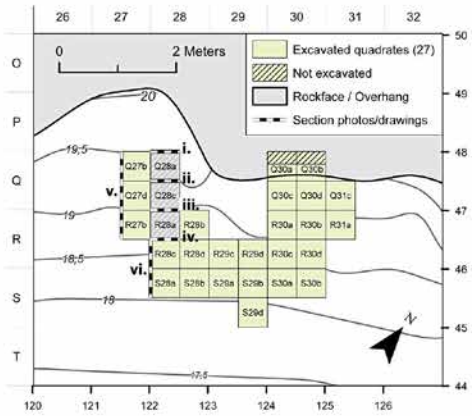
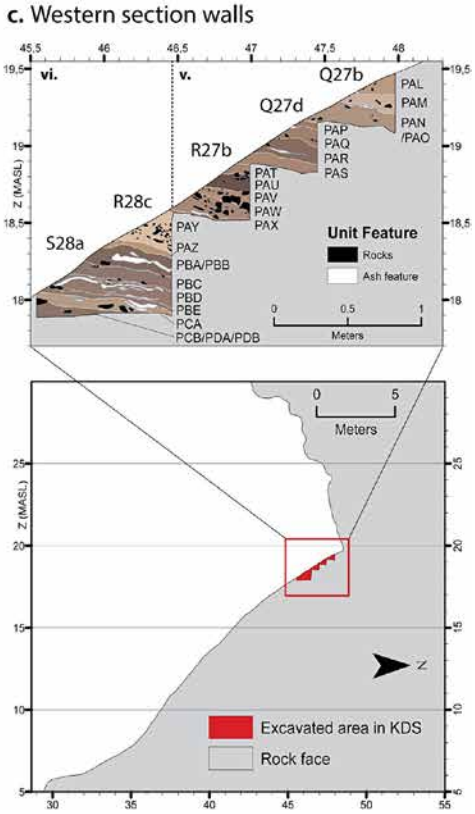
PAP
PAQ
PAR
PAS
60.3±3.8
Q28c
iii.
PAT
PAU
PAV
PAW
PAX
R28a
iv.
PAY
PAZ
PBA/PBB
59.4±4.6
PBC
65.5±4.8
PBD
64.6±4.2
PBE
PCA
63.5±4.7
(These units were only excavated in quadrate S29d.)
PCB
PDA/PDB
PDC/PDD
PE
71.6±5.1


b. Klipdrift Shelter site map
0
2 Meters
Excavated quadrates (27)
Not excavated
Rockface / Overhang
Section photos/drawings


c. Western section walls
vi.
v.
Q27b
Q27d
R27b
R28c
S28a
PAL
PAM
PAN /PAO
PAP
PAQ
PAR
PAS
PAT
PAU
PAV
PAW
PAX
PAY
PAZ
PBA/PBB
PBC
PBD
PBE
PCA
PCB/PDA/PDB
Unit Feature
Rocks
Ash feature
Meters
Z (MASL)
Excavated area in KDS
Rock face


SapienCE
CENTRE FOR EARLY SAPIENS BEHAVIOUR
UNIVERSITY OF BERGEN
UNIVERSITY OF BERGEN
Faculty of Humanities
PBC
PBD
PBE
PBEochre
New insights into ochre features and their associated behaviours from the Howieson's Poort layers at Klipdrift Shelter
Elizabeth C. Velliky, Magnus M. Haaland, Susan Mentzer, Karen van Niekerk, Christopher S. Henshilwood
[a]SFF Centre for Early Sapiens Behaviour (SapienCE), University of Bergen, Bergen, Norway
[b]Institute for Archaeological Science (INA), University of Tübingen, Tübingen, Germany
[c]Museum of Archaeology, University of Stavanger, Stavanger, Norway
[d]Evolutionary Studies Institute, University of the Witwatersrand, South Africa

ANCIENT PROTEIN ANALYSIS

Ancient proteins, in particular collagens, were studied long before the application of proteomics in archaeological research. However, advances in mass spectrometry have made palaeoproteomics the method of choice when other techniques such as genomics (which targets ancient DNA) or residue analysis (where lipids are studied) are not able to provide the desired information.

Palaeoproteomics aims to detect and characterise proteins within a sample; therefore it can be applied to a diverse range of materials. By providing information about the level of degradation and biological source of extracted proteins, palaeoproteomics is suitable for analysing fragmented proteins in ancient materials as well as distinguishing several sources of proteins in complex mixtures such as ancient paint. Accordingly, palaeoproteomics can be employed for a wide spectrum of applications including understanding past diet, subsistence and environmental inferences. In particular, proteomics is becoming increasingly important because proteins survive longer and in a wider range on environments than other biological molecules such as DNA, meaning that these techniques are applicable to a wider range of samples.

For my PhD projects, I aim to better understand the manner in which *Homo sapiens* used proteinaceous materials in South Africa, by studying several objects excavated at Blombos Cave (BBC) and Klipdrift Shelter (KDS). Knowledge of the precise nature of the organic compounds used for different tasks, and the consistency of the "recipes" followed when making them, will provide information about level of our ancestors' understanding of the materials that they used. I have developed sample treatment protocols in order to extract proteins from these materials and employ palaeoproteomics to identify the proteins. I work on a range of materials ranging from a red ochre mixture contained within the "paint" toolkits discovered in BBC to residues found inside ostrich eggshells from KDS.

TWO SAPIENCE EARLY CAREER RESEARCHERS
PARTICIPATE IN THE MOMENTUM CAREER DEVELOPMENT PROGRAM AT THE UNIVERSITY OF BERGEN

Postdoctoral appointments are, according to the Norwegian Research Council, "…meant to give highly qualified doctorate-holders the opportunity to further qualify for academic positions."(Research Council of Norway website) Furthermore, they are meant to increase international mobility (amongst and between research groups and the business sector) and promote gender equality. The Moment Career Development Program (Momentum Program) at the University of Bergen (UiB) is a program designed to help actualize some of these concepts by providing excellent resources for early career researchers (ECRs) at UiB.

The core of the program centers around training and advice to support career planning, development and research independence/leadership, to support and deliver competitive applications to funding bodies, to facilitate and expand participants' professional networks, and to promote the development of interdisciplinary connections and networks at UiB. Each faculty is responsible for nominating delegates from a pool of applications which are submitted annually. Selected delegates then must attend a series of workshops held at and outside of UiB, with core themes including excellence, grant writing, internationalisation, impact, and leadership. In addition to these workshops and retreats, delegates receive a NOK 100 000 stipend that they can either spend on mentoring, travel, networking, research visits, workshops or any other career development activity. In short, the program is meant to provide a jump start for ECRs to launch key stages in their career.

The program is prestigious and competitive. Usually, only two delegates are selected from each faculty. Nevertheless, so far, two of SapienCE's ECRs have been selected as delegates: Dr Magnus Mathisen Haaland in 2019-2020 and Dr Elizabeth Velliky in 2022-2023. Dr Haaland used the training he received from the Momentum Program to conceptualise and begin writing a Young Talents Grant from the Norwegian Research Council, though he left SapienCE to take up a permanent position at the University of Stavanger Museum of Archaeology before this was submitted. Dr Velliky plans to use the program to write a European Research Council starting grant focusing on ancient and modern uses of ochre and will use the funding to organise a workshop and undertake pilot research for the grant.

More information about the Momentum Program and how to apply can be found at:
https://www.uib.no/en/research/110492/momentum-career-development-programme-early-stage-researchers

U-TH DATING OF SHELL MIDDENS

FROM KLASIES RIVER MAIN SITE SHOWS CONSISTENT COASTAL EXPLOITATION PRIOR TO 110 000 YEARS AGO

Coastal habitats with their diversity of nutrient-rich resources have provided an advantageous backdrop for hunter-gatherer fishers through the millennia. Multiple groups made Klasies River main site (Figure 1) home during the Middle Stone Age, from before 120 000 years ago to about 48 000 years ago. Klasies River main (KRM) site currently overlooks the Indian Ocean and although the Quaternary climate fluctuated and the shore periodically moved further away, most of the layers contain plentiful shellfish showing that the ocean remained close enough for regular collection.

The current excavation at the site, led by SapienCE archaeologist Sarah Wurz, focuses on the Witness Baulk of Cave 1 (Figure 2) at KRM, on a phase previously thought to date to around 100 000 years ago, to Marine Isotope Stage (MIS) 5c. This estimate was based on previous ages from speleothems not directly associated with the archaeological remains. Wurz and her team uncovered small speleothems that formed on top of the occupational material deposited in the Black Occupational Soils (BOS) layer - bones of animals and shellfish that they consumed, stone tools and hearths. The speleothems formed as occupation decreased or stopped during a hiatus, and drip rates into the cave increased. Uranium Thorium dating of three in situ speleothems undertaken by isotope geochemist Robyn Pickering demonstrate that this hiatus occurred between 106 and 110 000 years ago (Figure 3).

The shellfish above and below the dated horizon indicate fluctuating coastal ecologies. In the ca. 100 000 year old layers overlying BOS, the dominance of shellfish such as alikreukel (giant periwinkle) and brown mussels indicate relatively sheltered conditions within a rocky coast. In the layers dating to older than 110 000 years ago more types of shellfish were added to the menu. Alikreukel occurs in lesser quantities, and brown mussels, whelks and limpets are targeted in higher numbers. This group of taxa reflects that rocky exposed shores were more prominent in the coastal environment in the period older than 110 000 years ago, in MIS 5d.

