Sibudu Cave, KwaZulu-Natal: Background to the excavations of Middle Stone Age and Iron Age occupations

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Sibudu Cave excavations have yielded an Iron Age occupation directly overlying a long sequence of final Middle Stone Age (MSA) layers dating *c.* 61 000–26 000 years ago. Older, undated layers contain a Howiesons Poort Industry. A diverse animal population is represented in the final MSA. Proxy environmental data suggest cooler, drier conditions with a larger savanna component to the vegetation than at present.

Introduction

Sibudu Cave, approximately 40 km north of Durban and about 15 km inland of the ocean (Fig. 1), is perched on a forested cliff overlooking the Tongati River, northern KwaZulu-Natal. The site is significant because it has a deep, well-dated Middle Stone Age (MSA) sequence and good organic preservation. It is particularly suitable for optically stimulated luminescence (OSL) dating because of the brightness and size of the quartz grains in its deposits. The deposits themselves have clear stratigraphy and preserve hearth structures (Schiegl *et al.*, this issue). The good organic preservation allows for analyses of charcoal, seeds and bone and these, in turn, permit environmental reconstructions of the period between about 26 000 and 62 000 years ago. Vegetation changes are apparent from the charcoal (Allott, this issue) and seed studies (Wadley, this issue), and faunal analysis (Plug, this issue) reveals that there was a rich and diverse animal population in the area. The cave occupants were clearly skilled hunters for there is little evidence that non-human predators contributed bone to the archaeologically recovered sample. Cultural material from Sibudu includes a huge collection of late MSA stone tools and rare pieces of worked bone, one of which has been directly dated (Cain, this issue). Residue analysis on a large sample of the stone tools shows that the cave occupants processed much plant material and used individual tools for multiple tasks (Williamson, this issue).

The excavations are ongoing and the papers presented here do not, therefore, provide the last word on Sibudu Cave. New excavations conducted since completing the analyses communicated in this issue have uncovered a long Howiesons Poort occupation in the deeper, older deposits of the site and there is no indication that bedrock will be reached soon.

Excavation of the site

That part of the cave floor where the excavations are being conducted lies at an altitude of approximately 100 m above mean sea level (a.m.s.l.), but the southern entrance nearer to the river is about 12 m lower, so that the 55-m-long cave floor (Fig. 2) slopes abruptly from north to south. The cave is about 18 m in width and it was formed by the river lowering its channel and eroding through the sandstone and shale cliff, during a marine regression (R. Maud, pers. comm.). Today, the cave is poised well above the river; probably because the incision of KwaZulu-Natal river channels into underlying bedrock (as a response to glacio-eustatic lowering of sea levels) took place during the Penultimate Glacial about 160 000 to 140 000 years ago, when sea level was about 100 m below that of today.[1] Further incision would have taken place during the Last Glacial of the late Pleistocene, when maximum sea level was probably as low as –130 m.[2]

A small trial trench of roughly one metre deep was excavated in 1983 by Aron Mazel of the Natal Museum. His excavation revealed that the uppermost layers of the cave contain Iron Age (IA) occupations and layers immediately below this contain MSA occupations. Two reversed radiocarbon dates were obtained for charcoal samples from MSA layers; the uppermost one was 26 000 ± 420 BP (Pta-3765) from layer MOD 2 at a depth of 20–30 cm from the surface; the second date of 24 200 ± 290 BP (Pta-3767) came from layer GAA2 at 79–88 cm below surface. This second, younger date is out of context and it must be rejected. The date of 26 000 BP is useful because it suggests that the site contains a final, late MSA occupation, but it should be considered a minimum estimate of the age, which may prove older when a new luminescence date is obtained.

The new excavations, which began late in 1998,[3] encompass 18 square metres and they include a two-metre trial trench that is now more than 2 m deep. The current base of the trial trench is not in sight of the cave's bedrock and it is estimated that several metres of deposit wait to be excavated. A further 16 squares are on average 70 cm deep. The deposit is excavated in 50-cm quadrants; it is screened through 2-mm mesh and the finds of cultural material and food remains from individual quadrants are separately curated. A permanent datum line is painted on the cave wall and the depth of each layer is measured from this datum. All stratigraphic depths referred to here are thus relative to the datum unless it is stated differently.

Dating and stratigraphy

The Sibudu stratigraphy is complex with thin, distinct, brightly coloured layers as well as palimpsests of hearths and ash lenses. In some instances, accumulations of inter-fingering lenses are termed members. A sedimentological analysis[4] of six samples shows that the sediments are poorly sorted and immature, largely comprising anthropogenically derived material such as ash, bone and worked stone. A smaller component of the sediments comprises weathered roof-rock, windborne sand, debris from microfauna and owls, and calcium carbonate and gypsum nodules, which form during decalcification of the deposits. The poor sorting of the sediments implies that little or no waterborne transportation occurred within the cave and sediment microscopy confirms this conclusion.[4] A mineralogical study of hearth and soil samples from Sibudu confirms that ash

