Final Permit Report on Archaeological Excavations conducted at Border Cave in KwaZulu-Natal from 2018-2021

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under the expert supervision of Professor Lyn Wadley
by Case Officers Weziwe Tshabalala and Bernadet Pawandiwa

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to Amafa-AkwaZulu Natali and SAHRA on 20/10/2021

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Executive summary

This final permit report documents information pertaining to excavation activities conducted in 2018 and 2019 at the Middle Stone Age site of Border Cave. It begins with site links to the project titled 'Excavation of Border Cave in the 21st Century'. The links are followed by information regarding the location of the site and its archaeological significance. Researchers participating in the project are grouped according to who excavated in 2018 and 2019, followed by a list of collaborators, their affiliations, and specialisations. The material that we have excavated since 2015 is housed at the University of the Witwatersrand in Johannesburg, and details about its curation are provided. Excavation materials and methods are given in detail, followed by a substantial section on our results. The results presented here have been extracted from a manuscript that will shortly be submitted to the journal *Quaternary Science Reviews*. The article will be one of many in a special issue that will be published in 2022, which is dedicated to research emanating from our new excavations at Border Cave. The results are presented under the following subheadings: areas excavated, organic remains, ochre and lithic artefacts, and a horncore feature. Three papers were published during the reporting period, two of which appeared in the highly esteemed journal *Science*. The contents of these publications are incorporated in the results section of this report. Site management and conservation measures are explained before closing with a brief conclusion. Future research directions are not discussed here. Proposed research activities and motivations for them are the subject of my soon to be submitted application for a new excavation permit to continue working at the site for the next three years. Three conference presentations were made during the reporting period, and they appear at the end of this report, and are followed by a reference list.

Site links

https://sahris.sahra.org.za/dashboard

https://sahris.sahra.org.za/cases/excavation-border-cave-21st-century

https://sahris.sahra.org.za/heritage-reports/new-excavations-border-cave

Site location and significance

Border Cave is situated in KwaZulu-Natal (27°1’19”S, 31°59’24”E) 82 km from the Indian Ocean (Figure 1). Located in the Lebombo mountain range below the rim of an escarpment at an elevation of *c*. 600 m above sea level, the cave faces West, overlooking eSwatini (formerly Swaziland). The shelter is semi-circular in shape and approximately 50 m wide by 35 m long. The cave formed in the Lower Jurassic felsic extrusive rocks of the Jozini Formation, Lebombo Group, approximately 182.1 ± 2.9 mya. Two volcaniclastic facies of the Jozini Formation are exposed in the cave: a clast- and a matrix-supported flow breccia. The cave formed through the weathering of these rocks. Border Cave records a long sequence of Stone Age occupations dating from ~227 ka to 24 ka. The lithic assemblages are attributed to MSA I, MSA II/Howiesons Poort (HP), MSA III and Early Later Stone Age (ELSA). The site has experienced five excavation episodes, starting with Dart in 1934. The most recent round of excavations began with our team in 2015, and a report on the new excavations was published three years later (Backwell et al., 2018). The site is remarkable for its preservation of organic material, including some of the earliest modern human remains, formal bone tools, cooked starchy rhizomes from layers dated to 170 ka, and suite of grass bedding layers, the oldest of which dates to 200 thousand years ago. Providing a continuous multi-proxy record of regional climate change, wood, seeds, and charcoal are preserved throughout the sequence. This contribution serves as an update on activities conducted in 2018 and 2019 and provides an overview of our findings to date.

Participating researchers

2018 excavation team

I am present at all excavations.

Professor Lyn Wadley, Evolutionary Studies Institute, University of the Witwatersrand, specialises in African Middle Stone Age archaeology, complex cognition, the study of organic remains and excavation techniques.

Dr. Francesco d’Errico, University of Bordeaux and French CNRS, specialises in African Middle Stone Age archaeology, behavioural modernity, bone tools and ochre analysis.

Dr. Christine Sievers, School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, specialises in seed identification and the study of plant remains.

Dr. Paloma de la Peña, Evolutionary Studies Institute and Centre of Exploration for the Deep Human Journey, University of the Witwatersrand, specialises in lithic analysis and excavation techniques.
Dr. Dominic Stratford, School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, specialises in sedimentary micromorpholgy and site formation processes.
Dr. Ghilraen Laue, KwaZulu-Natal Museum and School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, specialises in rock art and excavation techniques.

2019 excavation team
Professor Lyn Wadley, Evolutionary Studies Institute, University of the Witwatersrand.
Dr. Paloma de la Peña, Evolutionary Studies Institute and Centre of Exploration for the Deep Human Journey, University of the Witwatersrand, and University of Cambridge.
Dr. Dominic Stratford, School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand.
Dr. Amy Way, Australian Museum, and the University of Sydney, specialises in lithic technology and excavation techniques.
Mr. Peter Morrisey, (PhD. candidate), School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand, specialises in site formation processes and excavation techniques.
Ms. Ana Lucía Guarido, (PhD. candidate), Instituto Nacional de Antropología y Pensamiento Latinoamericano, CONICET, Argentina, specialises in taphonomy.
Ms. Julia De Stéfano, (PhD. candidate), Museo Etnográfico Juan B. Ambrosetti, Facultad de Filosofía y Letras, Universidad de Buenos Aires, Argentina, specialises in human burials.

Other collaborators
Dr. Irene Esteban, University of Barcelona, and Evolutionary Studies Institute University of the Witwatersrand, specialises in phytolith analysis.
Dr. Marine Wojcieszak, Royal Institute for Cultural Heritage, Belgium, specialises in chemistry and the analysis of residues.
Dr. Jamie Clark, George Mason University, and Evolutionary Studies Institute University of the Witwatersrand, and Universität Tübingen, specialises in faunal analysis.

Dr. Chantal Tribolo, University of Bordeaux Montaigne, specialises in thermoluminescence dating.
Dr. Norbert Mercier, University of Bordeaux Montaigne, specialises in thermoluminescence dating.
Dr. Kristian Carlson, Keck School of Medicine, University of Southern California, specialises in palaeoanthropology.
Dr. Tea Jashashvili, Keck School of Medicine, University of Southern California, specialises in palaeoanthropology.
Dr. Amélie Beaudet, Department of Archaeology, University of Cambridge, UK, specialises in palaeoanthropology.
Dr. Emese Bordy, University of Cape Town, specialises in geology.
Dr. William Banks, University of Bordeaux, specialises in Bayesian modelling and excavation techniques.
Prof. Marion Bamford, Evolutionary Studies Institute University of the Witwatersrand, specialises in palaeobotany.
Dr. Frank Neumann, Evolutionary Studies Institute, University of the Witwatersrand, specialises in palynology.
Dr. Guilhem Mauran, Evolutionary Studies Institute, University of the Witwatersrand, specialises in chemistry and the analysis of residues.
Dr. Sandra Lennox, Evolutionary Studies Institute, University of the Witwatersrand, specialises in anthracology.
Dr. Daniela Rosso, University of Nice, specialises in ochre analysis.
Ms. Olga Vilane, Amafa Heritage AkwaZulu Natali, specialises in the identification of stone tools, bone, wood, charcoal, and seeds.

Curation of Border Cave material

All archaeological material and sediment samples retrieved since 2015 are housed at the Evolutionary Studies Institute at the University of the Witwatersrand. The Institute is on the corner of Yale Road and Jorissen Street in Braamfontein, Johannesburg. The Border Cave material, database of piece-plotted finds, original notebooks, worksheets, section drawings and all documentation relating to the excavation are curated by Dr. Bernhard Zipfel (bernhard.zipfel@wits.ac.za Telephone 0117176683). The material is permanently stored in ziplock plastic bags in cardboard boxes, sorted by year of excavation and type (stone tools, fauna, charcoal, seeds, etc), and in the case of specimens in gypsum plaster jackets, in large plastic containers in the basement storeroom.

Excavation materials and methods

When we started excavating in 2015, we established a new grid tied into the original datum (pegs 1, 2 and 3 in Figure 1), which is now mapped with a total station theodolite. Our grid is aligned on the previous excavation grid, but it is not a perfect fit due to the change from the British Imperial System (inches, feet, yards) to the Metric one (metres and centimetres) in 1965. The difference can be seen in Figure 1 in the number of grid squares between the two areas that we have excavated. If one counts the squares in yards in ascending order to the left, one will see that the distribution of point-plotted artefacts does not correspond with the original grid squares. We use different square names from those used by Cooke and Beaumont. Our squares are named according to North and East lines. All layers, finds and features were recorded using a total station theodolite calibrated to a local spatial grid. The total station was also used in conjunction with digital photographs of excavated areas and profiles for conversion into 3D models (photogrammetry). Each specimen measuring over 2 cm maximum dimension was surveyed with the total station and allocated a unique total station number. In the database BO stands for bone, LI lithic, BL burnt lithic, OC ochre, SH shell, SD seed, WO wood, OES ostrich eggshell, TP topographic point, BK bucket point. Artefacts smaller than 2 cm were collected with the excavated sediment in buckets and each bucket was allocated a total station point number.

