

# Ritualized Behavior in the Middle Stone Age: Evidence from Rhino Cave, Tsodilo Hills, Botswana

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## ABSTRACT

Rhino Cave, located at the World Heritage site of Tsodilo Hills, is one of the three main Middle Stone Age (MSA) sites in Botswana. Initial investigations during the mid-1990s left unanswered a number of key questions regarding the early use of the cave. This prompted the current investigations, which have unearthed a wealth of MSA artifacts from a lag deposit. Results of a selectively employed *chaîne opératoire* analysis have revealed a very special set of behavioral patterns. It will be argued that the best-fit interpretation of the results from this investigation lies within the realm of ritualized behavior. The assemblage is characterized by an unexpectedly large number of MSA points, which are for the most part produced in non-locally acquired raw materials. These points are colorful, carefully and often elaborately made, and, once complete, never left the cave. They were either deliberately burned to the point where they could no longer be used, abandoned, or intentionally smashed. These artifacts were found together with tabular grinding slabs and pieces of the locally available pigment, specularite. This assemblage was recovered directly beneath a massive, virtually free-standing rock face that has been carved with hundreds of cupules of varying sizes and shapes. A section of the carved rock face was recovered from well within the MSA deposits in association with handheld grinding stones.

## INTRODUCTION

It has been proposed that “collective ritual – with its formal characteristic of amplified, stereotypical, redundant display – might be expected to leave a loud archaeological signature” (Watts 2009: 62). According to a number of researchers (e.g., Knight 2009; Knight 2010; Power 1999, 2009; Power and Aiello 1997; Watts 1999, 2002, 2009) the archaeological record of ochre use, dating from the late Middle Pleistocene, provides such a signature. Symbolism, a crucial feature of ritual behavior, has been central to the debate on behavioral modernity. Finds of shell beads (e.g., Bouzouggar et al. 2007; d’Errico et al. 2005; d’Errico et al. 2008; Henshilwood et al. 2004; Vanhaeren et al. 2006) and geometric engravings on red ochre (e.g., Barton 2005; d’Errico 2008; d’Errico et al. 2001; Henshilwood et al. 2002; Henshilwood et al. 2009; Henshilwood et al. 2001; Hovers et al. 2003; Jacobs et al. 2006; Mackay and Welz 2008; Mayer et al. 2009; Wilkins 2010) have been suggested to indicate the presence of symbolic traditions in the African Late Pleistocene, or Middle Stone Age (MSA). However, one area of investigation that could potentially reveal patterns of ritual behavior has received minimal attention within African MSA studies. This is the application of the *chaîne*

*opératoire*. Results from this method identify sequences of conscious choices made by the original artifact makers. The combined results of these individual sequences can provide insight into behavior patterns which are indicative of broader culturally determined traits and norms. By applying this methodological approach to a site that contains unusual or atypical MSA features, it can identify other ‘loud archaeological signatures’.

As noted by McBrearty (2003: 514) “one of the most difficult tasks for the prehistorian is to identify the emergence of novel behaviors.” The authors suggest that a set of novel behavioral patterns is a most apt description for the results that have emerged from a recent test excavation at Rhino Cave, located within the World Heritage site of Tsodilo Hills, Botswana. This site was initially excavated in the mid-1990s (Robbins et al. 2000a; Robbins et al. 1996) and is one of the three main MSA sites in the country. These initial investigations focused primarily on the cave sediments and their potential for producing paleoenvironmental data. Analyses of the rich MSA archaeological assemblage, uncovered during these excavations, was limited to morphological descriptions and a typological classification of the tools. Although these initial investigations established

Rhino Cave as an important archaeological site, a number of key questions regarding various aspects of the early use of the cave remain unanswered. Briefly, these include the unusual location of this site, the composition of the MSA assemblage, and the possible association of these finds to the rock art in this cave.

Since these questions were the starting point of the present research study they will be presented and addressed in detail in the course of this paper (see section: *Recent test excavation (2004–2006)*). As will be described in the following pages, the recent investigations have unearthed a wealth of MSA artifacts from a lag deposit. Results of a selectively employed *chaîne opératoire* analysis revealed a very special and, to our knowledge, as yet unique set of behavioral patterns. The assemblage is characterized by an unexpectedly large number of MSA points, which are for the most part produced in non-locally acquired raw materials. These points are colorful, carefully and often elaborately made, and, once complete, have been treated in a manner which bears no resemblance to their normal repertoire of assigned hunting or cutting functions. They were either deliberately burned to the point where they could no longer be used, abandoned, or intentionally smashed. These points were found together with well-formed grinding stones, pigments, and tabular grinding slabs which, it will be proposed, could have been used to reduce specularite. Finally, this assemblage was recovered directly beneath a massive, virtually free-standing outcrop that dominates the interior of this small hidden cave. This outcrop has been carved with hundreds of cupules of varying sizes and shapes.

In the following pages the geographical setting will be presented and a brief summary will be given of the procedures and strategies of the previous and recent excavations. The excavated assemblage will be introduced in light of the results of the *chaîne opératoire* analysis, where refitting was used to target aspects of this collection in an attempt to investigate questions regarding post-depositional disturbance, knapping patterns such as tool and blank selection, and specific behavioral choices. As this site has yet to be scientifically dated, emphasis has been placed on the MSA points since these artifacts are unquestionably *fossiles directeurs* for this period. Additional archaeological features from the MSA levels will also be presented, as will the results of night-time experiments to observe the effect of flickering light on the rock panel. Comparisons will be made to the lithic assemblages from Zimbabwe, Zambia, and Namibia, with special emphasis on the other main MSA sites in Botswana, White Paintings Shelter and #Gi. It will be argued that the best-fit interpretation of the results from the current investigation lies within the realm of ritualized behavior.

## GEOGRAPHICAL SETTING

### TSODILO HILLS

The landscape of Botswana is covered by the degraded sand dunes, relict sand sheets, pans (ephemerally flooded depressions), and fossil river valleys of the Kalahari (Jacob-

berger and Hooper 1991: 2322). Occasionally this sand sea is broken by the occurrence of widely separated and heavily weathered rock outcrops, or inselbergs (Jacobberger and Hooper 1991: 2322). The most impressive and famous of these formations in Botswana are the Tsodilo Hills (Figure 1).

Jutting from a seemingly unbroken flat landscape, Tsodilo Hills are the only major hills for over 100 km in any direction. They were formed in the Late Proterozoic and are composed of micaceous quartzites and quartz-schists (Cooke 1980: 82; Jacobberger and Hooper 1991: 2322; Thomas et al. 2003a: 54; Wright 1978: 239). Except for a series of small ephemeral springs and seeps in the three main hills, there is no surface water at Tsodilo Hills today (Thomas et al. 2003a: 54). However, as has been demonstrated in numerous studies, this was not always the case (e.g., Cooke 1975, 1980; Grove 1969; Thomas et al. 2003b; Thomas and Leason 2005; Thomas et al. 2000; Thomas and Shaw 1991, 2002).

The Hills, as named by the local Hambukushu and Ju/'hoansi San, are called Male, Female, Child, and Grandchild (alternatively North Hill or "The Hill that Wants to Live by Itself") (Campbell et al. 2010: 23, 177). Male Hill is the most dominant, rising to a height 410 meters from its immediate surroundings, making it the highest peak in Botswana (Jacobberger and Hooper 1991: 2322). The Hills also contain over 4,500 rock paintings which are located primarily on isolated rock panels and relatively unsheltered overhangs, constituting one of the highest concentrations of rock art in the world (ICOMOS 2001: 115). In 2001 the Hills were declared a World Heritage Site (ICOMOS 2001), although they had been protected under the Bushman Relics Act since 1934 (Segadika 2006: 31). The archaeological record of the area gives an account of human activities and environmental changes over at least 100,000 years (Robbins et al. 2000b). In addition to the rock art, the Hills also contain archaeological remains including Late and Middle Stone Age deposits (Robbins 1990; Robbins et al. 2000a; Robbins et al. 2000b; Robbins et al. 1996), Early Iron Age villages (Denbow 1986, 1990; Denbow and Wilmsen 1986) and numerous prehistoric specularite mines (Kiehn et al. 2007; Murphy et al. 2010; Robbins et al. 1998).

Tsodilo may technically be a series of hills but it is regarded by near and distant communities as a mountain in spiritual terms, the home of the Gods. Even the names of the Hills articulate a personalized living idiom. The Hambukushu and Ju/'hoansi, who live or previously lived at the Hills, all have myths placing their origins here; several sites being the location of special rituals, including rainmaking and praying to the ancestors (see summary in Keitumetse et al. 2007: 108–109). Even today, many church groups make pilgrimages to the hills to pray and drink from its healing waters.

### RHINO CAVE

Despite the fact that Tsodilo Hills and its surroundings are some of the most intensively investigated areas in Botswana, Rhino Cave escaped the notice of researchers un-

til the mid 1990s (Campbell et al. 1994b: 38). It was during the course of an audit of the rock art that Xhao Xontae, the headman of the local Ju/'hoansi San, revealed the existence of this cave to archaeologists (Xontae Xhao, son of Xhao Xontae and present headman of the local San, personal communication to contributor SC, 2007). It is, however, easy to understand how the site evaded detection, as it is perched high on the northernmost ridge of Female Hill and can only be approached by scrambling over, or squeezing between, massive boulders (Figure 1). Gaining entry to the cave is only slightly less arduous. On the western side of the ridge there is a raised, narrow, crawl space that ends with a considerable drop into the site. Alternatively, the wider eastern entrance offers two options: a two-meter jump or a slide down a steep boulder face, followed by a scramble over a rock-strewn opening near the present day floor (Figure 2). It is worth noting that during the MSA, the floor level would have been in excess of a meter lower and the entrance area further obstructed by large boulders (see Robbins et al. 2000a: Figure 4). Before the build-up of wind-blown sands on the eastern side of the Hills (Jacobberger and Hooper 1991: 2326; Lancaster 1981: 329–330) the climb to the top of the ridge would have presumably been even more difficult.

The interior of Rhino Cave is formed by a narrow fissure in the quartzite host-rock that has created an opening which is just under 11m long, and varies from 1.25m to 5m wide, with a resultant floor area of about 22m<sup>2</sup> (see Figure 2). The high ceiling and walls of the cave extend beyond the boulders that dominate the eastern opening, effectively blocking any direct sunlight. The floor covering is flat, powdery and devoid of virtually any vegetation. Today, during heavy rains, water flows along the chamber behind the southern wall, washes across the entrance and eventually exits near the base of the sloping boulder in the north eastern part of the cave (Lopang Tatlhago, National Museum of Botswana employee, personal communication to contributor SC, 2005). Analyses of the deposits indicate standing water also would have collected in this part of the cave during the Early Holocene (Robbins et al. 2000a: 28; Robbins et al. 2000b: 1110).

Clearly this is not an ideal habitation site, particularly as the Hills are replete with numerous well-protected rock shelters that are easily accessible. Yet Rhino Cave contains a number of obvious and distinctive features which attest to its use over a considerable period of time. Both main walls are decorated—the north wall contains a group of rock paintings, while virtually the entire quartzite outcrop, that dominates the south wall, has been ground to form an impressive series of grooves and depressions (see Figure 2). Furthermore, initial excavations at the site revealed Early Iron Age material and signs of sporadic use during the Late Stone Age (LSA), but quite surprisingly the weight of the evidence for use of the cave lies with the substantial body of lithic debitage attributable to the MSA (Robbins et al. 2000a; Robbins et al. 1996).

The paintings on the north wall, which have been described in detail elsewhere (Robbins et al. 1996: 32–34), are

dominated by an animal that has been interpreted to be a white rhinoceros, which gives the cave its name. Alternatively, this figure could represent an elephant (Robbins et al. 2010: 60).