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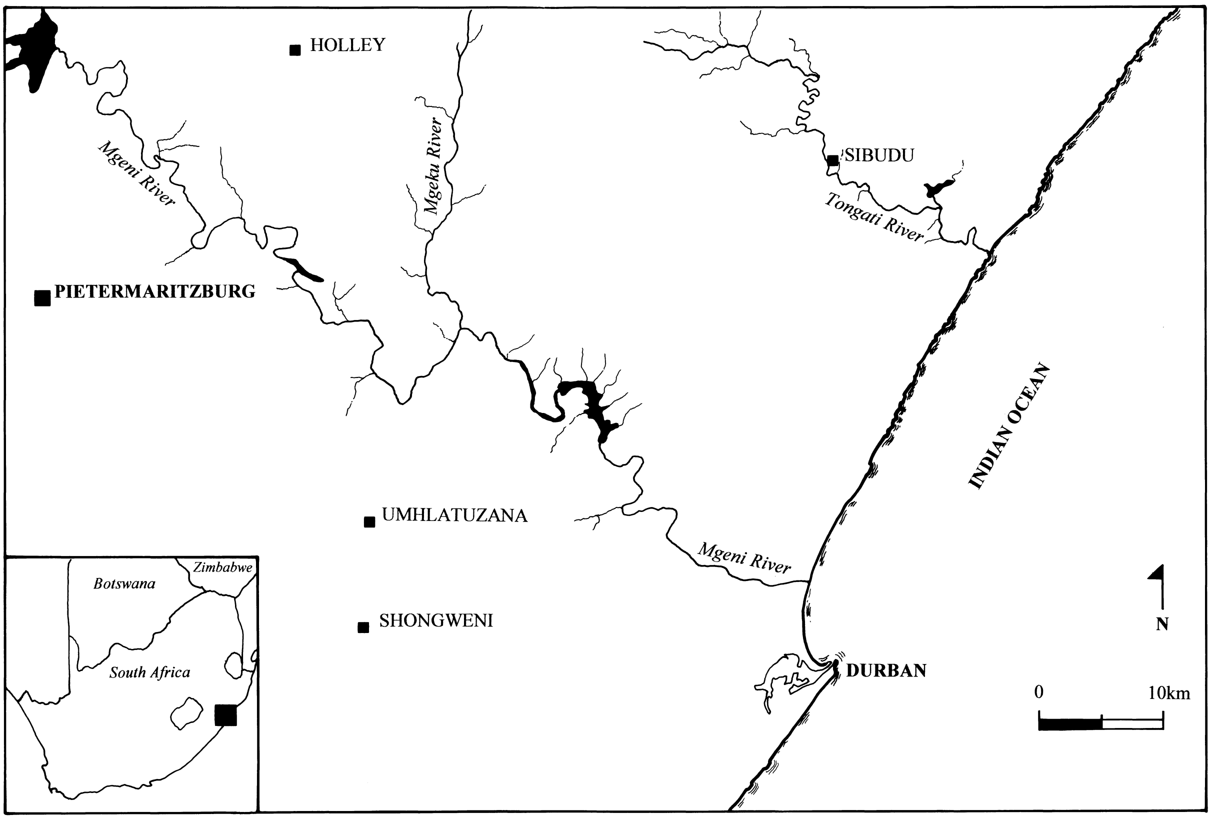

Fig. 1. Position of Sibudu Cave.

is a major component of not only the hearths, but also other deposits in the MSA layers studied (Schiegl *et al.*, this issue).

The stratigraphy is described here in broad, general terms to enable the reader of the collated Sibudu papers to place the various aspects of research in context. A caricature of the stratigraphy in the form of Table 1 is designed to show the possible relationship between strata in the northern and eastern parts of the excavation grid. This interpretation may alter when more detailed dating of the uppermost units is obtained. Two dating methods have been used: radiocarbon dating (^{14}C) on charcoal samples and optically stimulated luminescence (OSL) dating of sediment samples.† The majority of the MSA of South Africa has been shown to date to beyond the effective range of ^{14}C dating. Radiocarbon dating was therefore not a suitable technique for dating of most of the MSA sequence, owing to the limited half-life of ^{14}C. However, OSL dating has been shown to be suitable for the dating of sedimentary grains of minerals such as quartz.[5] Moreover, OSL dating can be applied to sedimentary deposits substantially older than the effective range of ^{14}C (~40 000 years), up to 200 000 years if in the right environment. The depositional age of the sediments can be determined and in an archaeological context the age of the archaeological remains can be inferred by association. Also, a combination of single aliquot and single grain analysis[6,7] provides the opportunity to investigate the possibility of mixing between the IA and the MSA deposits that may lead to the underestimation of age for the underlying MSA layers or the possibility of *in situ* disintegration of roof material that may result in the overestimation of age. Such an OSL dating approach was followed at Sibudu.

Below the surface sweep of the entire excavation grid there is brown silt with vegetal material (BSV) (Fig. 3). This contains Iron Age material culture items. The underlying brown sand with stones (BSS) also contains IA remains, and charcoal from a pit in square E3 has been dated to 960 ± 25 BP (Pta-8015) (calibrated to 1044 [1069, 1157] 1171 AD). Several large IA pits were dug into the MSA deposits, creating a mixture of MSA and IA material culture and food waste. To avoid contamination of the MSA layers surrounding the pits, the pit contents were removed prior to the excavation of the MSA layers. No Later Stone Age (LSA) remains are present in Sibudu and it seems that a long hiatus occurred between the final MSA occupations and the first IA occupations. This hiatus is not detectable as a sterile unit in the stratigraphy. Today the surface of the cave floor is scoured by wind in late winter/early summer and similar circumstances in the past may have prevented the accumulation of sterile deposits.

The stratigraphy of the final MSA, in the eastern part of the excavation, comprising squares C2, D2, D3, E2 and E3, is different from that in the northern part of the excavation grid (Fig. 3). The first MSA layer Co, which is undated, is a coffee-coloured, sandy deposit. It overlies Bu, which is a light grey, sandy-silt with lots of tiny roof spalls. A charcoal sample from square E2 in this layer was ^{14}C dated to 42 300 ± 1300 BP (Pta-8017) and an OSL age of 35.2 ± 1.8 kyr was obtained from the same layer. A thin, light-brown lens with white flecks of gypsum, LB MOD, is under Bu and over MC, which is a white ash unit that does not reach the eastern section wall and therefore does not feature in Fig. 3. Under this is Ore, which is dark-brown silt. Deep hearths, Ore 2 and PB, belong to Ore. A darker brown deposit, Cad, is below Ore in square C2. Beneath this is a small patch of orange sandy-silt, Pu.