Excavations were conducted with pastry brushes, leaf trowels and camera lens puffers, which were particularly useful to clean profiles, excavate ash deposits, and expose plant remains. While perfectly preserved, organic remains are extremely fragile, and can turn to dust when touched. Some wood, bone and bedding has therefore been impregnated with a weak glue solution (Paraloid™), for which acetone is the solvent. We do not excavate in spits, we excavate in layers, which are differentiated by colour and texture. Each excavator completed a worksheet for each *décapage* (plan/sub-unit) within a layer. Sediments and artefacts from each *décapage* were excavated, documented, sieved, and processed separately. Worksheet information for each *décapage* or layer included the square number (e.g. N103 E118), Member (e.g. 2 BS) layer name (e.g. Brown Caby), Munsell description of sediment colour (e.g. Brown 7.5YR 4/4), texture (e.g. silty), coherence (e.g. none), content (lithic, bone, tooth, seed, charcoal, shell, ostrich eggshell, wood, ochre, roof spall, other), specimen number and description, orientation and dip of lithics >4 cm, volume of sediment removed in litres, and plotting of finds on graph paper.

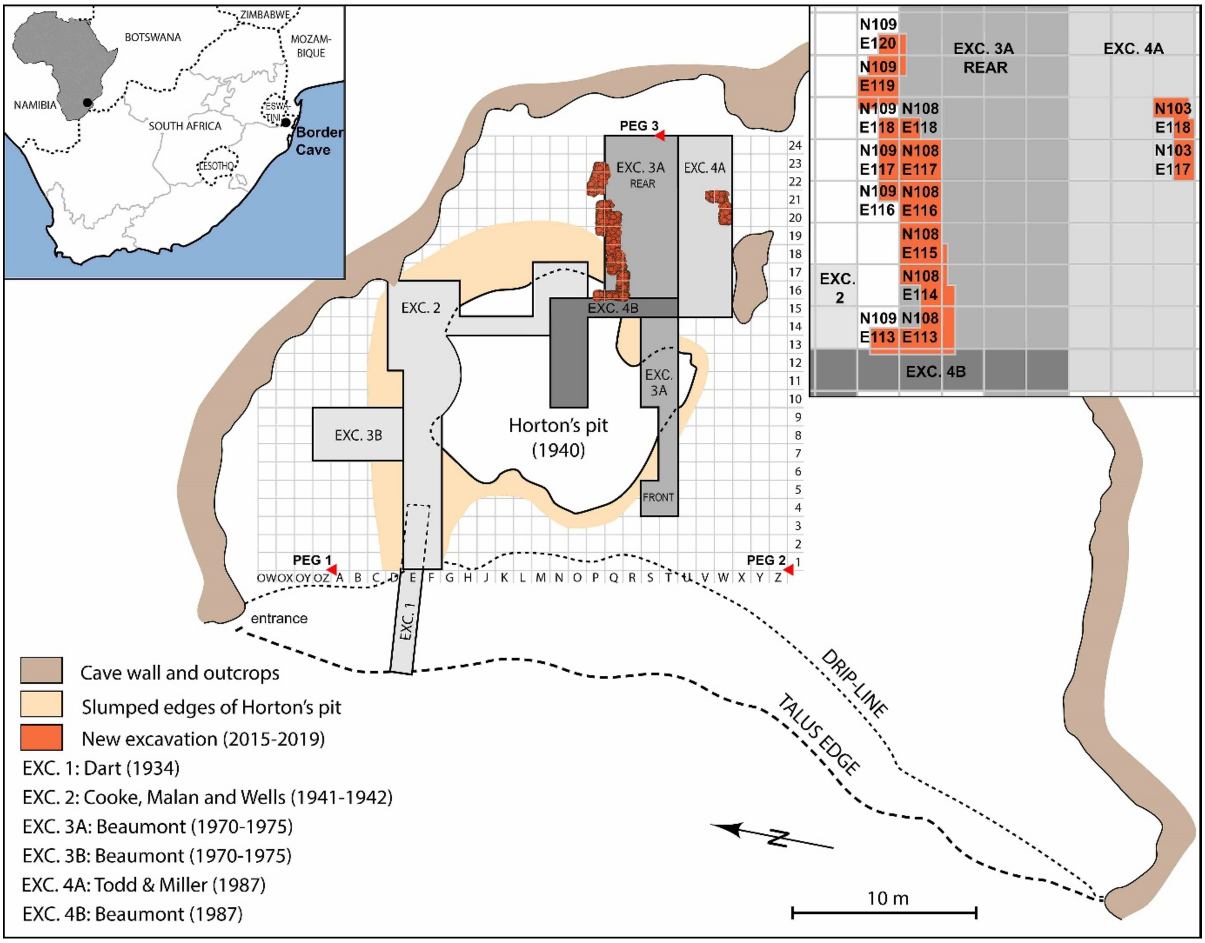

Figure 1. Location of Border Cave and a plan of the site showing the position of the various excavations from 1934 to 2019. The orange overlay shows the position of point-plotted artefacts in excavations conducted by us from 2015 to 2019 along the North wall of EXC. 3A and South wall of EXC. 4A. The insert provides the square names excavated according to North and East lines. The grid is the original one established by Cooke et al. (1945) in yards and followed by Beaumont (1973, 1978, 1980), Beaumont et al. (1978), Butzer et al. (1978), Grün and Beaumont (2001) and Grün et al. (2003). Our work is metrically calibrated so does not follow the original grid precisely.

Layers are named alphabetically by member, starting with **A**bba in 1 BS, **B**arry in 1 WA, **C**amy in 2 BS, **D**abby in 2 WA etc. The naming system was introduced in 2017, so layers from earlier years are named according to their description only. There is no strict alphabetical order within the members because new names starting with the same letter were introduced by excavators working in different parts of the deposit, and the relationship between them was unknown. Plan photographs were taken of each metre square, including a scale and North arrow, with closeups of features. Sediment samples were taken for each layer. The volume of all excavated sediment was measured in litres and then sieved using 2 mm and 1 mm mesh, and the contents carefully sorted into categories such as microfauna, bone flakes, seeds, ochre, and lithic fragments. Field notes were kept by all excavators in notebooks dedicated to each square opened.

During our 2018 field trip 15 blocks of grass mats/bedding and a horncore feature were jacketed with plaster bandages and lifted *in toto* for excavation and analysis under the microscope. The excavation and preservation of plant remains relies on the plaster jacket technique of reinforcing a block of deposit, rather than coating or impregnating the specimen with glue, which prevents microscopic analysis. Micromorphology blocks of the strata associated with bedding layers were also jacketed with plaster bandages, and later impregnated with resin for making thin sections. Two experimental catch trays that were set up in 2017 were cleaned of their contents. One is located at the foot of the South wall of the cave to monitor the rate of weathering of the pyroclastic breccia that constitutes the roof of the cave, and the other is in an open area to the South of the excavation to document bat guano accumulation per annum. In order to increase their reference collection, in 2018 and 2019 Christine Sievers and Lyn Wadley collected botanical samples from the Border Cave region. A permit was obtained from Ezemvelo Wildlife KwaZulu Natal for these collections and vouchers were lodged with the Durban Herbarium. Their main aims were to identify grasses, leaves and seeds represented in grass mats found throughout the sequence, as well as charred rhizomes originating from Members 4 WA and 5 BS. Scanning electron microscopy was used to study the rhizomes and photograph them and plant structures preserved in the bedding. In 2018 Optically Stimulated Luminescence (OSL) dosimeters were inserted in the deposit, and agate, mollusc and tooth enamel samples were taken for dating. During our field trip in 2019 we retrieved the dosimeters and couriered them to colleagues in France for analysis. No excavations were conducted in 2020 because our field trip was abandoned after three days due to the corona virus pandemic.

Results

Areas excavated

The excavation squares that we have been working in are staggered along the North face of Beaumont's excavation 3A Rear trench, along N108 and N109 lines, providing an almost continuous lateral profile of the deposit (Figure 2a). In 2018-19, excavations continued in squares N108 E113 and N109 E113 (Figure 1), sampling the oldest deposits, including 4 WA, 5 BS (also referred to as BACO A), 5 WA (BACO B) and 6 BS (BACO C.D) to bedrock. We also excavated square N108 E114 to increase the artefact sample size for Member 4 WA and bring us closer to two large pits exposed in the North section in 5 BS (Figure 1). We dug deeper in N108 E115 to better understand Member 4 BS. We continued our work in N108 E117 in order to sample HP layers. We sampled 2 BS and 2 WA (both MSA III), 3 BS, 3 WA, 1 RGBS (all purportedly HP) and 4 BS (MSA I), in other words before, during and after the HP, but found no diagnostic artefacts (*fossiles directeurs)*. In attempting to sample HP material, excavations were also conducted in N108 E116, including 3 WA, 1 RGBS and 4 BS. We also excavated N109 E117, where we sampled 2 WA, 3 BS, 3 WA, 1 RGBS and 4 BS, but only two lithic artefacts were found. Excavations in N109 E117-120 sampled the post-HP (2 WA, 2 BS.UP, 2 BS.LR) and ELSA (1 WA) layers (Figure 1). In order to increase the artefact sample size from ELSA layers (1 BSL, 1 WA) we opened two squares on the South face of Beaumont's excavation 3A trench (Figure 1), namely N103 E117 and E118. We compare our results with those of Beaumont in squares R/S 18 to 21 (Figure 1), which he excavated to bedrock (Beaumont, 1978). To our knowledge, and based on a lack of any diagnostic evidence, we did not excavate any Iron Age layers. This is not the focus of our research, and thus no comparison is made with the Iron Age material recovered by Beaumont. The uppermost layer that we have excavated is 1 BS.