Micromorphology of the dated horizons and other middens throughout the site was undertaken to provide a broader context to these results and to understand how the archaeological horizons formed, and which processes affected the occupational soils afterwards. Through the lens of the micromorphologist and geoarchaeologist, Susan Mentzer, it was shown that shell middens occur throughout the 21 metre sequence at KRM, at different degrees of preservation. KRM has such a long history that it is no surprise that it was subjected to many post-depositional processes, for example compaction, shell dissolution and soft sediment deformation. One important implication of the micromorphological results is that visual impressions, counts and density measures of shellfish cannot be used in a straightforward way to interpret the extent of shellfish exploitation.

This study shows that coastal exploitation was already habitual by 110 000 years ago at KRM. At KRM half a metre of shell middens occurs below the dated horizon and may have formed in early MIS 5e (130 000 and 110 000 years ago). These results add to the emerging insight that regular exploitation of coastal resources on the coast of South Africa occurred prior to 100 000 years ago. The finds from KRM complement those from Blombos Cave and multidisciplinary investigations of these sites' palaeoenvironmental proxies and cultural material promise to expand the frontier of knowledge on early *Homo sapiens* in Africa.

Figure 1:

Figure 2:

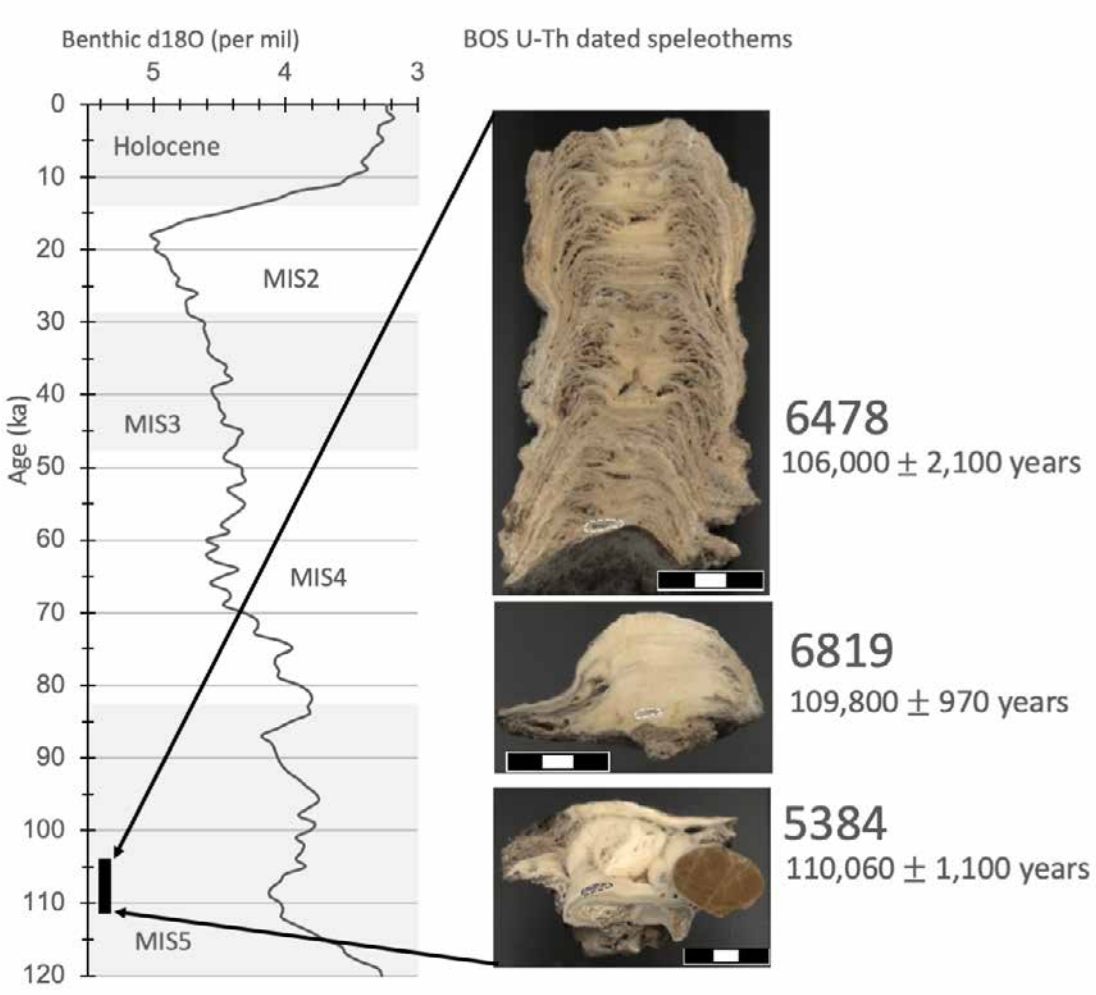


Figure 3:

BORDER CAVE

– AN EXCAVATION TO UNDERSTAND MIDDLE STONE AGE CULTURAL EVOLUTION

Early evidence of complex behaviour and symbolism is found at a handful of sites across the African continent, beginning about 160 thousand years ago. Border Cave, located in Kwa Zulu Natal, is one of these sites. A special volume of the journal Quaternary Science Review, comprising nine multiauthored papers, highlights the work carried out since 2015 in this vast cave by an international team of researchers led by Lucinda Backwell, Lyn Wadley and SapienCE researcher Francesco d'Errico.

The site has experienced five episodes of excavation. The first, which has remained unpublished, took place in 1934 when the famous paleoanthropologist Raymond Dart dug a narrow east-west trench at the entrance. The second, conducted in 1940 by Horton to extract guano from the middle of the cave, uncovered archaeological and human remains. During the third excavation episode, in 1941 and 1942, Cook and colleagues recovered additional human remains and clarified the stratigraphy of the site. They also reported the discovery of an in situ infant burial containing a perforated and ochred Conus sea-snail shell, which remained until recently the earliest known African burial. Excavations carried out by Beaumont between 1970 and 1975 and Beaumont, Todd and Miller in 1987 revealed Iron Age, Early Later Stone Age and Middle Stone Age horizons dated between 227,000 and 24,000 years ago.

Our interest in this site was stimulated, before we decided to resume excavations, by our analysis of artefacts discovered by Beaumont in the 44-40 thousand year old layers. The analysis of organic remains from these layers showed that Border Cave visitors were producing a material culture surprisingly similar to that found at recent Later Stone Age sites, suggesting that the subsistence strategies known among historical hunter gatherers have a deep past. This includes ostrich eggshell beads, bone arrowheads, a poison applicator, a lump of beeswax, a digging stick, microliths that were hafted with tree resin and a bored stone, probably used as a weight on a digging stick, decorated bone points, and bone awls. We interpreted a notched baboon fibula dated 44–42 thousand years ago as the earliest known system of notation, in which notches were added at different times using different stone tools.

Our ongoing excavations are sampling all archaeological layers, and aim to reassess the stratigraphic context of the sedimentary and cultural sequence, gain insight into site formation processes, improve the chronology of the site, make a detailed study of organic remains, identify long term cultural trends, and characterise expressions of complex behaviour and innovation.

The new excavations have led to major discoveries, some already published and others in the process of being published. We have shown that the Border Cave deposits are unparalleled in terms of plant preservation. Unburnt wood is rarely preserved at Middle Stone Age sites, and yet wood artefacts occur throughout the Border Cave sequence. Seeds are also recorded throughout the sequence as is desiccated grass bedding. In the oldest layers, bedding is

silicified, and the fact that it was preserved in layers dated ~200 years ago is extraordinary. Grass bedding throughout the sequence overlies a layer of ash, suggesting that ash was intentionally used as a clean surface that may also have deterred crawling insects.

Fifty-five charred underground storage organs, identified as *Hypoxis angustifolia*, are the oldest known examples of cooked starchy rhizomes, brought to the site to beprepared and shared 170 thousand years ago.

The abundance of land snails bearing evidence of heating in layers dated to between 168 and 77 thousand years ago suggests that they may have been part of the diet of visitors to the cave, and that more recent occupants ate them only occasionally.

Pieces of charcoal are found throughout the Border Cave sequence. Charcoal remains of camphor bush trees (*Tarchonanthus sp.*) are found in the ancient bedding dated to >227–144 and 74 thousand years ago. Nowadays, camphor leaves are used medicinally, for cosmetic purposes, and to produce perfumed smoke that can repel insects, but the wood is rarely used for making fires. Hence, the presence of *Tarchonanthus sp*. at Border Cave suggests that the use of these trees for purposes other than fuel was known and employed by Middle Stone Age people.

Reappraisal of the BC1 skull, found in 1940 by Horton, shows that the overall morphology of its endocast approximates the derived globular shape of the modern human brain, and that the bony labyrinth displays some ancestral features observed in *Homo erectus*, which are also recorded in variable proportions in modern humans. Gamma spectrometric uranium-series dating is the only non-destructive method available for dating the cranium and will soon be used to date this specimen.

New luminescence ages based on feldspar grains are in broad agreement with the previous chronology established for the site, which makes of this site one of the rare African sequences spanning 200,000 years.

Geoarchaeology and faunal taphonomy have started to elucidate site formation processes, showing that the members identified by Beaumont should not be considered as homogeneous units but as complex palimpsests affected by a variety of site formation processes active in the shelter. This finding is supported by lithic analysis of the Member 2 WA assemblage, which shows differences in technology between artefacts from the top, middle and basal part of that member.

The 2022 field season, the first after the pandemic, has shown that Border Cave is still far from having revealed all its secrets and deserves a careful investigation adapted to the exceptional archaeological richness of this site.