The dominant feature of the south wall is a massive quartzite outcrop that is slightly under 7m long, 2m high and approximately 1m thick. As can be seen in Figure 2, it appears to be virtually free standing, as only the lower back section rests on the stone beneath it. Access to a chamber behind the outcrop is gained by crawling through the opening created by the upraised section closest to the main entrance of the cave. From this hidden vantage point it is possible to see into the cave through the 20–30cm gap that runs the full length of the top of the outcrop. By maneuvering onto the ledge that runs parallel to this gap (see Figure 2) a small-bodied person can work their way up to a narrow opening that leads outside the cave, although today this is choked by rocks.

However, it is the face of this massive outcrop that is the immediate focus of attention upon entering the cave, as it has been ground with over three hundred grooves and depressions, hereafter referred to as cupules. These are confined to this single, vertical face and are concentrated on the lower 1.4m of the 2m high panel. The forms and condition of these cupules vary—some are long and thin, others oval to teardrop-shaped (also see Robbins et al. 1996: 34). They vary between 1–4cm in depth and while some are now heavily weathered, others appear to be relatively fresh. These cupules tend to overlap and truncate each other and many have been obliterated from repeated grinding. The profile of the panel suggests that several centimetres of rock have been removed by this action. These observations suggest that these cupules have been ground into the face of this outcrop over a long period of time. The carved face of this outcrop is illuminated during the mid-winter months, when for a few hours in the late afternoon a narrow arc of sunlight enters through a small opening in the ceiling of the cave and flickers directly across the carvings.

## EXCAVATIONS

### PREVIOUS INVESTIGATIONS (1995–1996)

The excavations conducted in 1995 (Robbins et al. 1996) and 1996 (Robbins et al. 2000a) produced a wealth of materials predominantly attributable to the MSA. The publications of these investigations briefly describe the archaeological remains, with equal attention given to the paleoenvironmental data and the cave sediments. As questions arising from these investigations prompted the most recent test excavation, and because these excavation reports were published in journals that are not easily accessible, a brief summary will be given of the most important results.

As can be seen in Figure 2, in 1995 and 1996 a trench was cut across the width of the cave, with two initial 1m excavation squares (Pits 1 and 2) extending from directly beneath the paintings on the north wall, followed by an extension in 1996 of two additional squares (Pits 3 and 4), terminating close to the gap under the carved panel. Very

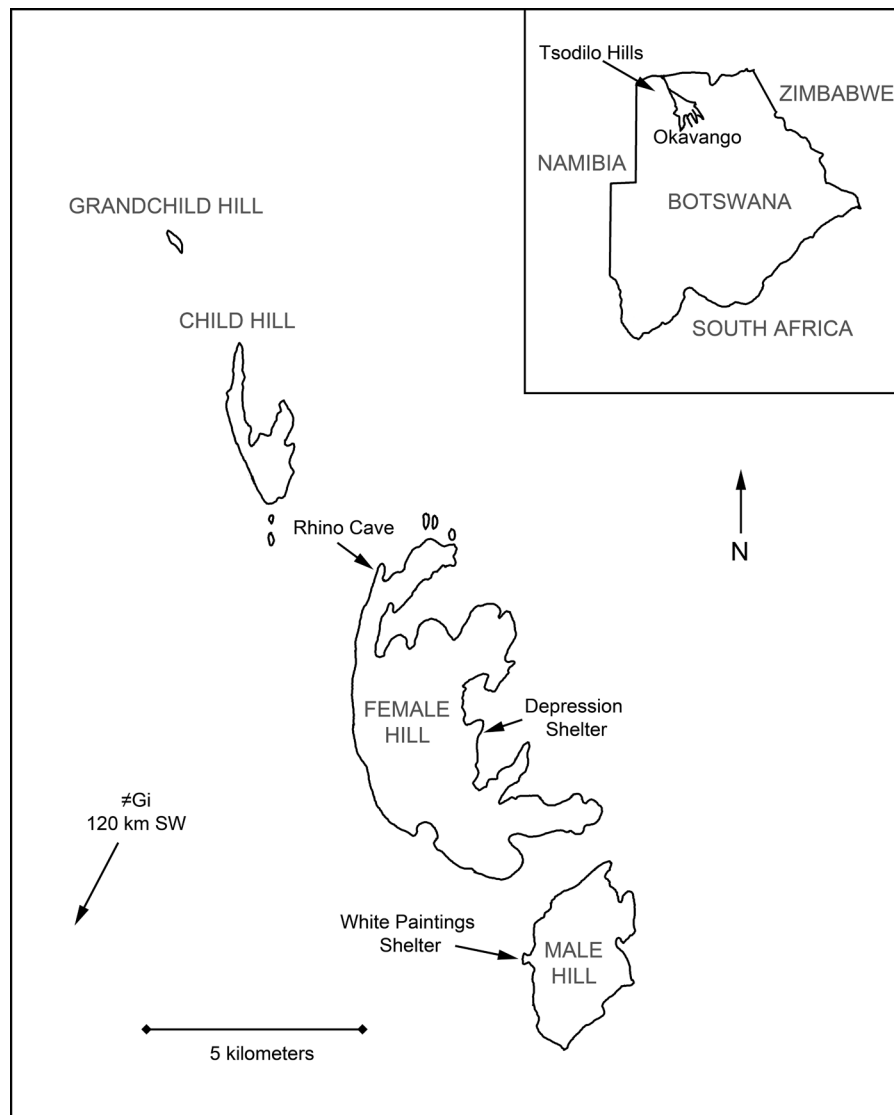


Figure 1. Map of Tsodilo Hills indicating the local archaeological sites referred to in the text. The hills are located approximately 40km west of the Okavango Panhandle (drawn by Sheila Coulson).

little material was recovered from the pit nearest the paintings, a large boulder dominated most of the second pit and the large rock outcrop directly beneath the carved panel was encountered just 40cm into Pit 4, the southern limit of the 1996 extension. Therefore, the published accounts concentrate on the findings from the two central units (Pits 2 and 3) (Robbins et al. 2000a: 19; Robbins et al. 1996: 25), which were excavated to a depth of 140cm, although auger probes indicated an additional 160cm of as yet unexcavated deposit (Robbins et al. 1996: 25).

The stratigraphy is composed of wedge-shaped units of deposit that broaden to the northwest and towards the interior of the cave (see stratigraphic cross section, Robbins et al. 2000a: Figure 5). The upper matrix is composed of medium to fine aeolian sand which is thought to have entered the site by way of gravity, water, or wind (Robbins et al. 2000a: 25, 29). These levels contained sparse indications of use of the cave during the most recent past and consist

of pottery, some lithic artifacts, fauna, and nut shell fragments. In Pit 2 these levels also contained denser concentrations of lithic materials from the LSA extending to a depth of 55cm. These loose sandy levels overlie a coarse deposit of sands and gravels created by the breakdown of the cave walls during colder, wetter periods (Robbins et al. 2000a: 27; Robbins et al. 1996: 28). These coarser deposits, which contain the materials attributed to the MSA, slope markedly. It is this slope that accounts for the MSA finds being concentrated below 90cm in Pit 2, while occurring at considerably shallower depths in Pit 3 (45cm) and Pit 4 (20cm).

A morphological investigation of the MSA assemblage from the 1995–1996 excavations determined that there were 95 unifacial and bifacial MSA points, many of which exhibited indications of corner-struck (otherwise known as *déjeté*) manufacture (Robbins et al. 2000a: 17; Robbins et al. 1996: 32). Also recovered from these deposits were an array of over 250 retouched artifacts including scrapers, awls,

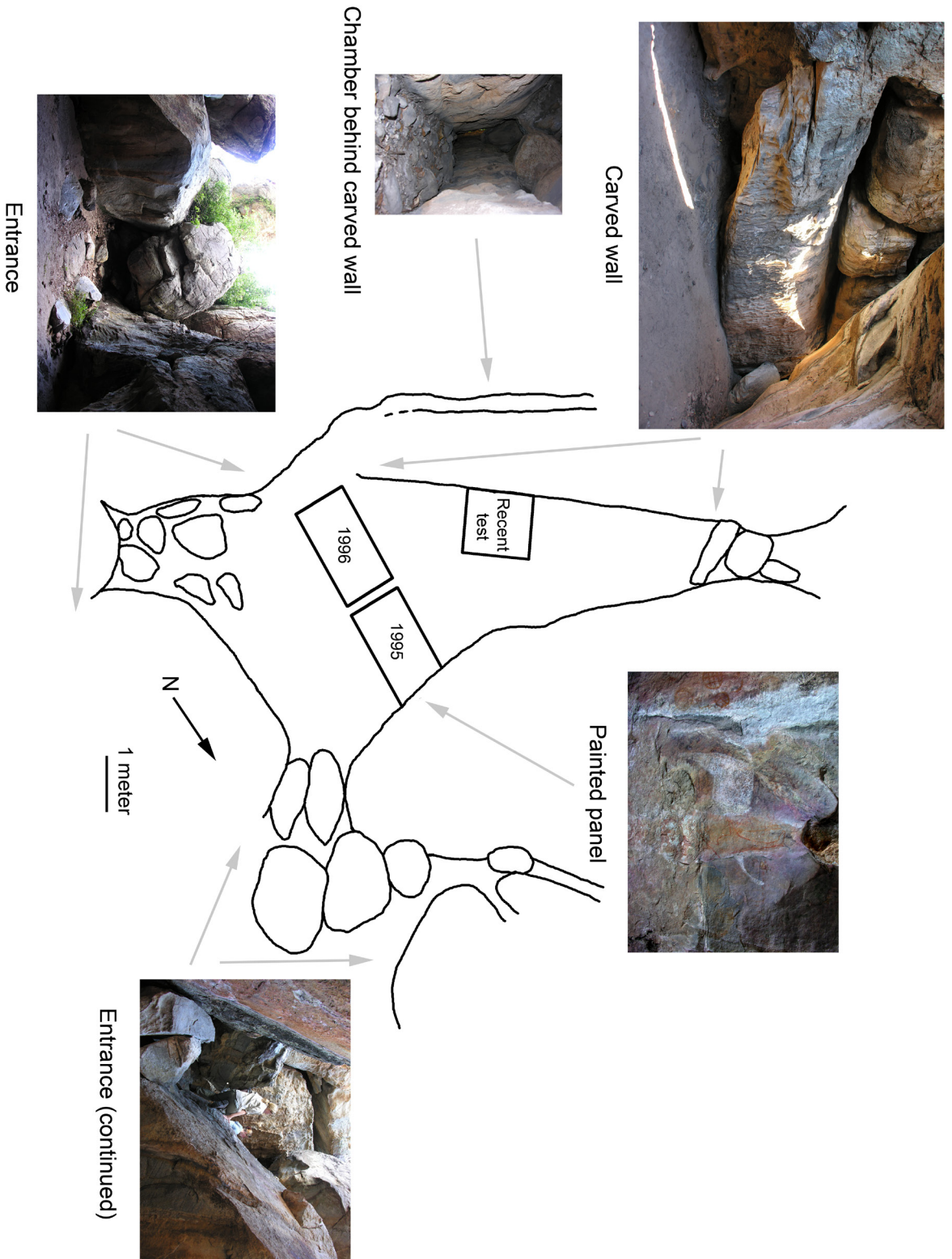


Figure 2. Rhino Cave, sketch map of the main features of the cave (photographs are taken from the cave floor and are not to scale). The paintings are immediately in front of the white mineral wash line, visible in far right, in the photo of the carved panel. The view of the entrance is completed by matching the slope on the large boulder to the continuation photo on the right (figure compiled by Sheila Coulson).

denticulates, and burins, although almost half of this total is composed of miscellaneous retouched pieces and broken tools (Robbins et al. 2000a: 23; Robbins et al. 1996: 45). Hammerstones or grindstones also were recovered (Robbins et al. 2000a: 22; Robbins et al. 1996: 34). Of further note was the recovery of specularite, which, as defined by Kearey (1996: 292), is a platy, metallic variety of haematite. This was found in the form of metallic crystals and vein specularite, which was often rich enough in iron to be attracted by a magnet (Robbins et al. 2000a: 22).