In the northern part of the excavation grid the first MSA layer

†(^{14}C), radiocarbon dates on charcoal; (OSL), optically stimulated luminescence dates. In this and the following articles on Sibudu Cave, the following dating conventions are observed. BP: this means that the date was obtained by radiocarbon (^{14}C) dating. The figure is uncalibrated and records a date before 1950, measured in radiocarbon years. kyr: this means units of a thousand years ago on an absolute time-frame, using calendar years. It is measured from the day that the sample was taken (in 2002 in the case of Sibudu). 'Years ago': this signifies years before the day when the sample was measured, as is the case with kyr. The term years ago is used when it seems more appropriate to generalize a date or range of dates than to quote an absolute figure.

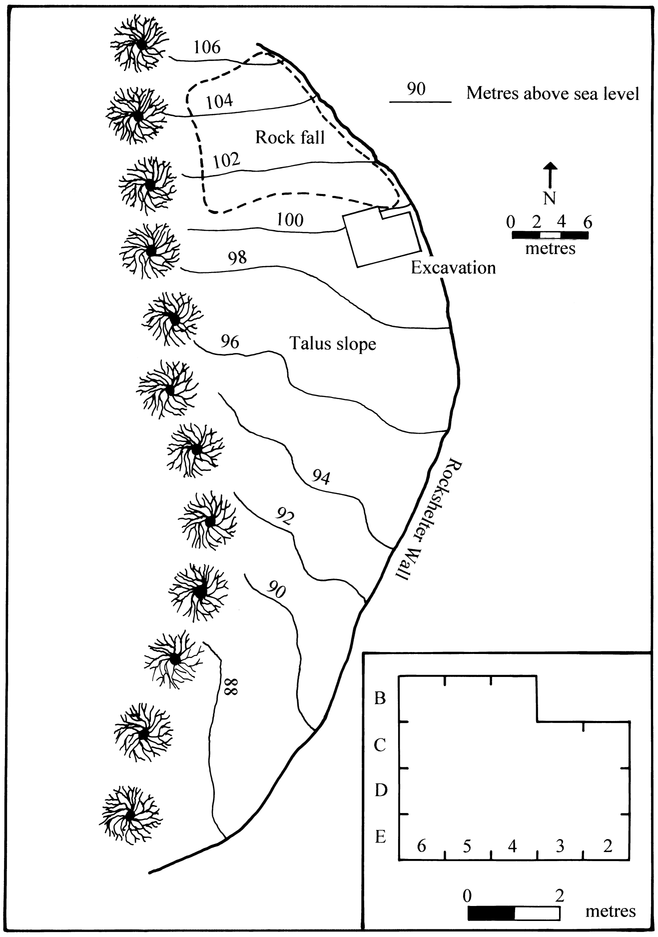

Fig. 2. Plan of Sibudu Cave.

below the Iron Age occupations is MOD, a mottled brown, silty-sand with flecks of white ash, gypsum and charcoal. This is the layer that was dated to 26 000 ± 420 BP (Pta-3765) in Mazel's excavation. O MOD below this, in squares B4, C2, C3 and C4, is a thick member comprising a palimpsest of hearths with orange-brown, burnt earth lenses at their bases, black carbonized layers in their centres and, sometimes, white, cream or grey ash capping. A charcoal sample from a sub-unit of O MOD, layer O MOD 2, collected at a depth of 224 cm below datum, was dated to 34 300 ± 2000 BP (Pta-8142). Dates of approximately 34 000 BP are problematic because of the fluctuation in the radiocarbon curve at this time; sample Pta-8142 calibrates to a most probable date of 38 400 BC, although it could date in the region of 41 000 BC (S. Woodborne, pers. comm.). However, even this date could be a minimum estimate, since an OSL date from a thinner lens of O MOD in square B5 is 51.8 ± 2.1 kyr. In square C3, at the base of the O MOD member, in a unit called O MOD2-BL, a charcoal sample dated to >45 000 BP (Pta-8136). In squares B5 and B6, O MOD is underlain directly by G MOD, an undated, light grey-brown deposit. G MOD is, in turn, underlain by RSp, a reddish-brown layer with white, chalk-like grains of gypsum and calcium carbonate. In the eastern squares C2 and D2 there is a variant of RSp, called RD, which contains little organic material and appears to be a lag deposit because it is densely packed with stone tools and roof spall. RSp is present in all but two squares excavated this far and is thus a good marker layer for the site. A charcoal sample from RSp in square B5 was dated to >41 400 BP (Pta-7775) and a further RSp charcoal sample from a hearth in square D3 was dated to >45 200 BP (Pta-8137). These infinite dates merely show that layer RSp is too old to be dated by the

Table 1. Current interpretation of stratigraphy in the north and east of the Sibudu excavation grid. All dates are BP unless otherwise stated.

