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Woodstock Rocks: From Acheulean to Iron Age in the Waterberg, Limpopo Province, South Africa

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ABSTRACT
The cliff terrace site, Woodstock Rocks, was exploited occasionally by hominins from the Earlier Stone Age to the Iron Age. A small excavation uncovered an Acheulean quartzite workshop with many flakes, but lacking large cutting tools and without organic preservation. Below the workshop site, a ferricrete river terrace cements Acheulean lithics that include large cutting tools, giant flakes and heavy-duty scrapers. A palaeomagnetic study reveals reversed polarity, implying that the ferricrete formation likely took place during the Matuyama Chron and that the lithic assemblage is older than 780 000 years. The cliff face was painted expansively, but both the Bushman and Iron Age farmer art is faded. There are some rare images including a wild dog, a bird and a possible genet. The southern edge of the cliff terrace has Middle and Later Stone Age lithics on the surface and talus slope, as well as grindstones, and ceramics that include Bambata sherds from six vessels. The proximity to the Mokolo River and sources of rocks for knapping, as well as smooth rock walls for painting ensured repeated Woodstock Rocks visits (not necessarily occupation) for generations of *Homo sapiens* visitors, as well as earlier hominins.

Keywords: Acheulean workshop, Matuyama Chron, Middle and Later Stone Age, ceramics, rock art

1. Introduction

Background and research question

Archaeological studies in the Waterberg remain under-developed, notwithstanding early exploration by Mason (1962), the thorough excavations by van der Ryst (1998, 2006) and Boeyens (Boeyens & van der Ryst 2014) and field surveys by Aukema (Aukema 1989; Huffman 1990, 2007) that remain unpublished because of his untimely death. On present evidence, sites in the low altitude foothills of the Waterberg have longer sequences of occupation than those on the highlands. Olieboomspoort (Fig. 1), on the Riet River, not far from Lephalale, is the best example of a low altitude site. Its deep sediments include stone assemblages from an ephemeral, undated, Earlier Stone Age (ESA) on bedrock (Mason 1962), followed by a long series of Middle Stone Age (MSA) occupations, one of which yielded a U-series/ESR (electron spin resonance) age estimate of 150 000±1400 (150±14 ka) years ago (Val et al. 2021). More recent Later Stone Age (LSA) occupations (Mason 1962; van der Ryst 2006) date to the last few thousand years and they include a large collection of Bambata ceramics that potentially originate from the first herder incursions into South Africa about 2000 years ago (Lander & Russell 2018). There are, until now, no records of ESA sites on the Waterberg highlands and the earliest archaeological sites presently known here contain MSA cultural material in rock shelters and in the open. Apart from Olieboomspoort, only one Waterberg shelter site, Red Balloon, has dated MSA occupations (with a weighted mean single grain OSL age of 96±4 ka ago) (Wadley et al. 2021) and it is thus important to obtain a better chronology for the entire sequence of occupation in the highlands. MSA sites are unlikely to be older than 300 ka ago or younger than 30 ka ago because this is the duration of the MSA presently known from elsewhere in Africa (Lombard et al. 2022). Assuming that some of the Waterberg MSA sites were as young as 30 ka ago, there still remains a curiously long gap in the occupation of the Waterberg plateau because LSA settlement on the plateau generally dates only to the last 1000 years, based on the preliminary work by van der Ryst in 1998. Notwithstanding this earlier observation, excavations in Kaingo Sheep Rock Shelter yielded OSL ages of about 4400 and 1860 years before present (Wadley et al. 2022). The Sheep Shelter extends van der Ryst's chronology slightly, but the site might be an exception because of its proximity to the reliable water supplies of the Mokolo River. We therefore speculate that the highlands were abandoned for environmental reasons that remain obscure until more dates and environmental proxies become available.

Understanding the gap in occupation and obtaining dates for the Waterberg sequence is a major research objective. First, however, we need to be sure that the gap in Waterberg occupation really exists, and we can only do this by dating several sites. The demographic movement into the Waterberg in the last 2000 years seems unprecedented elsewhere in South Africa, as is the extremely lengthy hiatus between MSA and LSA occupations. We targeted Woodstock Rocks as a site that might contribute to answering the research question.

Figure 1. Woodstock Rocks, Limpopo Province, Waterberg, together with other known archaeological sites in the area.

Woodstock Rocks

Woodstock Rocks are steep, west-facing sandstone cliffs above the Mokolo River (Fig. 2), on the farm Woodstock 161 KQ that is part of Kaingo Private Game Reserve in the Lephalale district of the Limpopo Province (24°02'52" S, 27°48'15" E) (Figs 1 & 2). The cliff bows to the river so the terrace hugging it is partly sheltered by a shallow rock overhang. The cliff terrace is about 30 m above the river, and it was used intermittently from the Stone Age to the Iron Age. We selected the site for excavation after visiting its rock art and observing ceramics and lithic artefacts on the terrace's surface. The cliff forming Woodstock Rocks has faded rock paintings over much of its lower surface and we call this painted area Woodstock Rocks Rock Art 1. About 10 m north of our datum peg (Fig. 2) is a high ledge (approximately 5 m above ground level) with relatively well-preserved paintings of an eland and several indeterminate antelope. This panel is named Woodstock Rocks Rock Art 2.

Several Waterberg Group rocks and minerals are suitable for knapping and examples of these were scattered on the surface of the site. The Mogalakwena Formation comprises sandstone, conglomerate and shale (Callaghan 1993). The conglomerate hosts pebbles and cobbles of cryptocrystalline silica. Volcanic rock, such as diabase, intruded the Waterberg sandstones and the resulting metamorphism of the sandstone produced quartzite, sometimes with veins of quartz where crystals can be found (Brandl 1996). Coarse-grained quartzite outcrops on the Woodstock Rocks cliff terrace. The Vaalwater Formation, the youngest part of the Waterberg succession, comprises a basin of deposits about 475 m thick, and no wider than 40 km (De Vries 1970, 1973; Jansen 1982; Callaghan 1993). This basin extends into part of the Kaingo Reserve and its margin is only a few kilometres from Woodstock. The Vaalwater Formation probably formed under shallow water (Jansen 1982), resulting in sediments that include fine-grained sandstone, siltstone and coarse-grained (originally termed 'gritty') sandstone (De Bruiyn 1971). Siltstones were regularly part of stone tool manufacture in the Waterberg (Wadley et al. 2016; Wadley et al. 2021; Wadley et al. 2022).

The southern part of the site (Fig. 2) has a very shallow ashy area close to the cliff face with mixtures of MSA and LSA tools and Bambata, Happy Rest, Diamant and Eiland facies ceramics, and beyond that is a water-eroded channel marked by small rock spall. The channel's slope suggests that artefacts washed from here to the talus slope where there are many stone tools, grindstones (SOM Figs 1 & 2) and fragments of pottery. The northern terrace has deeper sediments so this is where we elected to excavate.

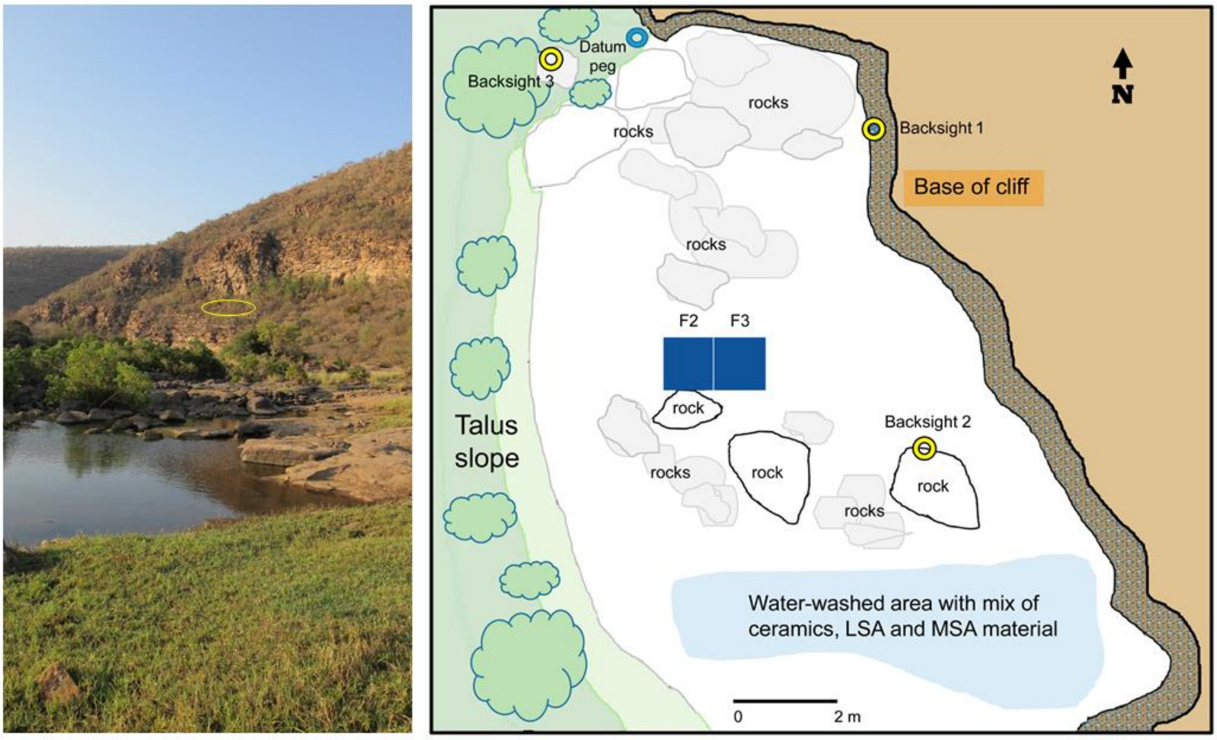

Figure 2. View of Woodstock Rocks (left, marked with a yellow oval) and site map (right). The dark blue squares labelled F2 and F3 mark the excavation (2x1 m). The datum peg and backsights are survey points for the total station readings. Woodstock Rocks Rock Art 1 is on the cliff illustrated here; Woodstock Rocks Rock Art 2 is north of the datum peg.

2. Methods

Botanical survey and seed study

No formal botanical survey was conducted, but trees and shrubs on the hillside and adjacent to the river were recorded. All excavated seeds were collected from the 1 and 2 mm sieves and were sorted into types. Seeds were not quantified because they have their origin in baboon faeces and are not archaeological inclusions. Nonetheless, their types are listed because they provide a record of edible fruits available in the area during the Holocene.

Rock art recording

The rock art at the site was recorded in February 2022, September/October 2022 and in January 2023. The site was photographed using Fujifilm X-T3 and Canon PowerShot G12 digital cameras. DStretch (Harman 2006) was later used to enhance many of the digital photographs, but many faded images were difficult to identify and we therefore decided against quantifying and tabulating the images. Detailed sketches were drawn of selected images and descriptive notes were recorded in the field and supplemented after viewing the digitally-manipulated images. Selected images were digitally traced and redrawn using Adobe Illustrator software. Photographs, digitally-enhanced images, and field sketches were used to ensure the maximum accuracy of the tracings and redrawings. Tracing from photographs is not ideal as subtle details may be missed and Dstretch introduces visual artefacts that can be misconstrued. Digital tracings should be checked at the rock face, but time constraints did not allow this.

Surface survey

The dripline, shallow deposit in the south of the site, and the talus slope were surveyed for ceramics, grindstones and any lithics that might provide information about use of the site through time. Ceramics were collected and drawn. Grindstones were photographed, counted and left at the site. Several surface lithics were photographed.

Below the cliffs, close to the Mokolo River, we found a ferricrete terrace with large lithics cemented in it. The proximity of this river terrace to the cliff terrace above it suggests that material from the higher terrace might periodically topple from the talus slope to the lower terrace. This suggestion is strengthened by the large number of artefacts on the talus slope and by the similarity of the artefacts found on the cliff terrace and those embedded in the river terrace ferricrete. The quartzite used on the cliff and at the river has the same range of textures (predominantly coarse-grained), and it is the same grey colour; in contrast, the quartzite that was exploited at another site, several kilometres distant from Woodstock Rocks, is fine-grained and is pinkish-brown.