Approximately 12,000 pieces of lithic debitage were recovered from the MSA levels. As a dense concentration was found between the boulders in Pits 2 and 4 it was concluded that extensive “flint knapping” was conducted at this spot during the MSA (Robbins et al. 2000a: 29). The boulder, which fills most of Pit 2, was proposed to be a knapping seat, as next to it was found “some hammerstones and tools that were not finished...small retouching flakes and artifacts such as some MSA points with very sharp edges and tips that do not appear to have been used” (Robbins et al. 1996: 25). Elsewhere it is remarked that the points were recovered in various stages of manufacture, with some appearing “to have been abandoned as a result of failures at thinning or retouching, while others were finished and are in pristine condition” (Robbins et al. 1996: 32). Although an exact figure was not given for 1996, the initial excavations reported 56% of the raw materials used were locally available quartz and quartzite (Robbins et al. 1996: 39), with the remainder comprised of non-local materials including “several varieties of chert, jasper, chalcedony and silcrete” (Robbins et al. 2000a: 21). The presence of such “large amounts of exotic materials” is suggested as an indication that they were either acquired directly from their source or through exchange networks between the people at Tsodilo and those who resided near the various sources (Robbins and Murphy 1998: 61). The possible origins for these raw materials have been placed far afield, for example near the Aha Hills (>125km), along the Boteti River (>200km) and in the vicinity of Kudiakam Pan (>400km) (Murphy 1999: 372; Robbins 1987a, 1989; Robbins et al. 2000b: 1105; Weedman 1993: 68), although, as observed by Murphy (1999: 230), closer outcrops could have been exposed in the past.

As noted by Robbins et al. (2000a) the deposits in Rhino Cave were heavily sloping and the upper levels were loose and powdery. However, the only specific mention of a control on the stratigraphic integrity for this site is the refitting of two pieces of a jasper flake, which were both found in the 55–60cm (LSA) level of Pit 2 (Robbins et al. 1996: 28). These factors should be taken into account when considering the reported “uncertain” and “problematic” radiocarbon and thermoluminescence (TL) dates for this site, specifically those from the MSA levels (Robbins et al. 2000a: 19, 29). A small sample of charcoal, taken from Pit 3 at 65–70cm, was used to obtain the first date of 14,500±50 BP for the MSA level. The second date is from a TL sample, which produced a date of 18,175±2871 BP, and was taken from the upper 30cm of the thin heterogeneous deposits of Pit 4. As the excavators admit, this is not only next to the

cave wall, but also within centimetres of the rock outcrop beneath it. Furthermore, this date was determined without field gamma spectrometer readings, meaning that the water content of the deposits and the annual dose at the sampling site was not measured (Robbins et al. 2000a: 19). The dating of the MSA assemblage from this site then had to revert to a typological comparison to the nearby well-dated MSA sites of White Paintings Shelter (66,400±6,500 and 94,300±9,400 BP) (Robbins et al. 2000b: 1092) and the open-air pan site of #Gi (77,000±11,000 BP) (Brooks et al. 1990: 62) which is approximately 120km southwest of the Hills (Robbins and Murphy 1998: 60). For example Laurel Phillipson (2007: 20), who recently re-examined a selection of the MSA points from the 1996 excavations, states that she concurs “with the excavators that the Middle Stone Age lithics from these adjacent sites appear so similar... that the series of age determinations from the White Paintings Shelter can also be applied to the material from Rhino Cave.” Therefore, although the exact dating of Rhino Cave remains unresolved, this MSA assemblage can be considered to be generally comparable to the those from White Paintings Shelter and #Gi (Robbins and Murphy 1998: 60).

The original excavators drew few conclusions as to how Rhino Cave was used. Due to the fairly small size of the cave it was determined that it would have only accommodated a small group of people (Robbins and Murphy 1998: 60) and on the basis of the amount of lithic debitage recovered they surmise that during the MSA the cave was used “over a lengthy period” of time (Robbins et al. 2000a: 29). The proximity of the cluster of LSA artifacts in Pit 2 to the painted wall is found to be “interesting” (Robbins et al. 2000a: 30), while the only definitive statement on the function of the cave is that the site may have been used for brief visits to conduct “rituals in connection with the rock art” during the Early Iron Age on the basis of pottery, nutshells, bone fragments, and a scattering of lithic finds, dated to that period (Robbins et al. 2000a: 30; Robbins et al. 1996: 35). However, the southern wall of the cave, with its hundreds of carved grooves and depressions, remained “enigmatic in relation to age and function” (Robbins et al. 2000a: 30). [Note: also see Brook et al. (2011) for minimum dates of two cupules.]

#### RECENT TEST EXCAVATION (2004–2006)

As Rhino Cave is only the third main MSA site in Botswana, it is not surprising that the initial investigations produced more questions than answers. The impetus for a new test in this cave was, therefore, a combination of tantalizing observations and unanswered questions that arose from these initial excavation results. One of the present contributors (NW) felt that testing closer to the carved wall of the cave would offer the greatest potential for determining how and when this panel was carved (Walker 2010). For the other contributors (SC and SS) their attention was drawn to the published statements pertaining to the extremely rich and unusual MSA lithic assemblage—for example, as locally available quartz was used in tool production, then why were large quantities of non-local raw materials be-

ing brought to this cave; were these materials used for restricted or specific purposes such as the production of certain types of artifacts; and, why were so many complete, unused, 'pristine' points reportedly manufactured and then left in this unlikely knapping site? However, the overriding unanswered question was still—how was this cave used during the MSA?

In an attempt to further explore these deposits and to answer some of the outstanding questions which arose as a result of the earlier excavations, a 1m<sup>2</sup> test pit was positioned directly beneath the central portion of the carved wall and well away from the water run-off area (see Figure 2). A preliminary test was initiated here in 2003 (by contributor NW), but excavations began in earnest in 2004 (Coulson 2004)—the work reported in this paper is based on the materials from 2004–2006. The square was excavated in 50x50cm units and, as the upper deposit is composed of loose sands, the finds were not piece plotted. Initially the quadrants were excavated by bucket units (each bucket being 1/100th of a cubic meter), however, this proved to be difficult to control and the excavation of the quadrants was changed to digging in 5cm spits that were augmented with depth readings.

It was soon evident that the only stable wall in the excavation was the rock outcrop directly beneath the carved panel. The other three profiles required the support of wooden shoring and account for why this test took so long to complete. In 2006, the west wall of the pit was extended by an additional two half quadrants (25x50cm each) to accommodate the extendable plywood shoring and to allow a rigid folding ladder to be opened in the pit, thereby offering an additional safety measure for the excavator (Coulson 2006). In addition, as these half quadrants were dug in 5cm spits, they served as a control for the finds retrieved from the bucket units during the 2004 investigations. Unfortunately, at various points during the excavations there were small wall collapses of these deposits. In each case the resultant material was treated separately and marked accordingly. Two members of the crew were assigned to watch for any indication of material filtering down behind the shoring: this was not only to ensure the integrity of the recovered materials but primarily to assure the safety of the person working in the bottom of the pit.

This test pit was excavated to a depth of 185cm before the limit of the support shoring was reached, although archaeological material was still being recovered. As would be anticipated in such a small cave the upper section of deposit from the test pit corresponds with the loose sandy matrix reported from the 1995–1996 excavations (see Robbins et al. 2000a: Fig 5, Units A and B). However, in this part of the cave this forms a 65–90 cm thick layer of homogeneous sand—it is this loose powdery matrix that made the walls of the test pit so unstable. This deposit lies directly over an unmistakable densely packed lag deposit of coarse sands and gravels, exfoliated sections of the cave walls, and an astonishing amount of knapping debitage. This level is encountered between 80–100 cm below the surface and was still continuing with no visible change in composition

when digging stopped at 185cm (see Robbins et al. 2000a: Fig 5, Unit D). This deposit slopes towards the entrance of the cave, however, the slope is not as pronounced as was reported for the earlier excavations.

The archaeological finds from the recent test excavation can be divided into three distinct groupings (as determined by contributor SS, Staurset 2008). The uppermost two are composed of material that can be assigned to the Early Iron Age or Late Stone Age (these will be described and discussed in a future publication). Below these layers, between 80–100 cm, is the aforementioned abrupt change in the deposit from sands to coarse sands and gravels. This lag deposit marks the appearance of finds attributable to the MSA. As can be seen in Table 1, these include unifacial and bifacial points, large scrapers, denticulates, becs, burin spalls, a variety of core types including Levallois and discoidal, and a large amount of knapping debitage (ca 10,000). In addition, this deposit contained a variety of handheld grinding stones, many of which are well-made, numerous lumps of specularite and small fragments of ochre. Unfortunately, faunal remains were not preserved. With a few exceptions, artifacts attributable to the MSA are confined to this deposit and despite the coarse matrix are in excellent condition. There was no obvious change in the assemblage, which was still continuing when excavations reached the limit of the support shoring at 185cm. Use of the locally available milky and glassy quartz and quartzites is evident throughout all of the layers, although there is an increase in the amount of good quality quartz from about 125cm. However, raw materials that are not found in the Hills, or the immediate vicinity (hereafter referred to as non-locally available or non-locally acquired raw materials), such as silcrete and a variety of silcretized materials, especially chalcedonies, were recovered in large numbers predominantly from the MSA deposits. It should be noted that the closest source of silcrete to Tsodilo Hills is approximately 50km to the west in the Xaudum Valley (Nash and Hopkinson 2004: 1543) and the nearest source of chalcedony is located in excess of 100km away (Monutsiwa Gabadirwe, Geologist with National Museum of Botswana, personal communication to contributor SC, 2008).

Obviously, there is a need for reliable dates for the finds from Rhino Cave, especially with regard to the finds from the MSA deposits. This is recognized as a priority but has been deferred until the next stage of investigations at this site. Our prolonged excavation of a single pit, positioned adjacent to the cave wall, did not comply with the requirements for TL sampling (e.g., Liana and Roberts 2006; Richter 2007; Richter and Krbetschek 2006; Richter et al. 2007). However, the volume of debitage recovered indicates that there must have been a considerable amount of human activity over a prolonged period of time.

## ANALYSIS OF THE MSA ASSEMBLAGE FROM THE RECENT TEST EXCAVATION

**METHODOLOGY—THE *CHAÎNE OPÉRATOIRE***  
To accommodate the wealth of material retrieved from the

TABLE 1. ARTIFACT COUNTS FOR MSA LEVEL OF RECENT TEST EXCAVATION 2004–2006.\*

Artifact types	Total
	292
<b>MSA points:</b>	
Unifacial	53
Partially bifacial	2
Bifacial	33
<i>Other point types and point fragments:</i>	
Levallois points	5
Point fragments	5
Misc. retouched	55
<b>Scrapers</b>	23
<b>Denticulates</b>	5
<b>Becs</b>	4
<b>Burin spalls</b>	5
<b>Grinding stones - handheld</b>	28
<b>Cores:</b>	
Levallois	21
Discoidal	14
Kombewa	1
Amorphous	23
Bipolar	5
Single and double platform	10

\*Note: the majority of the miscellaneous retouched pieces are probably unfitted point fragments. They have been listed separately to maintain the integrity of the categories 'points' and 'point fragments'.

excavation, a methodology was required that would not only provide a general overview of the entire collection but also enable detailed analyses to be undertaken on select groups of artifacts. The *chaîne opératoire* approach was chosen as it has proven to be highly successful on other sites containing assemblages where a specific set of questions were posed (e.g., Bergman et al. 1990; Bodu et al. 1987; Cahen and Keeley 1980; Cahen et al. 1979; Coulson 1986; Edmonds 1990; Skar and Coulson 1986). Although the *chaîne opératoire* is commonly used as a methodological approach for analyzing collections from European Stone Age sites, elements of this method have only recently been implemented in Southern Africa (e.g., Lombard 2005, 2006c; Lombard et al. 2004; Van Peer and Wurz 2006; Villa et al. 2005; Wurz 1999, 2000, 2005; Wurz et al. 2005). Its application to the MSA collections from Rhino Cave marks the first occasion of its use in Botswana.