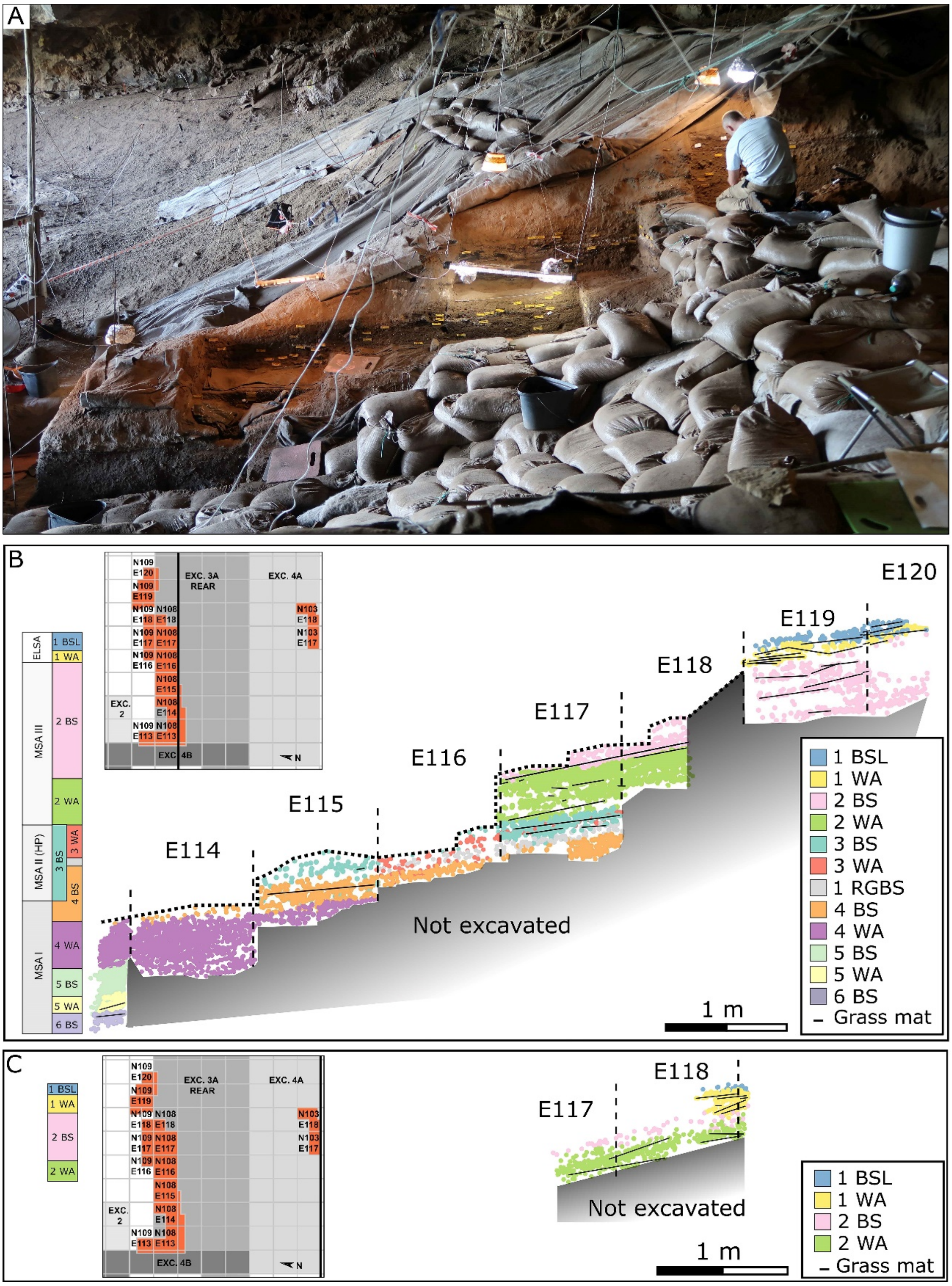

Figure 2. A, Photograph of excavations conducted from 2015-19 along the North face of Beaumont's Excavation 3A trench. The youngest deposits are towards the back of the cave on the right, and the oldest towards the centre of the cave on the left. B, Stratigraphic sequence along the north wall with plotted grass mats shown as lines. C, Stratigraphic sequence along the south wall with grass mats shown as lines. The bold vertical lines in the plans indicate the position of the section shown.

Our fine-resolution excavation methods have enabled us to expose layer upon layer of remnants of occupational surfaces as moments captured in time. The preservation at the site is such that intact grass mats and hearths remain relatively fresh and uncompressed and can therefore be isolated for study (Wadley et al., 2020a). Our millimetre-scale approach identifies 10 layers where Beaumont sees one for Member 1 BS, and 14 for Member 1 WA. We identify 53 layers within his single Member 2 WA and 51 in 4 WA. Stratigraphic layers identified and excavated to date are listed with their host member in Table 1. Updated section drawings of profiles were made of N103 E118 and N109 E117 and 118. New profiles were drawn for N103 E117 and N108 E114 and the adjacent squares N108 E113.5-115. At the end of the 2018 excavations 547.70 litres of sediment were removed and in 2019 285.85 litres. The volume of sediment removed by member since 2015 is given in Table 2 and shown in Figure 3a.

Table 2. Volume (litres) of sediment removed by member by year

Year	1 BS	1 WA	2 BS	2 WA	3 BS	3 WA	1 RGBS	4 BS	4 WA	5 BS	5 WA	6 BS	
2015	23.70	12.50	14.50	0.00	5.50	0.00	0.00	0.00	39.25	0.00	0.00	0.00	95.45
2016	10.52	4.80	59.70	12.40	0.00	0.00	0.00	0.00	39.30	17.05	0.00	0.00	143.77
2017	0.00	52.50	316.20	173.10	135.60	0.00	0.00	0.00	29.50	86.25	0.00	0.00	793.15
2018	4.00	20.20	57.00	102.25	100.50	33.50	64.50	85.00	12.00	17.00	16.75	35.00	547.70
2019	0.00	0.00	0.00	47.00	17.50	0.00	4.00	13.50	203.85	0.00	0.00	0.00	285.85
Total	38.22	90.00	447.40	334.75	259.10	33.50	68.50	98.50	323.90	120.30	16.75	35.00	1865.92

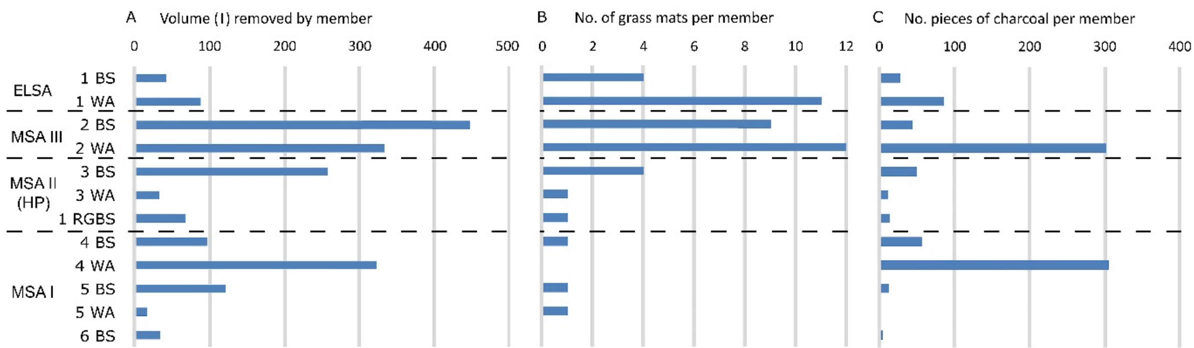

Figure 3. Histograms showing A, volume in litres of sediment removed per member; B, number of grass mats per member, and C, number of plotted pieces of charcoal per member excavated from 2015-19.