Sibudu North stratigraphy	
BSV	
BSS	
MOD	26 000 ± 420 (^{14}C)
O MOD	51.8 ± 2.1 kyr (OSL)
O MOD2	40 898(38 397) 35973 BC (^{14}C)
O MOD2-BL	>45 000 (^{14}C)
G MOD; B MOD	
RSp	>41 000 (^{14}C) 53.4 ± 3.2 kyr (OSL)
YSp	
BSp	56.7 ± 2.3 kyr (OSL)
BSp2	
SPCA	
BL	
Or	61.5 ± 2.2 kyr (OSL)
Mi	
SS; Che	57.0 ± 2.3 kyr (OSL)
Eb	
Ma; MY	
BO; **P**; BP; OP; Iv; BM	59.6 ± 2.2 kyr (OSL)
Su	
Ch	
Su2	
Ch2	60.8 ± 2.3 kyr (OSL)
Y1	59.0 ± 1.9 kyr (OSL)
B/Gmix; BL2; BL3	58.1 ± 2.5 kyr (OSL)
Bor; Ymix	
YA1	
Sibudu East stratigraphy	
BSV	
BSS	960 ± 25 (^{14}C)
Co	
Bu	42 300 ± 1300 (^{14}C); 35.2 ± 1.8 kyr (OSL)
LB MOD	
Es; Ore; PB; Ore2	
RSp; RD; Cad; Pu	>45 000 (^{14}C)
YSp	
BSp	
BSp2	
SPCA	
Not excavated further by 2002	

(^{14}C), radiocarbon dates on charcoal; (OSL), optically stimulated luminescence dates. Dated layers are in bold.

radiocarbon method. An OSL date for RSp from square B6 provides an older and more reliable date of 53.4 ± 3.2 kyr. Below RSp is YSp, a discontinuous yellow-beige, sandy-silt and below this is BSp, a brown, sandy-silt with black and white flecks of charcoal and gypsum. An OSL age of 56.7 ± 2.3 kyr was estimated for BSp. An older layer, BSp2, contains the same brown matrix as BSp, but it envelopes a labyrinth of hearths and ash lenses.

Below BSp2 is another thick member that occurs in all excavated squares: SPCA is camel-coloured or grey-white sand that contains calcium carbonate. Darker deposits fill small pits that may be solution cavities in this layer. SPCA is the deepest layer excavated in the main excavation grid and deeper layers are represented in the trial trench only in squares B5 and B6. SPCA is underlain by a thin, discontinuous black lens, BL. Below this, the Or layer that is coloured orange to beige has exceptionally good bone preservation and it is dated by OSL to 61.5 ± 2.2 kyr. Mi is another black layer and it is distinguished by calcite crystals that cling to its rock spalls. Che is thin, disjointed, chestnut-brown, fine sand that seems to be part of layer SS, which is partly compacted sand marbled with yellow, beige and pink-orange. SS is dated by OSL to 57.0 ± 2.3 kyr. A black, ashy layer, Eb, is below SS. Ma is a mahogany-brown silt that rests on

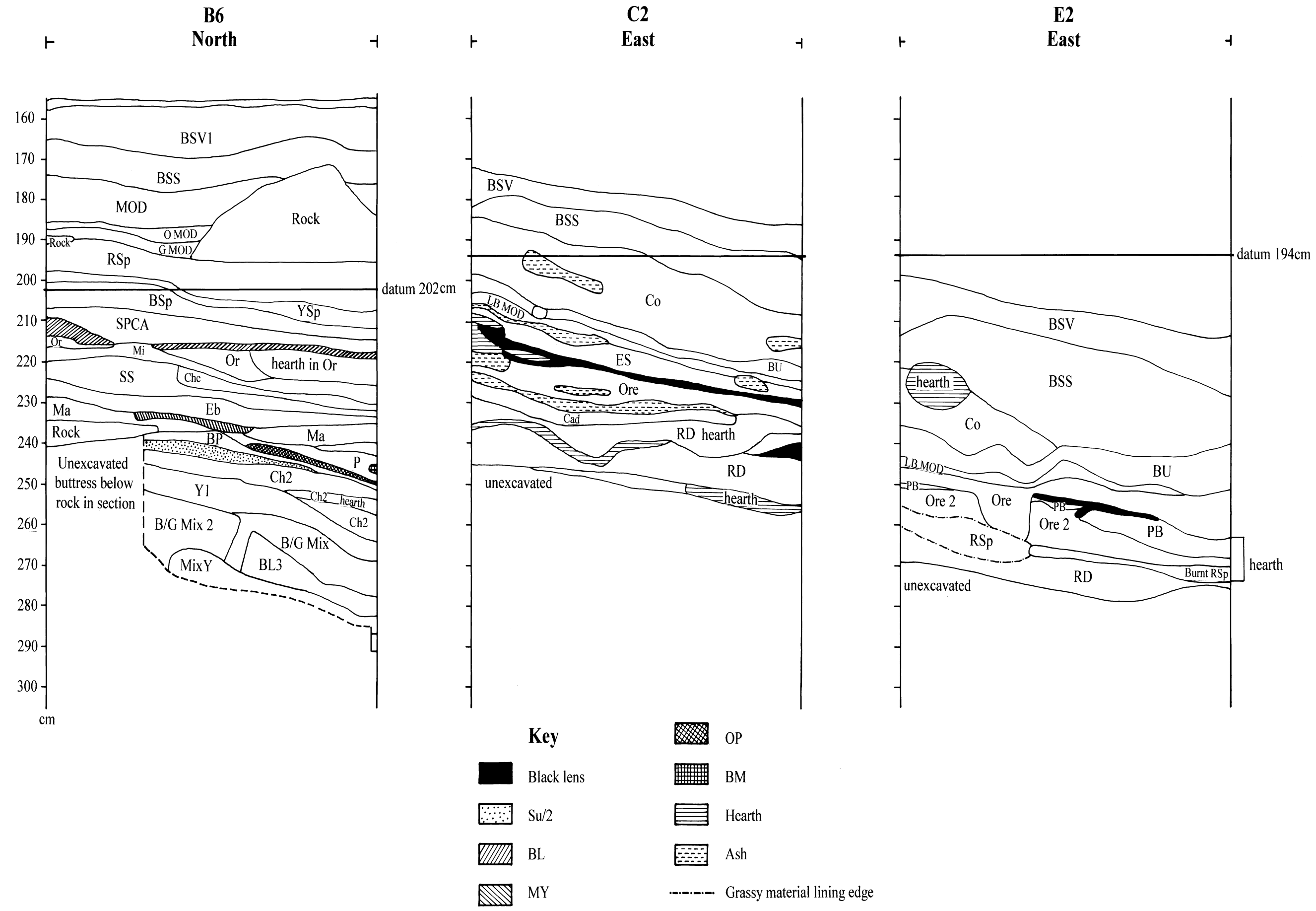

Fig. 3. Stratigraphy of Sibudu Cave.