The growing popularity of the *chaîne opératoire* is partially due to its ability to surpass typological description by identifying the sequence of conscious choices made by the original artifact makers. The combined results of these individual sequences provide insight into behavior pat-

terns indicative of broader culturally determined traits and norms. The application of this methodological approach has resulted in the production of firm evidence for a variety of aspects of the MSA that in the past would have been beyond our reach. These include hunting and tool production procedures (Lombard 2004, 2005, 2006a, b, c, 2007; Lombard et al. 2004; Lombard and Wadley 2007; Soriano et al. 2009; Wadley 2005; Wadley et al. 2004), site use and management (Wadley 2006b; Wadley and Jacobs 2004; Wadley and Whitelaw 2006), and style (Wurz 1999, 2000, 2005).

However, it is also possible to use the *chaîne opératoire* to provide evidence of a more fundamental nature. Even before the most recent testing began at Rhino Cave there were unanswered questions from the previous investigations, such as—to what degree had post-depositional movement affected the deposits (Robbins et al. 2000a: 19; Robbins et al. 1996: 25) and, in light of the exceptional quantities of lithic materials recovered from this cave, would it even be possible to separate the various individual sequences of artifact production (Robbins et al. 2000a: 19; Robbins et al. 1996: 29)? These questions needed to be answered before individual behavioral patterns, such as the proposed on-



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*Figure 3. Refitted partially bifacial MSA point from Rhino Cave with three flakes and flake fragments from the final stages of production. To the right are two associated flakes that could not be refitted but came from the same manufacturing sequence. Depths in centimeters below surface (BS) are listed. All artifacts are crenated or crazed from burning – the flake on the right is most affected (photo by Sheila Coulson).*

site manufacture of tools, could be examined. To address these fundamental concerns, as well as the research questions regarding behavior patterns, the method of refitting was applied.

Refitting is a very simple method. The goal of a refitter is exactly the inverse of the prehistoric artifact maker, or knapper, “in that the intention is to reconstruct the original nodule from which flakes were struck” (Cahen 1987: 1). Whereas practically any site will benefit from refitting analysis, what will be achieved is totally dependent on the approach, in particular the questions being posed and the groups of materials selected. In this study (for contributors SS and SC) the initial focus of investigation at Rhino Cave was on the non-local lithic raw material types and specifically the MSA points produced from them. In preparation for analysis, the entire collection from the recent test pit was washed and sorted according to raw material type and the artifacts selected for further analysis were labelled. This included all complete, or virtually complete, retouched MSA points, as well as all debitage produced in the same raw material. These selected groups were placed on separate refitting trays, thereby allowing the groups to be easily compared and cross-checked. This is an essential step, for, as has been noted previously (Villa et al. 2005: 405), a refitting, or technological study, can not be conducted from within the confines of a finds bag. As can be seen for the example

shown in Figure 3 these materials were sufficiently distinct that it was a relatively simple process to refit the debitage and to determine whether or not the remaining flakes were likely to refit. Attempts to refit a group were stopped once it was determined that continued efforts would probably not produce any additional information. As a further control of the layer integrity, the corresponding finds from the LSA deposit were included in this analysis. No refits were possible between artifacts found in the LSA and MSA layers.

#### EXTENT OF POST-DEPOSITIONAL MOVEMENT

Before the research questions posed at the onset of this investigation regarding MSA behavioral patterns and the use of the cave could be addressed, it was first necessary to examine the question of post-depositional disturbance on this site. As previously noted, the loose sands of the upper levels would have easily allowed movement within the deposit. Even in the densely packed lower level we cannot discount bioturbation or other disturbance factors associated with lag deposits. As has been previously noted (e.g., Dibble et al. 1997; Richardson 1992; Villa 1982), even on sites with supposedly distinct stratigraphic layering this should not be taken as a guarantee that artifacts have remained fixed in their original locations. Fortunately, at

Rhino Cave the technology and typology of the LSA and MSA materials are so distinct that most artifacts could be readily identified. This also meant that it was possible to determine, even during the course of excavation, that a few diagnostic MSA artifacts appear to have percolated up through the looser sediments of the LSA layer and must therefore be considered out of context.

In an attempt to begin to determine the extent of disturbance in the MSA deposit from this site, artifacts were selected that would offer the best opportunity for refitting. Fortunately, this proved to be a surprisingly straightforward procedure as, for example, it was quickly determined that diagnostic artifacts, such as the MSA points, were made from a wide variety of distinctly colored materials, with easily distinguishable associated knapping debitage (for example, see Figure 3). This selection process also was aided by the overall excellent condition of the lithic assemblage. Contrary to reports by the previous excavators (Robbins et al. 1996: 32), there is virtually no indication of discoloration or patination on the lithic assemblage from this site. Reports by Phillipson (2007: 20) of the apparent “heavily worn, blunted and/or broken” condition of a selection of MSA points from the 1996 excavations has been responded to elsewhere (Coulson 2008).

It was possible (for contributors SS and SC) to refit a wide variety of knapping groups at Rhino Cave. The majority form clusters of two or three flakes that were recovered either from within the same excavation unit or were separated horizontally or vertically by less than 10cm (the full refitting study will be presented in detail in a future publication). An example that offered evidence of the extent of movement in this deposit is shown in Figure 3. This partially bifacial MSA point has three refitted flakes or flake fragments which, when replotted, indicate 24cm of vertical displacement. Also illustrated are two flakes which were determined to have come from the same knapping sequence. This attribution was made on the basis of distinct technological features and an immediately recognizable raw material. These flakes are considered to be ‘associated’ to this refitted group and increase the level of vertical displacement to 40cm. It bears repeating that, as the excavation was conducted in 5cm spits, this is the maximum extent of separation possible—if piece plotting had been feasible on this site, the distance between these artifacts would most likely have been reduced. Finally, in addition to the two flakes shown in Figure 3, this associated group also contains 11 tiny chips. These chips were recovered from within the same 40cm of deposit as determined for the refitted group and the two associated flakes; therefore, refitting them would not have contributed additional information regarding the limits of disturbance.

This range of disturbance from bioturbation is not unusual or excessive (Cahen and Moeyersons 1977; Hofman 1986). At the nearby rockshelter of White Paintings Shelter, disturbance was determined to range between 0–30cm, which the excavators felt was “modest” (Robbins et al. 2000b: 1091). While at the open-air MSA site of #Gi, Kuman (1989: 267) confirmed that the only way to determine the

exact level of vertical movement was through the replotting of sets of conjoined pieces. Unfortunately, at this site refitting was not possible because of the restricted sample size at her disposal. Therefore, the level of disturbance at #Gi was judged on the basis of artifact condition and size sorting, revealing that there had been considerable movement of the artifacts by trampling, which was exacerbated by slow soil build-up (Kuman 1989: 279).

On the basis of the refitting analysis on groups of artifacts from the recent test excavation at Rhino Cave there is evidence to support a degree of movement within the coarse sands and gravels containing the MSA assemblage. Most refits indicate movement of between 0–10cm, with the maximum range being 40cm. This pattern was confirmed by the range of depth measurements from groups of obvious raw material types that have yet to be refitted but clearly represent a single tool and its associated waste flakes. These results combined with the plotting of diagnostic tool types indicate that some of the MSA material had percolated a few centimeters up into the sands, but there is no indication of LSA artifacts working their way down into the coarse sands and gravels.

#### ANALYSIS OF THE MSA POINTS

As has been previously stated the research interest for two of the contributors (SC and SS) focused on the extremely rich and unusual MSA lithic assemblage from this site. Initially this was in response to unanswered questions that arose from the findings from the 1995–1996 excavations. Results from the most recent test excavation only served to reinforce the relevance of investigating the role played by the broad range of non-local raw materials brought to this site and its connection to the overriding question of how this site was used.

To address these questions the MSA points from the recent test excavation were selected for an in-depth *chaîne opératoire* analysis. The method of refitting was used in an attempt to determine manufacturing characteristics and to reveal production differences which could be attributed to the use of a wide variety of different raw material types. The analysis focused on the points because they were produced in both locally available and non-locally acquired raw materials and, unlike other tool types, such as scrapers or burins, their production is confined to the MSA ( 2). As there are, as yet, no dates for these deposits at this site, analysis of this particular artifact group would ensure our results would indicate behavioral patterns attributable to the MSA (McBrearty and Brooks 2000: 497–498, 500).

For the purposes of this analysis all MSA points from within the 1m<sup>3</sup> of deposit from the recent test excavation were investigated as a single unit. Future investigations may detect differences over time throughout the deposit but with an established range of 40cm of possible displacement there was no justification for attempting to separate these artifacts according to depth measurements. Finally, examples of MSA points from the 1995–1996 excavations have been included when it was deemed useful to illustrate various distinctive features. These are labelled as being

**TABLE 2. ARTIFACT COUNTS FOR MSA LEVEL RECENT TEST EXCAVATION 2004–2006 (indicating locally available raw materials, non-locally available materials, and unburnt and burnt artifacts).\***

<b>Artifact types</b>	<b>Unburnt</b>	<b>Burnt</b>	<b>Total</b>
	224	68	292
<b>MSA points:</b>			
Local quartz + quartzite	26	0	26
Non-local materials	36	26	62
<b>Other point types and point fragments:</b>			
<b>Levallois points</b>			
Local quartz + quartzite	2	0	2
Non-local materials	3	0	3
<b>Point fragments</b>			
Local quartz + quartzite	0	0	0
Non-local materials	0	5	5
<b>Misc. retouched</b>			
Local quartz + quartzite	9	0	9
Non-local materials	24	22	46
<b>Scrapers:</b>			
Local quartz + quartzite	8	0	8
Non-local materials	14	1	15
<b>Denticulates</b>			
Local quartz + quartzite	2	0	2
Non-local materials	3	0	3
<b>Becs</b>			
Local quartz + quartzite	1	0	1
Non-local materials	3	0	3
<b>Burin spalls</b>			
Local quartz + quartzite	1	0	1
Non-local materials	4	0	4
<b>Grinding stones - handheld</b>			
Local quartzite and ironstone	28	0	28
<b>Cores:</b>			
<b>Levallois</b>			
Local quartz + quartzite	2	0	2
Non-local materials	13	6	19
<b>Discoidal</b>			
Local quartz + quartzite	6	1	7
Non-local materials	7	0	7
<b>Kombewa</b>			
Local quartz + quartzite	0	0	0
Non-local materials	1	0	1
<b>Amorphous</b>			
Local quartz + quartzite	10	1	11
Non-local materials	8	4	12
<b>Bipolar</b>			
Local quartz + quartzite	5	0	5
Non-local materials	0	0	0
<b>Single and double platform</b>			
Local quartz + quartzite	4	0	4
Non-local materials	4	2	6

\*Note: the majority of the miscellaneous retouched pieces are most probably unfitted point fragments. They have been listed separately to maintain the integrity of the categories 'points' and 'point fragments.'

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Figure 4. Selection of Middle Stone Age points from Rhino Cave. All are from the recent test excavation with the exception of three from the 1995 excavation—these are from RC2 95-100 (top row, fourth from left and bottom row, center two) (photo by Sheila Coulson).

from Rhino Cave Pit 2 or Pit 3 (RC2 or RC3).

The MSA points from the recent test excavation can be subdivided as follows: 53 unifacial, 2 partially bifacial, and 33 bifacial points, plus 5 Levallois or discoidal pointed flakes, which by definition have no retouched edges. Even though this last category has been intentionally produced from prepared cores, and has proven to function more than adequately as spearheads (Boëda et al. 1999; Lombard 2005), they have nevertheless been removed from the following analysis as it could be argued they were not irrefutably meant to serve as points. This leaves a total of 88 retouched MSA points for this analysis. The predominant raw material type used in their manufacture is chalcedony (42), with silcrete (18) and an as yet unidentified shiny, white, silcretized organic material (2) accounting for the final examples of the non-locally acquired raw materials. The remainder are produced in locally available milky and glassy quartz (24) and quartzite (2). Thus 30% of the MSA points from this test pit were made from locally available materials while 70% were produced in materials that had to be brought to the cave from outside the Hills.