The relatively high volume of sediment removed from Members 2 BS and 4 WA correspond in some cases with a high number of finds. Member 2 BS is a thick deposit and was excavated in six of our eight squares opened along the North profile (Figure 2b). Member 4 WA is also a thick unit, sampled in three squares. In other instances, the data show that even though very little sediment was excavated, a great deal of archaeological information was retrieved, as in the recovery of grass bedding in Members 5 BS and 5 WA (>140 ka). Here we present data based on piece-plotted artefacts only, as bucket finds continue to be processed. All numbers will be subject to some later revision, especially seeds, ochre and charcoal. We also compare the trends appearing from the material we have collected with trends observed in material recovered by Beaumont in excavation 3A Rear.

Organic remains

Desiccated complete leaves are preserved in 2 WA, in layers Dark Brown Dijon (Figure 4) and Dark Yellowish Brown Dossy, dated *c*. 60 ka.

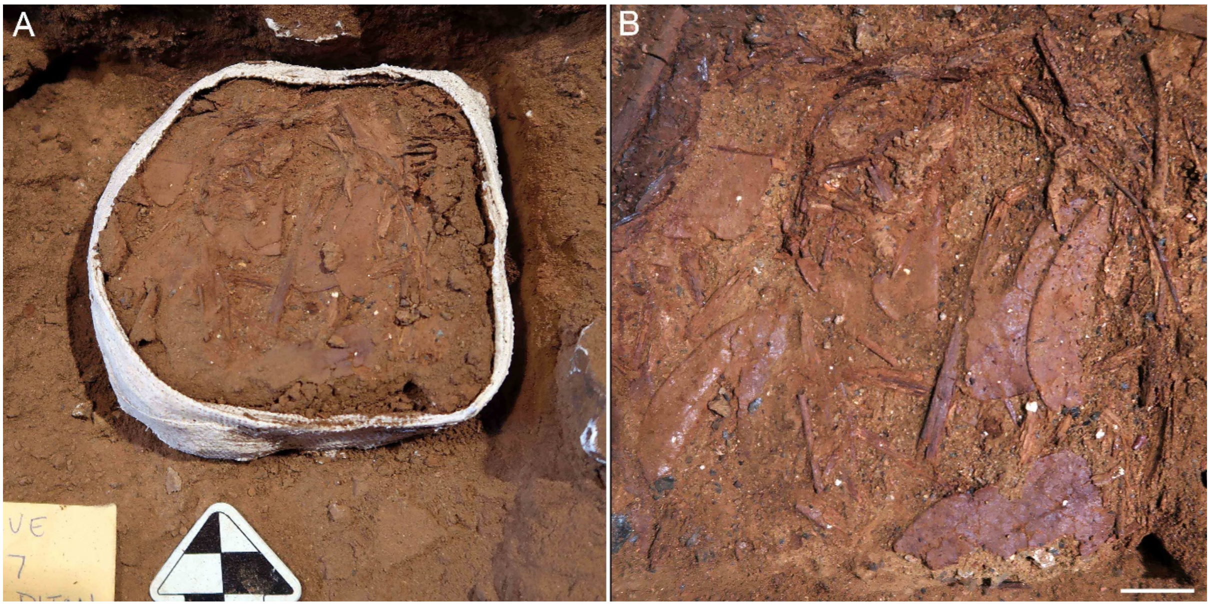

Figure 4. A bed of desiccated *Chionanthus foveolatus* leaves found in square N118 E109 in Member 2 WA, aged ~60 ka, in layer Dark Brown Dijon. A, Plaster jacket made around the feature *in situ*. B, Close up view showing leaf colour, margins and ribs. Scale in b = 1 cm.

A total of 45 layers of grass mats/bedding have been identified in the squares excavated between 2015 and 2019 (Table 1 highlighted in grey, Figure 2b, c). They are extremely well preserved and are rich in seeds, ochre and lithics (see Wadley et al., 2020a). Figure 3b shows the number of mats by member, with four from 1 BS, 11 from 1 WA, nine from 2 BS, 12 from 2 WA, four from 3 BS, one from 3 WA, one from 1 RGBS, one from 4 BS, none from 4 WA, and one each from 5 BS and 5 WA. Even though relatively little sediment was excavated from 1 BS and 1 WA there is still a high number of mats recorded for the ELSA. Their abundance decreases sharply in the HP layers, with the last of the mats recorded in 1 RGBS at ~74 ka. The oldest grass bedding was found in N109 E113 in 5 BS (Brown Jolly plan 2) dated 161–144 ka, and 5 WA (Kevin), dated >227 ka. Unlike the bedding in the younger members, which is entirely organic and retains pigmentation, the grass in 5 BS and 5 WA is white because it has silicified. This diagenetic change was confirmed using Raman spectroscopy (Wadley et al., 2020a). Microscopic analysis identified an unusually high number of grass phytoliths associated with the silicified grass, supporting the interpretation that it was intentionally introduced as a floor cover. Charcoal in the bedding includes *Tarchonanthus trilobus* (broad-leaved camphor-bush) that has aromatic leaves like those from *T. camphoratus*, which is used as an insect repellent in modern plant bedding in Africa (Beentje, 1999). Thin sections of the microstratigraphy show silicified, laminar bedding underlain with ash. The grass mats/bedding found throughout the sequence occur on layers of ash, which suggests that ash was intentionally spread before grass and aromatic leaves were laid down, and that the ash and leaves may have served as an insect repellent (Wadley et al., 2020a). Notably high numbers of charcoal are found in 2 WA and 4 WA (Figure 3c), corresponding to the volume of sediment removed. The oldest charcoal was found in 6 BS, dated >227 ka.

Fifty-five charred underground storage organs, identified as *Hypoxis angustifolia*, were described (Wadley et al., 2020b). Forty-four come from 4 WA and 11 from 5 BS, making them the oldest known examples of cooked starchy rhizomes at 170 thousand years old. To date, 140 seeds have been found *in situ* and double that amount in the sieve. Figures 5a-b show the number of plotted seeds found *in situ* by member, compared to what Beaumont found in excavation 3A Rear. Beaumont recovered around 1,400 seeds within excavation 3A Rear, most of them coming from the Iron Age layers (Beaumont, 1978). While he mentions seeds in layers below 2 WA, our excavations yielded seeds throughout the sequence (Figure 5c). The highest number of plotted seeds (*n*. 48) comes from Member 4 WA, but this could be due to the long time period that it covers (168–113 ka) and the fact that a relatively large volume of sediment has been excavated from this thick unit. Forty-one come from 2 WA at ~60 ka, and this may be due to the high volume of sediment removed from this member. The seeds from 4 WA and 2WA are charred and come from ash layers. Twenty-seven have been found in 2 BS, and one in the ELSA layers.