Excavation

The excavation took place in September/October 2022 with SAHRA permit #3629. The cliff terrace in front of the rock art was carpeted with bidim geotextile to prevent dust from coating the rock art. A 2x1 m grid (squares F2 and F3), was aligned north, on the northern part of the terrace where there was space to excavate between the rock fall debris (Fig. 2). A Nikon Nivo 5C total station was used for piece plotting and site mapping. All worked stone over the size of 20 mm was x, y and z plotted with the total station. Standard archaeological techniques were applied: excavation followed natural stratigraphy and the Munsell Soil Colour Chart was used for all colour coding on dry sediment assessed in well-lit shade. Sieving of excavated sediment (through 1 mm and 2 mm nested screens) took place at the edge of the talus slope so that dust did not reach the paintings. After the excavation, the base of the trench was lined with geotextile, rocks, and sediment-filled biodegradable hessian sacks. The sacks were hidden with sieved, raked soil from the excavation.

Lithic analysis

Lithics were washed in cold water and coded by rock or mineral type. Pieces of particular interest that were heavily coated with a claylike patina were cleaned for 40 minutes in an ultrasonic cleaning tank with water and one drop of dishwasher liquid soap, heated to 60 degrees Celsius. Most lithics were made on local coarse-grained quartzite that is difficult to ‘read’, making knapping scars challenging to count. Lithics were first sorted into broad typological categories: core, whole flake (cortical or non-cortical, *Levallois*/pseudo-*Levallois*), broken flake, blade, retouched pieces (tools), and chips and chunks. Chips were sorted into two categories: those smaller than 10 mm and those between 10 and 20 mm. Cores were further subdivided into bipolar, single platform (with a separate blade category on single platforms), adjacent platform, opposite platform and those with radial flaking. Within the flake category, trimming flakes, preparation flakes and rejuvenation flakes were combined because it is impossible to separate them accurately (McNabb 2009).

Lithic measurements and statistical analysis

Length, breadth and thickness of all whole flakes were measured in mm with digital callipers. Non-cortical flakes on quartzite from layers Very Dark Greyish Brown, Dark Brown and Brown were selected for statistical analysis because of their large sample size, and to detect possible change through time. All outliers greater than the 1.5 interquartile range were removed and a one-way analysis of variance (ANOVA) was used to determine whether there were statistically significant differences in the mean length, breadth, length:breadth ratio, and thickness of the measured artefacts between stratigraphic units. The test was done using R4.2 and RStudio 2022.07.1 Build SS4. A Tukey's HSD post hoc test was run on thickness.

Coring for Optically Stimulated Luminescence (OSL) dating

To obtain OSL age estimates for the basal sediments, we retrieved three sediment cores in plastic tubes hammered into the sections of square F3. One core was removed from just above the rock fall and two from below it. The cores were sent to Professor Richard Roberts at the Earth Laboratory of Wollongong University in Australia accompanied by the Australian soil sampling permit 0006327625 and light-safe letter. The sediments were subjected to single grain OSL analysis in the Earth Laboratory.

Coring for palaeomagnetic analysis of ferricrete from the river terrace below Woodstock

Twelve core samples were collected from ferricrete from the river terrace below Woodstock Rocks using a portable, petrol-powered drill and oriented *in situ* with magnetic and sun compasses. Samples were prepared as 2.5 cm diameter cylindrical specimens, of which at least one per sample was demagnetised at the University of Johannesburg. One specimen was subjected to alternating field (AF) demagnetisation from 5 mT to 100 mT, but the method was ineffective at removing the specimen's remanence. All other specimens were initially subjected to low field-strength alternating field (AF) 'cleaning' steps of 2.5, 5, 7.5 and 10 mT using a Molspin, Ltd. 2-axis tumbling shielded demagnetiser, 2G Enterprises™ DC-4K vertical superconducting rock magnetometer (SRM). Hereafter, the specimens were fully thermally demagnetised in ~20 heating steps from 100-620°C using an ASC Scientific shielded furnace. Specimen remanence was measured using the SRM after each successive demagnetisation step. Magnetic components were identified from demagnetisation data via least squares analysis (Kirschvink 1980) using Paleomag 3.1b3 (Jones 2002).

3. Results

Modern vegetation on the Woodstock Rocks hillside and riverine route into the botanical reserve

The surface layers of the excavation were plant-rich with seeds and wood. The seeds seem mostly to have eroded from baboon faeces. As a result, they cannot inform us of human use of the plants. Nonetheless, the excavated seed collection provides a useful Holocene environmental record. *Grewia* (rosyntjie) seeds were the most common, but *Ziziphus mucronata* (buffalo-thorn) and *Sclerocarya birrea* (marula) seeds were also plentiful and other edible fruits were present too, such as *Bridelia mollis* (velvet sweetberry), *Mimusops zeyheri* (moepel), *Hexalobus monopetala* (shakama plum) and *Pappea capensis* (jacket plum). To compare excavated plant material with what is available in the modern environment, we conducted an informal survey of trees and shrubs in the areas that we walked and drove (SOM Table 1). Seed taxa present archaeologically, but not recorded in the survey, are likely growing locally. These are *Berchemia zeyheri* (red ivory), *Chaetacme aristata* (thorny elm), Cucurbitaceae (melons) and *Lannea* sp. (wild grape). The seed assemblage provides no evidence of any change in vegetation during the Holocene, and the absence of any seeds from lower layers precludes comparisons with periods before this.

Rock art

Paintings cover the rock face behind the excavation in the area we have called Woodstock Rocks Rock Art 1. Exposed to the elements, much of the art has deteriorated; thus, the motifs are visible only through close inspection or with the aid of Dstretch technology (SOM Fig. 3). The fine-line paintings, attributed to LSA hunter-gatherers (e.g., Eastwood & Eastwood 2006; Eastwood et al. 2010), are predominantly monochrome and primarily in red, and less frequently in yellow. Nearly all the images are animal and human figures. In a sheltered position on the far right of the overhang, remnants of two bichrome eland are visible, implying that more images using this method may have existed in the past (SOM Fig. 4). While we could not perform quantitative analysis, it is clear that animal images are most common. Most of the animal representations are of antelope, but due to the challenges posed by poor preservation, precise identification to species level is not attempted here. The two bichrome eland (one of which is illustrated in SOM Figure 4) were identified from their distinctive body shape and the distinctive manner of depiction. Two other animal paintings were recognised. The first is a small creature with a large, bushy tail and a feline-like head (Fig. 3). It potentially represents either a genet or a white-tailed mongoose. There are possible stripes on the tail, but these may be an artefact of the uneven rock surface. Confirmation of stripes would make a genet the more likely subject. The second image (Fig. 4) we identified as a wild dog, an identification supported by the renowned environmentalist and wildlife author, Clive Walker (pers. comm. June 2023).

Figure 3. Woodstock Rocks Rock Art 1: this small yellow animal with a bushy tail may be either a genet or a white-tailed mongoose. Image enhanced with Dstretch lds.

Numerous handprints, in yellow and red, are placed across the rock face of Woodstock Rocks Rock Art 1. Yellow handprints predominate and are, on average, smaller than those made in red. Two of the red hands are placed high on the rock wall well above the reach of even the tallest person. Paintings high above human reach are common in rock art sites, even in places where rock shelter sediment could not have been removed or deflated. It seems likely that artists sometimes used simple scaffolding made of branches to access out-of-reach rock surfaces. Faded white finger-paintings, similar to those attributed to initiation art produced by Iron Age farmers (Smith & van Schalkwyk 2002; Smith 2005), can be discerned. Of these, only one image is clearly representational (Fig. 5). Its elongated neck and legs have led us to identify it as a large game bird. Although the step in the rock below the bird's legs suggest that short legs were intended, thereby favouring a korhaan identification, the body shape is not correct for a korhaan. Instead, the bird's hunched back, pronounced breast, thickset thighs, long neck and the broken line between dewlap and tail suggest that the painting may represent an ostrich.

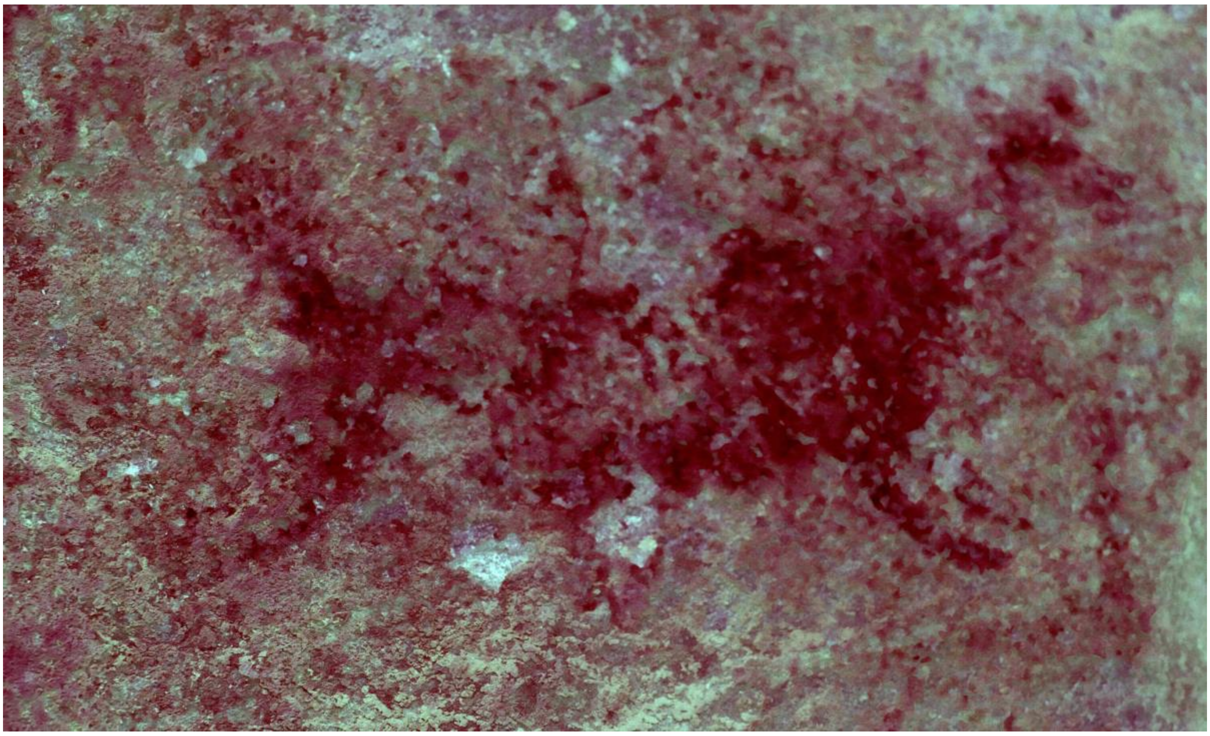

Figure 4. Woodstock Rocks Rock Art 1: enhanced image of a wild dog (Dstretch yre).

Figure 5. Woodstock Rocks Rock Art 1: redrawing of a white finger-painted bird with a long neck.

Approximately 10 m north of our datum peg (Fig. 2) there are additional rock paintings in a small recess that we have called Woodstock Rocks Rock Art 2. The art is approximately 5 m above ground level (SOM Fig. 5), but it is possible to climb rocks to access the recess. Eight antelope appear to be part of a single painting episode (Fig. 6). The largest, an eland, has a white head and legs and body outlined in white. No traces of other pigment are visible so we conclude that the body was never filled with pigment. In contrast, the other seven antelope are rendered in red with white outlines. The images in this recess have generally survived well, however, there is an accumulation of dust adhering to parts of the rock surface, obscuring certain features. The seven antelope are painted in a similar way, yet exhibit unique body shapes, heads and neck lengths.