several discontinuous layers: MY, which looks like SS, BO, a burnt-ochre silt, BP, a brown silt with white flecks, and P, which is an orange-brown sandy-silt with white flecks of gypsum. P is dated by OSL to 59.6 ± 2.2 kyr. The small lenses Iv (white ash) and BM (black ash) are probably parts of a hearth within P. OP is a discontinuous, orange sand with crumbs of gypsum and charcoal. Su and Su 2 are thin, concreted, gritty layers of sulphur-yellow sand. This colour is unique in the sequence. The two sulphur-coloured layers are separated and underlain by chocolate-coloured lenses, Ch and Ch2. Ch2 is dated by OSL to 60.8 ± 2.3 kyr. G1 is a grey ash in the north-eastern corner of Square B5. Y1 is a yellow, sandy-silt with some spalls and it has been dated by OSL to 59.0 ± 1.9 kyr. B/G Mix and B/G Mix2 are mottled brown-grey, ashy deposits with some spalls. B/G Mix has been dated by OSL to 58.1 ± 2.5 kyr. BL2 and BL3 are dark ash units within B/G Mix. W is a white ash layer in the north-eastern corner of square B5 and Bor is a deep brown, organic-rich deposit under B/G Mix2. Y Mix and YA 1 are yellow, ashy silts.

The relationship between the stratigraphy in the north and that in the east of the excavation grid is not yet fully understood and it is hoped that more dates from the younger layers will provide the necessary resolution. Table 1 is therefore a preliminary statement and it suggests that the northern members MOD to OMOD2 do not have stratigraphic equivalents in the eastern part of the excavation grid. O MOD, dated 51.8 ± 2.1 kyr near the top of the northern sequence, is considerably older than layer Bu (35.2 ± 1.8 kyr), which is near the top of the eastern sequence and there may be a hiatus between these older and younger units. At this preliminary stage of dating, it therefore seems that the eastern part of the excavation grid, which is close to the cave wall, contains a small area in which a relatively young set of occupation horizons occurs. This set appears to be missing from the northern part of the excavation grid.

Environments: present and past

Today the Sibudu area receives an average summer rainfall of about 750 mm and average winter rainfall of about 250 mm. Summers are humid and hot with mean January temperatures of 22–25°C and mean July temperatures of 17–20°C. Clearly these conditions would have been different during the Last Glacial, when most of the Sibudu sequence described here was being formed. Circumstances would not, however, have been uniformly dissimilar from those of today: the oxygen isotope record for the deep-sea core RC17-69 off KwaZulu-Natal[8] shows two cold periods (Stages 2 and 4) and one somewhat warmer period (Stage 3 — about 60 000 to 32 000 years ago) during the Last Glacial. Thus it is not possible to characterize the climate and vegetation regime of the Last Glacial simplistically, even though the Last Glacial environment was generally cooler and drier than the present regime.

In contemporary environmental circumstances Sibudu Cave falls within the Indian Ocean Coastal Belt, specifically within the Tongaland-Pondoland regional vegetation mosaic that has its southern boundary in the neighbourhood of Port Elizabeth and its northern boundary at the Limpopo River in Mozambique.[9] North of the Limpopo is the Zanzibar-Inhambane regional mosaic of the Indian Ocean Coastal Belt. The two regional mosaics have only 29 species in common, so the vegetation of the two coastal belt regions is dissimilar.

In the Tongaland-Pondoland regional mosaic there are five main types of forest, using Moll and White's definition: undifferentiated lowland forest, sand forest, dune forest, swamp forest, and fringing forest.[9] Broadly speaking, the area around Sibudu Cave falls within undifferentiated lowland forest called Coastal Forest by Lubke and McKenzie,[10] Coastal Bushveld-Grassland by Low and Rebelo,[11] Coast Belt Forest by Acocks[12] and a Coastal and Riverine Ecozone by Grant and Thomas.[13] The forest is essentially evergreen with varying proportions of semi-deciduous species and it develops from just above sea level to about 300 m a.m.s.l. where rainfall is usually greater than 700 mm and temperatures are not extreme.[9]

Existing examples of the original vegetation are mere remnants; the main cause of its eradication in the Tongaat area has been deforestation for the planting of sugar plantations. The vegetation around Sibudu Cave has survived because of the rugged cliff, which is not useful to farmers, but sugarcane plantations extend right to the edge of the cliff above the cave. Unfortunately, even this remnant forest on the steep slope is threatened by encroaching exotic species, by its use as firewood and by the extensive stripping of bark for traditional medicine.