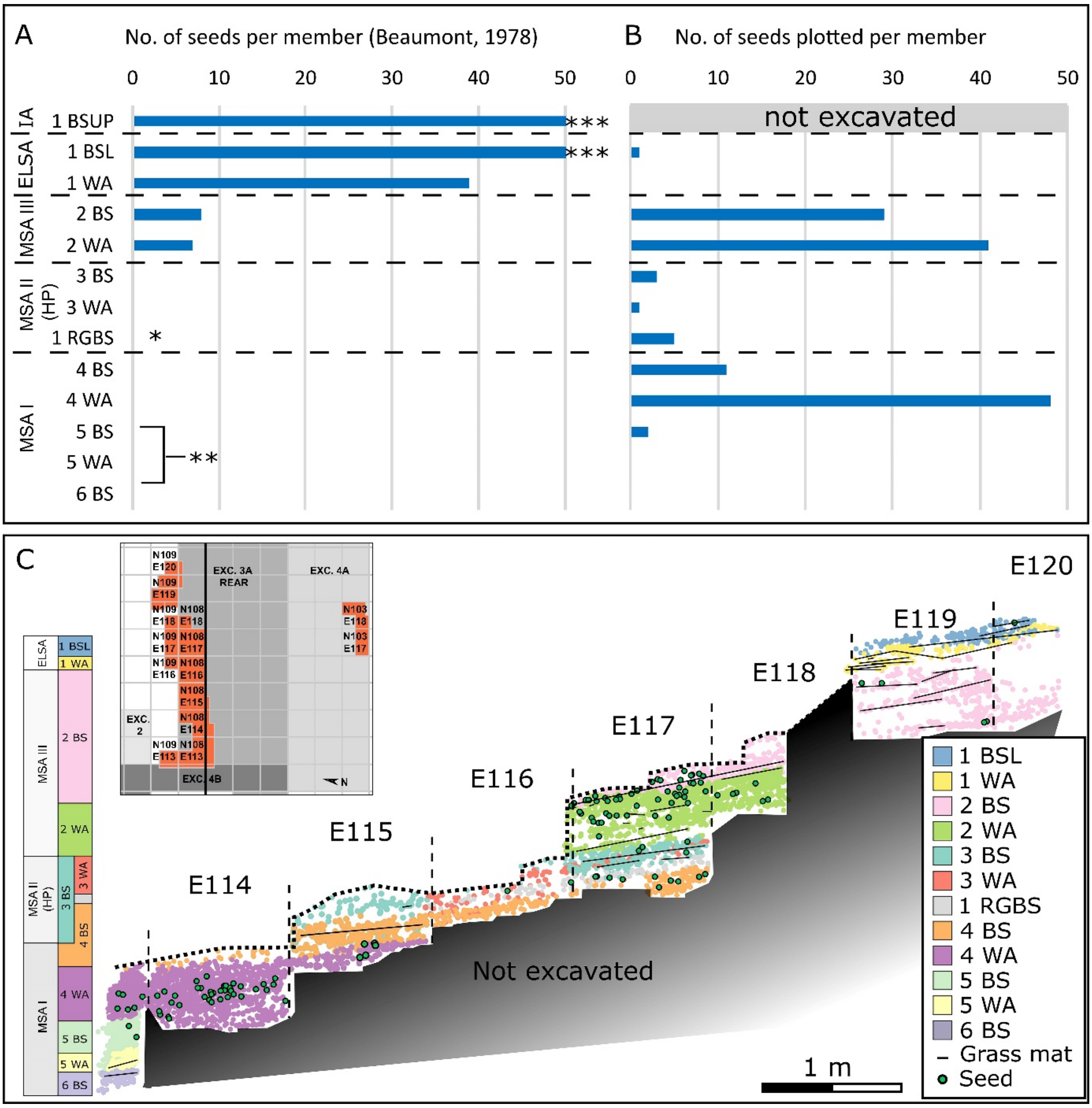

Figure 5. Histograms showing A, number of seeds per member excavated by Beaumont (1978), and B, number of plotted seeds per member excavated from 2015-19. *not identified by Beaumont in EXC. 3. Rear, **grouped under BACO member, ***>50. C, Stratigraphic distribution along the north wall of plotted seeds recovered from members excavated from 2015-19. The bold vertical line in the plan indicates the position of the section shown.

Little information is available on wood from Beaumont's excavations. What has been published focuses only on the worked wood, especially notched pieces recovered from Iron Age, ELSA and MSA II (2 WA) contexts (Beaumont, 1978). In our excavation, wood was found in abundance in the upper members (2 BS, 2 WA, 3 BS). The distribution of wood plotted is similar to that of the grass mats, except that wood is preserved unaltered in the MSA I layers, which include 4 BS, 4 WA and 5 BS (Figure 6a).

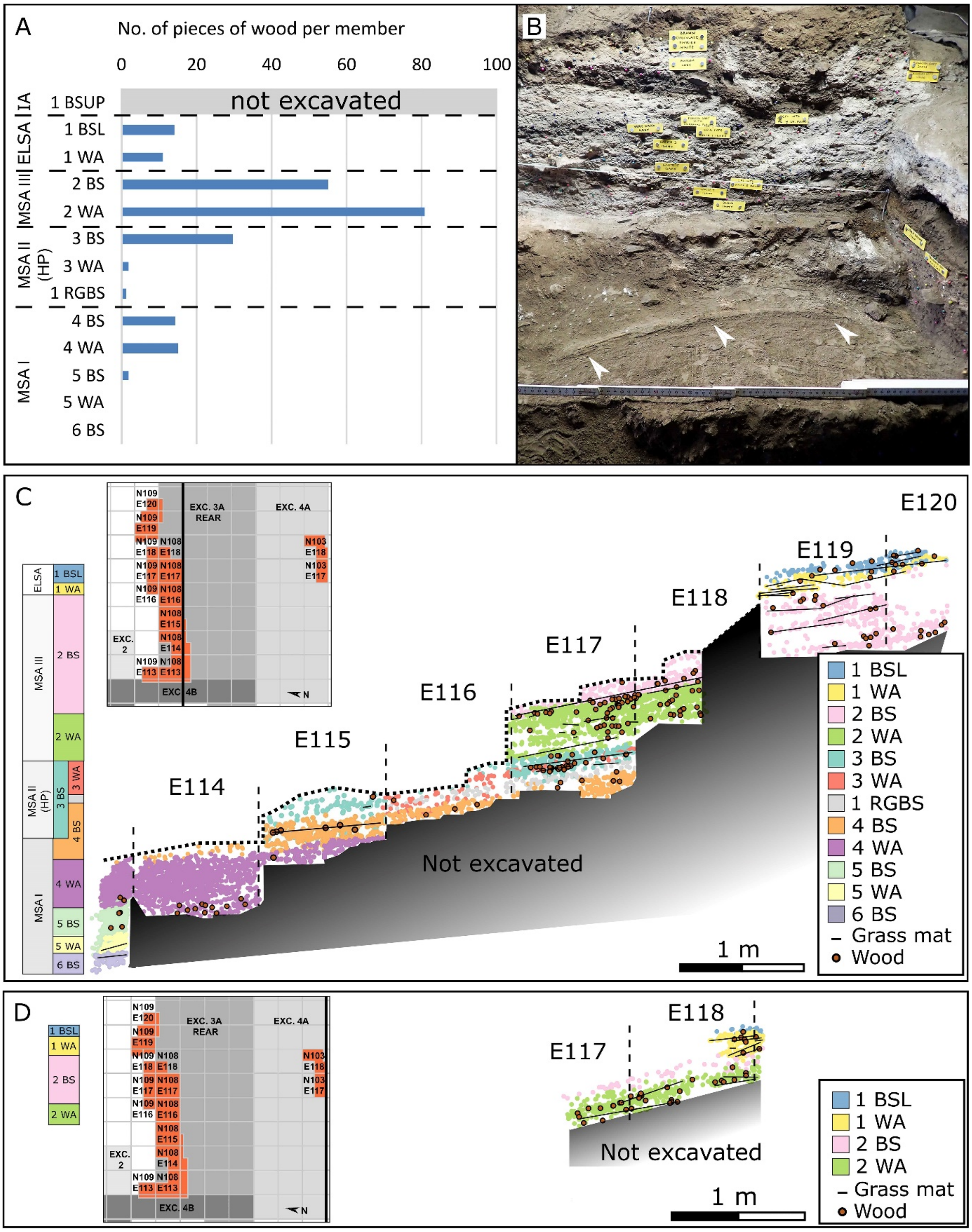

Figure 6. A, Histogram showing the number of pieces of plotted wood per member excavated from 2015-19. B, Photograph of a long piece of pedestalled wood (arrows) recovered in N108 E114, in Member 4 WA, in Pit 1 and Pit 2 in layer White 8 Idaho, plan 6. C-D, Stratigraphic distribution of the recorded pieces of plotted wood recovered along the North (C) and South (D) walls from members excavated from 2015-19. The bold vertical lines in the plans indicate the position of the section shown.

This pattern is likely a function of volume of sediment removed from each member (Figure 3) and better preservation in younger deposits. Wood is present in Member 4 WA, where it occurs in Pit 1 and Pit 2 in square N108 E114 (Figure 6b). Two pieces are recorded in Member 5 BS, dated 161–144 ka. Of particular interest is the discovery of one notched piece of wood coming from 2 WA Brown Daria, dated ~60 ka. It increases the ELSA assemblage found by Beaumont, consisting of a potentially shaped piece in Member 2 WA and four notched pieces originally belonging to a single notched stick, recovered from 1 WA (Beaumont, 1978; d'Errico et al., 2012). A second find of interest that is currently under investigation is an organic container-like object associated with a stick. They were found inside a pit lined with cemented ash in Member 5 BS. The find is exceptional given its age, and provides rare insight into organic material culture and technology ~150 ka.

The remains of *Achatina* land snails were found in relatively high numbers in the MSA I (4 BS, 4 WA) and HP (3 WA, 1 RGBS) members (Figure 7). While the highest number of plotted shells in 4 BS may be a function of the volume of sediment removed from this thick unit, the low numbers in the younger deposits do not match this pattern. From all of the excavations conducted by Beaumont, he found 3,529 pieces of *Achatina* shell, representing a minimum number of 84 individuals (Beaumont, 1978), with the highest number in 4 BS (*n*. 1,076), as is the case with our excavations. It appears therefore that between 168 ka and 77 ka land snails may have been part of the diet of visitors to the cave, and that MSA III people ate them only occasionally. *Achatina* are most active during the warm wet summer months. During the cold and dry winter months they bury themselves deeply in the soil at the base of trees and shrubs, amongst dense clumps of herbaceous plants or under logs (Herbert and Kilburn, 2004), which may suggest that they were consumed seasonally, in summer. For the ELSA, our data and Beaumont's diverge. For the *Achatina* remains we only rely on a general count of the shells from excavations 3A and 3B as Beaumont's results include some of the younger layers that were capping part of the sequence we excavated. It appears that ELSA populations also consumed land snails, but only occasionally.