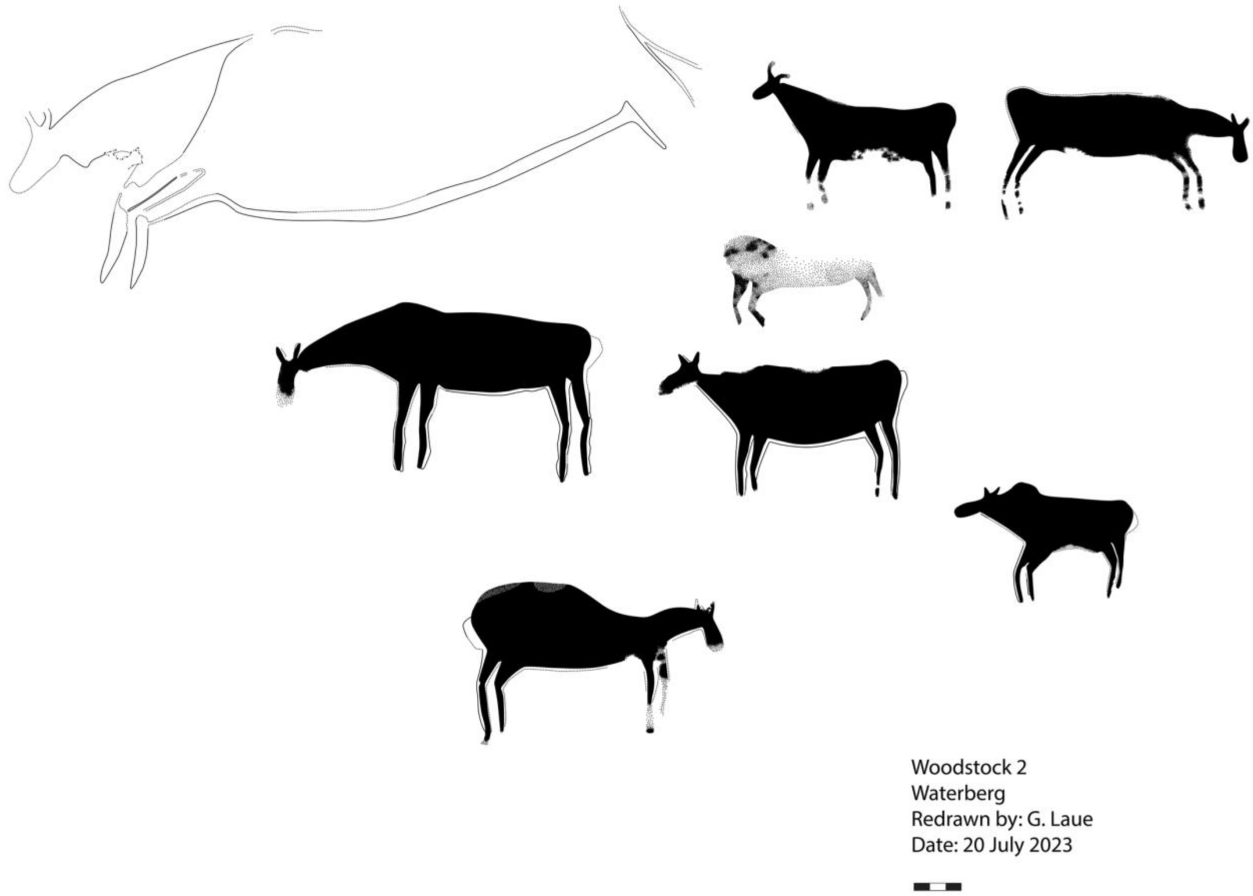

Figure 6. Woodstock Rocks Rock Art 2: redrawing of eight antelope in the small, high alcove north of the datum peg (black=red; white=white).

Surface observations

The southern area of the cliff terrace contains MSA lithics, including two bifacial points (Fig. 7), but there are also LSA lithics, such as thumbnail scrapers, many grindstones and some ceramics. A conflated palimpsest of surface material lies in shallow, ashy sediment on bedrock. This extends along spall-laden channel wash to the dripline and steep talus slope a few metres from the cliff face. Abundant finds on the talus slope demonstrate that rain periodically flushed artefacts over the edge and this supports our proposed link between the cliff terrace and river terrace. Potsherds include 2000-year-old Bambata ones – these are amongst the earliest ceramic types known in southern Africa and they may belong to pastoralists. The surface collection yielded decorated pieces from six different Bambata vessels. These and the Iron Age farmer vessels were probably left at the cliff during ritual proceedings. Iron Age ceramics, particularly from the Happy Rest, Diamant and Eiland facies, were also found on the surface near the cliff and on the talus slope (see Table 1 & Fig. 8).

The surface collection of ceramics totalled 84 sherds of which 66 were decorated and 18 undecorated. The excavation yielded six sherds of which three were decorated and three undecorated. The diagnostic vessels in the collection included 50 jars, 17 constricted jars and 13 bowls. The decorated sherds come from different vessels because their designs are not the same. Three Eiland facies bowls were burnished with red ochre on the outside and inside of the vessels. Tswana pottery is represented by a Letsibogo facies bowl sherd, which was burnished with graphite on the inside.

Fifty upper grindstones and six lower grindstones were found scattered over the site surface (SOM Figs 1 & 2), particularly on the talus slope in the southern area that we did not excavate because of the shallow sediments and artefact admixture. These surface artefacts were left at the site. Occasionally, grindstones have red stains on them that are visible to the naked eye, and these stones may have been used to process iron oxides (ochre) to make red powder. Microscopic analysis would undoubtedly reveal more ochre traces. A few of the upper grindstones have percussion marks on them and they may have served as hammerstones as well as grindstones. They were not examined in detail because microscopic examination in the laboratory is required and we did not want to remove material that was not part of the excavation trench. It is likely that the grindstones were recycled (and even re-purposed) through the ages, so their context is uncertain.

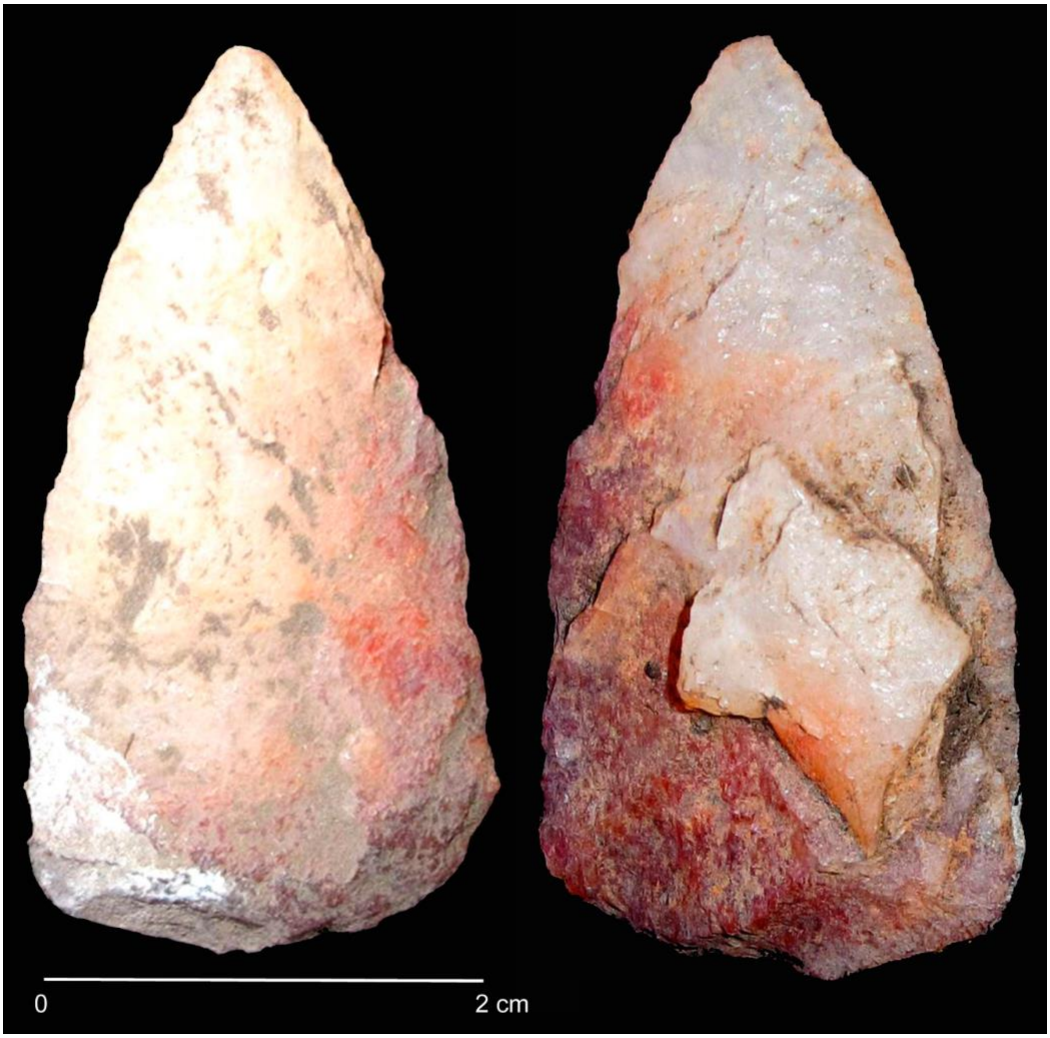

Figure 7. Both faces of an agate bifacial point found on the unexcavated surface, south area.

Table 1. Ceramic sherds from various facies recovered from the Woodstock Rocks surface collection and excavation.

Location	Facies	Jars	Constricted jars	Bowls	Indeterminate	Total
Surface collection	Bambata	3	2	1	0	**6**
	Happy Rest	4	0	0	0	**4**
	Diamant	2	0	0	0	**2**
	Eiland	32	11	4	7	**54**
	Undecorated	9	3	6	0	**18**
Excavation	Eiland	0	1	1	0	**2**
	Letsibogo	0	0	1	0	**1**
	Undecorated	0	0	0	3	**3**
	Total	**50**	**17**	**13**	**10**	**90**