The cave is camouflaged by the shadows of the forest. There is a rich diversity of taxa including: canopy species such as: *Celtis africana, C. mildbraedii, Millettia grandis, Combretum kraussii, Albizia adianthifolia, Harpephyllum caffrum, Ficus lutea, F. natalensis, F. polita, F. sur, F. glumosa, F. ingens, Mimusops obovata, Strychnos gerradii, S. henningsii, S. usambarensis, S. decussata, Croton sylvaticus, Protorhus longifolia, Vepris lanceolata, Bridelia micrantha, Zanthoxylum davyii, Calodendrum capense*; sub-canopy species such as *Teclea gerrardii, Clausena anisata, Canthium inerme, Drypetes arguta, Rawsonia lucida, Diospyros natalensis, Cryptocarya woodii, Ochna natalitia, Sideroxylon inerme, Maerua racemulosa;* woody lianas and climbers such as *Asparagus* spp, *Capparis tomentosa, Cyphostemma hypoleucum, Cissus fragilis, Rhoicissus digitata, R. tomentosa, Dalbergia armata, D. obovata, Uvaria caffra* and *Dalechampia capensis*; and forest margin species such as *Clerodendrum glabrum, Combretum molle, Dichrostachys cinerea, Rhus chirindensis, R. gueinzii, R. pentheri, Kraussia floribunda, Vangueria randii, Lagynias lasiantha, Trema orientalis* and *Crotalaria pallida.*

Other species that more properly belong in woodland, bushland and thicket vegetation include *Trichilia emetica, Syzygium cordatum* and *Euclea natalensis.*[9] The rare *Celtis mildbraedii,* represented by a single large specimen that dominates the Sibudu hill slope, is an indicator of a mature forest in historical times.[14] The fruits of *C. mildbraedii* are so sought after by thick-billed weavers and monkeys that there is little chance for any seeds to reproduce.

Both the preliminary charcoal analysis (Allott, this issue) and the seed analysis (Wadley, this issue) show that many of the taxa listed here were also present during the Last Glacial, when the site was occupied. There are, however, a few species represented during the MSA that do not currently grow in the coastal regimes of KwaZulu-Natal. These imply that more northerly vegetation elements were once part of the region and that the local savanna component may have been larger than it currently is. The fauna represented in the cave and described in this issue by Plug lend support to the interpretation of substantial tracts of savanna during the Last Glacial. Zebra are particularly well-represented in the cave, but large animals such as giraffe, which thrive in dry savanna, are also present. According to Plug, the presence at Sibudu of brown hyena, giraffe, grey rhebuck, klipspringer, blue wildebeest, sable/roan, waterbuck, impala and red hartebeest all suggest that drier than present conditions and an open savanna vegetation occurred during late Pleistocene times. She suggests that conditions may have been comparable to those of the modern Kruger National Park.

The increased savanna component would have been stimulated by drier as well as cooler conditions and there are proxy data in KwaZulu-Natal to support the appearance of these prerequisites. Colluvial deposits accumulated here during the Last Glacial and this colluviation evidently occurred during periods of increased aridity and reduced vegetation.[15] Further support for the dry phase comes from the western shores of Lake Sibayi, KwaZulu-Natal, where freshwater diatomite beds and calcareous clays developed between about 45 000 and 24 800 years ago, suggesting drying out of the lake.[16] Isotope studies of KwaZulu-Natal palaeosols show that there was no change in the proportions of C_4 and C_3 grasses between about 45 000 and 12 000 years ago[17] and this implies that, notwithstanding the altered precipitation pattern, there was no change from the current summer rainfall pattern.

During the last glaciation Sibudu would, of course, have been placed further from the coast than it is today because of the lowering of sea level. This is evidenced by the KwaZulu-Natal river mouths that in the past were cut back into bedrock considerably more than their present level.[18] Relatively broad bed-rock channels occur just below mean sea level; perhaps they are Eemian channels from the Last Interglacial stage, but these are incised by deeper, narrower troughs, thought to be of Last Glacial age. Such incisions are seen in the Tongati and Mgeni, as well as other KwaZulu-Natal rivers.[16] The Tongati River bedrock channel is cut back to –30 m because small rivers have small bedrock channels, but the Mgeni River cuts back –52 m into bedrock near Durban.[19] At the height of the last glaciation the shoreline in the Durban region was 30 to 40 km offshore of its present position and similar distances could be expected for the coastline off the Tongati River mouth. It can therefore be predicted that the presence of marine creatures would be uncommon in most of the MSA layers of Sibudu.

The cultural remains

The Iron Age layers BSV and BSS contain potsherds, upper and lower grindstones, rare pieces of metal, many glass beads, pits filled with ash, bones, seed, wood, wooden stakes, potsherds and even some basket-work. The remains of daga (burnt clay) hut floors were present together with grass matting and a digging stick. A cache of bead necklaces comprising many coiled strands was found in a small pit in square B4 of layer BSS. Most of the beads were Indian red glass beads (M. Wood, pers. comm.), but there were a few turquoise glass beads and an entire necklace of ostrich eggshell beads into which were strung a marine shell and a few blue glass beads.

Directly below the Iron Age occupation layers are traditional MSA material culture items because no LSA occupations are present in the cave. Most of the MSA cultural material is made from stone. Analysis of the stone tools from the upper layers of the eastern part of the excavation is complete, but not yet published (Wadley, in prep.). Here there are some rare examples of small bifaces and hollow-based points. Neither bifaces nor hollow-based points were found in the northern part of the excavation grid. The bifaces are not points, but are elliptical tools with sharp cutting edges and they have been worked entirely across both faces by removing small flakes from their perimeters. Hollow-based points are triangular projectile heads that have their bases thinned and shaped to a concave form to facilitate hafting.[3] Hollow-based points were also found at Umhlatuzana Cave,[20] approximately 90 km from Sibudu, and the tool type may be a regional variant of the final MSA. Other retouched tools found in these layers include unifacial and bifacial points, straight and convex scrapers, scaled pieces and notches.