As can be seen in Figure 4, these MSA points vary from short, thick and foliate, to triangular or oval-shaped, and display a wide range of styles. The length (determined from the tool's base to tip) ranges from 24–66mm with an average length of 35mm. A common feature in their manufacture is that cortex is retained at the base, with a natural corticated concavity in the nodule being intentionally positioned along the central axis of the tool. An equally regular occurrence is that blanks were chosen from *déjeté* flakes

indicating their removal from a discoidally prepared core. There is little indication of tools being reworked—the majority are unifacial, and on the basis of the angle of the retouch, there appears to have only been one row of retouch applied to shape the point (e.g., Towner and Warburton 1990). This observation was confirmed by the results of the refitting analysis.

A surprising feature, which immediately became evident during the process of sorting the raw materials in preparation for the refitting study (as determined by contributor SS), was that virtually every point appeared to be produced on a flake taken from a different core. As can be seen in any of the figures illustrating these points, including the artifacts from the earlier excavations (Robbins et al. 2000a: Figure 6; Robbins et al. 2010: Figure 3.19; Robbins and Murphy 1998: Plate 2a; Robbins et al. 1996: Figure 6) the range and variety of colors, particularly in the tools made from chalcedony, is quite exceptional. Even if allowance is made for variations in color within a single nodule or block of raw material, it could not account for this level of diversity. Furthermore, the cores retrieved from these MSA deposits do not match the size or the color variation of the points. Large flakes (as is seen in Figure 5), that were presumably brought to the site as blanks for tool production, also follow this pattern—they do not match the color variations for the points or the cores found on-site. The colors of these potential blanks are not a result of patination or staining—this range of vibrant colors reflects the natural shades of the raw materials. With regard to the silcretes this is harder to determine, as this material has a limited range

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*Figure 5. Selection of colorful flakes of non-local raw materials brought to Rhino Cave. Right of separation line: from the 1995–1996 excavations. Top row, second from right is from RC2 90–95, the remainder are from RC3 ranging between 60–85cm. Left of separation line: burnt flake of unusual breccia from the recent test excavation—the large mottled red and white flake adjacent to it is in the same material but unburnt (photo by Sheila Coulson).*

of colors, but by including features such as grain size, the debitage in this material also seems to follow the same pattern. Therefore, it appears the non-locally acquired raw materials brought to this cave represent a range of individual choices, or ‘one-offs,’ where bright coloring was a decisive factor in the selection process.

The refitted knapping debitage for the MSA points made from non-locally acquired raw materials confirms that these tools were completed in the cave, as has been illustrated in the example in Figure 3. Once this pattern was determined, it was readily apparent that the vast majority of the remaining, as yet unrefitted, points and their associated waste materials followed this exact same pattern. This was also found to be the case for the points made from locally available milky and glassy quartz (Figure 6). Obviously refitting these materials (as determined by contributor SS) was considerably more difficult. However, it was possible to not only refit points from this material to their manufacturing debitage, but also, in a limited number of cases, to conjoin these points to a series of flake blanks that had been transformed into scrapers. Again, this indicates that the points and, in this case, associated other tool types, were not only manufactured in the cave but also that the tools and debitage had remained in the area where they were originally manufactured.

Experimental replication of the production sequence for these point types has not yet been undertaken so it is

not possible to determine potential manufacturing pitfalls (for production failures in the MSA see Villa et al. 2009). However, producing the thinner, more fragile tip would be likely to be a source of failure. This is not the case at Rhino Cave, where the tips of the 88 MSA points recovered are complete or virtually complete. Furthermore, there are no indications of impact fracturing from use on these points. One of the contributors (SC) has experience with refitting this type of macro-fracture breakage from other research projects and is familiar with the groundbreaking experiments of Bergman and Newcomer (1983), Fischer et al. (1984) and Fischer (1989). The typical pattern of fluting or ‘burination’, especially at the tip, and bend and snap fractures common for this type of damage, were readily apparent on the artifacts examined from comparative collections such as White Paintings Shelter and #Gi, as reported by Donahue et al. (2004) and Brooks et al. (2006: 240). However, the few occurrences of minor damage observed on the MSA points for Rhino Cave can be attributed to minor edge damage from the coarse deposit, burning, or other sources of more recent damage.

Further examination of the assemblage revealed that a large portion of the non-locally available material had been subject to burning—a chi-square test indicated this relationship is statistically significant (chi-square=42.663, degrees of freedom=1,  $p < 0.0001$ , see Appendix 1). Although a variety of tools, cores, and debris were burnt, by far the most

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Figure 6. Selection of Middle Stone Age points in quartz from Rhino Cave. Top row, from left: 1995 excavations (RC2 95-100) and 1996 (RC3 45-50, RC3 85-90). Bottom row, from recent test excavation: varying depths (105–140cm). The brown/red tinge on some specimens is adhering cave deposit (photo by Sheila Coulson).

frequent category were points (chi-square=15.476, degrees of freedom=1,  $p < 0.0001$ , see Appendix 2). [Due to the small data sample for some of the tool types, such as denticulates, becs, and burin spalls, the complete type contents of Table 2 were not applicable for chi-square testing.] The burning, which will be discussed in detail in the following pages, left the artifacts exhibiting characteristics of short-term exposure to low-temperature fires, whereby the stone is brittle to the point of being unusable and the color is altered. The higher proportion of burnt points when compared to other artifact categories indicates selection, which would not be present if they had been burnt in random fires. These artifacts were found intermixed with unburnt ones; no spatial pattern was evident for the burnt pieces. This is likely at least partly a result of movement within the strata, but, as burning was evident throughout the entire MSA sequence, it seems likely that burning of artifacts was a recurring behavioral pattern.

It has been stated by McBrearty et al. (1998: 108) that the life history of a stone artifact can be divided into stages, which begins "... with raw material procurement, proceeds through manufacture, use, alteration, curation and discard, continues through burial diagenesis, and concludes with

retrieval and study by the archaeologist. [Although] not all artifacts experience this ideal history." The life cycle of the MSA points recovered from the recent test excavations at Rhino Cave most definitely do not follow this "ideal history." Here the *chaîne opératoire* of these 88 points indicates an exceptional and anomalous behavioral pattern. As will be demonstrated in the following pages, after they were manufactured, these artifacts were either intentionally destroyed by burning (along with their debitage) or abandoned or smashed.

#### Burnt MSA Points

As there is a considerable range and variety of evidence of destruction from burning at this site it is first necessary to briefly describe the main features attributable to this type of damage. The characteristics of heat alteration in lithic specimens were originally determined on the basis of a series of laboratory experiments conducted on fine-grained cherts, although other lithic materials, including quartz, also were tested (Purdy 1975, 1982; Purdy and Brooks 1971). The purpose of these experiments was principally to determine the characteristics of intentional heat alteration, whereby the knapping qualities of fine-grained materials

are improved (also see Beauchamp and Purdy 1986; Bleed and Meier 1980; Brown et al. 2009b; Domański et al. 2009; Domański and Webb 1992; Domański et al. 1994; Flenniken and Garrison 1975; Gregg and Grybush 1976; Griffiths et al. 1987; Inizan and Tixier 2001; Mercieca and Hiscock 2008; Olausson and Larsson 1982; Patterson 1984; Rick and Chappell 1983; Robins et al. 1978; Schindler et al. 1982; Webb and Domański 2009; Weymouth and Mandeville 1975). However, these investigations also identified the features of heat stress on stone artifacts, regardless of whether the thermal alteration was intentional or accidental.

Purdy's (1975: 136) experiments determined that lithic objects can tolerate being placed directly into a source of heat providing the temperature does not exceed 350° centigrade. However, at temperatures above 400°, the heat exceeds the elastic limits of the material and the piece begins to deteriorate (Purdy 1975: 136). Above 500° thin smaller artifacts exhibited cracking, crazing, and shrinkage, while larger specimens fell apart into angular fragments (Purdy 1975: 138). Damage on the surface of the lithic pieces in the form of circular spalls, or potlids, occurred during the heating process, as the piece was expanding, but never during the cooling stage (Purdy 1975: 136). Artifacts subjected to intense prolonged heat resulted in a piece which Purdy (1975: 139) described as being 'dead,' as it was completely altered by hundreds of interconnected potlids, resulting in an 'orange peel-like' surface, and fell apart if any pressure was applied. At this stage, extreme color change, commonly referred to as 'burnt white,' is also evident, although color alteration and a transformation of the inner luster of the stone are initiated at lower temperatures (also see Domański and Webb 1992: 602; Inizan et al. 1999: 24).

Color change during burning can be highly variable and depend on the rock type (e.g., Patterson 1984: 168; Rick and Chappell 1983). According to Purdy and Brooks (1971: 323) color alternation begins at temperatures as low as 240° to 260° (also see Domański et al. 2009: 1403). The most common color change is to reddish hues (e.g., Patterson 1984: 171; Webb and Domański 2009: 820) which is the result of iron compounds or goethite transforming to haematite during the heating process (Patterson 1984: 171; Schindler et al. 1982: 529). However, many types of siliceous minerals show virtually no change in color because they lack iron compounds or other heat-sensitive trace elements (e.g., Collins and Fenwick 1974: 135; Domański et al. 2009: 1406).

It is also important to note that campfires burn at temperatures ranging from 500–700° centigrade depending on the source of fuel (e.g., Backhouse and Johnson 2007; Fraser et al. 2003; Stinson and Wright 1969; Werts and Jahren 2007). Temperatures in the underlying deposits vary from 100–700° (Werts and Jahren 2007: 852), although the penetration depth of fire in sediment is low (Bellomo 1994: 176; Wadley 2009).

Although the experiments listed above are restricted to fine-grained siliceous minerals from other countries, observations (by contributor SC) have confirmed that, with minor variations, the characteristic traits of burning can also be applied to the variety of raw material types recovered

from Rhino Cave (also see Bellomo 1994: 177; Deal 2001: 7; Domański and Webb 1992; Purdy and Brooks 1971; and Rowney and White 1997, for observations on similar fine-grained raw materials). These raw materials include chalcedony, chert, jasper, agate, silcrete, quartzite, and quartz. As the characteristics of burning on this last material are seldom addressed they warrant further description.

The characteristics of burnt quartz also were determined on the basis of experiments (e.g., Ballin 2008; Brantley et al. 1990; Driscoll 2010; Gonick 2003; Purdy and Brooks 1971: 322, 324). These were undertaken to verify recorded observations, such as the bleaching of the original color, the formation of microfractures, and inclusion decrepitation (Kinnunen 1993; also see Luedtke 1992: 84). Experiments on various types of quartz confirmed these characteristics of burning and also documented "(i) pitting and 'peeled-off' surfaces, (ii) a dull and opaque appearance (where fresh quartz tends to be clear and vitreous), (iii) various degrees of 'granulation' and disintegration, and (iv) occasional areas with either a reddish or a pink hue" (Ballin 2008: 51). Further experiments by Driscoll (2010: 173–185), using four sources of quartz, replicated all but the first of these features. As an informal test, various samples of quartz from Tsodilo Hills were left overnight in a campfire—all of the features noted above were identified. It is also worthy of note that, according to Kinnunen (1993: 17), in contrast to other fine-grained lithic materials, intentional heat-alteration of quartz renders the material more difficult to retouch (also see Inizan et al. 1999: 22).