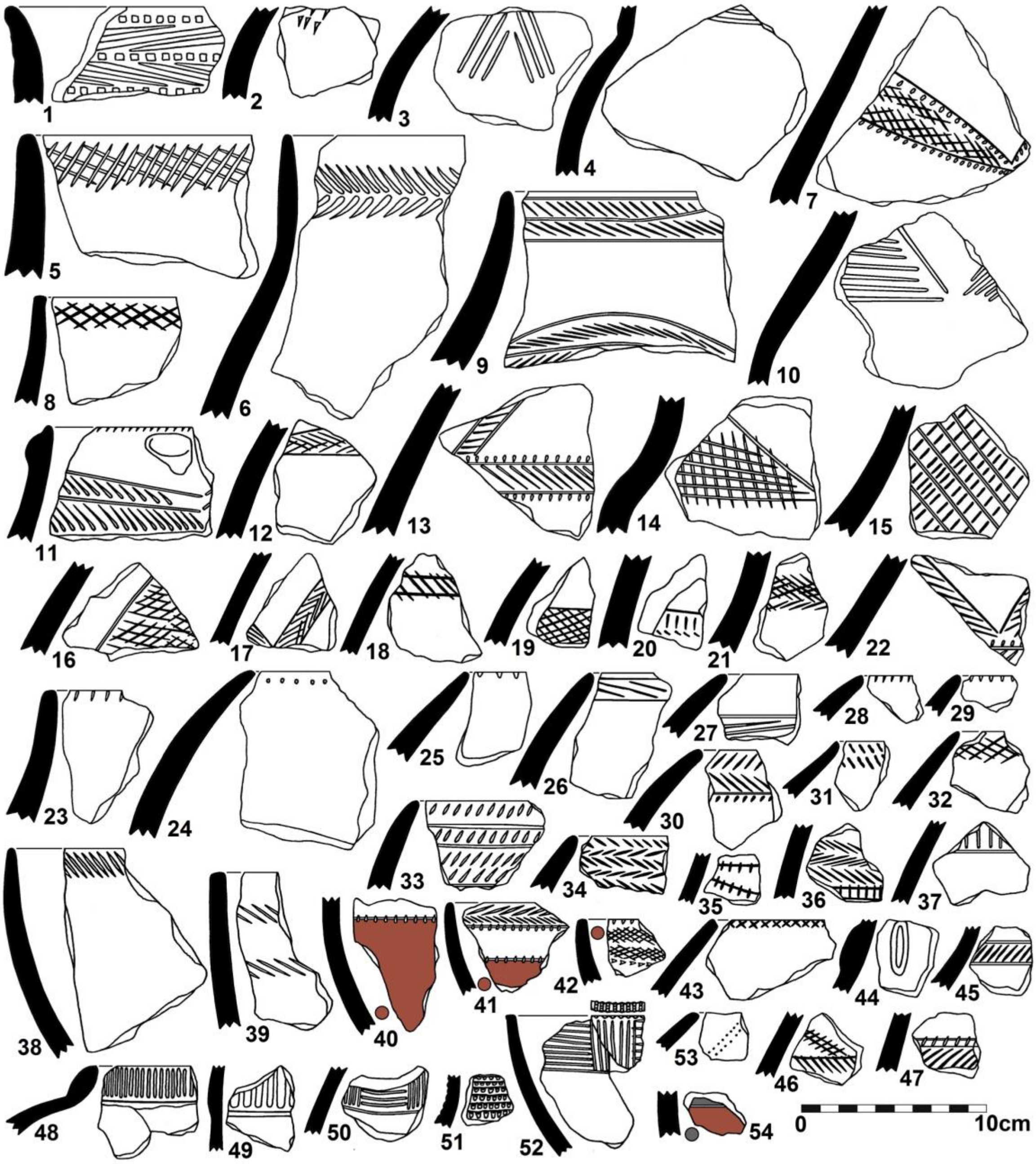

Figure 8. Decorated ceramics retrieved during the surface collection (sherds 1-38, 40-42, 44-53) and excavation (sherds 39, 43, 54). They represent the Happy Rest facies (1-4); Diamant facies (5, 6); Eiland facies (7-47); Bambata facies (48-53) and Letsibogo facies (54) pottery (grey dot=grey colour inside; red dot=red ochre colour inside).

The excavation

The excavation trench was placed where sediment appeared to have some depth (Figs 2 & 9). In addition to recording the volume of deposit, Table 2 lists the bucket points recorded by the Nikon total station for each layer and its associated plans. Below the organic-rich surface layers that yielded 59% of the total deposit volume (Table 2), the sediments were filled with rock spalls and rock fall (Fig. 9). The seeds and other plant material in Surface were often enclosed in baboon faeces. A few rodent bones were also found in Surface. The basal layer, Brown, which has the richest lithic artefact content (and highest volume density of artefacts), produced only 6% of the excavated sediment (Table 2) and the stratigraphy (Fig. 9) implies that the sediment that we encountered in Brown was trapped in hollows in the bedrock. The tightly packed lithics with a little sediment cushioning them suggests the sort of deflated 'pavement' that occurs when sand and organic material are flushed out.

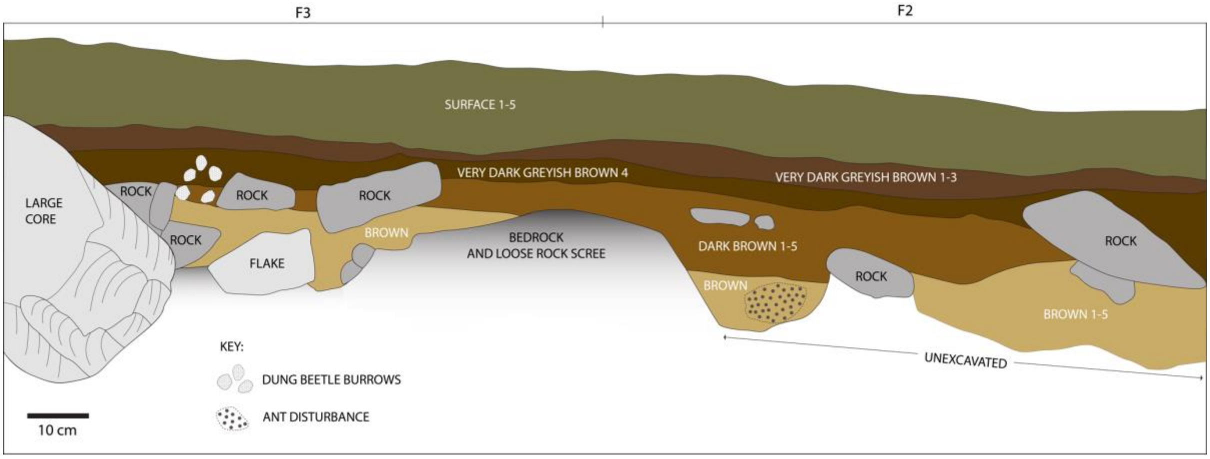

Figure 9. Woodstock Rocks stratigraphy of the south wall. Rockfall appears to predate and postdate the accumulation of lithics and sediment in Brown. Note the slope of the sediment (towards the talus) and the dung beetle burrows and ant disturbance that is likely to have allowed some MSA and LSA artefacts to penetrate the older layers.

There was some artefact mixing between unrelated technologies in square F2, which has its west section close to the dripline where artefacts might have been flushed in or out of the site by water. Nonetheless, the inclusion of LSA lithics in the trench was small and lithics that were unequivocally MSA were also scarce. Notwithstanding the bifacial points found on the surface in the south of the site, no such artefacts were recovered from the excavation and few ceramic sherds were found in the trench. Because this was an exploratory excavation, we did not conduct fabric analysis, but we observed artefacts standing on edge, implying disturbance, and the terrace surface slants towards the talus so that artefacts are encouraged to move downslope. The sediment slope is clearly visible in the section (Fig. 9).

Table 2. Woodstock Rocks stratigraphy, bucket points (BP) and litres of sediment. The volume of sediment is presented in litres because the excavation buckets are calibrated in litres.

Layer	Plan	BP F2	BP F3	Litres F2	Litres F3	Litres total
Surface	1	150	55	46	34	**80**
Surface	2	291	200	42	36	**78**
Surface	3	438	331	48	39	**87**
Surface	4	504	382	41	30	**71**
Surface	5	597	459	50	24	**74**
Surface total						**390 (59%)**
Very Dark Greyish Brown (VDGB)	1 & 2	622	525	23	24	**47**
Very Dark Greyish Brown (VDGB)	2	0	552	0	28	**28**
Very Dark Greyish Brown (VDGB)	3	696	662	21	22	**43**
Very Dark Greyish Brown (VDGB)	4	758	724	16	18	**34**
VDGB total						**152 (23%)**
Dark Brown	1	797	767	13	6	**19**
Dark Brown	2	847	809	10	5	**15**
Dark Brown	3	1035	1052	14	3	**17**
Dark Brown	4	1093	0	7	0	**7**
Dark Brown	5	1105	0	1	0	**1**
Dark Brown Rockfall	0	869	867	3	15	**18**
Ant's nest under rock 1	0	868	0	1	0	**1**
Dark Brown total						**78 (12%)**
Brown	1	1222	900 & 1159	4	12	**16**
Brown	2	1259	1278	8	3	**11**
Brown	3	1296	0	4	0	**4**
Brown	4	1303	0	12	0	**12**
Brown total						**43 (6%)**
Total litres from all layers						**663 (100%)**

To estimate ages for the oldest Woodstock occupations, we retrieved three sediment cores (SOM Fig. 6), one from just above the rock fall and two below it. The sediment was processed by single grain optically stimulated luminescence (OSL) dating in Australia at the Earth Laboratory of Wollongong University, but unfortunately it was not possible to obtain an age from the cores because of the loss of integrity caused by mixing of grains in the sediment.

Under the rockfall, in layer Brown (Fig. 9), we recovered large lithics that were made on site from the quartzite blocks that lie close to the cliff. We now describe these and the other lithics from the excavation.

Lithic analysis

The Woodstock Rocks assemblage is flake-rich with relatively few retouched pieces (Table 3). Points are rare, and even the most common formal tools – scrapers and notches – are rather scarce. Amongst the broken tools is the tip of a quartzite handaxe (Fig. 10.1) and the base of a bifacial tool that may have been a small handaxe (Fig. 10.3). A few large bifacial trimming flakes are also present (Fig. 11.2) and some whole and broken flakes have twisted profiles. Cores are most prevalent in layer Brown (Tables 3 & 4), and the largest cores were excavated from this layer. The highest volume density of lithics occurs in Brown, indeed the volume density is at least 10 times that of the other three layers (Table 3). One giant core that seems to be a single platform core with several removals (not listed in the table) is wedged into the F3 east section wall (of layer Brown) and was not removed from the trench (Fig. 9). Casual and single platform cores are most common, but bipolar cores are rare (Table 4). Giant cores in the form of grey quartzite boulders are present on the cliff terrace and large prepared cores were observed near the talus slope (e.g., Fig. 12.2). Radial flaking of cores is evident from some by-products, as well as *Levallois* and pseudo-*Levallois* flaking. Few cores showed evidence of elongated flake removals and this is consistent with the presence of rare elongated flakes, but many short, wide ones (e.g., Fig. 12.1).

Table 3. Frequencies of cores, flakes and retouched pieces. Volume densities of the pieces are calculated as the number of pieces per litre of sediment (VDGB=Very Dark Greyish Brown).

Layer	**Core**	**Bipolar core**	**Cortical flake**	**Whole flake**	**Broken cortical flake**	**Broken flake**	**Bifacial point**	**Unifacial point**	**Scraper**	**Notch**	**Other tool**	**Broken tool**	**All retouched pieces**
Surface 1-2	5	0	5	17	3	56	0	0	2	2	0	1 scraper	0
Surface 3-4	7	0	4	21	1	64	0	1 broken	1	1	2	1	11
Lithic/litre (163 litres)	**0.07**	**0**	**0.06**	**0.23**	**0.02**	**0.74**	**0**	**<0.01**	**0.02**	**0.02**	**0.01**	**0.01**	**0.07**
VDGB 1-2	3	0	4	15	2	28	0	0	2	1	2	0	3
VDGB 3-4	12	1	8	27	11	53	0	0	3	3	1	1	0
Lithic/litre (152 litres)	**0.09**	**<0.01**	**0.08**	**0.28**	**0.09**	**0.53**	**0**	**0**	**0.03**	**0.03**	**0.02**	**<0.01**	**0.02**
Dark Brown 1-3	9	1	28	32	6	61	0	0	3	0	0	1	10
Dark Brown 4-5	3	2	2	6	5	64	1	1	2	2	0	0	0
Lithic/litre (78 litres)	**0.15**	**0.04**	**0.38**	**0.49**	**0.14**	**1.60**	**0.01**	**0.01**	**0.06**	**0.03**	**0**	**0.01**	**0.13**
Brown 1	10	1	36	60	8	127	0	0	4	3	4	4	0
Brown 2	7	0	7	12	15	78	0	0	1	1	0	4	0
Brown 3-4	8	0	0	71	0	101	0	0	0	1	1	5+1 scraper	29
Lithic/litre (43 litres)	**0.58**	**0.02**	**1.00**	**3.33**	**0.53**	**7.12**	**0**	**0**	**0.12**	**0.12**	**0.12**	**0.33**	**0.67**
Grand total (all layers)	**64**	**5**	**94**	**261**	**51**	**632**	**1**	**2**	**18**	**14**	**10**	**18**	**53**