Cochrane's preliminary analysis (in prep.) of the post-

Howiesons Poort (*c.* 61 000–26 000 years ago) stone tools from the trial trench in the northern part of the excavation grid. He shows that there are few technological or typological changes within this period, but there are changes in the use of raw materials evident between the older versus the younger layers. Dolerite and hornfels tools are most common in the upper layers, whereas quartz becomes a far more important rock type in the earlier layers. Williamson has microscopically analysed the residues from a selection of Sibudu stone tools (see this issue) and has identified a predominance of plant residues on the tools. In addition, she has found frequent traces of ochre and resins on some tools and there is compelling evidence to suggest that such residues represent the remains of hafting material that once attached the stones to bone or wooden hafts.[21]

Excavations in late 2002 yielded a Howiesons Poort Industry in square B6 of the trial trench, in layers not shown in Fig. 3. Although as yet undated, this industry is clearly older than 61 000 years ago. Backed tools are predominantly segments, most of which are manufactured on dolerite and are therefore less regular in appearance than backed tools associated with Howiesons Poort assemblages from most other sites. The backed artefacts are accompanied by a higher proportion of blades and more large sandstone flakes than the more recent Sibudu assemblages. The density of worked stone appears, based on an intuitive examination, to be far greater in the Howiesons Poort layer than in any of the more recent layers. To some extent this may be because there is less organic material in the Howiesons Poort than in more recent deposits, although organic remains, such as bone, charcoal and charred seeds still occur here. Since the industry has, as yet, been excavated from only one square metre of the site, little more can be said about it at present.

Deliberately engraved bone was not recovered from the excavation before the late 2001 season, when a piece of caudal rib with ten parallel notches was recovered from square E2, layer BSp2. The bone was directly dated by accelerator mass spectrometer (AMS) to 28 880 ± 170 BP (GrA-19670) and it is the only directly dated piece of worked bone in the southern African MSA. The piece is described and interpreted by Cain, in this issue. Layer BSp2, in which the engraved bone was found, is definitely older than 28 880 ± 170 BP because it lies within the sequence that dates to >51 000 years ago. The implications of this dating conundrum will be discussed elsewhere (Wadley, Cain and Woodborne, in prep.). Other pieces of MSA worked bone include a ground, polished 'pin' from square C2, layer Co. This 'pin' is much thinner than ground and polished bone points that are found in southern African LSA sites.

Discussion

Sibudu Cave contains one of the most extraordinary sequences of post-Howiesons Poort MSA dates in South Africa. There are ten OSL dates for this Industry at the site. Nine of the dates are between about 61.5 ± 2.2 kyr and 51.8 ± 2.1 kyr. These nine dates were obtained from a depth of deposit spanning more than a metre. Probably no more than ten thousand years of occupation is represented in this deep deposit, much of which is culturally rich. This suggests intensive occupation during a relatively short space of time, something that was not anticipated in an earlier assessment of the site.[3] Higher in the sequence there appears to have been one pulse of occupation supported by an OSL age of 35.2 ± 1.8 kyr. A more recent MSA occupation might date to about 26 000 years ago, based on a radiocarbon date that Mazel obtained in the 1980s, but the layer may prove older when new OSL dates are processed.

Proxy environmental data from Sibudu in the form of charcoal, seeds and fauna suggest that the cave inhabitants experienced cooler, drier conditions than at present and that there may have been a larger savanna component to the vegetation than is the case today. During the entire MSA sequence animal populations include species that today thrive in savanna environments and the faunal list includes species, like giraffe, which are not known historically in the Sibudu area.

The presence of a final MSA industry with hollow-based points and an earlier Howiesons Poort Industry makes the Sibudu sequence comparable to that from Umhlatuzana Rock Shelter, approximately 90 km southwest of Sibudu. Holley Shelter, about 60 km west of Sibudu, is another KwaZulu-Natal shelter site containing MSA occupation, but it does not include a Howiesons Poort Industry.[22,23] Border Cave, north of Sibudu on the Swaziland border, should be culturally and perhaps even environmentally similar to much of the Sibudu sequence, but MSA occupation at Border Cave is not more recent than 40 000 years ago[24] and it is therefore only the earlier assemblages that can be compared with Sibudu. Border Cave contains both Howiesons Poort and pre-Howiesons Poort industries, but the siliceous rocks used at this site make direct comparisons with the hornfels and dolerite tools of Sibudu impossible. Rare backed tools were also found in the small assemblage from the 'lost' southern KwaZulu-Natal site of Alfred County,[25] but it is unwise to ascribe such a tiny assemblage to Howiesons Poort or, indeed, to any other industry.

The notched bone from Sibudu, which is either dated 28 880 ± 170 BP or >51 000 years ago, depending on which date is accepted, can be compared to older pieces from the Howiesons Poort of Klasies River Mouth, which include a bone point as well as a piece of notched rib.[26] Worked bone points and awls from Blombos Cave are even older.[27–29] A residue analysis of the notches on the Sibudu notched bone showed that there were no residues in the cut-marks themselves. This suggests that the notches were not functional in the sense of, for example, having been used to prevent twine from slipping from a haft.

Future work at Sibudu Cave will involve excavating the trial trench through the Howiesons Poort layers and advancing the remaining 16 squares to meet the level of the trial trench. Environmental studies such as seed and faunal analyses will continue. New studies, not incorporated here, but to be included in the next round of research, involve geomorphology of the cave sediments and isotope examination of the deposits and the grazer teeth.