AN 'INVISIBLE' FOOD
AND ITS ROLE IN COGNITIVE EVOLUTION

Food is essential for survival, and most species devote a huge amount of time and energy to obtaining it. A species' diet tells us a great deal about the traits and skills that have evolved in line with its mode of subsistence. Humans are generalists in what we eat. Therefore, compared to the specialists (such as species that only eat insects or fruits), it is easier for us to find potential sources of food. But identifying which food is suitable is a much more demanding task. As generalists lack genetically stored knowledge about what should be eaten, figuring out what is edible constitutes a key learning task in early life. According to a pioneer in this field, Paul Rozin, psychological systems that evolved for this learning task may have served as pre-adaptations also for other, non-related tasks. By becoming co-opted for the new tasks, these systems would then have helped to drive cultural and cognitive evolution more broadly. For SapienCE, information about the food consumed in the African Middle Stone Age is therefore not only important in its own right – being a key concern for people's subsistence and lifestyles – but is also informative for reconstructing their social organisation, cognitive strategies, and symbolic capacities. For several reasons, the foraging and consumption of mushrooms as food provides an ideal testbed to investigate this.

THE (ALMOST) INVISIBLE FOOD
. . . growing underground and not leaving any trace

For most of their lifetime, the fungal organisms that produce mushrooms are invisible. These organisms consist of an extensive network of rootlike hyphae, which are typically so hair-thin that they are hard to see even when unearthed. Together, these hyphae make up the mycelium, which in many species is perennial and in some can grow to several thousand years old. Once a year, for a couple of weeks, some individuals of some species of fungi produce fruiting bodies that emerge above ground, with the sole purpose of producing and dispersing spores. These fruiting bodies are what we call mushrooms, and it is these that capture the interest of mycophagous, that is, mushroom-eating species such as humans and other primates.

Mushrooms have played an important role as a source of food in most human cultures around the globe, and indeed throughout the history of the hominin line. Growing evidence for mushroom consumption in prehistoric *Homo sapiens*, in now extinct Neanderthals, and in contemporary non-human primates indicates that edible mushrooms would most likely also have been a target of those human groups whose traces we find in our excavation sites in the Southern Cape area. As mushrooms lack skeletal structures such as bones or shells, and hence remain invisible in the archaeological record, they have never before been considered a relevant – or even plausible – part of prehistoric diets of the African Middle Stone Age.

Screening the evidence for a potential usage of this valuable source of food in the Southern Cape area, and illuminating how our ancestors would have learned to tackle its vagaries, is the focus of a collaboration between SapienCE and Nofima, the Norwegian Institute of Food, Fisheries and Aquaculture Research.

THE (HIGHLY) AMBIVALENT FOOD
. . . high risk – high gain

Fresh mushrooms predominantly consist of water (up to 90%), but their dry matter is rich in carbohydrates, essential amino acids (protein), and variable amounts of lipids, including beneficial, polyunsaturated (omega-3/6) fatty acids. In addition, they contain distinct cocktails of important vitamins and minerals. Thanks to this favourable composition, mushrooms can be a highly valuable source of food for humans and other primates: nutritious, unique in flavour, and easy to harvest when in season. However, by no means are all fungus species edible. A large number are merely unsuitable for consumption, numerous species are poisonous, and some are downright lethal.

There are two uncertainties that are particularly worrisome for any mushroom forager. First, there is no way to see which species are edible and which are not. In the early days of mushroom foraging, some pioneers must have simply tried to figure this out, risking their life in the process; and their descendants had to learn from these trial-and-error

experiments, remember their outcomes, and pass on the knowledge, often so dearly bought, to the next generation. The second uncertainty bedevilling mushroom foraging is the potentially fatal risk of confusing edible mushrooms with poisonous ones. These two uncertainties are further exacerbated by the vast number of existing species. For successful foraging and safe consumption, it is therefore essential to learn enough reliable information to handle these risks, and to gain manifold insights into the ecology of fungi and where to find the tastiest ones. As such, the accumulation and transmission of knowledge about mushrooms can be seen as a prime example of cultural evolution.

UNEARTHING EVIDENCE

. . . how to secure a body of critical knowledge

In short, while mushrooms are a valuable source of food, they can also be a highly risky choice: nourishing, delicious, and easy to pick, but also fickle and hazardous, even potentially deadly. A major question for all investigations into prehistoric subsistence patterns – and hence also key to SapienCE – is therefore how those feeding off mushrooms have tackled such challenges. More precisely, when and why did our ancestors begin to explore the world of mushrooms? Which cognitive skills and cultural strategies have enabled mycophagous species more generally, and humans in particular, to take advantage of this food source while safeguarding the survival of both the knowledge accumulated and the people relying on it? And how have these skills and strategies evolved?

In two recent papers on mushroom foraging and consumption, Andrea Bender (SapienCE) and Åge Oterhals (Nofima) demonstrated how distinct cultural traditions have shaped the body of knowledge about mushrooms, with a focus on how and why edibility appraisals for a range of mushrooms change. A review of the ethnomycological literature reveals an astonishing diversity in people's attitudes towards mushrooms in general and in their preferences for particular species, across cultures and over time. Even more astonishing is the diversity in whether and which species are regarded as edible to begin with. While fungal toxins are inherently factual in nature, the correct diagnosis is less straightforward than one might believe. Even with the help of modern technology, species are frequently misidentified. The diagnosis of toxicity is hampered further by a range of possibly confounding factors and by the obscure fungal chemistry, the complexity of which is unparalleled in other biological kingdoms. Crucially, though, edibility appraisals are also affected by cultural attitudes, which can force evaluations of one and the same piece of information into diverging directions.

Hypotheses derived from these findings will be tested in a set of studies by our new postdoctoral fellow Aliki Papa (see her story on page 56-57), the goal of which is to examine the cultural processes involved in the preservation and transmission of expert knowledge on a truly fascinating source of food.

Two members of the Fungus Culture & Cognition team (Åge Oterhals, a senior scientist from Nofima, and Aliki Papa, a postdoc in SapienCE) delved into the key process used to acquire, accumulate, and transmit critical information in the hominin line: In cultural transmission, knowledge about mushrooms is passed on from an expert to a novice through teaching and apprenticeship, typically during a foraging trip.

An exemplar of Tricholoma columbetta. As with most mushroom-producing fungi, its main body resides underground, but in this species, even the fruiting body is often difficult to spot – despite being snow-white and of substantial size – because it tends to be covered by thick vegetation. Here, you can see the same mushroom in the same place, before and after its unveiling.

Exemplars of three different species from three different families: two of them edible, the third highly poisonous. One of the former (Volvopluteus gloiocephalus) is avoided even by many experts because of the risk of confusing it with poisonous exemplars of the Amanita family, especially the deadly poisonous Amanita virosa.

USING KNOT-TYING TO EXPLORE HUMAN COGNITIVE EVOLUTION

The ability to make knots would have been a major asset/advantage in human evolutionary history. Even the use of simple knots would have enabled prehistoric humans to manufacture nets and snares to capture food, and composite tools that could have been used for making shelter.

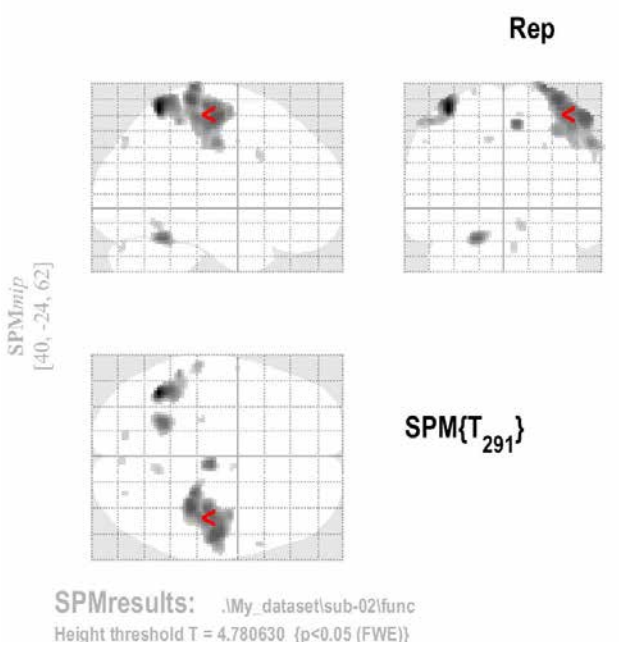
One of the issues when trying to investigate cognitive evolution in Pleistocene humans is that a lot of their actions leave traces that do not preserve well over time. Most of the material culture items of prehistoric human societies are made of perishable materials, such as plant material, bone and leather. Direct evidence of cord and knot-making is, therefore, less likely the further back in time you go. However, indirect evidence such as representations in art and wear-marks on artefacts imply that humans might have tied knots since sometime in the lower Paleolithic period. Wear patterns on shell beads from Blombos cave indicate that prehistoric humans were tying these shell beads to strings at least seventy thousand years ago

Social learning and culture can be found in human societies, but also in groups of non-human animals such as some primates, cetaceans, birds and insects. Through social learning, individuals can share knowledge and behaviors through generations that make up the groups' cultural traditions. Although cultural evolution happens in non-human animals, humans differ in that their cultural evolution seems to be open ended. When they reach a plateau in their innovation, humans incorporate new materials to further innovation, something you don't usually see in non-human animal populations. This has allowed humans to develop complex technology and social organisation that we see around us today, setting us apart from other animals.