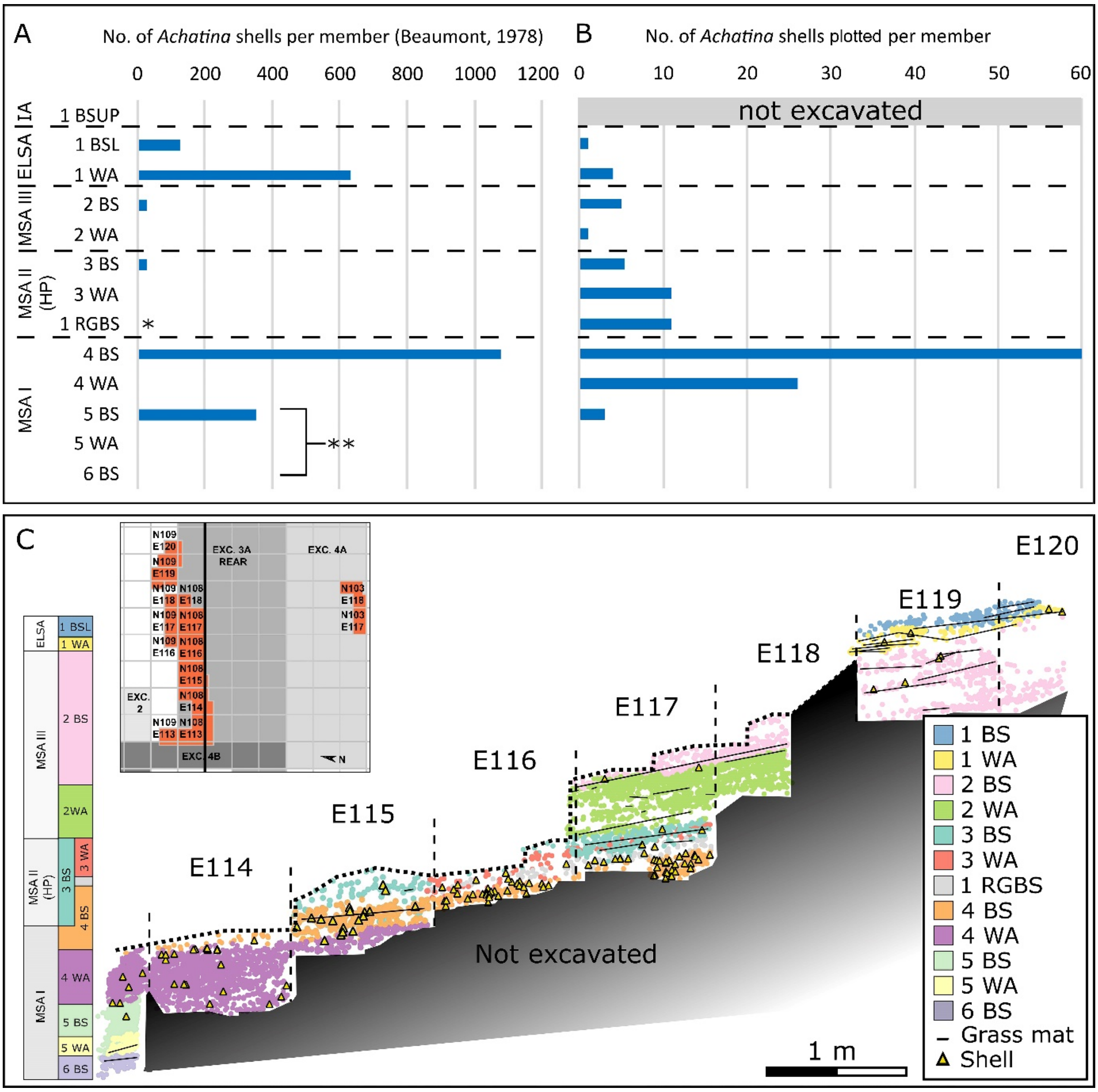

Figure 7. Histograms showing A, number of *Achatina* shells per member excavated by Beaumont (1978), and B, from 2015-19. *not identified by Beaumont in EXC. 3. Rear, **grouped under BACO member. C, Stratigraphic distribution of the plotted *Achatina* shells recovered along the North wall from members excavated from 2015-19. The bold vertical line in the plan indicates the position of the section shown.

In 2018 the fauna excavated from 2015-18 was analysed, including all piece-plotted bone and the bucket finds from the 2017 campaign. Along with the mammalian fauna, the remains of two human infants were identified. One is represented by the centrum of an upper or mid thoracic vertebra from 1 BSLC dated 42.6 ka. The other is represented by a femoral shaft in two pieces from 2 BSL, dated 60–49 ka. The identified fauna includes at least three bird taxa, tortoise, and one reptile. Apart from the two human infants, no primates are represented in the current assemblage, and no carnivores either. Bovids are the most common taxa identified, and all bovid size classes are represented. Small mammals are rare and include hyrax and lagomorphs. Figure 8 shows the number of pieces of bone plotted per member and their comparison to what Beaumont found in squares R/S 18 to 21. Bone is represented throughout the sequence, except in Member 5 WA (>227 ka), the second to last oldest member; however, the total volume of excavated deposit from this Member is quite small. MSA III deposits show a spike in bone recovered in 2 WA at ~60 ka. Similar trends can be seen in Beaumont's excavation of squares R/S 18 to 21. This may reflect the relatively high volume of sediment was removed from this member, but it could also reflect variation in site formation processes or human behaviour. The members above (2 BS) and below (3 BS) had a relatively high volume of sediment removed, yet the bone densities are less than half that of 2 WA. The relatively small volume of HP deposit sampled (3 BS, 3 WA, 1 RGBS) yielded a similarly small sample of bone. The MSA I deposits (4 BS, 4 WA, 5 BS, 5 WA, 6 BS) reflect the same density as the volumes of sediment removed from these members, with a spike in 4 WA (168–113 ka). Despite the many hearths constituting this member, bone was still preserved.

The absence of bone tools and recovery of only a few personal ornaments (three ostrich eggshell beads) from our sample is likely because we have excavated very little of the ELSA deposits (Members 1 BSLC and 1 WA). In addition to the three ostrich eggshell beads previously described from 1 BSLC (d'Errico et al., 2012), eight pieces of ostrich eggshell have been found, three in Member 1 BSLC (42 ka), one in 2 WA (~60 ka), two in 3 BS (~72–56 ka), and one piece in 4 BS in Dark Brown Hayley (91–71 ka), and it is stained red with ochre. According to preliminary observations, they all fall within the size range of those intentionally broken by modern San women for the purpose of making blanks for the production of a string of ostrich eggshell beads. This is significant because the oldest beads made from ostrich eggshell found by Beaumont date to 42 ka (Beaumont, 1978; d'Errico et al., 2012).