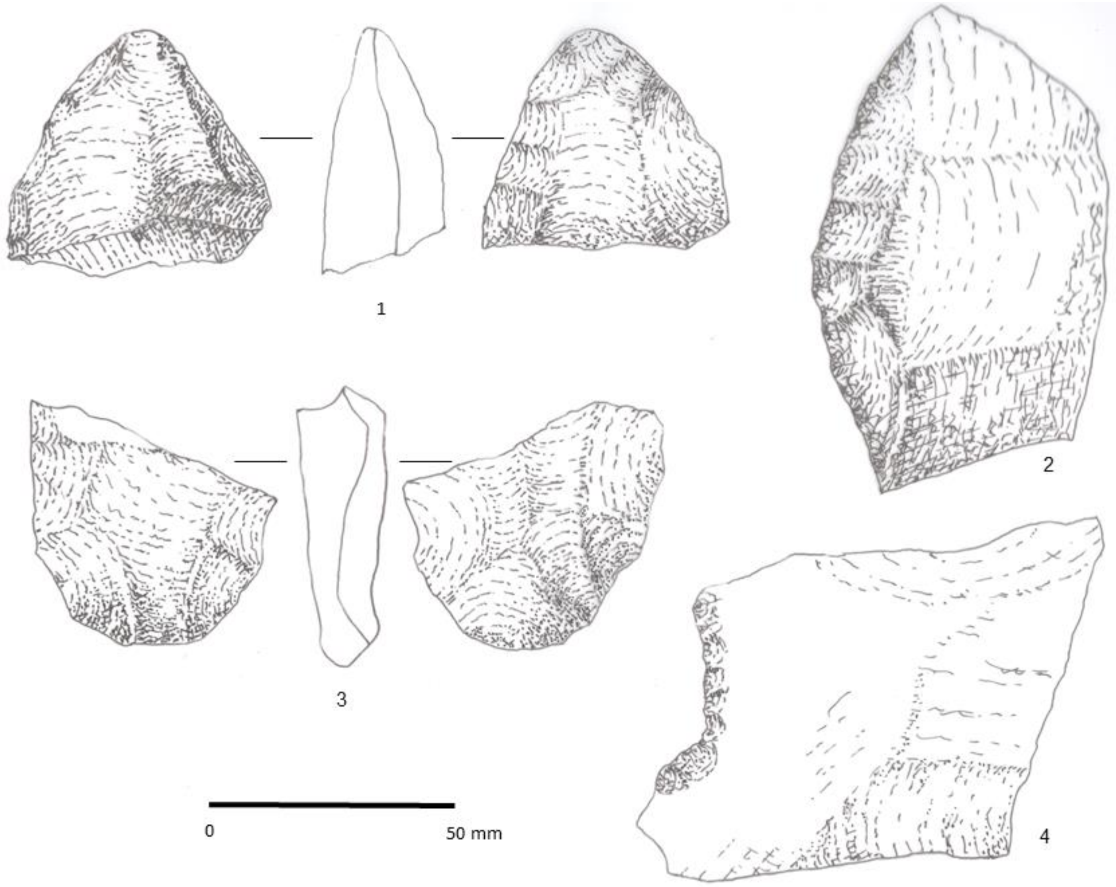

Figure 10. Formal tool sample. 1) Broken tip of handaxe: #874, F3 Brown 1; 2) scraper: #683, F2 VDGB 3; 3) broken base of handaxe: #1281, F2 Brown 3; 4) notch: #1141, F2 Brown 1 (where 1, 3, 4=quartzite; 2=sandstone).

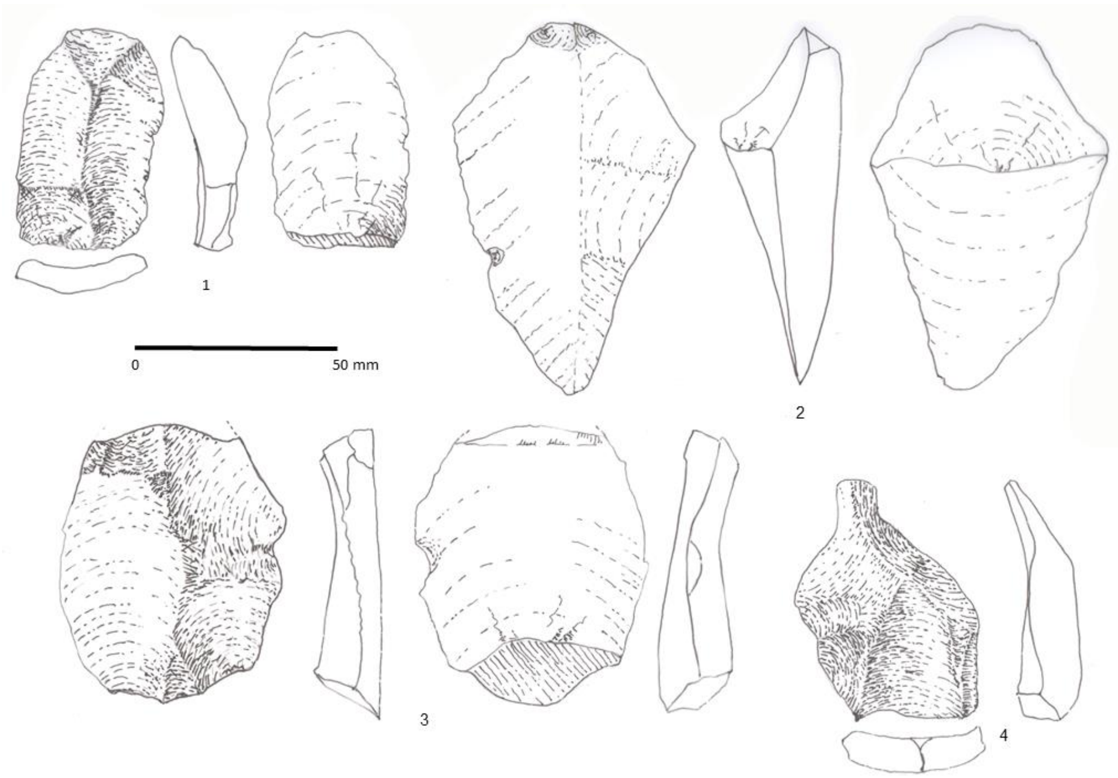

Figure 11. Various quartzite flake types from layer Brown. 1) #872, F3 Brown 1; 2) #897, F3 Brown 1; 3) F2 Brown 4 (not plotted); 4) #1285, F2 Brown 3.

Table 4. Woodstock Rocks core classification (where indet.=indeterminate; p.=platform; DB=Dark Brown; VDGB=Very Dark Greyish Brown). Two blade cores were identified, showing reduction from a single platform along the long axis of the core.

Layer	Casual/indet.	Single p.	Adjacent p.	Multiple p.	Opposed p.	Radial	Prepared	Blade	Bipolar	Broken	Total
Surface 1	2	1	0	0	1	0	0	0	0	0	**4**
Surface 2	1	0	0	0	0	0	0	0	0	0	**1**
Surface 3	1	0	0	0	0	0	0	0	0	1	**2**
Surface 4	1	3	0	0	0	0	0	1	0	0	**5**
Surface 5	0	0	1	0	0	0	0	0	0	0	**1**
VDGB 1-2	0	0	2	0	0	0	1	0	0	0	**3**
VDGB 3	2	1	0	0	0	0	0	0	1	0	**4**
VDGB 4	1	2	1	0	0	1	1	0	0	2	**8**
DB 1	0	0	0	1	0	0	0	0	0	1	**2**
DB 2	0	3	0	0	0	0	0	0	0	0	**3**
DB 3	2	2	0	0	0	0	0	0	1	0	**5**
DB 4	0	2	0	0	0	0	0	1	2	0	**5**
Brown 1	3	1	2	1	2	0	1	0	1	0	**11**
Brown 2	5	1	0	0	0	1	0	0	0	0	**7**
Brown 3	2	1	0	0	0	0	0	0	0	2	**5**
Brown 4	1	1	0	0	0	0	0	0	0	1	**3**
Total	**21**	**18**	**6**	**2**	**3**	**2**	**3**	**2**	**5**	**7**	**69**

Figure 12. Woodstock Rocks quartzite flake and core. 1) Flake: F3 Brown 1; 2) core: Surface find. Note the clay-rich patina on the flake.

Almost all (96%) Brown cores are quartzite (Table 5; Fig. 13); 98% of Brown cortical flakes and 95% of broken flakes are also quartzite, followed by 91% of whole, non-cortical flakes (Table 5; Fig. 13). The relationship between quartzite core and flake percentages may imply that relatively few large flakes were considered suitable for further shaping. We think that large flakes were probably the desired blanks for making other products. Furthermore, the scarcity on the cliff terrace of LCTs, or fragments of them, suggests that prized pieces were removed from the cliff terrace for use elsewhere. The presence of some LCTs (SOM Fig. 8) on the river terrace tends to support the interpretation of off-site transport of blanks, albeit close by.

Although there are only five siltstone cores and four cortical flakes, there are a great many siltstone chips (Table 5). Siltstone chips smaller than 10 mm comprise only 8% of chips in Brown (80% of the chips in Brown are quartzite), but 39% in Very Dark Greyish Brown (Fig. 13).

Table 5. Distribution of rock types among retouched pieces, cores, flakes and chips.

Typology and raw materials		Surface 1-2	Surface 3-5	**Total**	Percentage	VDGB 1-2	VDGB 3-4	**Total**	Percentage	Dark Brown 1-3	Dark Brown 4-5	**Total**	Percentage	Brown 1	Brown 2	Brown 3-4	**Total**	Percentage	**Grand total**
Retouched pieces	Quartzite	3	2	**5**	71	3	4	**7**	70	3	5	**8**	89	9	1	2	**12**	80	**32**
	Siltstone	1	0	**1**	14	0	1	**1**	10	0	0	**0**	0	2	1	0	**3**	20	**5**
	Other	0	1	**1**	14	0	2	**2**	20	0	1	**1**	11	0	0	0	**0**	0	**4**
Broken retouched pieces	Quartzite	1	2	**3**	100	1	0	**1**	33	0	0	**0**	0	4	4	4	**12**	86	**16**
	Siltstone	0	0	**0**	0	1	1	**2**	77	0	0	**0**	0	0	0	2	**2**	14	**4**
	Other	0	0	**0**	0	0	0	**0**	0	1	0	**1**	100	0	0	0	**0**	0	**1**
Cores	Quartzite	2	5	**7**	58	4	7	**11**	79	0	1	**1**	20	9	7	8	**24**	96	**43**
	Siltstone	1	1	**2**	17	1	0	**1**	7	0	2	**2**	40	0	0	0	**0**	0	**5**
	Other	2	1	**3**	25	0	2	**2**	14	0	2	**2**	40	1	0	0	**1**	4	**8**
Cortical flakes	Quartzite	4	2	**6**	67	2	5	**7**	70	26	2	**28**	93	35	7	0	**42**	98	**83**
	Siltstone	0	2	**2**	22	1	0	**1**	10	1	0	**1**	3	0	0	0	**0**	0	**4**
	Other	1	0	**1**	11	1	1	**2**	20	1	0	**1**	3	1	0	0	**1**	2	**5**
Whole flakes	Quartzite	13	16	**29**	76	9	18	**27**	64	31	1	**32**	86	50	12	63	**125**	91	**213**
	Siltstone	3	5	**8**	21	4	7	**11**	26	1	3	**4**	11	5	0	6	**11**	8	**34**
	Other	1	0	**1**	3	2	2	**4**	10	0	1	**1**	3	0	0	2	**2**	1	**8**
Broken flakes	Quartzite	44	41	**85**	69	17	38	**55**	59	59	48	**107**	79	124	89	100	**313**	95	**560**
	Siltstone	8	12	**20**	16	8	17	**25**	26	7	20	**27**	20	10	4	0	**14**	4	**86**
	Other	7	12	**19**	15	5	9	**14**	15	1	1	**2**	1	1	0	1	**2**	1	**37**
Chips 10-20 mm	Quartzite	48	57	**105**	55	44	39	**83**	40	126	161	**287**	63	378	256	393	**1027**	82	**1502**
	Siltstone	34	33	**67**	35	50	58	**108**	52	41	87	**128**	28	76	50	38	**164**	13	**467**
	Quartz	6	13	**19**	10	3	5	**8**	4	7	26	**33**	7	13	11	4	**28**	2	**88**
	Other	0	1	**1**	1	8	0	**8**	4	2	7	**9**	2	37	0	0	**37**	3	**55**
Chips <10 mm	Quartzite	27	19	**46**	24	21	34	**55**	18	53	97	**150**	27	370	234	3006	**3610**	80	**3861**
	Siltstone	22	29	**51**	26	52	70	**122**	39	56	112	**168**	31	104	129	147	**380**	8	**721**
	Quartz	36	51	**87**	45	60	72	**132**	42	79	108	**187**	34	91	67	76	**234**	5	**640**
	Other	5	4	**9**	5	2	2	**4**	1	11	34	**45**	8	20	14	255	**289**	6	**347**

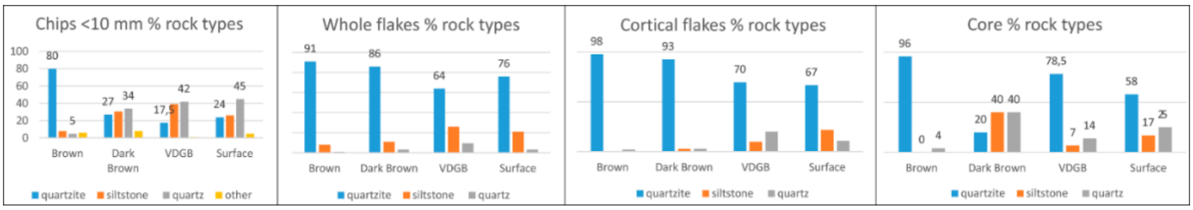

Figure 13. Woodstock Rocks percentages of quartzite, siltstone, quartz and other rocks in the chip, whole non-cortical flake, cortical flake and core categories. Whereas quartzite is most common amongst flakes and cores, this is not the case amongst chips smaller than 10 mm in layers other than Brown.