The group of burnt MSA points from the recent excavations at Rhino Cave is composed of 26 complete or virtually complete specimens in chalcedony (n=21) and silcrete (n=5). [It is anticipated that additional refitting will increase this total, as the point fragment and miscellaneous retouched piece categories, listed in Table 2, are primarily composed of burnt point fragments.] As can be seen in the examples in Figure 7, these artifacts are cracked and crazed—dropping them onto a hard surface would cause them to shatter. However, with one exception, all of the points in this group show no signs of prolonged exposure to heat. They are not burnt white and although heavily crenated they are still virtually complete. The most common evidence of damage on these points is small highly diagnostic potlids which have spalled off from the thin retouched edges. It is also evident that these specimens were in excellent condition when they were burnt. For example, the silcrete point, in the lower right in Figure 7, is pristine except for the refitted potlid spall seen on the right of the dorsal surface (as shown) and others on the ventral face. This point is finely executed and extremely thin (5.5mm). In common with the burnt specimen produced in white silcrete, shown above it, these two points have retained their sharp tips. The apparent minor damage on the other examples is also a result of heat alteration and not from impact from use.

The refitted example of the partially bifacial MSA point, shown in Figure 3, highlights another distinctive feature of this pattern of burning—not just the points, but also their related manufacturing debitage, was burnt. As can be seen

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*Figure 7. Rhino Cave, selection of burnt points. All are from the recent test excavation, except the point in the middle of the bottom row, which is from the 1995 excavation (RC2 115-120). Apparent damage to point tips seen in some examples is due to heat spalling. Top row, far right and left are in silcrete, as is bottom row, far right. The color of the white example is natural and not a result of prolonged burning. The remainder are made in chalcedony (photo by Sheila Coulson).*

in this figure, the flake on the right is more heavily altered by the heat and, in this case, the MSA point only exhibits minor cracking and crazing. Once again, this behavioral pattern is mirrored in the examples that have not yet been refitted.

It has been suggested that this burning pattern was simply the result of local brush fires (Robbins et al. 2007: 3). There is, however, no reason to suppose that brush ever accumulated in the cave. As this pattern is found through the MSA deposit, this explanation requires the repeated occurrence of natural blazes that were extremely selective in what they chose to burn. While it is acknowledged that post-depositional burning can affect an assemblage (e.g., Wadley 2009), the results of chi-square testing on the ma-

terial from Rhino Cave (see Appendix 1 and Appendix 2) renders the possibility of the observed pattern of burning being coincidental as highly unlikely. It should also be noted that none of the artifacts from the overlying LSA layers were burnt.

Elsewhere it has been demonstrated that during the MSA silcrete was intentionally heat treated (Brown et al. 2009b). In this case, heating reddened the color of the material and improved its knapping qualities. This process enabled experimental knappers to replicate MSA bifacial points from a raw material that had previously been found inadequate (Brown et al. 2009a; Sealy 2009: 323). However, another study conducted less than 100km away, determined that local silcrete from that area did not require



heat alteration to reproduce identical point types (Villa et al. 2009: 442). At Rhino Cave, the possibility of intentional heat alteration cannot be discounted. However, if the intent was to improve the quality of the raw materials then each and every attempt was an abject failure. These thermally altered specimens are cracked, crazed, and do not display the characteristic glossy sheen of intentional heat alteration. They are heated past the stage where the knapping quality would have been improved.

However, one aspect, which will be explored in greater detail in the following pages, is whether these artifacts could have been burned to alter or intensify the color of the stone (e.g., Eriksen 2006; Inizan et al. 1999: 24). With a few exceptions, the burned artifacts from Rhino Cave are now colored deep pink to purple/red.

In summary, there is a very distinctive pattern of burning at this site. A group of 26 MSA points and their associated debitage are heat damaged to the point of destruction. However, they have not been exposed to long-term burning of the type that is commonly found when an artifact is discarded into a hearth—a common feature on any number of Stone Age sites. It is suggested that these MSA points and their associated manufacturing debitage were selectively and intentionally burnt in short-term restricted fires that caused their coloring to change to various reddish hues. These cracked and crenated specimens were recovered in direct association with unburnt points and their associated unburnt manufacturing debitage. The unused blanks of non-locally acquired raw materials brought to Rhino Cave are also normally unaffected by heat damage. This behavioral trait is found to be primarily restricted to the MSA points in this assemblage and occurs from the onset of the MSA deposit, at approximately 1m below the surface and was still evident when digging ceased at 185cm.

### Unaltered Abandoned MSA Points

As noted previously, one of the research questions selected (by contributors SC and SS) for further investigation was the reported occurrence of complete, unused, “pristine” points being manufactured but then abandoned in this unlikely knapping site (Robbins et al. 2000a: 20; Robbins and Murphy 1998: 60; Robbins et al. 1996: 32). From the 1996 excavation alone (Robbins et al. 2000a: 21) 65 MSA points and fragments were recovered, of which 33 were complete and another 18 were classified as preforms or points in various stages of manufacture. The remainder of this total is comprised of point bases (n=2) and tips (n=12)—although these categories would have been substantially reduced if specimens broken during production, for example due to end-shock, had been recognized (Inizan et al. 1999: 34; Odell and Cowan 1986: 204; Shea 1988: 443).

From the recent test excavation, MSA points manufactured in the cave, but then abandoned, accounts for the largest category (n=57). This includes not only the specimens produced in non-locally acquired materials, such as chalcedony (n=17), silcrete (n=13), and the as yet unidentified shiny, white, silcretized organic material (n=1), but also the points made from local materials such as glassy

and milky quartz (n=24) and quartzite (n=2) (see examples in Figures 4 and 6). This group of points was found to be distributed throughout the MSA deposit, beginning initially at about 1m and continuing to the bottom level of 185cm.

As was determined for the burnt points, these artifacts follow the same behavioral pattern in that they were brought to the site as partially prepared points or blanks, completed in the cave and then abandoned. The chalcedony MSA points in this category are the clearest and easiest to determine since they are in excellent condition (see Figure 4). The distinctly colored blanks or preforms used in their manufacture made the selection of associated debitage a straightforward procedure. The occasional specimen has retained some of the outside weathered surface of the original core but with one or two exceptions there was no indication of patination. An exceptional example is the point shown in the upper right corner of Figure 4. This shiny orange-colored chalcedony specimen is heavily coated on both surfaces with desert varnish or wind gloss (Inizan et al. 1999: 91). It was transformed into an MSA point by the addition of a small amount of direct retouch which cuts through this coating. Desert varnish occurs when a surface artifact has been exposed to strong winds and clay-laden sand for a lengthy period of time. Therefore, this artifact obviously must have been brought to the cave as a salvaged flake which had been produced at some point in the distant past. The collection of these partially prepared points and blanks, including this artifact, all follow the general pattern of choosing individual exceptionally colored specimens.

The silcrete artifacts in this grouping all exhibit a degree of degrading—the dorsal scars and edges are beginning to deteriorate. This is not the case in the silcrete examples that have been subject to heat damage, as discussed above. At this stage of our research it is not possible to determine whether this can be explained by differences in the quality of the silcrete or whether it is perhaps due to variations between the various silcrete sources. Alternatively, as demonstrated by Brown et al. (2009a, b), heat alteration—in this case, heat damage—could have increased the durability of these silcreted. Further research is required to gain a fuller understanding of the properties of this common Southern African raw material type (for definition, see Kearey 1996: 285; also see Nash and Hopkinson 2004; Nash et al. 2004).

The locally available quartz was used to produce both unifacial (n=14) and bifacial (n=10) MSA points. This high quality material is freely available throughout the Hills both in veins and spalled fragments. It was the most common raw material used on all of the excavated sites from this area (Robbins 1990; Robbins and Murphy 1998; Robbins et al. 2000b), and has even been suggested as the material of choice for the possible MSA component at the base of the nearby site of Depression Cave (Robbins 1990; Robbins and Murphy 1998: 61) (see Figure 1). Although quartz creates a considerable amount of fragmented debitage and shatter (e.g., Driscoll 2010: 119-120; Driscoll 2011; Mourre 1996), experimental knappers (e.g., Inizan et al. 1999: 22; Mourre 1996) have found it to be comparable for tool production to chalcedony, silcrete, silcretized materials, and

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Figure 8. Rhino Cave, point from the top of the MSA deposit which exhibits intentional battering on both the dorsal (left) and ventral surfaces. Arrows indicate the extent of the repeated battering, with associated misstrike rings and cracking (photo by Sheila Coulson).

quartzite. Obviously this raw material type was no impediment to the MSA tool maker, as is evident in the examples shown in Figure 6. As noted previously, various specimens were refitted within this raw material category. There were no notable differences detected in the production patterns when this material was examined, although there does appear to be a greater tendency to fractures during manufacture. This is not surprising considering the planes of cleavage and fracture mechanics of quartz (e.g., Driscoll 2011; Mourre 1996; Tallavaara et al. 2010).

#### Intentionally Broken MSA Points

The last and smallest category of MSA points from Rhino Cave is composed of artifacts that were intentionally broken—these are made in chalcedony (n=3) and a white, shiny, silcretized organic material (n=1) (see Figure 16 below, center). These breaks could initially be mistaken for bending fractures from impact or manufacturing faults. However there is one vital difference—these types of breaks produce a clean snap (Bergman and Newcomer 1983; Inizan et al. 1999: Figure 6), whereas intentional breaks have a point of impact and a positive and negative bulb of percussion (Bergman et al. 1987; Bergman and Newcomer 1983: 242). This type of break is commonly found at the junction of dorsal scars or in the centre of the dorsal or ventral surface. A related example is shown in Figure 8—a unifacial point, in vibrant red and white chalcedony, which has been intentionally battered but did not break. The battering has produced misstrike rings and cracking, which is most apparent on the ventral surface. No skilled knapper would attempt to reduce a piece by striking so far in from the edge, nor would they do this repeatedly. The battering to the dorsal surface of this 9mm thick point is less intense but has still produced a crack in the centre of the point. These blows were intentionally designed to break the piece.

Once again the examples in this category were produced in distinctly colored raw materials. This group of intentionally broken MSA points is also the only category

where any of the remaining fragments have yet to be recovered, even though these pieces would have been easily recognizable. There are a number of possible explanations as to why these are missing, the most obvious being that only one pit has been excavated in this area of the cave. However, it is also a possibility that, in common with the burnt MSA points, these artifacts could have been destroyed elsewhere and then re-deposited in this part of the cave. Redispersion would also account for why burnt points and their associated debitage are also found in direct association with unburnt examples.

#### RE-EXAMINATION OF THE MSA ASSEMBLAGE FROM THE PREVIOUS EXCAVATIONS (1995–1996)

A re-examination of the MSA assemblage from the 1995–1996 excavations (Robbins et al. 2000a; Robbins et al. 1996) from Rhino Cave, housed in the National Museum of Botswana, was recently conducted (by contributor SC). Approximately 80% of the collection was still available; fortunately, this included most of the MSA points essential for this study. As seen in Table 3, the artifact counts differ from the published accounts (Robbins et al. 2000a: Table 2; Robbins et al. 1996: Table 3). This discrepancy is partly due to the abovementioned availability of the collection and partly to differences in nomenclature.