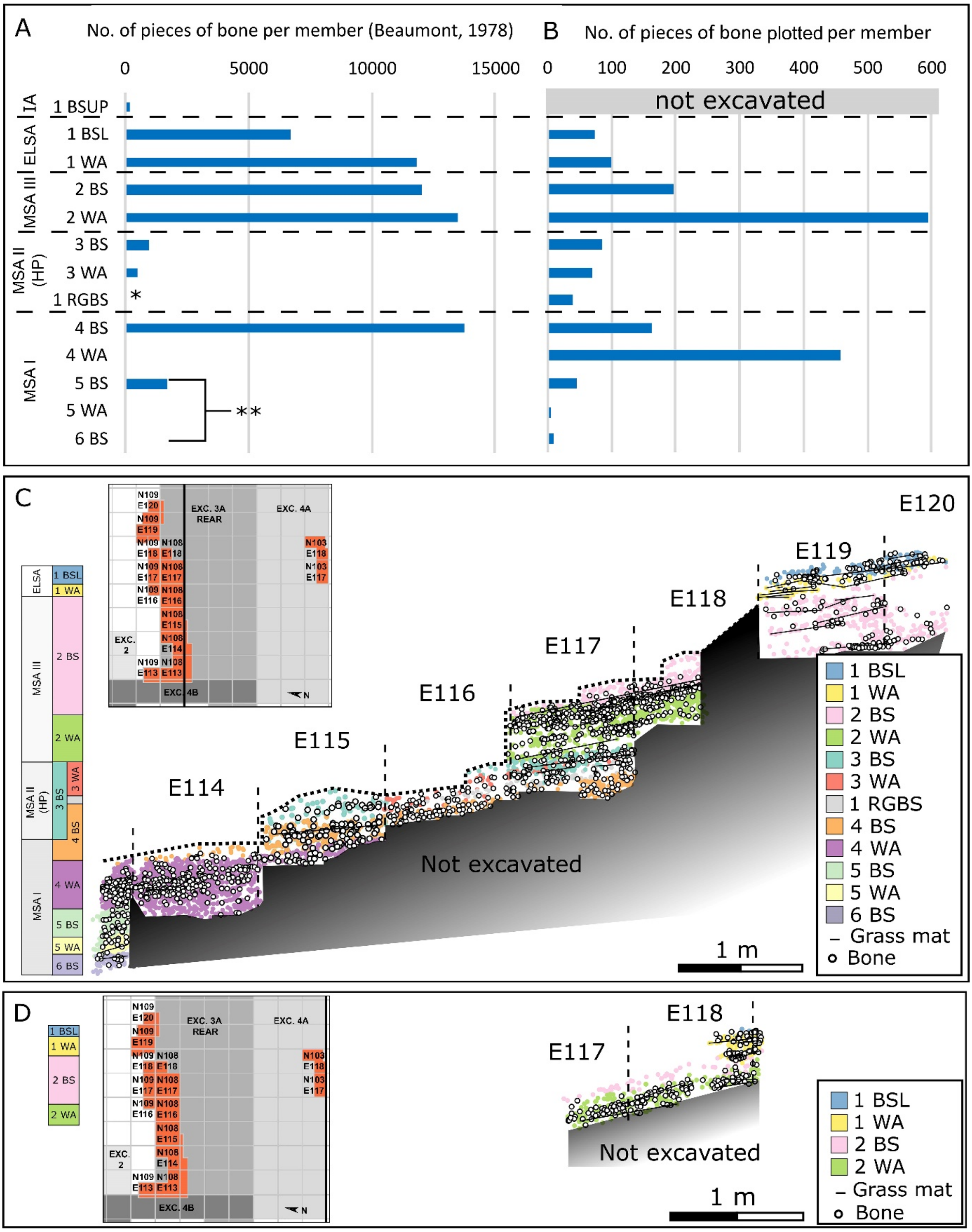

Figure 8. Histograms showing A, the number of pieces of bone recorded per member excavated by Beaumont (1978), and B, plotted from 2015-19. *not identified by Beaumont in EXC. 3. Rear, **grouped under BACO member. C-D, Stratigraphic distribution of the plotted pieces of bones recovered along the North (C) and South (D) walls from members excavated from 2015-19. The bold vertical lines in the plans indicate the position of the section shown.

Ochre and lithic artefacts

Figure 9 shows the number of plotted ochre pieces found by member and a comparison with what Beaumont found in squares R/S 18 to 21. The numbers are low, below 20 for most members, except for Member 4 WA with 33 pieces representing the period 168–113 ka, a peak in 2 WA with 80 pieces at approximately 60 ka and a lessening trend from 2 BS.UP (*n.* 33) to 1 BS.LR, where only nine pieces were found. A similar trend is visible in Beaumont's numbers from his excavation of squares R/S 18 to 21. The main difference lies in the upper layers. Most of the upper layers of the squares we excavate were excavated by Beaumont, so were not included in our comparison. The higher number of pieces associated with MSA III (2 BS, 2 WA) corresponds with the high volume of sediment removed from these layers. In the silicified 5 WA bedding, red and orange ochre grains are up to 37 times as frequent as in over- and underlying layers, and they are smaller and rounder than the dark red, angular fragments from cave roof detritus that provides an ochre source (Wadley et al., 2020a). Elemental and mineralogical analyses by means of scanning electron microscopy coupled with energy dispersive X-ray spectroscopy and µ-Raman spectroscopy cannot distinguish grains from bedding and those from over- and underlying layers (Wadley et al., 2020a), which could suggest that people used ochre from the cave.

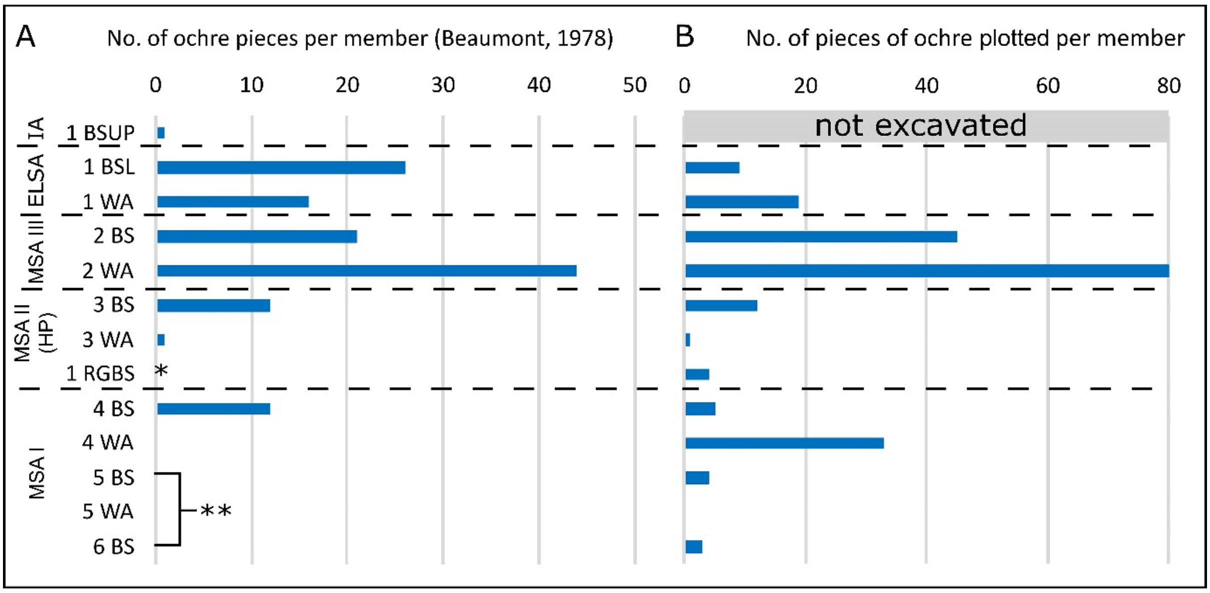

Figure 9. Histograms showing A, the number of pieces of ochre recorded per member excavated by Beaumont (1978), and B, plotted from 2015-19. *not identified by Beaumont in EXC. 3. Rear, **grouped under BACO member.

Figures 10a-b show the number of lithics by member and the comparison with the material Beaumont recovered in squares R/S 18 to 21. Relatively few lithics have been found in the ELSA layers. Quartz crystals were found complete in 2 WA (~60 ka) and shattered in 1 WA (43 ka). In 2 WA the lithic distribution is clearly stratified on grass mats. Relatively few lithics were found in the purported HP layers and final MSA I in 4 BS, while the highest number were retrieved from underlying 4 WA and 5 BS (>100 ka). Stone flake and blade manufacture is associated with the 5 WA bedding layer. The lithics described cannot be assigned to a specific industry, but they resemble those in the 1987 Member 5 WA collection of Beaumont, labelled MSA I/Pietersburg (Wadley et al., 2020a).

Horncore feature

A horncore in Member 2 BSL, dated 60–49 ka, was found lying with the tip half on a mat of burnt grass bedding towards the edge of a fireplace (Figure 11a). The tip half was covered with a black shiny residue, which was also present on nearby stone tools (Figure 11b). Knowing that variation exists in modern and archaeological glue recipes (Villa et al., 2012, 2015; d'Errico et al., 2012; Wadley et al., 2015), we wanted to know if the black residue was melted keratin, and if it was, whether it had been used as a substitute for beeswax or latex for hafting. We set out to test the hypothesis by conducting a heating experiment with a modern sheathed horncore. Experimental results showed that keratin does not transform into viable glue when heated. Instead, it reduces immediately to a glassy brittle black residue. Our finding strongly supports a scenario of incidental deposition of residue on the archaeological stone tools (Backwell et al., 2020). Previous combustion experiments have shown that the sediment below a fire can reach 300+ °C through vertical heat transfer (Aldeias et al., 2016; Sievers and Wadley, 2008; Werts and Jahren, 2007). This implies that horn sheaths in archaeological deposits, separated from overlying combustion features by thousands of years, can transform into a black residue that may deposit on nearby stone and bone tools. It thus calls for great caution in interpreting residues on artefacts.

Finally, about 250 ml of sediment and roof spall was collected from the one catch tray in 2018 and again in 2019, supporting our hypothesis that roof degradation is a significant part of the site formation process (Backwell et al., 2018). No bat guano was found in the other tray even though bats occupy the back of the cave.