In the Brain Activation in Cognitive Evolution (BRACE)-project, we want to look at the neurological basis of this form of social learning. Combining a transmission chain design with neuroimaging, we wish to look at neural activation and how it might change through several instances of social transmission of a simple skill. In the transmission chain design, participants usually learn how to produce a simple artefact and pass information about the artefact and its production on to the second participant in line. The second participant produces the artefact and then passes information along to the third participant, and so on until all participants have produced their own artefact. This is then repeated until you have several chains of participants. Usually, these kinds of studies find that the end product becomes more efficient and/or better as you move down the chain of participants.

In our study we want to look at the neural basis for this social learning process. While using functional magnetic resonance imaging (fMRI) to record brain activation participants learn how to tie simple knots. To pass information along to the next participant in the chain each participant makes an instructional video, showing step by step how to tie the knot. By doing this, we want to gain a deeper understanding of the social transmission of the evolutionary relevant task of knot-tying and see if the tendency for artefact improvement is reflected in the neural activation.

Knowing the brain areas involved in different skills we know were performed by prehistoric humans allows us to trace the evolution of brain development through our prehistory. For knot tying we know that this is a goal-oriented behavior which requires executive functions and planning. These functions take place in the prefrontal cortex of the brain. We can therefore infer that prehistoric humans that tied knots would have a fairly well-developed prefrontal cortex, as well as the capacity for fine motor control and guiding. By investigating brain activation patterns in acquiring knot-making skills, and the variations in execution that accumulate along the way, we aim to contribute some insight into the cognitive and behavioral demands of early technologies and their effect on cultural evolution, as well as a deeper understanding of the human mind.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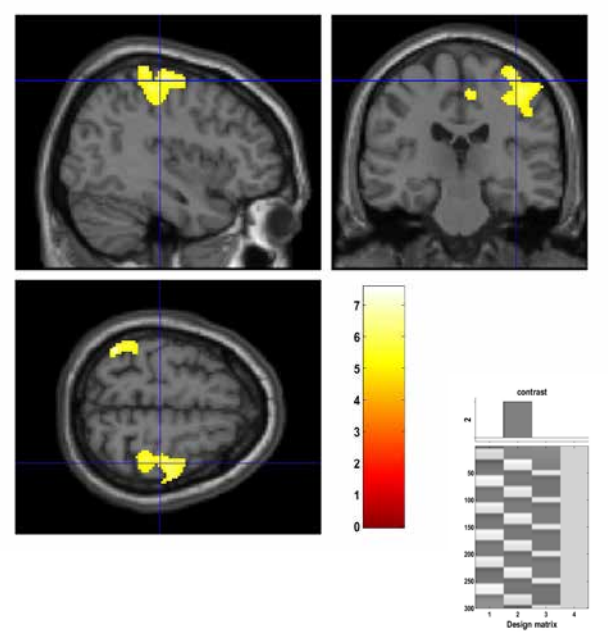
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CONNECTING MINDS.
INTEGRATING MODELS OF COGNITIVE EVOLUTION

MAY 2-6, 2022

Understanding the origins of the modern human mind is not only one of the goals of SapienCE but also a pillar of cognitive evolution research. Over the past two decades, ground-breaking research in Africa, like the discoveries at Blombos Cave, and new scientific techniques such as ancient DNA analysis, have disputed long-established models of cognitive evolution. One model which has been disputed is the so-called 'Palaeolithic Revolution' hypothesis, which attributed modern human cognition to recent biological changes during the Upper Palaeolithic in Europe.

Whereas those breakthroughs have changed paradigms in the archaeology of cognition, they also have confronted us with other challenges. For instance, they have highlighted a need for broader theoretical frameworks able to accommodate multiregional and multi-species data, and for ways of interpreting empirical information in terms of long-term evolutionary trends. Facing up to these issues requires more frequent dialogue across fields and multidisciplinary approaches that can connect theories of how the human mind evolved to how that process may be traced, reconstructed, tested, and explained through evidence from bones, artefacts, genes, and brains.

From May 2nd to 6th, 2022, more than 35 participants convened at the Lorentz Centre, in the Dutch town of Leiden, to discuss these issues in a workshop titled *Connecting Minds. Integrating Models of Cognitive Evolution.* The meeting was organized by SapienCE postdoctoral fellow Larissa Mendoza Straffon, supported by a grant from The John Templeton Foundation, in collaboration with three researchers from The Netherlands; Geeske Langejans (University of Delft), Gerrit Dusseldorp (Leiden University & Wits University) and Mariska Kret (Leiden University). The guests included junior and senior researchers from over a dozen countries and diverse backgrounds, active in various disciplines including archaeology, neuroscience, linguistics, anthropology, and evolutionary biology. Fellow SapienCE postdoc Elizabeth Velliky was one of the attendees.

In daily work sessions, the group discussed core concepts and key questions in the study of hominin cognition, and how these are addressed in their own research communities. Another key theme was how to deal with the limitations of empirical data and the knowledge gaps in existing models of cognitive evolution. During the week, the results of these discussions were turned into the basis for six collective papers. These aim to advance the field by establishing a common ground and setting a new course for interdisciplinary research on the origins of modern human cognition. These papers will be published as an issue of *Topics in Cognitive Science.*

During the five days of the workshop, the participants not only had formal and informal discussions and writing sessions, but also plenty of opportunities to enjoy the beautiful town of Leiden and socialise during lunches, dinners and bar visits. They also enjoyed an excursion to Zandmotor Beach, where they went hunting for fossils from Doggerland, (the submerged Pleistocene landscape that once connected the British Isles, The Netherlands and Southern Scandinavia), guided by Luc Amkreutz, curator of prehistory at the Royal Museum of Antiquities in Leiden.

The organizers hope that, in addition to being remembered as a good experience, the *Connecting Minds* workshop will yield lasting collaborations among colleagues as well as novel ideas that will blaze the trail for future research on the evolution of human cognition.

NEW RESEARCHERS

ASIA ALSGAARD - FISH BONES AND SEAL TEETH IN THE MIDDLE AND LATE STONE AGE

The national fish of South Africa is the dusky black galjoen, which is named after the heavily armed Dutch Galleon ships of previous centuries. The name suits the fish's feisty nature and, for this reason, is a sought-after sport fish today. During Dr. Karen van Niekerk's zooarchaeological analysis she demonstrated that early humans caught the galjoen as far back as 110,000 years ago. Between then and now, the coastal environment has changed dramatically. Sea levels rose and fell. The cold water current of the western coast expanded further east. Estuaries and wetlands formed.

In my project I will expand on Dr. van Niekerk's work by exploring how human exploitation of fish and seals changed alongside different environmental conditionals at the coast. Using stable isotope analyses of seal tooth enamel and fish bone collagen, I will investigate how these environmental changes might have impacted fish and seal populations and, in turn, human harvesting practices. This is a multi-site project incorporating data from Blombos Cave, Klasies River Main Site, Hoffman's/Robberg, and Nelson Bay Cave including multiple species across the Middle and Late Stone Ages. It will include stable isotope analyses as well as body size reconstruction using 3D geometric morphometrics.

As part of the EU's Marie Skłodowska - Curie SEAS (Shaping European Leaders for Marine Sustainability) Programme, I am supervised by Dr. Karen van Niekerk, Dr. Carin Andersson Dahl, and Dr. Mimi Lam. I am grateful for the help and expertise of many colleagues, including Dr. Sarah Wurz, Dr. Judy Sealy, Dr. Wilhelmina Seconna, and Leesha Richardson without whom this postdoctoral project would not be possible. With the permit application for analysis now in place thanks to Samantha Mienies, I look forward to presenting results in the future.

NEW RESEARCHERS

ALIKI PAPA - THE EFFECTS OF MUSHROOMS ON CULTURAL AND COGNITIVE EVOLUTION

CULTURAL TRANSMISSION AND MUSHROOM CONSUMPTION

We know that mushrooms have been a source of food for *Homo sapiens* since prehistoric times. We also know that, since early infancy, humans engage in cultural transmission: we become uniquely masterful in learning and using the information available in our social environment and in passing it on to others. Thus, every new generation of learners is exposed to a generation of transmitters, who deploy (or teach) the target information. The learners typically acquire that information with high degrees of fidelity.

Our reliance on social learning significantly decreases the need to employ trial-and-error strategies. This proves very adaptive, especially in high-risk behaviors such as mushroom foraging. To clarify, it is more efficient and safer to learn from others which mushrooms are edible (and where and how to forage them) than to have to go through the – highly likely detrimental – process of trying each species to assess its edibility.

The human capacity for the high-fidelity imitation of information is one of the factors enabling cumulative cultural evolution. Yet, for the transmitted information to remain up-to-date and applicable, members of the learner-generation are occasionally required to modify it. For example, Generation 1 transmits to Generation 2 that you can eat mushroom x, because most of those who ate it were fine afterwards and only two people became sick, but not severely. Generation 2, then, introduces the modification that, to eat mushroom x, it is safer to cook it, because all who cooked it remained healthy after consuming it except one person who had very mild indigestion symptoms. This modification is transmitted to the next generations, who acquire them and apply their own modifications. Due to high-fidelity imitation, the information is generally preserved, and the modifications accumulate. Imitation and innovation, then, orchestrate cumulative cultural evolution and – by extension – lead to the synthesis of the grand volume of mushroom information made available to us today.