As would be expected on such a small site, the behavioral patterns identified for the MSA points recovered from the recent test excavation also were evident for those recovered from the previous excavations. Results of chi-square test for MSA points from excavations (1995–1996), confirmed that the burning of points produced in non-locally acquired material was unlikely to have been coincidental (chi-square=15.62, degree of freedom=1, p<0.0001). Furthermore, by combining the MSA points from all of the excavated squares, thereby increasing the data sample to 149 points, the pattern of selective burning of non-locally acquired material was not only confirmed but further rein-

**TABLE 3. ARTIFACT COUNTS FROM THE RHINO CAVE MSA LEVEL EXCAVATIONS FROM 1995–1996 (indicating locally available raw materials, non-locally available materials and unburnt and burnt artifacts).\***

Artifact types	1995 Pit 1		1995 Pit 2		1996 Pit 3		1996 Pit 4		Combined Pits 1–4		Total
	Unburnt	Burnt	Unburnt	Burnt	Unburnt	Burnt	Unburnt	Burnt	Unburnt	Burnt	
<b>MSA points:</b>											
Local quartz + quartzite	0	0	3	0	17	0	1	0	21	0	21
Non-local materials	0	0	9	3	11	16	0	1	20	20	40
<b>Other point types and point fragments:</b>											
<b>Levallois points</b>											
Local quartz + quartzite	0	0	1	0	2	0	0	0	3	0	3
Non-local materials	0	0	2	0	4	1	1	0	7	1	8
<b>Point fragments</b>											
Local quartz + quartzite	0	0	3	0	5	0	0	0	8	0	8
Non-local materials	0	1	3	2	4	10	0	0	7	13	20
<b>Misc. retouched</b>											
Local quartz + quartzite	0	0	0	0	0	0	0	0	0	0	0
Non-local materials	0	1	0	2	1	0	0	0	1	3	4
<b>Scrapers:</b>											
Local quartz + quartzite	0	0	1	0	2	0	0	0	3	0	3
Non-local materials	2	0	4	0	8	0	0	0	14	0	14
<b>Denticulates</b>											
Local quartz + quartzite	0	0	0	0	1	0	0	0	1	0	1
Non-local materials	0	0	0	0	2	0	0	0	2	0	2
<b>Becs</b>											
Local quartz + quartzite	0	0	0	0	0	0	0	0	0	0	0
Non-local materials	1	0	2	0	2	0	0	0	5	0	5
<b>Burin spalls</b>											
Local quartz + quartzite	0	0	0	0	0	0	0	0	0	0	0
Non-local materials	0	0	1	0	0	0	0	0	1	0	1
<b>Grinding stones - handheld</b>											
Local quartzite and ironstone	2	0	2	0	22	0	7	0	33	0	33
<b>Cores:</b>											
<b>Levallois</b>											
Local quartz + quartzite	1	0	0	0	4	0	0	0	5	0	5
Non-local materials	0	0	1	1	8	2	0	0	9	3	12
<b>Discoidal</b>											
Local quartz + quartzite	1	0	0	0	1	0	0	0	2	0	2
Non-local materials	0	0	1	0	4	0	0	0	5	0	5
<b>Kombewa</b>											
Local quartz + quartzite	0	0	0	0	0	0	0	0	0	0	0
Non-local materials	0	0	0	0	0	0	0	0	0	0	0
<b>Amorphous</b>											
Local quartz + quartzite	0	0	1	0	12	0	0	0	13	0	13
Non-local materials	0	0	0	0	12	0	0	0	12	0	12
<b>Bipolar</b>											
Local quartz + quartzite	0	0	0	0	1	0	0	0	1	0	1
Non-local materials	0	0	0	0	0	0	0	0	0	0	0
<b>Single and double platform</b>											
Local quartz + quartzite	0	0	0	0	0	0	0	0	0	0	0
Non-local materials	1	0	0	0	2	0	0	0	3	0	3
<b>Grand Total</b>									176	40	216

\*Note: the totals vary considerably from the published accounts (Robbins et al. 2000a; Robbins et al. 1996). This is partly due to the availability of the collection and partly to differences in nomenclature. Chi-square tests on these artifact counts confirm that the non-locally acquired material was unlikely to have been coincidental (chi-square=35.06, degree of freedom=1,  $p < 0.0001$ ). The combination of previous excavations (1995–1996) and recent test excavation (2004–2006) reinforces this pattern (chi-square=78.09, degree of freedom=1,  $p < 0.0001$ , see Appendix 3).

forced (chi-square=30.66, degree of freedom=1,  $p < 0.0001$ , see Appendix 4).

To illustrate this, examples of these artifacts have been incorporated in Figures 4, 6, 7. Although the original excavators had observed some idiosyncratic forms of behavior, such as the manufacture but abandonment of MSA points, their chosen method of analysis effectively prohibited the identification of a broader range of individual behavioral characteristics. For example, placing the debitage from various stages of artifact production within categories of general raw material types, combined with the use of typological classifications for the retouched tools, precluded virtually any possibility of identifying separate *chaînes opératoires*. This in turn prevented the recognition of the distinct behavioral attributes found on this site.

An additional unusual characteristic, identified as yet only within the initially excavated materials, is the collection of blanks made on an array of colorful, non-locally acquired, raw materials. A number of these were recovered, predominantly from Pit 3 of the 1996 excavation (see Figure 5), and in all likelihood account for at least some of the “large unretouched blades” reported by Robbins and Murphy (1998: 60). As described earlier, these colorful blanks were removed from a wide variety of cores which, as yet, have not been found. Of particular interest are the two flakes of breccia in Figure 5—the large unburnt specimen was retrieved from RC3 80–85cm, while the smaller burnt flake (to the left of the separation line) was recovered in the recent test excavation. These two flakes are the only pieces of this highly distinctive heterogeneous material, which is clearly unsuitable for modification into a retouched tool. However, these flakes provide an excellent example of an intentionally selected, non-locally acquired, colorful raw material. The level of fire damage on the small flake, from the recent test excavation, indicates that the artifact was heated to the same level observed on the MSA points, i.e., enough to intensify the color while only causing minor crazing. The collection and treatment of these two flakes further supports an observation regarding the entire MSA collection from Rhino Cave—it is anticipated that when a *chaîne opératoire* analysis of the entire assemblage is undertaken, a number of other select artifact categories also will be found to exhibit distinct behavioral patterns, such as those identified for the MSA points.

#### ADDITIONAL ARCHAEOLOGICAL FEATURES ASSOCIATED WITH THE MSA ASSEMBLAGE FROM THE RECENT TEST EXCAVATION

##### Pigments and Grinding

Ochre has figured prominently in the recent debate on symbolism and ritual in the MSA (e.g., Barham 2002; Henshilwood et al. 2009; Henshilwood et al. 2001; Hovers et al. 2003; Knight 2009, 2010; Knight et al. 1995; Mackay and Welz 2008; Marean et al. 2007; Marean et al. 2004; Mayer et al. 2009; McBrearty and Stringer 2007; Watts 1999, 2002, 2009). Contrary views, arguing for more utilitarian uses of this mineral, also have received considerable attention

(e.g., Barton 2005; Lombard 2005, 2006c, 2007; Mithen 1999; Wadley 2001, 2005, 2006a, 2010; Wadley et al. 2004). It is anticipated future analysis on the pigments from Rhino Cave will contribute to this debate. However, at this stage of our research our findings remain as general observations.

Two forms of pigment were found in the MSA deposits of the recent excavation at Rhino Cave—ochre or red iron oxide and specularite, a form of haematite with a metallic silvery luster. Ochre occurred only as tiny flecks that disintegrated easily and could be a bi-product of the burning process described above. However, specularite was common, occurring as veins in fist-sized chunks of quartz or as small pebble-sized lumps. This locally available material (Murphy et al. 2010; Robbins et al. 2000a: 22; Robbins et al. 1993; Robbins and Murphy 1998: 60; Robbins et al. 1998) was recovered in the initial excavations as slabs with rounded edges, which were polished from use (Robbins et al. 2000a: 21–22, 24) (Figure 9). No obviously worked or used specimens were found in the recent excavation.

An intriguing feature, which will be prioritized in future research, is the reported magnetic qualities of some pieces of specularite from this cave. According to Robbins et al. (2000a: 21–22), some of the vein specularite artifacts are rich enough in iron to be attracted by a magnet when the artifact is balanced near the midpoint. Specularite is not normally ferromagnetic but may become so upon heating, as this induces a phase change to magnetite or maghemite (e.g., Collinson 1974; Dunlop 1972). This alteration may be intentional; several southern African ethno-historical accounts (e.g., Dunn 1931: 110; How 1962 [1970]: 35) mention the heating of specularite to further enhance its natural redness/chroma.

How specularite was being used in the cave remains an open question. Robbins et al. (2000a: 22; 2010: 62) suggested the artifact shown in on the left in Figure 9, could have been used for preparing hides (for similar examples from Twin Rivers, Zambia, see Barham 2002: Figure 4 and 5; 2005). It can also be suggested that the rounded edges on the large slabs of specularite could have been produced by grinding against the carved rock face. As the carved panel is exposed, and has been reworked over the ages, no remaining traces of pigment would be expected to have survived. This was confirmed by rinsing the cupules with distilled water and examining the runoff under a microscope.

The only indication of possible use of specularite comes from an unusual group of grinding stones, shown in Figure 10. These are naturally corrugated slabs of quartzitic-sandstone of which four examples were recovered in the most recent tests excavations at a depth of between 130–165cm. Two additional specimens were found in the 1996 excavations (see Figure 10). Another example of this type of artifact (not illustrated) contains traces of haematite in the base of the striations (Stephan Coetzee, Department of Physics, University of Botswana, personal communication to contributor NW, 2005). It is, therefore, suggested that at least one function of these naturally corrugated slabs was the grinding of specularite.

Grinding stones were found throughout the MSA de-

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Figure 9. Rhino Cave, polished edges of vein specularite. Both are from the MSA layers, RC3 100–105cm (Robbins et al. 2000a: 24, Figure 7) and RC2 120–130cm (photo by Sheila Coulson).

posit. These are of a size and shape which indicate that they were handheld. They vary in size between 5–10cm and are made from quartzite or ironstone. As reported by the initial excavators (Robbins et al. 1996: 29), a number of these artifacts could also have served as hammerstones. Many are broken and bear indications of battering, abrasion and striations along the ends and edges. The finest and most carefully worked example in this group was retrieved from a depth of 165–170cm (see Figure 13 below). This artifact is made in ironstone and has long striations on all faces. The ends show bevelling extending from the sides onto the edges of the top and bottom of the artifact, indicating that this tool also was used end-on. No traces of pigment could be seen on this or on any of the other grinding stones and no lower grinding stones were recovered from any of the excavations.

### The Carved Wall

As described earlier, the massive quartzite outcrop on the south wall of Rhino Cave displays in excess of 300 cupules of varying sizes, shapes, and depths (Figure 11). Robbins et al. (1996: 34) described this formation and noted the fact that the late afternoon winter sun fell upon these carvings (Robbins et al. 2000a: 18; Robbins et al. 2007: 4), but concluded that both the age and function of this feature remained “enigmatic” (Robbins et al. 2000a: 30).

There are at least 30 cupule sites on the Hills (Walker 2010: Table 1), most of which are associated with Late Stone Age material. These are part of the much larger body of

over 400 rock art sites at Tsodilo, documented since 1976 by the National Museum of Botswana (Campbell 1998; Campbell et al. 1994a; Campbell et al. 1980; Walker 1998). With a few exceptions, notably Depression Shelter and Rhino Cave, the cupules are found in smaller concentrations on horizontal or sloping surfaces. These carvings have a variety of shapes; while most are circular such as those found at Depression Shelter, some sites also contain grooves or cigar/canoe-shaped forms (Walker 2010). Rhino Cave is unusual, not only for the number of cupules but also for the variety of forms, as can be seen in Figure 11 and Figure 12 (also see Robbins et al. 1996:34).

On the basis of direct observation, it is evident that the Rhino Cave cupules were ground over a considerable period of time, as the profile of the outcrop is now undercut, and the condition of the cupules varies from heavily weathered to virtually pristine (see Figure 12 top). It is this feature that prompted one of the contributors (NW) to focus investigations on how and when this panel was carved. The original excavators proposed that the cupules may have been ground into the rock face using well-rounded hammer stone/grindstones such as those recovered from the LSA deposits (Robbins et al. 1996:34).