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1. Maud R.R. (2000). Estuarine deposits. In *The Cenozoic of Southern Africa,* eds T.C. Partridge and R.R. Maud, pp. 162–172. Oxford University Press, New York.
2. Ramsay P.J. (1995). 9000 years of sea-level change along the southern African coastline. *Quat. Intern.* **31**, 71–75.
3. Wadley L. (2001). Preliminary report on excavations at Sibudu Cave, KwaZulu-Natal. *Southern Afr. Humanities* **13**, 1–17.
4. Pickering R. (2002). *A sedimentological analysis of six archaeological soil samples from Sibudu Cave, Kwazulu-Natal, South Africa.* Unpublished report, University of the Witwatersrand, Johannesburg.
5. Huntley D.J., Godfrey-Smith D.I. and Thewalt M.L.W. (1985). Optical dating of sediments. *Nature* **313**, 105–107.
6. Jacobs Z., Wintle A.G. and Duller G.A.T. (2003). Optical dating of dune sand from Blombos Cave, South Africa: I — multiple grain data. *J. Hum. Evol.* **44**, 599–612.
7. Jacobs Z., Duller G.A.T. and Wintle A.G. (2003). Optical dating of dune sand from Blombos Cave, South Africa: II — single grain data. *J. Hum. Evol.* **44**, 613–625.
8. Prell W.L. and Hutson W.H. (1979). Zonal temperature anomaly maps of Indian Ocean surface waters: modern and Ice Age patterns. *Science* **206**, 454–456.
9. Moll E.J. and White F. (1978). The Indian Ocean coastal belt. In *Biogeography and Ecology of Southern Africa,* ed. M.J.A. Werger, pp. 561–598. W. Junk, The Hague.
10. Lubke R. and McKenzie B. (1998). Coastal Forest. In *Vegetation of South Africa, Lesotho and Swaziland,* eds A.B. Low and A.G. Rebelo, pp 11. Department of Environmental Affairs and Tourism, Pretoria.
11. Low A.B. and Rebelo A.T. Coastal Bushveld-Grassland. In *Vegetation of South Africa, Lesotho and Swaziland,* eds A.B. Low and A.T. Rebelo. Department of Environmental Affairs and Tourism, Pretoria.
12. Acocks J.P.H. (1988). *Veld Types of South Africa*, 3rd edn. *Mem. Bot. Surv. S. Afr.* **57**, 1–146.
13. Grant and Thomas (1998). *SAPPI Tree Spotting: KwaZulu-Natal Coast and Midlands.* Jacana, Johannesburg.
14. Boon R. and Symmonds R. (2001). Notes on the tree of the year 2001: *Celtis mildbraedii* Natal White Stinkwood, *uzinhlu* (Z). *PlantLife* **24**, 30–32.
15. Botha G.A. and Partridge T.C. (2000). Colluvial deposits. In *The Cenozoic of Southern Africa,* eds T.C. Partridge and R.R. Maud, pp. 88–99. Oxford University Press, New York.
16. Maud R.R. and Botha G.A. (2000). Deposits of the south eastern and southern coasts. In *The Cenozoic of Southern Africa,* eds T.C. Partridge and R.R. Maud, pp. 19–32. Oxford University Press, New York.
17. Lee-Thorp J.A. and Talma A.S. (2000). Stable light isotopes and environments in the southern African Quaternary and Late Pliocene. In *The Cenozoic of Southern Africa,* eds T.C. Partridge and R.R. Maud, pp. 236–251. Oxford University Press, New York.
18. Cooper J.A.G. and Flores R.M. (1991). Shoreline deposits and diagenesis resulting from two Late Pleistocene highstands near +5 and +6 metres, Durban, South Africa. *Mar. Geol.* **97**, 325–343.
19. Orme A.R. (1976). Late Pleistocene channels and Flandrian sediments beneath Natal estuaries: a synthesis. *Ann. S. Afr. Mus.* **71**, 77–85.
20. Kaplan J. (1990). The Umhlatuzana Rock Shelter sequence: 100 000 years of Stone Age history. *Natal Mus. J. Humanities* **2**, 1–94.
21. Wadley L., Lombaard M. and Williamson B. (in press). Ochre as a hafting material of Middle Stone Age tools: the evidence from Sibudu Cave, KwaZulu-Natal, South Africa. *Antiquity.*
22. Cramb J.G. (1952). A Middle Stone Age industry from a Natal rock shelter. *S. Afr. J. Sci.* **48**, 181–186.
23. Cramb J.G. (1961). A second report on work at the Holley Shelter. *S. Afr. J. Sci.* **57**, 45–48.
24. Grün R. and Beaumont P.B. (2001). Border Cave revisited: a revised ESR chronology. *J. Hum. Evol.* **40**, 467–482.
25. Mitchell P.J. (1998). The archaeology of the Alfred County Cave, KwaZulu-Natal. *Natal Mus. J. Humanities* **10**, 1–17.
26. Singer R. and Wymer J. (1982). *The Middle Stone Age of Klasies River Mouth in South Africa.* University of Chicago Press, Chicago.
27. Henshilwood C. and Sealy J. (1997). Bone artefacts from the Middle Stone Age at Blombos Cave, southern Cape, South Africa. *Curr. Anthropol.* **38**, 890–895.
28. Henshilwood C.S., d'Errico F., Marean C.W., Milo R.G. and Yates R. (2001). An early bone tool industry from the Middle Stone Age at Blombos Cave, South Africa: implications for the origins of modern human behaviour, symbolism and language. *J. Hum. Evol.* **41**, 631–678.
29. Henshilwood C.S., d'Errico F., Yates R., Jacobs Z., Tribolo C., Duller G.A.T., Mercier N., Sealy J.C., Valladas H., Watts I. and Wintle A.G. (2002). Emergence of modern human behaviour: Middle Stone Age engravings from South Africa. *Science* **295**, 1278–1280.