Quartzite flakes are longer, wider and thicker than siltstone flakes (Tables 6 & 7). Measurements of whole quartzite flakes (Table 6) suggest that the non-cortical quartzite flakes from Brown might be larger than their equivalents in the other layers, yet the one-way ANOVA showed no significant statistical differences between group means for length (F[2.154]=2.096, p=0.126), breadth (F[2.160]=2.588, p=0.078) and the length:breadth ratios (F[2.169]=2.506, p=0.085) in layers Brown, Dark Brown and Very Dark Greyish Brown. A statistically significant difference between the group means was, however, shown for thickness (F[2.158]=6.322, p=0.0023). The Tukey's HSD post hoc test showed that the mean thickness of non-cortical flakes in Brown was different from that in both Dark Brown and Very Dark Greyish Brown (Table 8; Fig. 14). Surface flakes were excluded from the test because of the small sample size.

Table 6. Mean measurements in mm for quartzite whole flakes (cortical and non-cortical) from all layers (with plans merged), including length, breadth, length:breadth ratios (L:B) and thickness. Ranges are presented in parentheses below the means.

Layers	N (non-cortical flakes)	Length	Breadth	L:B	Thickness
Surface	26	32.57 (14.2-86.3)	28.01 (7.5-82.6)	1.29 (0.4-2.7)	11.21 (2.6-49.4)
VDGB	26	37.91 (15.9-184.5)	34.83 (11.8-143.3)	1.14 (0.5-2.3)	10.41 (3.5-68.3)
Dark Brown	49	33.76 (11.8-104.2)	22.82 (7.9-59.0)	1.55 (0.6-3.1)	8.68 (3.4-26.4)
Brown	103	41.01 (15.3-122.3)	32.04 (9.0-103.7)	1.41 (0.5-2.5)	12.31 (3.5-41.8)
Layers	**N (cortical flakes)**	**Length**	**Breadth**	**L:B**	**Thickness**
Surface	6	42.85 (17.6-70.4)	33.35 (12.7-78.7)	1.50 (0.7-2.3)	12.48 (4.7-30.2)
VDGB	7	41.39 (23.9-68.0)	27.54 (18.2-43.2)	1.49 (1.0-1.7)	9.01 (5.8-18.2)
Dark Brown	39	31.41 (8.7-66.6)	27.46 (12.4-75.8)	1.25 (0.4-2.2)	9.10 (4.0-17.8)
Brown	73	33.57 (12.2-103.6)	28.83 (8.9-125.1)	1.23 (0.5-2.3)	9.50 (3.4-37.8)

Table 7. Mean measurements in mm for siltstone whole flakes (non-cortical) from all layers (with plans merged), including length, breadth, length:breadth ratios (L:B) and thickness. Ranges are presented in parentheses below the means.

Layers	N (non-cortical flakes)	Length	Breadth	L:B	Thickness
Surface	9	29.28 (20.0-43.0)	20.52 (11.7-33.0)	1.50 (0.8-2.3)	6.32 (3.3-16.8)
VDGB	13	25.44 (13.4-39.5)	21.90 (8.4-55.0)	1.34 (0.6-2.3)	6.82 (1.5-13.4)
Dark Brown	13	23.49 (14.9-31.6)	20.11 (10.2-34.3)	1.28 (0.6-2.4)	5.12 (2.8-8.7)
Brown	8	29.94 (15.7-41.5)	21.26 (12.5-33.0)	1.35 (0.5-2.8)	5.35 (3.1-9.2)

Table 8. Statistical differences between mean thickness of non-cortical flakes in Brown, Dark Brown and Very Dark Greyish Brown (VDGB).

Layers	Dark Brown	VDGB
VDGB	p=0.9946	X
Brown	p=0.00647	p=0.03905

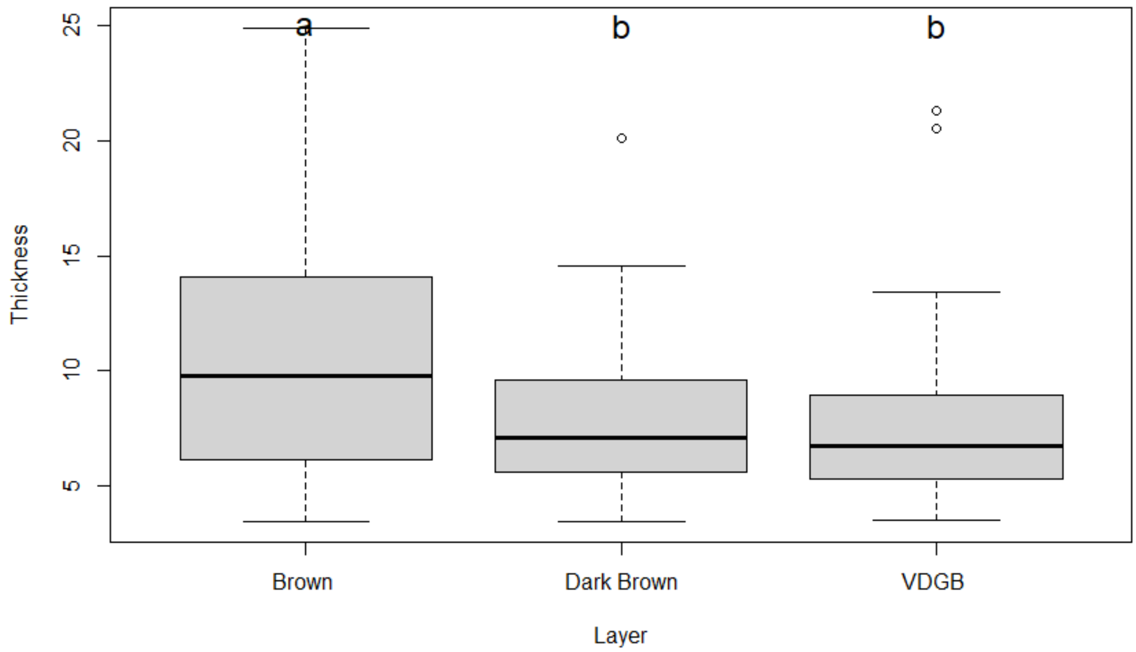

Figure 14. Box plot for thickness of non-cortical, quartzite flakes from layers Brown, Dark Brown and Very Dark Greyish Brown (VDGB). The a and b show which groups are statistically different from each other.

Lithics larger than 2 cm were point plotted with the total station and mapping examples are in Figures 15 and 16. The figures show that there are no >2 cm artefacts in the rubble plotted around the rocks. This suggests that the channels of rubble represent areas of wash.

Lithics observed (not excavated) next to the Mokolo River, either eroding from, or embedded in the ferricrete terrace included large quartzite flake blanks, handaxes and broken LCTs, and giant scrapers (SOM Figs 7-9).

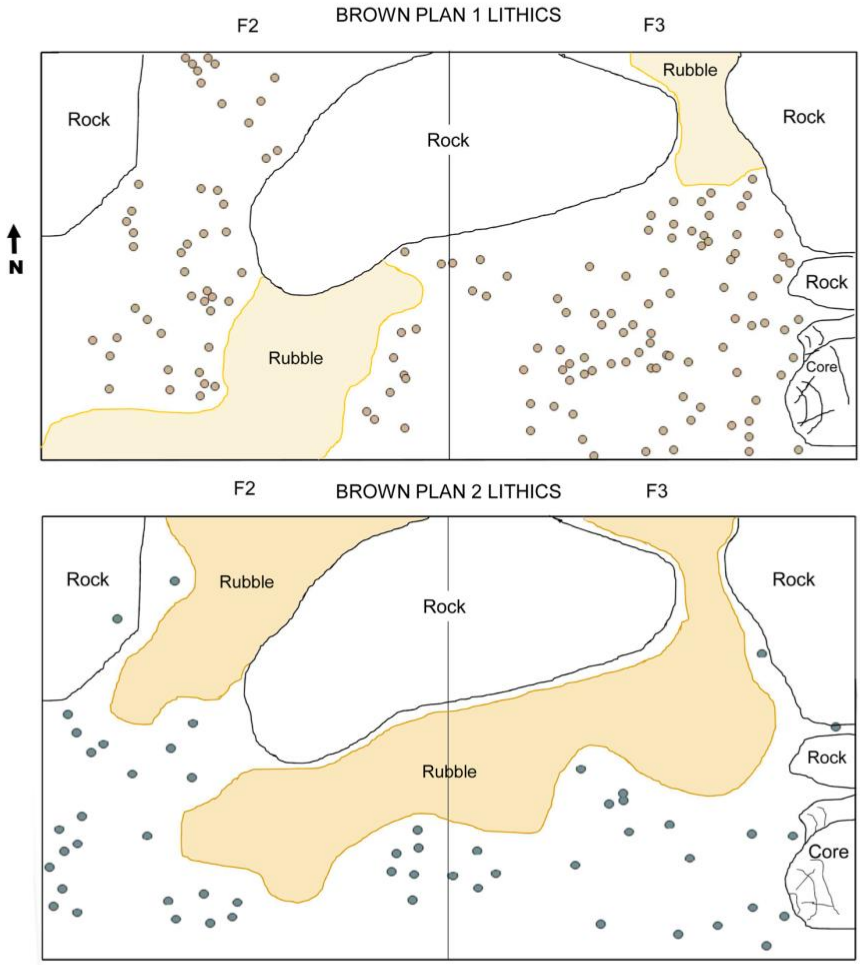

Figure 15. Woodstock Rocks layers Brown 1 and Brown 2: distribution of stone artefacts >2 cm (circles) between the rock fall and rocky rubble. In the south-east corner of F3 there is a large quartzite core from which flakes have been removed. Each square is one metre.

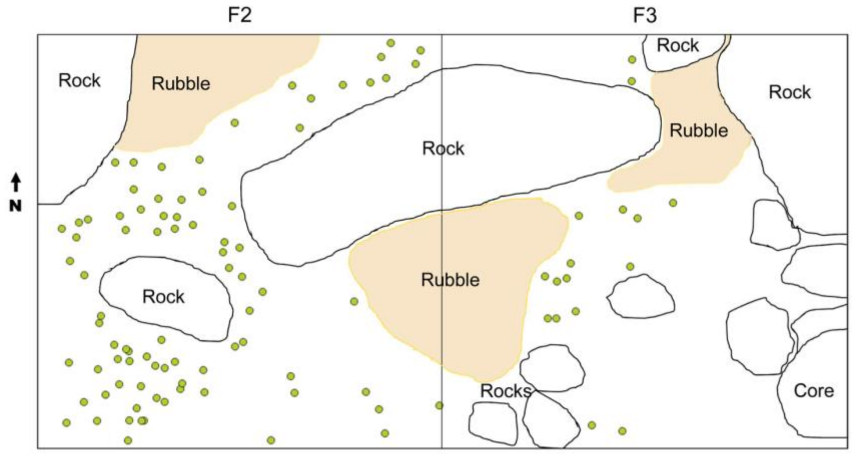

Figure 16. Woodstock Rocks layer Dark Brown, plan 3: distribution of stone artefacts (circles). Rockfall and rubble appeared in this plan in square F3 where there were fewer stone tools >2 cm than in square F2. Each square is one metre.