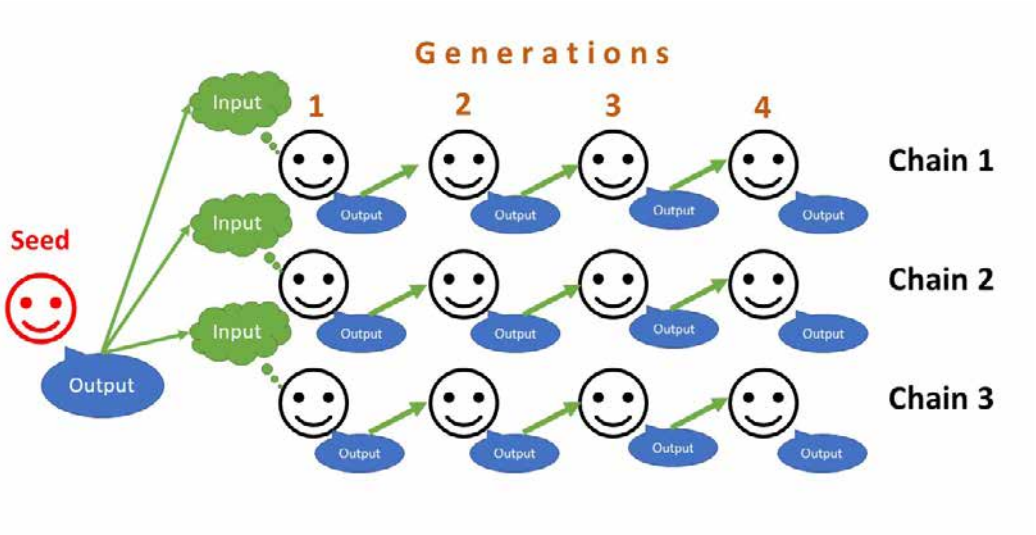


Figure 1: The linear transmission chain paradigm. In this, the seed (i.e., Generation 0) is usually a participant or a confederate trained by the experimenter to provide some cultural information (e.g., reciting five edible mushrooms and their phenotypic properties). That information is used as input for Generation 1 (i.e., the first participant) of each chain. Afterwards, Generation 1 provides said information and their output is used as the input of Generation 2 of the same chain. Generation 2's output is used as the input of Generation 3 and so on, until all the generations constituting a chain have provided the information.

CURRENT PROJECT

If we could go back in time far enough, we would be able to trace how mushroom knowledge – acquired and transmitted by our species since prehistoric times – has affected the evolution of our cognition more generally and our culture(s).

This project will employ iterated learning experiments, which will model the process of cumulative cultural evolution of mushroom-related information (e.g., distinguishing which are edible vs. which are poisonous, which areas might provide better gathering/foraging mushroom sites etc.). Human participants will constitute individual generations within linear diffusion chains (see Figure 1).

Cognitive biases (e.g., copy-the-expert instead of copy-the-peer) have been found to operate during transmission. Their effects appear to become increasingly apparent with each transmission cycle, as the modifications that accumulate will reflect them (e.g., the information available to each new generation will consist significantly more of variants provided by experts than by peers, presumably to the point where the peers' variants will disappear). In this cumulative cultural evolution model, then, we expect the effects of cognitive biases operating during transmission to manifest in the end-product, thereby illuminating how mushroom foraging and consumption may have shaped our cognition by instrumenting the evolution of such biases (e.g., a learn-from-the-expert bias). In addition, some of the experiments will be conducted cross-culturally, with participants from mycophilic populations (i.e., who positive attitudes towards wild mushroom-foraging and actively pursue it) vs. mycophobic ones (whose negative attitudes towards wild mushroom-foraging and usually rational fear of wild mushrooms discourage them from pursuing the activity). Findings from those comparative studies will help us understand better the role of distinct attitudes and traditions on the process of cultural transmission itself.

In summary, we plan to examine the cumulative cultural evolution of mushroom information, by focusing on the mechanisms enabling its conservation (such as high-fidelity social learning, cognitive biases, etc.) and modification (including innovation, mutation, etc.). In so doing, we aim to advance our understanding of how the evolution of our species' culture (e.g., attitudes, theoretical frameworks) and cognition (e.g., in the form of cognitive biases) may have been affected by mushroom-related attitudes and behaviors.

OUTREACH

WORKING WITH LOCAL COMMUNITIES IN SOUTH AFRICA

Working with the local communities where we conduct our research is an important aspect of SapienCE. Without the help of the local community our work would be much more difficult or downright impossible. In 2022 we were fortunate to be able to reconnect with friends in the area around Blombos Cave after two years of Covid-related absence.

In 2022 we had the pleasure of hosting the local community leaders and other archaeology enthusiasts from Still Bay and Riversdale for a guided tour of the Blombos excavations by the SapienCE Director, Professor Henshilwood. The group was eager to learn about their part of South Africa as one of the cradles of modern human behaviour. We are grateful to Izak Venter and members of the Hessequa Archaeological Society for their steadfast support of SapienCE.

SapienCE continued and expanded the fruitful collaboration with friends from UNESCO-supported Gouritz Cluster Biosphere Reserve (GCBR). This collaboration is important as it also includes obtaining new information about previously unknown Middle Stone Age sites in parts of the Western Cape province covered by the reserve. This is an excellent example how harvesting local knowledge about the landscape can lead to insights important for SapienCE research. Our SEAS postdoctoral fellow, Asia Alsgaard, will also benefit from access to this information in relation to her own research on local fishing and fish management practices. The collaboration will include a geological survey and characterisation of local ochre and silcrete sources, on which a Still Bay-based geologist Pieter-Jan Gräbe and SapienCE postdoctoral fellow and ochre specialist Elizabeth Velliky will work together in the future.

ORIGINS OF EARLY SAPIENS BEHAVIOUR AT ORIGINS CENTRE

UNIVERSITY OF THE WITWATERSRAND

SapienCE's *Origins of Early Sapiens Behaviour* exhibition had a very successful year at the Origins Centre at the University of the Witwatersrand (Wits University). Since opening in November 2021, nearly 9,000 people visited the exhibition, of whom around half were children and approximately one third attended as part of school tours. The exhibition contains a range of archaeological materials which have been discovered over three decades of excavations at Blombos Cave, Klasies River and Klipdrift shelter.

This is the third iteration of the exhibition, and a specially-designed interactive education space was added to the previous version. This area proved to be particularly popular, with learners and adults getting engrossed in completing the puzzles, drawing with ochre and decorating the ostrich eggs. The videos and images created for the exhibition by Academy Award winning documentary filmmaker Craig Foster continued to be popular. Overall, visitor feedback was very positive, with many commenting that it was clearly organised, eye-catching and provided just the right amount of information.

Our colleagues at the Origins Centre, Dr Amanda Esterhuysen and Dr Tammy Hodgskiss, have developed an activity workbook inspired by the exhibition. Focusing on the Middle Stone Age archaeological record in South Africa, and illustrated by artist Alistair Findlay, the book should be printed early next year. The workbook focuses on the technological and behavioural innovations of the Middle Stone Age (e.g. engravings and hafted tools), how people lived at that time and how we excavate archaeological sites. It is aimed at Grade 5-7 learners to be used when teaching 'Hunter-gatherer lifeways', within the current South African school curricula. We hope that this workbook will provide a lasting educational legacy for both SapienCE and the Origins Centre exhibition.

The Origins Centre exhibition closed in December 2022, but new SapienCE exhibitions are planned for 2023. Firstly, the exhibition from the Origins Centre will be relocated to an exhibition space at Cape Point in the Table Mountain National Park. Secondly, the University of Bergen Museum will build and host a new SapienCE exhibition. Three members of the museum staff visited the Origins Centre exhibition, and were inspired by what they saw. Like Blombos, Klipdrift and Klasies River, the SapienCE exhibitions look set to keep producing results in 2023.

Visitors to the exhibition at Origins Centre,
25 November 2021 – 7 September 2022:

8814
4261 children (2711 children visited as part of school tours);
4553 adults.

Visitors reacted very positively towards the exhibition. They generally spent **30 mins** in the exhibition and interactive space, but often a lot longer. Visitors felt that it was clear, eye-catching and provided just the right amount of information. The interactive, education space was well used, with learners and adults getting engrossed in completing the puzzles, drawing with ochre and decorating the ostrich eggs. All the stations and parts have faired very well given the frequent use by people.

Educational workbook inspired by the Early Sapiens exhibition

Amanda Esterhuysen and Tammy Hodgskiss have developed an activity workbook focusing on the Middle Stone Age archaeological record in South Africa. This has been illustrated by artist, Alistair Findlay. The book should be printed in the next few months. The workbook focuses on the technological and behavioural innovations of the Middle Stone Age (e.g. engravings and hafted tools), how people lived then and how we excavate archaeological sites. It is aimed at Grade 5-7 learners to be used when teaching 'Hunter-gatherer lifeways', within the current school curricula.

VIPs at Origins

The exhibition was enjoyed by many South African and foreign tourists during the 14 months it ran at Origins Centre, and was visited by some local and international VIPs. Shamilla Chettier, the Deputy Director General of the South African Department of Tourism, attended the launch of the exhibition. Mags Pillay, the Director of the Cradle of Humankind World Heritage Site, also attended the launch. Manuel Carvalho, the Portuguese Ambassador in South Africa and Carlos Marques, the Consul General of Portugal in Johannesburg visited the exhibition. A tour group from Wales, hosted by the British Council and Drama for Life Centre at Wits, had a guided tour in the museum and exhibition. Dr Robyn Pickering, co-director of the Human Evolution Research Institute (SA) visited the exhibition, as did the South African Archaeological Society. Many school, university and college students enjoyed the exhibition and had enthusiastic conversations in the interactive area. A few university groups were Leeds University (UK), Queens University (Canada), Union College (US), Free State University (SA) and Inscape College (SA). The Launch of the TEDx Johannesburg Salon talk series was hosted in the Origins of Early Sapiens exhibition, hosted by Professor Bruce Rubidge. The original engraved Blombos ochre 'the world's oldest known art' was put on display in the exhibition for a one day Wits Centenary Objects exhibition on heritage day 24 September 2022, drawing large crowds and much excitement.