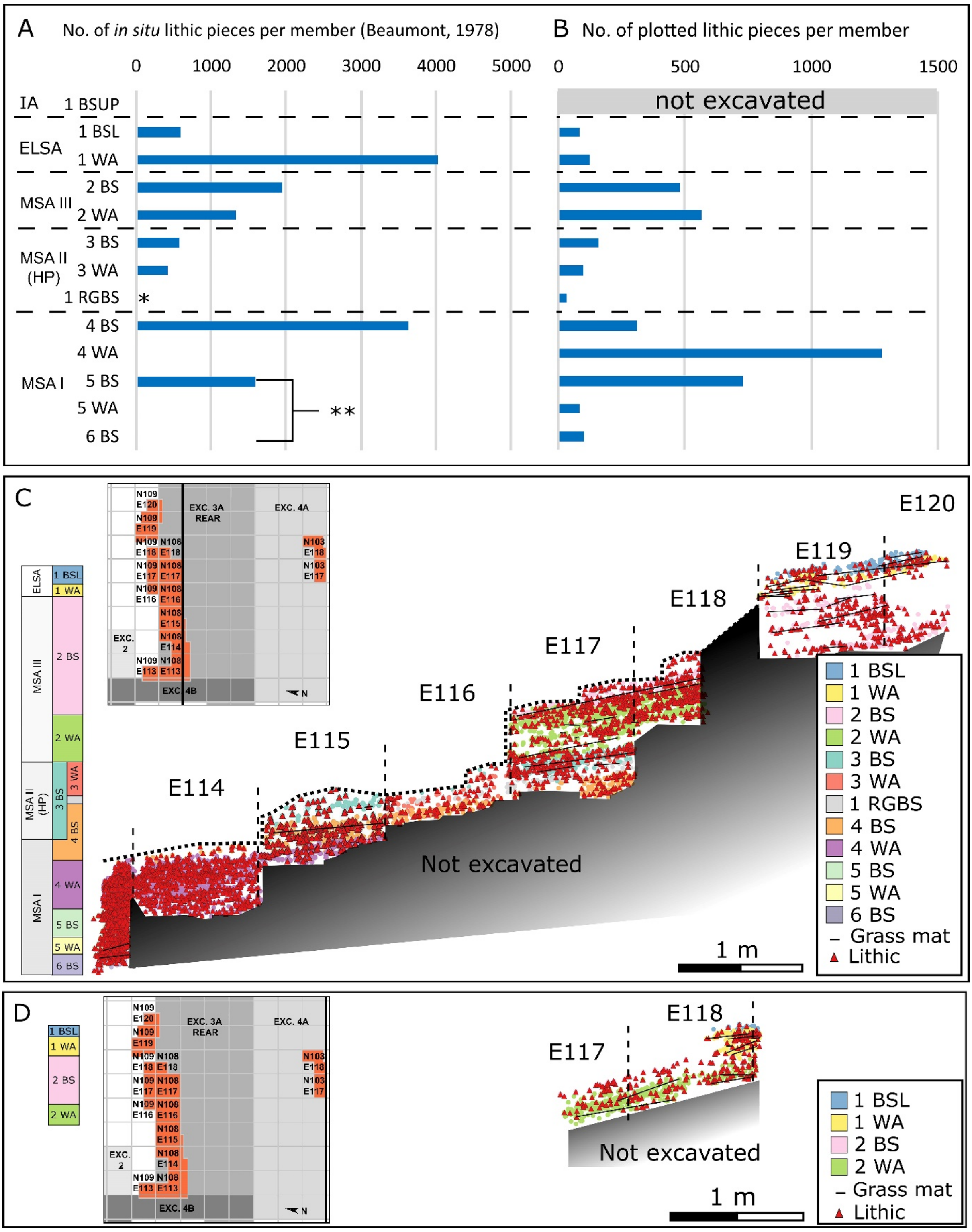

Figure 10. Histograms showing A, number of lithics recorded per member excavated by Beaumont (1978), and B, number of plotted lithics from 2015-19. *not identified by Beaumont in EXC. 3. Rear, **grouped under BACO member. C-D, Stratigraphic distribution of the plotted lithic artefacts recovered along the North (C) and South (D) walls from members excavated from 2015-19. The bold vertical lines in the plans indicate the position of the section shown.

Figure 11. A, Horncore in Cilla combustion feature 1 in N109 E119/120 showing the calcined basal half of the horncore in the centre of the white ash and the tip on a burnt grass mat. A black shiny substance covers the tip and surrounding area. A narrow trench has been excavated around the feature to facilitate the construction of a plaster jacket. B, Lithics uncovered close to the tip of the horncore showing the same black substance associated with the horncore adhering to their surfaces. The black substance has tiny charcoal and ash inclusions. C, Horncore feature in a plaster jacket. Scale in b = 10 mm, scale in c = 30 mm.

Site management and conservation

Site management and conservation between field seasons was carried out by Len van Schalkwyk, Chris Wingfield and Amon Sokhela of eThembeni Cultural Heritage. Site closure entailed stabilizing sections with sandbags and wooden boards and covering the entire excavation area with geotextile.

The curator of the museum, Olga Vilane, is also the guide for the site, and we are in regular contact with her. We have given her training in the recognition and identification of bones, teeth, stone tools, ochre and seeds, as well as curation of archaeological materials. She is a valuable member of our team and as such appears as a co-author on the manuscript I am soon to submit. She will be kept up to date regarding the outcomes of our research programme.

Conclusion

The 2018-19 excavations at Border Cave have shed a great deal of light on early human behaviour in southern Africa. The relatively high volume of sediment removed from Members 2 BS and 4 WA correspond in some cases with a high number of finds. In other instances, even though very little sediment was removed, a substantial amount of archaeological information was retrieved. Employing high-resolution excavation and analytical techniques, we have recovered the remains of two human infants from layers dating to 43 ka and between 60–40 ka, discovered and described 55 cooked geophytes aged 170 ka, and exposed and discussed ancient grass bedding from layers dated 200 ka. Analysis of the bedding and sequence of hearths shows that from about 200 thousand years ago, people could produce fire at will, and used fire, ash, and aromatic plants to maintain clean, pest-free camps. The identification of the cooked starchy rhizomes to the taxon *Hypoxis angustifolia*, which has an almost pan-African distribution, has potential behavioural implications. The rhizomes could have provided a reliable and familiar carbohydrate source for mobile groups moving within and out of Africa. Border Cave is remote from dispersal routes out of Africa, yet it contributes data on the ease with which early *Homo sapiens* could travel within the continent (Wadley et al., 2020b).

Conference presentations

***Society for American Archaeologists (SAA)* 2019**

New excavations at Border Cave: preliminary reflections on stratigraphy and site formation processes.

Dominic Stratford, Lucinda Backwell, Lyn Wadley, Francesco d'Errico, Paloma de la Peña, Emese Bordy, Will Banks, Justin Bradfield, Marine Wojcieskszak.

The Border Cave rock shelter, situated on the western scarp of the Lebombo Mountains, KwaZulu-Natal, has a long history of archaeological investigation starting with Raymond Dart in 1934. Phases of informal and formal excavation of the rock shelter, formed in Early Jurassic fragmental rocks of the Jozini Formation, have yielded remarkable archaeological assemblages including five hominin specimens and spanning MIS 4, 5 and 6. BC1 and 2 have unsecure provenances. BC3 and BC4 are claimed to have been excavated from burial contexts, while BC5 was excavated from strata 3WA during Peter Beaumont's extensive excavation of the site in the 1970's. The ages and stratigraphic associations of these specimens have been debated. Beaumont's excavations revealed a long lithostratigraphic sequence documenting perhaps 200,000 years of sedimentation and anthropogenic occupation through until the Iron Age. Remarkable preservation of organic matter has provided a wealth of data on the anthropogenic activities and environmental context through the Border Cave sequence which is divided up into multiple BS (Brown Sand) and WA (White Ash) Members. New investigations, started in 2015, aim to develop greater contextual and chronological resolution to this sequence and its rich archaeological record. Here, we present some preliminary geoarchaeological observations of the Border Cave stratigraphy made during these new excavations.

***Society of Africanist Archaeologists (SAfA)* 2020**

A geoarchaeological investigation of site formation processes in the upper Brown Sand and White Ash stratigraphic units at Border Cave, KwaZulu-Natal, through the application of fabric analysis.

Thomas Beard, Lucinda Backwell, Frrancesco d'Errico, Paloma de la Peña, Lyn Wadley, Dominic Stratford.

Border Cave, located in the rhyolitic Lebombo Mountains of KwaZulu-Natal, South Africa, contains a particularly long record of archaeological deposits spanning over 200,000 years. Significant finds include evidence of early burial practices, personal ornamentation and high levels of organic preservation. As part of a larger geoarchaeological program at the site, this study utilises fabric analysis to explore geogenic and anthropogenic contributions and their influences on deposit geometry, particle organisation and assemblage integrity through the stratigraphic facies of the upper sedimentary sequence. Two fabric analyses have been conducted, a dedicated fabric excavation and a GIS based investigation (using context sheets), both of which investigate the upper portion of the sequence (1BS, 1WA, 2BS and 2WA). These analyses will provide spatial data that will elucidate site formation processes. Preliminary results reveal some areas with isotropic organisation and some with anisotropic organisation, the latter suggesting influences of low energy fluvial/colluvial processes.

***12th International Meeting of Phytolith Research* 2021**

Bedding layers from Border Cave, South Africa: a phytolith and FTIR investigation.

Irene Esteban, Lyn Wadley, Lucinda Backwell.

Border Cave is a well-known South African Middle and Later Stone Age archaeological site located in KwaZulu-Natal, that has provided exceptional plant preservation, probably unparalleled in South African archaeology. The site preserves multiple bedding structures in numerous layers, some survived as visually ephemeral fragments of silicified plant material while in others desiccated plant is preserved. This study presents ongoing research on the phytolith and chemical composition of sediments from bedding layers dating from ~227 to 24 ka. The complexity and distinctiveness of these deposits provide an excellent opportunity to study the relationship between plant exploitation strategies and sleeping behaviours of the ancient inhabitants of Border Cave. The results here presented are further investigated from a taphonomical perspective, that is critical to conducting a more reliable interpretation of plant-human behaviours in the cave.

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