Palaeomagnetic results

The natural remanence of specimens is dominated by northerly and upward directed magnetisation, which is similar to the present-day geomagnetic field at the sampling locality (Fig. 17; SOM Figs 10 & 11). Two specimens yield inconsistent results. This is likely due to an error in orientation during sampling and their results are not further considered. Nine specimens displayed north-up components located at 354.4° declination and -43.0° inclination with a 95% probability (α_{95}) of 12.9° and precision parameter (k) of 15.0 during demagnetisation up to 520°C. The remanence, however, moved away from these northerly directions towards southerly downward directions during thermal demagnetisation along planar trajectories. Specimen remanence typically becomes increasingly spurious with demagnetisation above 600°C. In some samples the remanence is resolved further along these trajectories away from the north-up (normal) remanence towards a south-down (reverse) magnetisation. The reverse magnetisation is best resolved in specimen WS02 (Fig. 18), but in most specimens it was not fully resolved before magnetisations became spurious (possibly due to the conversion of goethite to magnetite during the heating process). The reverse magnetisation is constrained in nine specimens as either linear trajectories towards the origin or as planar trajectories away from the lower stability north-up components and was quantified using the method of McFadden and McElhinny (1988) for the combination of line and plane fits. This high-stability reverse magnetisation is located at 186.5° declination and 47.5° inclination with an α_{95} of 23.5° and k of 11.6 (Fig. 18).

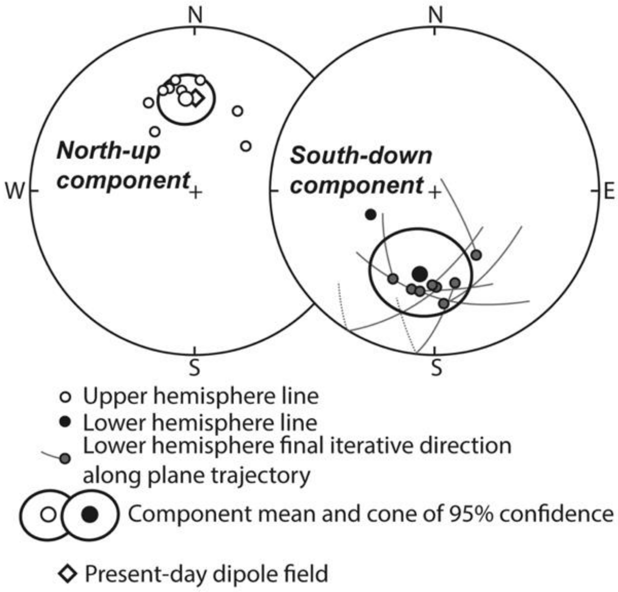

Figure 17. Woodstock Rocks ferricrete terrace: identified magnetic components, their means and 95% confidence cones.

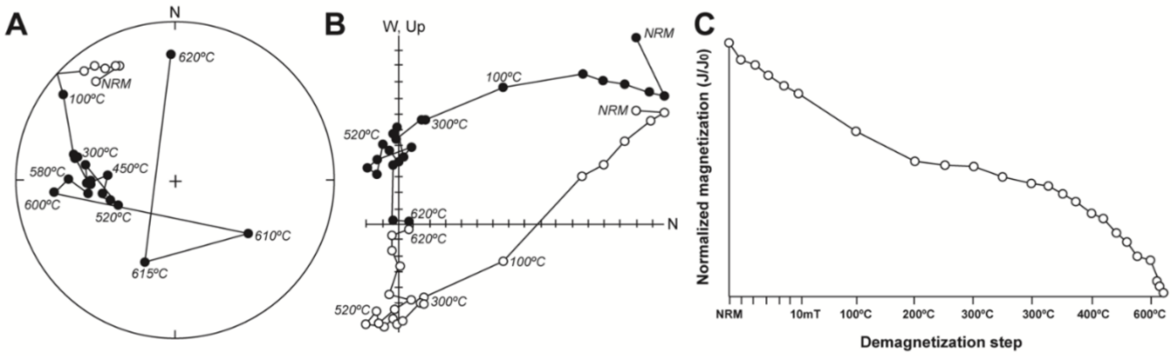

Figure 18. Woodstock Rocks ferricrete terrace: demagnetisation of sample WS02. a) Equal-area projection (open symbols=upper hemisphere magnetisation; closed symbols=lower hemisphere magnetisation); b) orthogonal projection (open symbols=magnetic inclination; closed symbols=magnetic declination; tick marks=10^{-6} A/m); c) normalised magnetisation (J/Jo).

4. Discussion

The southern part of the Woodstock Rocks cliff terrace was used by people in the MSA and LSA, as well as by Iron Age farmers and possibly also by pastoralists using the Mokolo River as a well-watered corridor for their stock. The MSA and LSA lithics on the surface, like points and scrapers, imply that the site was once a domestic locale. In contrast, we can probably rule out the possibility that Iron Age farmers dwelled in the shelter, although there are a few potsherds, grindstones and a 'late white' finger painting. Finger-painted art and ceramics from Happy Rest, Diamant and Eiland facies, demonstrate the presence of Iron Age farmers, but they most likely visited the shelter only occasionally for ritual purposes. While finger-painted farmer art is found throughout the Waterberg (Smith 1999), it is unusual to find only one representational image as is the case at Woodstock Rocks. In other shelters where this type of art occurs there tend to be more paintings and, in such cases, the art is sometimes thought to be used in initiation ceremonies (Smith 1999, 2005). The finger-painted bird motif at Woodstock is also out-of-the-ordinary, regardless of the species intended, though bird images have been recorded at Olieboomspoort, too (van der Ryst 2006).

Ochre powder ground on some of the grindstones may have been used for colouring human skin on some ritual occasions, but it is also an ingredient of the paint that would have been used for the red, brown and yellow rock art at the site. The ochre, grindstones, and the abundant, faded rock art across the cliff face imply that the cliff terrace was used for rituals such as rain-making or initiation ceremonies in the last few thousand years, whereas it may have served other purposes in the deeper past. Rain-making and initiation ceremonies sometimes took place in isolated rock shelters (Schapera 1930; Feddema 1966; Kinahan 2020), for example, from about AD 1000, Eiland facies pots containing offerings were left in rock shelters (Aukema 1989; Huffman 1990, 2007; van der Ryst 1998). Eiland pottery is linked to a period with a great deal of rain-making activity in the Waterberg (Aukema 1989). Part of the initiation ceremonies for northern Sotho and Tswana boys is still conducted in secluded gorges, and here the initiates are taught to hunt, to recognise regiment totems, and to fight the enemy (Jensen Krige 1962; Bruwer 1963). Handprints are relatively common in the rock art of the Waterberg and there are many handprints of various sizes at Woodstock Rocks. Some researchers argue that herders were the authors of the prints (van Rjissen 1994; Smith & Ouzman 2004). The presence of Bambata pottery in the shelter confirms that herders were on the landscape, but we are doubtful that the majority of the handprints in the Waterberg, and at this site in particular, was made by herders. The small yellow handprints seem intimately connected with the Woodstock Rocks fine-line paintings and they were probably made by the same artists. The larger red handprints are for the most part placed some distance from the fine-line art and in some cases these prints are very high on the rock face. Their distance from the fine-line art may be deliberate and perhaps these red handprints are associated with the finger painting in the shelter.

The hunter-gatherer art at Woodstock includes some uncommon imagery. Small carnivores are rare motifs in southern African rock art so the presence of one at Woodstock Rocks is important regardless of whether the depiction is a genet or a white-tailed mongoose. Eland paintings are not unusual in the Waterberg, but they are less common here than, for example, in the Drakensberg (e.g., Vinnicombe 1976) or Cederberg (Hollmann 1993). Other antelope such as hartebeest are better represented in the Waterberg (e.g., Laue 2000). Notably, Woodstock Rocks has at least three eland paintings represented in two different ways. In Figure 6 from Woodstock Rocks Rock Art 2, the eland is painted in white with the body as an outline, whereas yellow and white bichrome eland are portrayed in a Woodstock Rocks Rock Art 1 panel (SOM Fig. 4). Even the seven antelope in the Woodstock Rocks Rock Art 2 panel demonstrate unusual features and they cannot be identified to species. Their long, square muzzles are like hartebeest, but their bodies are unstandardised and not recognisable antelope types. Since the artists were exceptionally competent, the distortion is deliberate and these 'non-real' antelope probably played an important role in the hunter-gatherer belief system.

Although there is hunter-gatherer rock art on the rock walls of the northern part of the cliff, there is scant evidence of MSA and LSA occupation here. Instead, this part of the site, where we excavated (Fig. 2), seems to have been an Acheulean lithic workshop where quartzite was extravagantly knapped and discarded. Large quantities of rock waste are common at Acheulean quarry sites in South Africa, for example in the Karoo (Sampson 2006), and also in other parts of the world, such as India (Petraglia et al. 1999) and northern Israel (Barkai et al. 2016). The frequencies of quartzite cores, including giant ones, together with large frequencies of quartzite flakes, and cortical flakes and chips supports the interpretation of a primary production area at Woodstock. The coarse-grained quartzite used most often at this site was presumably challenging for the knappers. Notwithstanding this handicap, there is some evidence for the knapping of prepared cores at Woodstock, including radial cores and a few that bear some resemblance to the Victoria West cores known from the Karoo, as well as from sites like Montagu Cave (Keller 1973) and Canteen Kopje (Li et al. 2017). Prepared core technology is not unusual in Acheulean assemblages and the Victoria West cores at Canteen Kopje are estimated to be about one million years old (Li et al. 2017), making them broadly contemporary with the Woodstock Rocks assemblage. *Levallois* techniques, more often associated with MSA or Middle Palaeolithic technologies (Gallotti & Peretto 2015; Agam et al. 2022), have a similar volumetric concept to Victoria West cores (Li et al. 2017).

Acheulean knapping techniques included striking large flakes from which LCTs (or scrapers) were later fashioned. On Woodstock's cliff site, several very large flakes lie on the surface, but the excavation yielded few flakes with a maximum dimension larger than 200 mm. In contrast, the river terrace contains some flakes as long as 400 mm and as wide as 300 mm, with a mass as great as 5 kg. It seems likely that one goal at the cliff terrace workshop was to produce large flakes suitable as blanks for shaping LCTs. If this was the case, then the appropriate blanks were probably taken elsewhere to produce LCTs because we excavated only fragments of them, and the large flakes recovered from the excavation trench were not suitable blanks for LCTs. Large blanks from the cliff workshop may have been deliberately transported to the river where they were further shaped and used. This practice was inferred in the Sundays River Valley where large flake blanks (perhaps made from off-site boulder cores) were transported on-site expressly for handaxe production (Lotter & Kuman 2018). However, at Woodstock Rocks some lithics may also have rolled from the steep talus slope of the cliff terrace down to the river terrace. As we have previously suggested, the slope and position of the cliff terrace make this likely. In addition to large flake blanks on the river terrace there are quartzite LCTs, and a variety of tools like giant scrapers, some of which look as though they were failed LCTs repurposed as scrapers. Goren-Inbar and colleagues (2008) showed that in the Acheulean of Israel, the flakes on which massive scrapers were fashioned are by-products of the initial stages of the *chaîne opératoire* aimed to produce bifacial tools. Thus, the production of these massive scrapers depended on the availability of large flakes originating from the knapping of giant cores (Madsen & Goren-Inbar 2004).