"

I wasn't going to spend time on this exhibition but it caught my eye and I was sucked in!

The videos are amazing! The shadows cast on the artwork at the end of the room are also great- and make you feel that there is a hunter in the room with you!

The video actors are acknowledged.

Needless to say I loved this!

What a beautifully put together exhibition

This should be a permanent exhibition in the museum.

"

ARK

In the autumn of 2022, PhD candidate Heidi Øhrn and the Brain Activation in Cognitive Evolution (BRACE) project was featured in a performance piece by Alwynne Prichard. The performance, entitled "ARK", took place at the University Museum of Bergen on the 2nd of November. Alwynne Pritchard took inspiration from the Museum itself and the shadows cast by the exhibitions when creating the performance.

"The University Museum of Bergen is an archive of histories, discoveries and speculations. It's a chronicle of adventures, not only human and animal but also vegetable and mineral - and a place in which we're invited to contemplate our past, present and future impact on this earth. It's also a haunting refuge for shadows and reflections."

- Alwynne Pritchard

The performance consisted of storytelling, poetry, music, and song created especially for Bergen's ensemble Currentes.

It opened with Alwynne Pritchard sharing an apparently real (but in fact fictional) account of a meeting with a very old woman on the steps of the museum. The woman, whose name is Hrefna, says she has been waiting on the steps since before the museum was constructed and has since been guarding the animals inside. This anecdote becomes the text material sung during the performance.
After this story, a poem reflecting on the shadows cast in the museum is read by 16-year-old Elise Hitland. To bring story-telling into the realm of research directly associated with the museum, a short summary of the BRACE project was read. This is then followed by the musical performance. Featuring a SapienCE project in this performance demonstrates how our research fits into a larger context, allows us to reach a broader audience, and ties our upcoming exhibition at the University Museum to other activities happening there.

EXHIBITION

The University Museum of Bergen and SapienCE are collaborating on an exhibition showcasing both the research process and science results being used to answer the Centre's research questions. In November, the head of the department of Research and Science Communication at the University Museum of Bergen and project owner of the exhibition, Eli Kristine Ø. Hausken, the curator for the exhibition, Åshild S. F. Thorsen, and the project manager, Marit Kjeksrud Amundsen traveled to South Africa with the SapienCE project manager Žarko Tankosić.

FROM SOUTH AFRICA TO BERGEN

The purpose of the visit was to experience the exhibition at The Origin Center Museum at the University of the Witwatersrand (Wits), and to connect with both members of SapienCE and colleagues at Wits.

"The connections that were made in South Africa, will strengthen collaboration, and inspire our exhibition production" says Hausken. "For us it was highly valuable to visit the exhibition at The Origins Centre. It gave us an insight into the process of knowledge production within SapienCE, and also into how the project has been communicated in South Africa. The new exhibition in Bergen will further shed light on the sources, methods and issues that researchers in the Centre are working on."

"Our meetings and experiences were inspiring, and we feel we have a better understanding of the message SapienCE wants to communicate through the exhibition. We will bring all the inspiration and input with us when we now start the formal process with the subcontractor. We are excited!" Eli Kristine Hausken concludes.

FIELD VISIT

The exhibition is now in the content production phase and we are collaborating with the researchers. Curator Åshild S. F. Thorsen is traveling to Blombos Cave in the spring of 2023 to produce photos and video portraits in the field with several SapienCE colleagues.

"Being able to meet the researchers in their 'natural habitat' as a visual anthropologist and the head curator for this exhibition is an amazing opportunity" says Åshild. "This will give the exhibition that extra level of significance, where we explain the process of knowledge production – that is so important for the University of Bergen and for society. The installations in the exhibition will provide an insight to the researchers' findings within the fields of cognition research, archaeology, and climate research."

The exhibition will open in the second quarter of 2023.

TEAMBUILDING TRIP TO HARDANGER

SapienCE members had a very successful teambuilding trip to Hardanger in June 2022. Over a period of three days the team presented research updates followed by focused group discussions. Workshops led by the University of Bergen's Human Resources (HR) department added a new element to this year's teambuilding event.

The first day was set aside to work with HR looking at ways to build an even stronger SapienCE team. In the workshop we were encouraged to look at new ways of collaborating, both professionally and socially.

The SapienCE Centre of Excellence is built around a carefully selected interdisciplinary team of archaeologists, climatologists and psychologists living and working in various countries, with the goal to increase our understanding of how and when *Homo sapiens* evolved into who we are today.

After nearly two years of not being able to meet, due to Covid-19 and lockdown, it was important to revitalise the team. HR led this work in a professional, constructive and enjoyable way. Using thought-out and inspiring methods, they coaxed us out of our comfort zones. The goal of these sessions was to formulate new ways to bring the team closer together and enhance our collective performance. Some of the ideas from these sessions have been successfully implemented and we hope to schedule another teambuilding event in spring 2023.

A highlight of the Hardanger visit was the opportunity to meet colleagues from the University Museum who will be creating the SapienCE exhibition to be launched in late spring 2023. They led an inspiring workshop, presenting their plans and discussing ideas about how they will to showcase the work of SapienCE.

3D SCANNING

WITH UNIVERSITY OF STAVANGER ARCHAEOLOGICAL MUSEUM/ROCK ART GROUP

On the tiny island of Austre Åmøy, off the coast of Stavanger, hundreds of ships look out towards the North Sea. These Bronze Age ships are carved into rock panels along with human figures, bear paws, circles, and other symbols which likely would have been visible to those approaching the island from the sea. The Rock Art group at the University of Stavanger Archaeological Museum is working to catalog and interpret petroglyphs in the Rogaland region with the use of the Artec Leo and Space Spider 3D scanners, the latter of which is on loan from SapienCE.

The engravings were mostly documented in the early 1900s and are one of the biggest concentration of petroglyphs in the Rogaland region. Many subsequent interpretations have used these early descriptions and drawings of the petroglyphs to aid in archaeological interpretations. However, due to wear of the petroglyphs themselves, the original designs can be difficult to interpret using the naked eye alone. Also, some of the petroglyphs are today painted, which was not the case when they were originally discovered, further confusing accurate interpretations. This is where 3D scanning can supplement existing interpretations with invaluable new data.

During a workshop, archaeologist Dr. Wenche Brun and photographer Dr. Annette Græsli Øvrelid trained SapienCE postdocs Dr. Elizabeth Velliky and Dr. Asia Alsgaard along with project manager Dr. Žarko Tankosić, on using the Leo and Space Spider to scan both rock art and artefacts. Dr. Magnus Mathisen Haaland, Department Manager of the Collections department at the Arkeologisk Museum and SapienCE member, along with Dr. Žarko Tankosić worked to facilitate the loan and collaboration.

Standing on a slippery stone face set at a 45° angle, the SapienCE group watched as Wenche and Annette skittered up the rock to a fleet of carved boats. Wenche pointed to a seemingly unmarked area nearby they had previously scanned using the Artec Leo, only to uncover petroglyphs unrecorded in the original descriptions. The Åmøy site is already one of the biggest Norwegian concentrations of petroglyphs, but Wenche and Annette's work suggests it may be even more extensive than is currently realised.
Although their work is on-going, they took the time to provide training to the SapienCE group on using both the Leo and Space Spider as well as the Artec software. The Leo and Space Spider scanners are both handheld devices, but each has slightly different scan resolutions, accuracy and working distances. Hold the Leo in your hand, unconnected to any battery pack or computer, and you can quickly and easily scan an area, with the image appearing on the screen of the device in real time.

The Space Spider requires a bit more set up, since it needs to be attached to both a power source and a laptop. Scanning also requires a bit more patience and surface preparation, but the reason for this is that the resolution and degree of detail is slightly higher than that which the Leo provides. Furthermore, unlike the Leo, the Space Spider is perfect for scanning artefacts, such as the hand-sized fishing net weight Annette used as a demonstration. Taken together the Leo and Space Spider complement each other's strengths and weaknesses. This training will be immensely valuable for the 2023 field season at Blombos Cave where SapienCE researchers will be using the Space Spider to 3D scan excavation stratigraphy and any important contexts as they are uncovered.