The river terrace and the Acheulean assemblage on it became cemented with ferricrete (SOM Figs 10 & 11). We have no way of knowing whether the hardpan formed tens of thousands, hundreds of thousands, or simply hundreds of years after the discard and/or deposition of the implements next to the river, but the human use of the river terrace of necessity predated the formation of the ferricrete. The ferricrete records a northly-up magnetisation, believed to be a viscous remanent overprint that was recorded in the present-geomagnetic field. This recent magnetic overprint, however, partially obscures a south-down (reverse) characteristic remanence that remains stable during thermal demagnetisation up to 600°C. Nine of the ferricrete cores yielded evidence for this high-stability reversed magnetisation, thus we know that the ferricrete terrace was likely cemented during the Matuyama Chron and therefore has to predate 780 ka. Part of the Acheulean sequence in Thomas Quarry, Morocco, also yielded reversed polarity (Gallotti et al. 2021) and can be attributed to the Matuyama Chron, but there are not many African sites fortunate enough to have a chronological framework, even a relative one.

For a while, the lack of dating frameworks led archaeologists to look for technological refinements in Acheulean lithics as a means of seriation. Initially, typological differences between Acheulean assemblages seemed uncertain, particularly because the raw material used plays a role in determining size (Mitchell 2002), as well as the number of flake scars that can be removed from an edge to create a thin cutting edge. Nonetheless, more recent studies suggest that some time-related knapping refinements occurred in South Africa, for example, there appears to be an increase in the effort allocated to flaking later Acheulean handaxes. Greater tip refinement is evident in handaxes from the later Acheulean assemblages in Cave of Hearths compared to those in the Rietputs 15 early Acheulean, dated to about

1.3 Ma (Li et al. 2018). Furthermore, the thinning methods for later Acheulean handaxes resulted in thinner tips than those found on early Acheulean handaxes (Caruana 2020). At sites like Wonderwerk, where there is a dated sequence and where the same rock type is used through time, it also seems possible to detect chronological changes in technology. Here, the earliest Acheulean to arise from the Oldowan, somewhere between 1.5 and 1.1 Ma ago, contains simple bifacial technology that subsequently developed into handaxe production with non-invasive flaking (Chazan 2015).

The Wonderwerk sediments contain several normal and reversed polarity signals, interpreted to have occurred between 0.78±0.18 Ma to 1.85±0.23 Ma (Matmon et al. 2012). Uranium-lead (U-Pb) dating of speleothems buried in Stratum 5 gave an age of 0.548±0.027 Ma, while two samples from Stratum 10 yielded U-Pb ages of 0.839±0.026 and 0.734±0.069 Ma (Pickering 2015). Woodstock Rocks therefore fits chronologically in the middle of the Wonderwerk sequence, a period that is not well-represented in southern African sites. Early dates like those at Wonderwerk have also been found at Sterkfontein, where the Acheulean assemblages appear to have developed from an earlier Oldowan Industry, at about 1.7 Ma ago (Kuman 1994; Kuman & Clarke 2000). Another early Acheulean site, at Rietputs, in Vaal River gravels, generated a range of cosmogenic burial ages between 1.89±0.19 and 1.34±0.22 Ma ago (Gibbon et al. 2009). The final stages of the later Acheulean are represented at sites like Amanzi Springs, in the Eastern Cape, where there are dates between about 534 and 390 ka ago (Caruana et al. 2023). Like Woodstock, Amanzi is interpreted as an Acheulean workshop that was visited repeatedly to access rocks, water and other resources. Although dates for the Acheulean are not abundant anywhere, the chronology is sufficiently well-established to demonstrate that the technology was long lasting, relatively conservative, and that it probably survived in some areas until about 300 ka ago. Surprisingly, an even younger OSL age estimate of 222±31 ka has been obtained for the final Acheulean occupation (layer 21) in Montagu Cave where side-struck flakes from quartzite boulder cores were used to manufacture LCTs (Archer et al. 2023). Not only was the Acheulean long lasting, it was also geographically widespread, occurring, for example, from the southernmost tip of South Africa to Atapuerca, Spain (Lombao et al. 2023), India (Petraglia et al. 1999; Mitchell 2002) and China (Kuman et al. 2016).

Cave or rock shelter sites with Acheulean assemblages are rare in South Africa, perhaps because the hominins stayed away from them until they were able to reproduce fire for themselves, and could then use it for protection against predators like leopard and hyena that tend to make use of rock tunnels and caves. In South Africa, Acheulean cave occupations are recorded only at Olieboomspoort (Mason 1962; van der Ryst 2006), Montagu (Keller 1973; Archer et al. 2023), Cave of Hearths (Mason 1962; McNabb 2009) and Wonderwerk (Volman 1984; Beaumont & Vogel 2006; Chazan 2015). As mentioned at the beginning of the paper, a few LCTs were recovered from the basal layers of the Waterberg site, Olieboomspoort, in both the Mason (1962) and van der Ryst (2006) excavations. Two coarse-grained quartzite cleavers from Mason's excavation are illustrated by Val and colleagues (2021: fig. 12), who did not recover any Acheulean lithics when their test excavations reached bedrock, suggesting that visits to this site were rare in the ESA. This makes Woodstock Rocks the first substantial Acheulean site in the Waterberg, as well as the first dated ESA site in the area.

Woodstock Rocks was attractive for hominins in the ESA because it has in abundance two desirable resources – water, and rocks suitable for knapping. Hominins in the ESA were tethered to water sources, such as rivers, lakes or pans (e.g., Sampson 1972, 1985, 2006), and their lithics tend to concentrate within an easy distance for obtaining water, but not too close to risk danger from carnivores (Sampson 2006). Woodstock Rocks fits this well-established pattern, as does Wonderboom in the Magaliesberg (Lombard et al. 2021). Although Acheulean knappers are known to have transported rocks considerable distances from their outcrops or deposition areas, there are also workshop sites where knappers would have produced blanks suitable for LCTs that would then have been removed from the workshop area (Goren 1979). This pattern of transport may result in workshop sites that do not have large flake blanks or LCTs. At some Acheulean sites like this, there are more cores than flakes, or at least a higher-than-expected proportion of cores suggesting that the flakes made at the workshop site were transported elsewhere (Goren 1979; Caruana et al. 2019). Smaldeel 3, in the flood basin of the Gariep Dam, Upper Karoo, is a hornfels quarry site studied by Sampson (2006) that yielded no handaxes, cleavers, or even roughouts or preforms from LCTs. His subsequent surveys revealed that biface preforms occurred in less than one per cent of the known quarries. This suggests that the Smaldeel large blanks were transported to activity areas where they were later shaped and used. A similar situation was recorded at Gesher Benot Ya'aqov (GBY), Israel, where layers V-5 and V-6 have a near-absence of handaxes, but side-scrapers, end-scrapers and burins are present in these Acheulean assemblages (Goren-Inbar & Sharon 2016). Handaxes are rare in this part of the GBY sequence, yet several flake types from the biface knapping process were found. These include short, wide flakes that are thick at the proximal end and that resulted from attempts to create a striking platform for removing thinning and shaping flakes. Also included are resharpening flakes and small flakes with edges that retain remains of a bifacial edge, and snapped handaxe tips (Goren-Inbar & Sharon 2016). Although the Woodstock excavation was small and the lithic assemblage is therefore a mere shadow of what must lie on the cliff terrace, the diagnostic elements of Acheulean knapping are present in low frequencies. Woodstock's coarse-grained quartzite makes the recognition of scar types and flake removals difficult, and we were not able to differentiate shaping or thinning flakes, but with further excavations and a larger lithic sample that includes more fine-grained quartzite (a rock type present in low frequencies in our excavation), it may be possible to get a better idea of the *chaîne opératoire* of large cutting tool production on the cliff terrace. At Cave of Hearths, where quartzite whole flakes dominated the collection, as they do at Woodstock Rocks, McNabb (2009) showed that it is not possible to differentiate the products of core working from those of large cutting tool thinning and shaping. Furthermore, he showed that flaked flakes and their spalls smudge the boundaries between blanks, waste products and tools (McNabb 2009: table 7.13). Barkai and colleagues (2016) also found that at quarry and workshop sites in northern Israel, manufacturing debris from the first stages of bifacial preform production are indistinguishable from debitage ensuing from other strategies.

We, like many other researchers, have, thus far, created the impression that the workshop at Woodstock Rocks was solely intended for the production of large flake blanks that would be further knapped into LCTs. However, Gallotti and Peretto (2015) warn that Acheulean technology was not exclusively focused on producing LCTs. *Chaîne opératoire* studies of core and flake assemblages, such as those from Isernia La Pineta, Italy, dated to about 0.6 Ma, demonstrate that small debitage technology is neither opportunistic nor unstructured (Gallotti & Peretto 2015). Instead, at this site, knappers deliberately concentrated on a discoid method of flaking to produce medium-sized flakes intended for small tool manufacture. Thus, we should not automatically assume that all Acheulean workshop sites aimed to produce LCTs alone, or aimed to produce them at all. In some Israeli workshop sites, a curated lithic production *chaîne opératoire* occurs together with simple flake production (Barkai et al. 2016) and perhaps this situation was common. At Penhill Farm, an Acheulean site in the lower Sundays River Valley, Eastern Cape, the most common retouched tools were small ones, especially scrapers (Lotter 2020). These small tools were knapped on site, presumably for site-specific tasks.

Sites, like Woodstock Rocks, retain quantities of cortical flakes, non-cortical flakes unsuitable for tool-making, and much debitage that includes chips, and flakes for the trimming or shaping of tools or for rejuvenating cores. The vast majority of flakes was recovered from layer Brown at the base of the Woodstock sequence. Quartzite formed a far higher percentage of flakes and chips, in layer Brown, than siltstone ones. We are not able to claim with certainty that there were repeated Acheulean exploitations of Woodstock's quartzite resource over a long period. Undoubtedly, though, palimpsests of lithics are represented at the site. It may not be possible to tease out separate palimpsests, yet the excavation has four clear stratigraphic units. We are fairly confident in ascribing one palimpsest, the oldest, to layer Brown where a rockfall sealed some of the lithics and entrapped others. Square F3, closest to the cliff face has the least disturbance, but even square F2, on the terrace's dripline, has few lithics that are obviously contaminants from more recent occupations. Mostly, it is the siltstone component of the assemblage that is likely to have intruded from MSA occupations. Rare chalcedony tools, like thumbnail scrapers, are LSA inclusions. The rock type distribution suggests that, unlike the quartzite *chaîne opératoire*, the siltstone knapping process did not begin on the northern cliff terrace where we excavated; there are only five siltstone cores and four cortical flakes. Nonetheless, there are a great many siltstone chips, suggesting that siltstone artefacts were completed and/or sharpened at the site.

5. Conclusion

Woodstock Rocks is a painted cliff site with a shallow overhang at its southern end, while the northern area is less sheltered, but has the cliff as protection on its eastern aspect. The cliff terrace was used repeatedly by hominins during the Acheulean and the site represents the first Acheulean lithic workshop excavated in the Waterberg. Some favoured quartzite flake blanks may have been carried downhill to the Mokolo River terrace directly below the cliff terrace, and other lithics may have tumbled there from the steep talus slope. The river terrace and its associated Acheulean lithics have been cemented by ferricrete that postdates the hominin activity. The palaeomagnetic study of the ferricrete provides the first, albeit broad, chronology for the ESA in the Waterberg and it shows that the cementation of the Acheulean lithics took place during the reversed polarity of the Matuyama Chron, before 780 ka ago. The more recent *Homo sapiens* use of Woodstock Rocks was during the MSA and LSA. The presence of Bambata pottery in the southern area implies that herders may have been in the area by 2000 years ago. Just a few kilometres from Woodstock, fine-line paintings of fat-tailed sheep were made in Kaingo Sheep Rock Shelter above a stream feeding the Mokolo River (Wadley et al. 2022). Iron Age farmers also used the site from about 1000 years ago, evidenced by ceramics and finger-painted rock art.

Unfortunately we could not date the Woodstock Rocks MSA or LSA occupations, so our original research aim remains unfulfilled. Nonetheless, our preliminary excavations suggest that the site is worth further investigation and excavation, particularly to expand the sample of lithics from the Acheulean workshop.

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Supplementary online material

Wadley et al. Supplementary Online Material File 1

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