JH 96 VP GP

SapienCE LUNCH SEMINARS

23.06	Silvia Frisia	Neanderthal in the cave: the Altamura Man	The University of Newcastle Australia
26.08	Aksel Timmermann	Climate effects and Human evolution	Pusan National University, Korea
06.09	Maarten Vanden Eynde	Drawing the Line/ On Signs and Signifiers in Art and Artefacts	Department of Fine Arts, University of Bergen
20.10	Geir Harald Samuelsen	Light Darkness Light	Department of Fine Arts, University of Bergen
17.11	Jennifer Miller	Ostrich eggshell beads reveal 50,000-year-old social network in Africa	Max Planck Institute for the Science of Human History, Jena

SAPIENCE STAFF AND MANAGEMENT

SAPIENCE LEADER GROUP

Christopher Henshilwood
Professor
Director, PI

Carin Andersson Dahl
Research Professor
PI

Andrea Bender
Professor
PI

Eystein Jansen
Professor
Deputy Director, PI

Žarko Tankosić
Administrative leader

Karen van Niekerk
Senior Researcher
PI

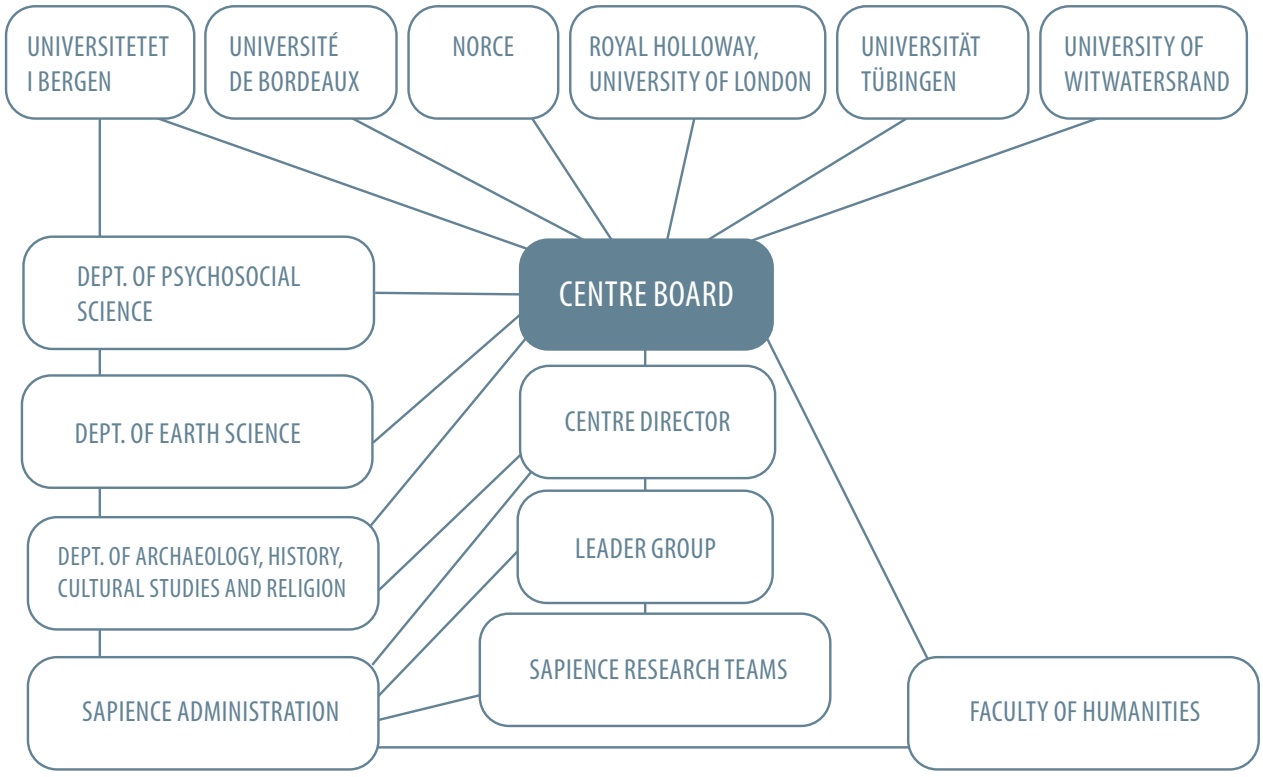
Sarah Wurz
Professor
Senior Scientist

Francesco d'Errico
Professor
Senior Scientist

Christopher Miller
Professor
Senior Scientist

Simon Armitage
Professor
PI

CENTRE STRUCTURE



PIs AND RESEARCHERS AT SAPIENCE

Christopher Stuart Henshilwood	PI, Professor, SapienCE Director	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
	DST/NRF SARChI Chair in Modern Human Behaviour	Evolutionary Studies Institute University of the Witwatersrand Johannesburg, South Africa
Eystein Jansen	PI, Professor, SapienCE Deputy Director	Department of Earth Science, University of Bergen
Karen van Niekerk	PI, Senior Researcher	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Andrea Bender	PI, Professor	Department of Psychosocial Science, University of Bergen
Simon Armitage	PI, Professor	Centre for Quaternary Research, Department of Geography, Royal Holloway University of London
Carin Andersson Dahl	PI, Research Professor	NORCE Norwegian Research Centre Division of Climate & Environment
Francesco d'Errico	Directeur de recherche de classe exceptionnelle	CNRS Université de Bordeaux
	Professor II	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Christopher Miller	Professor	Institute for Archaeological Sciences, University of Tübingen
	Professor II	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Sarah Wurz	Professor	School of Geography, Archaeology and Environmental Studies, University of Witwatersrand
	Professor II	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Kenneth Hugdahl	Professor	Department of Biological and Medical Psychology, University of Bergen
Torill Christine Lindstrøm	Professor	Department of Psychosocial Science, University of Bergen
Anna Nele Meckler	Professor	Department of Earth Science, University of Bergen

		Department of Earth Science, University of Bergen
		NORCE Norwegian Research Centre Division of Climate & Environment
		NORCE Norwegian Research Centre Division of Climate & Environment
		NORCE Norwegian Research Centre Division of Climate & Environment
		NORCE Norwegian Research Centre Division of Climate & Environment
		Eberhard-Karls-Universität Tübingen Senckenberg Center for Human Evolution and Paleoecology Department of Archaeology, History, Cultural Studies and Religion, University of Bergen

SapienCE Postdoctoral Research Fellows 2022

Turid Hillestad Nel	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Magnus Mathisen Haaland	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Jenny Maccali	Department of Earth Science, University of Bergen
Ozan Mert Göktürk	Department of Earth Science, University of Bergen
Elizabeth Velliky	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Larissa Mendoza Straffon	Department of Psychosocial Science, University of Bergen
Asia Alsgaard	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Aliki Papa	Department of Psychosocial Science, University of Bergen

Doctoral Fellows (Ph.D. candidates) 2022

Ole Fredrik Unhammer	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Karl Purcell	Department of Earth Science, University of Bergen
Jovana Milić	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Zahra Haghighi	Department of Archaeology, History, Cultural Studies and Religion, University of Bergen
Heidi Øhrn	Department of Psychosocial Science, University of Bergen

SAPIENCE ADMINISTRATION

The organisation, management and administration of SapienCE is regulated through the "Guidelines for Centre of Excellence (SFF-IV) at the University of Bergen". The guidelines are based on the requirements and guidelines of the Research Council of Norway, and were adopted by the University Board on 24 August 2017.

The guidelines state that SapienCE is led by a centre Director responsible for all activity at the centre and who reports to the board. The centre has a Leader Group consisting of the centre director, vice director and research directors (PIs). The Leader Group shall participate in the preparations of the items to be discussed by the Board. In addition, SapienCE has a Scientific Advisory Committee to support the centre by providing input on the centre's scientific strategy and challenges throughout the project period. The centre has an Administrative Leader who shall assist the centre Director in the day-to-day operations of the centre, serve as secretary to the Leader Group and be the liaison to other administrative personnel and partners. Additional administrative resources shall possess expertise to meet the needs of the centre; infrastructure, finance, HR, research administration and advisory services, administration of doctoral education, information dissemination and communication. The administrative resources are partly funded by the Research Council of Norway and partly by the University of Bergen.

The resources are organised so that the centre's administration, beyond the position of Administrative Leader, shall be an integral part of the ordinary administration. This ensures administrative expertise at the department and faculty levels, and ordinary guidelines and procedures are followed as in the regular university units. Thus, administrative support is provided for their respective employees by all the SapienCE partners, which either contribute with in-kind funding or receive dedicated grants from the centre. The employer's liability follows the employment, and the local administrations are responsible for HR related and ordinary financial matters.

Personnel involved in SapienCE administration in 2022	
Žarko Tankosić	Administrative leader
Janne-Beate Buanes Duke	Adviser, Media and communication
Mari Knudsen	Adviser, Finance and accounting
Vibeke Wallacher Enæs	Executive officer, Front desk (until 1 September 2022)
Sarah Sharif Hordvik	Senior Executive Officer, Doctoral education coordinator
Anna Lisa Arefjord	Adviser, HR
Torunn Saunes	Senior Executive Officer, Web support
Grethe Bruvoll	Higher Executive Officer, Front Desk
Bjørg Anja Teigland	Senior Executive Officer
Faculty of Humanities	
Asbjørn Sæther	Adviser, HR
Kirsten Moen	Senior Adviser, Research
SapienCE administrators, curation and field support in Cape Town, South Africa	
Samantha Mienies	Curator/Collections Manager Evolutionary Studies Institute, University of the Witwatersrand
Lisa Hulett	Assistant Evolutionary Studies Institute, University of the Witwatersrand

SAPIENCE FUNDING IN 2017-2022

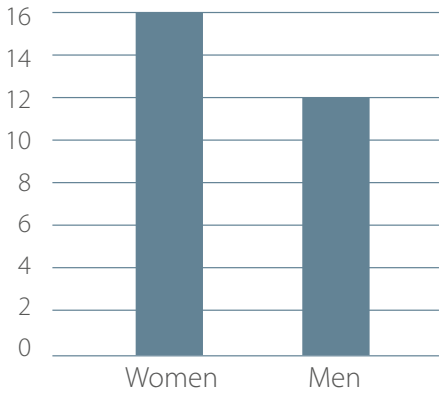
In 2022 the principal sources of funding for SapienCE were the Research Council of Norway (RCN) and own-financing from the host institution, University of Bergen, in addition to the substantial level of in-kind contributions. SapienCE obtained additional funds from national and international sources. These funds were instrumental for the heightened post-Covid activity of SapienCE in 2022, particularly related to the Centre's archaeological research. An overview of SapienCE finds for 2017-2022 is presented below:

SapienCE Funds 2017-2022 (*1000 NOK)

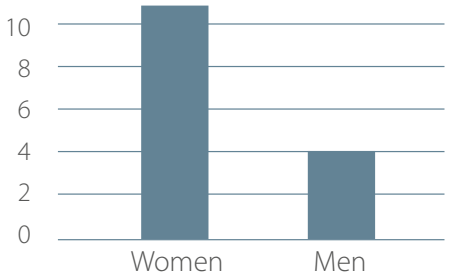
Source	2017	2018	2019	2020	2021	2022
Own financing (Host Institution)	1 630	7 640	9 450	12 567	10 142	10 002
Agreed in-kind plus additional estimated in kind (Partner Institutions)	248	1 275	1 109	662	683	599
RCN contribution	0	11 725	9 607	11 641	18 962	12 771
Additional project funds (University of the Witwatersrand, South Africa; HUMEVAL, Norway)	0	2 880	3 316	2 852	14 550	27 627
TOTAL FUNDING OF CENTRE ACTIVITY	**1 878**	**23 656**	**23 483**	**27 946**	**44 337**	**50 999**

DISTRIBUTION OF GENDER IN SCIENTIFIC POSITIONS AT SAPIENCE

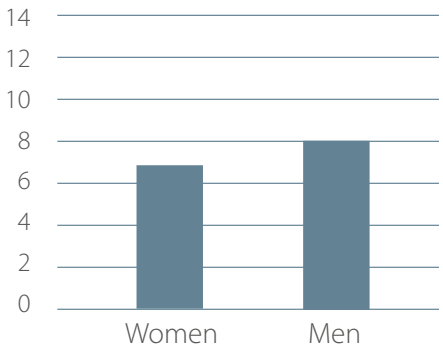
All scientific positions		
	Number of	% number of



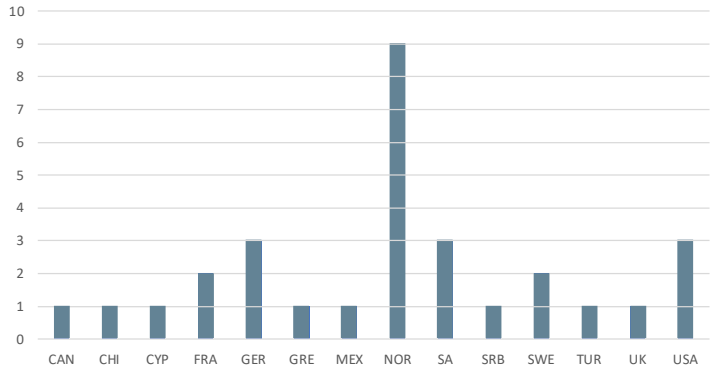
Early career researchers		
	Number of	% number of
Women	11	73
Men	4	27
Total	15	100



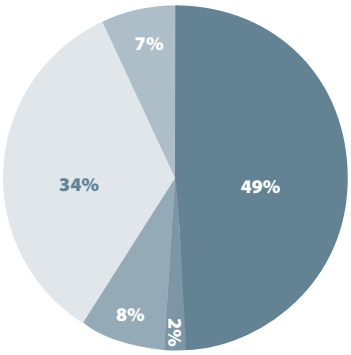
Senior scientific positions		
	Number of	% number of
Women	7	47
Men	8	53
Total	15	100



SapienCE researchers by nationality

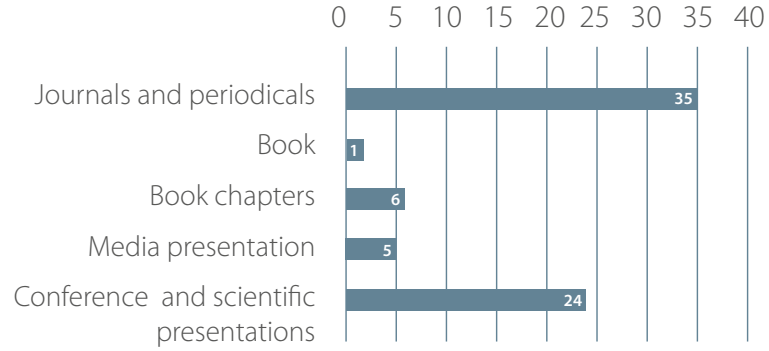


SCIENTIFIC AND ACADEMIC OUTPUTS



- Journals and periodicals: **35**
- Book: **1**
- Book chapters: **6**
- Media presentation: **5**
- Conference and scientific presentations: **24**

SapienCE scientific OUTPUTS 2022



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d'Errico, F., Backwell, L.R., Wadley, L., Geis, L., Queffelec, A., Banks, W.E., Doyon, L. 2022 'Technological and functional analysis of 80-60 ka bone wedges from Sibudu (KwaZulu-Natal, South Africa).' *Scientific Reports* 12.

Göktürk, O.M., Sobolowski, S.P., Simon, M.H., Zhang, Z., Jansen, E. 2023 'Sensitivity of coastal southern African climate to changes in coastline position and associated land extent over the last glacial.' *Quaternary Science Reviews* 300, 1-11.

Mackay, A., **Armitage, S.J.**, Niespolo, E.M., Sharp, W.D., Stahlschmidt, M.C., Blackwood, A.F., Boyd, K.C., Chase, B., Lagle, S.E., Kaplan, C.F., Low, M.A., Martisius, N.L., McNeill, P.J., Moffat, I., O'Driscoll, C.A., Rudd, R., Orton, J., Steele, T.E. 2022 'Environmental influences on human innovation and behavioural diversity in southern Africa 92-80 thousand years ago.' *Nature Ecology and Evolution* 6.

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Stolz, C and **Miller, C.E**. 2022 Geoarchaeologie. Springer

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Wurz, S., Pickering, R. and Mentzer, S.M., 2022. U-Th dating, taphonomy, and taxonomy of shell middens at Klasies River main site indicate stable and systematic coastal exploitation by MIS 5c-d. *Frontiers in Earth Science,* 10.

SOCIAL MEDIA

In 2022, we organised the first SapienCE social media (SoMe) team consisting of Elizabeth Velliky, Janne-Beate Buanes Duke, Torunn Saunes, and Zarko Tankosic. This has had a massively positive impact on the Centre's SoMe exposure.

TWITTER

Since the start of the team, in September 2022, we had 655 followers on Twitter. We now have 764, an increase of 109 or 16%.

Our top month was September 2022. This is consistent with when the SoMe team started having regular meetings with scheduled output and content generation ideas.

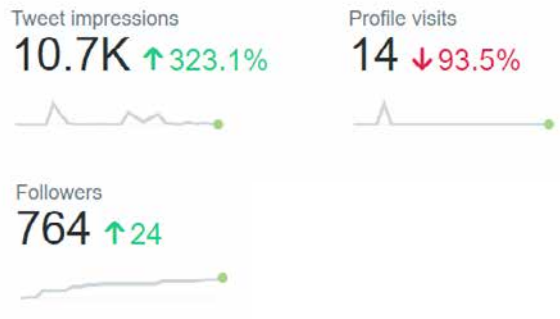
We have had a consistent rise in followers and tweet impressions since the implementation of a SoMe team.

There seems to be a consistency with tweet impressions and our advertised positions, with months where positions were advertised having the highest rate of tweet impressions.

FACEBOOK

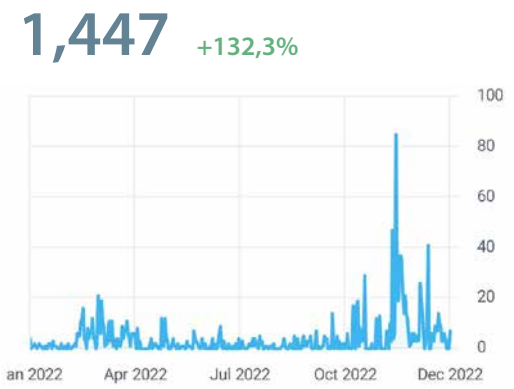
Similar results can be reported for our Facebook reach, which has more than doubled in comparison to 2021.

We have also recorded a 130% increase in the number of visits to the SapienCE Facebook page in 2022.



Facebook Page Reach:

Facebook Page Visits:



Join us on Twitter! Be the first to receive interesting news and information about SapienCE events in Norway and South Africa. Links to new publications and events are regularly posted to Twitter. Scan the QR code to stay up to date.

Of course, we have a Facebook page! We post news, events and papers here, but there are big differences between the interests of our Twitter and Facebook followers. Follow our Facebook page for future announcements of grants and vacancies. Scan the QR code and reflect on the fact that, like our SapienCE archaeologists, you're interested in yesterday's cutting-edge technology.

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ILLUSTRATIONS FROM PUBLICATIONS
p. 32 from Göktürk, O.M., Sobolowski, S.P., Simon, M.H., Zhang, Z., Jansen, E. 2023 'Sensitivity of coastal southern African climate to changes in coastline position and associated land extent over the last glacial.' Quaternary Science Reviews 300. 1-11.

p. 39 from d'Errico, F., Backwell, L.R., Wadley, L., Geis, L., Queffelec, A., Banks, W.E., Doyon, L. 2022 'Technological and functional analysis of 80-60 ka bone wedges from Sibudu (KwaZulu-Natal, South Africa).' Scientific Reports 12.

p. 47 from Wurz, S., Pickering, R. and Mentzer, S.M., 2022. U-Th dating, taphonomy, and taxonomy of shell middens at Klasies River main site indicate stable and systematic coastal exploitation by MIS 5c-d. Frontiers in Earth Science, 10.

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