As noted above, 28 grinding stones were recovered from the MSA deposits from the recent excavation. Grinding or smoothing stones can serve a multitude of functions and, although their presence in direct proximity to the carved wall is suggestive, it cannot automatically be assumed that these artifacts were used on it. Regardless, all

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Figure 10. Rhino Cave, quartzitic-sandstone slabs with natural striations, suggested as being used for grinding pigment. Examples from left to right: 1996 excavation RC 4 (55–60), and recent 2006 test excavation from 160–165cm and 130–135cm (photo by Sheila Coulson). [Note that the MSA in Pit 4 (excavated in 1996) was reported to occur from 20cm below the surface.]

the grinding stones recovered from this deposit have working edges that fit the dimensions of the present cupules and could potentially have been used to carve this wall.

Thus far, the only evidence for how and when the wall was carved is the recovery of a small section of the carved panel (as identified by contributor NW) which had spalled from the outcrop (Figure 13). This was excavated at a depth of 140cm. Even allowing for the present known maximum extent of bioturbation this carved fragment was located firmly within the MSA deposit. Future investigation plans include detailed analysis of the deposits to determine the levels of ground residue from this wall. Until this can be undertaken questions as to when the grinding of cupules first commenced or when this process stopped remain unanswered. However, at present it can be stated that this panel was being carved at some point during the MSA. Even though it is not possible to determine the configuration of ground cupules on this panel at any point in the past, the carved fragment found in the MSA deposit has the same elongated grooves as those presently found on sections of the outcrop.

#### SITE COMPARISONS

Regional variation in the African MSA is commonly based on characteristic point styles (e.g., Clark 1988; McBrearty and Brooks 2000). In Botswana the MSA has been considered to be part of the Bambatan industry of Zimbabwe, Zambia, and Namibia (e.g., Brooks et al. 2006: 236; Kuman 1989: 185–186). The Bambatan is “distinguished by short, broad foliate and triangular points, both unifacial and bifa-

cial, with retouch ranging from marginal to invasive” (McBrearty and Brooks 2000: 500). These points are frequently produced on *déjeté* flakes from discoidal cores and made in both local and non-local fine-grained materials. They differ markedly from the various point types of the well-documented industries of the South African MSA (e.g., Brooks et al. 2006; Sampson 1972; Singer and Wymer 1982; Villa et al. 2009; Volman 1981; Wadley and Whitelaw 2006; Wurz 2000).

To place the findings from Rhino Cave in context it is necessary to examine them in light of nearby MSA sites from the surrounding countries (Figure 14). Emphasis will be placed on the use of local and non-locally acquired raw materials and interpretations of these localities. The other main MSA sites from Botswana, White Paintings Shelter and #Gi (see Figure 14), will be discussed in more detail, as these assemblages have recently been re-examined (by contributor SC). Comparisons to sites further afield are based on published accounts (Table 4).

#### WHITE PAINTINGS SHELTER, MALE HILL, TSODILO HILLS

Comparisons between this site and Rhino Cave were made on the basis of the morphological similarities of the MSA assemblage from White Paintings Shelter (Murphy 1999: 274, 289–290; Phillipson 2007: 20; Robbins and Murphy 1998: 60) and on similar patterns of use of substantial quantities of non-locally acquired raw materials (Robbins et al. 2010: 57). The shelter has been interpreted as being occupied during the MSA by relatively small groups of people

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Figure 11. Rhino Cave, the carved south wall shown in the mid-winter late afternoon light (photo by Sheila Coulson).

visiting the Hills repeatedly on a long-term basis (Robbins and Murphy 1998: 60–61). Murphy (1999: 374) has suggested that during the later MSA, the shelter served as a convenient stop-over point for small groups that were following the large migrating herds of animals. Here, tools were reworked and replaced using raw materials that had been acquired *en route*—the presence of impact fractured points supports this interpretation (Donahue et al. 2004). Alternatively, it has been suggested that the site was perhaps part of an aggregation area for fairly large groups of people, with use occurring on a seasonal basis (Robbins and Murphy 1998: 60–61).

A recent cursory examination of the *chaînes opératoires* of the MSA assemblage from White Paintings Shelter (by contributor SC) indicates that, in comparison to Rhino Cave, the pattern of acquisition of non-locally available materials is different. As reported by Robbins et al. (2000b: 1105), 55% of the assemblage is produced from non-locally available materials. However, it has yet to be determined whether these artifacts were manufactured from a large number or only a few blocks of stone (note the similarity of the silcrete in the three examples, middle row, left, in Figure 15). The wide range and diversity of colorful, non-

locally available raw materials, characteristic of the Rhino Cave points, are not present at White Paintings Shelter (see Figure 15, middle row, and also see color plate in Robbins et al. 2010: Figure 3:11). A likely interpretation is that there were fewer visits during the MSA to White Paintings Shelter.

#### ≠GI, NEAR THE AHA HILLS

The MSA assemblage that most closely resembles Rhino Cave was recovered at ≠Gi. Both technological and typological similarities have been noted and the recent dates from the sealed deposit have, therefore, been referred to with regard to the White Paintings Shelter and Rhino Cave assemblages (Robbins and Murphy 1998: 60). ≠Gi has been interpreted as a hunting site due to the presence of almost 600 points (Kuman 1989: 200), a number of which exhibited impact fractures (Brooks et al. 2006: 239; Kuman 1989: 201). These were associated with the remains of large, difficult, and elusive prey, including zebra, cape warthog, and large bovids (*Pelorovis* and *Megalotragus*) (Brooks et al. 1990: 62; McBrearty and Brooks 2000: 508). Investigations confirmed that the MSA tool makers at this site were heavily reliant on non-locally acquired raw materials (see Figure 15, bot-

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*Figure 12. Rhino Cave, closer views of the carved wall. Top: the variation in grooves and depressions or cupules and the differences in overall condition. Note: 10cm scale. Bottom: a close-up of natural spalling (this missing spall has not yet been recovered) (photos by Sheila Coulson).*



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*Figure 13. Rhino Cave, spalled fragment of carved wall retrieved from depth of 140cm in MSA deposit and ironstone grinding stone from 165–170cm. Note the similar shapes of the concave grooves on the spall and the convex working edge of the grinding stone (photo by Sheila Coulson).*

tom row), with 80% of the raw materials used being high quality cherts and chalcedonies. These can be acquired from within a range of 100km of the site (Kuman 1989: 256), although as noted by Brooks et al. (2006: 239) medium to large cobbles of these materials could have been extracted from the conglomerate underlying the MSA horizon on this site. However, as there was a significant degree of curation, with evidence of resharpening and some recycling of the formalized pieces, it was concluded that there was a shortage of good quality materials readily available at #Gi (Helgren and Brooks 1983: 193; Kuman 1989: 256). Kuman (1989: 255, Table XVII) determined that 3% (n=241) of the flakes, from the upper excavation unit alone, were re-cycled or salvaged specimens, as they bore traces of desert varnish or patina. Furthermore, over 40% of the analyzed sample of 412 MSA points (Kuman 1989: 202) was intensively retouched as they were either partially or completely bifacially worked—this total would be even higher if points had not been reworked into other tool forms, such as scrapers or knives (Brooks et al. 2006: 237). As can be seen in the

examples shown in Figure 15 (bottom row), this working (and re-working) of the tool edge is often steeply-angled and the retouch is more casually applied, although this did not compromise the overall standardized shape of these points (Brooks et al. 1990: 62; Brooks et al. 2006: 237–239; Kuman 1989: 244). Kuman (1989: 203) has demonstrated that these tools were highly curated and also functioned as cutting tools during their lifetime. In contrast, none of the MSA points from Rhino Cave are impact fractured and they show virtually no indications of re-working or curation. Another indicator of use, basal thinning to facilitate hafting, is reported at #Gi (Brooks et al. 1990: 62; Brooks et al. 2006: 237) but is rarely found at Rhino Cave.

However, these two sites share a number of characteristic technological features, one example being the manufacture of large partially bifacial points (Figure 16). A highly distinctive attribute of these tools, is that while the dorsal surfaces are fully shaped by retouch, the ventral surface exhibits deep scalar retouch which is restricted to one edge, while a row of shallow retouch extends to the tip and



Figure 14. Map of the sites referred to in the text. All have similar lithic MSA assemblages and are located within an 800km radius from Tsodilo Hills (drawn by Sigrid Staurset). See Figure 1 for a detailed view of the Tsodilo Hills sites.

part way down the opposite edge (most clearly seen in the middle specimen illustrated in Figure 16). The smaller size of this tool type at #Gi could be explained by the shortage of raw material.

#### OTHER COMPARATIVE SITES

The number of well-documented MSA sites in Botswana, Zimbabwe, Zambia, and Namibia is not large. With few exceptions reliable dates are scarce and chronologies are limited, therefore, the range of possible comparative sites is restricted. The following brief overview includes sites investigated in different decades, in different archaeological traditions, and published in varying levels of detail. Shared features are the presence of point types and technological attributes similar to those found at Rhino Cave and their relative proximity to Tsodilo Hills. Most of these sites have been attributed to the Bambatan, an industry originally defined for assemblages from the late MSA of Zimbabwe

(Armstrong 1929, 1931; Cooke 1957, 1963; Jones 1932, 1933), sometimes referred to as the “Rhodesian Stillbay” (Jones 1940), which is in essence undated. However, the well-dated sites of Twin Rivers and Mumbwa Caves, in Zambia, have been assigned to the Lupemban, although researchers agree (Barham 2000a: 246–247; Clark and Brown 2001: 324–325) that they also resemble the MSA of Zimbabwe. The MSA of southern Angola as yet remains almost virtually unknown (but see Gibson and Yellen 1978).

As can be seen in Table 4 a variety of site types are represented, including open-air localities, shelters, and caves. Although there are a limited number of dates, their range confirms occupation of this area throughout the MSA. The use of both local and non-locally acquired materials is also a common feature, although the relative amount of non-local materials varies between being a predominant source, e.g., #Gi, to rare occurrences, as is the case at Twin Rivers (and possibly also at Depression Cave). The *chaîne opératoire*

TABLE 4. NEARBY SITES WITH MSA COMPONENTS LOCATED WITHIN AN 800KM RADIUS FROM TSODILO HILLS.

Site Name	Location	Type	Dating	Raw Materials used	Burning of lithic artifacts	Interpretation	Reference
White Paintings Shelter	Tsodilo Hills, Botswana	Shelter	66 400±6 500 and 94 300±9 400 BP (Robbins et al. 2000b;1092)	Local material and large amounts of non-local	<1%	Stop-over point for small groups with long term re-occupation	(Brook et al. 2003; Donahue et al. 2004; Feathers 1997; Murphy 1999; Phillipson 2007; Robbins et al. 2000b; Stewart et al. 1991)
Depression Shelter	Tsodilo Hills, Botswana	Shelter	Deepest deposits approx. 40 000 years (Robbins et al. 2010: 59)	Predominantly local	No burning (as determined by contributor SC)	Deepest levels are possibly attributable to MSA - assemblage on local materials	(Brook et al. 2003: 57-59; Robbins 1987b, 1990; Robbins and Campbell 1988; Robbins et al. 2010)
#GI	Aha Hills, Botswana	Open-air	77 000±11 000 (TL) (Brooks et al. 1990:62)	Mainly non-local	Minor	Hunting site	(Brooks et al. 1990; Brooks et al. 2006; Brooks and Yellen 1977; Helgren and Brooks 1983; Kuman 1989)
Hwange National Park	West Zimbabwe	Open-air (several sites and scatters)	One site reported to date to approx. 100 000 BP (Haynes and Klimowicz 2009: 68)	Local material, some possible exotics	Not reported	Short-term campsites	(Haynes and Klimowicz 2009)
Bambata	Matopos Hills, Zimbabwe	Cave	Not directly dated	Local (ca. 75%) and non-local	Not reported	Habitation site	(Armstrong 1929, 1931; Jones 1940)
Khani	Western Zimbabwe	Open-air	Not directly dated	Local and imported	Not reported	Hunting/workshop site	(Cooke 1950, 1955, 1957, 1959; Jones and Summers 1946; Summers 1955)
Twin Rivers	Central Zambia	Hilltop/ cave	Several MSA layers, dates ranging from 170-270 ka (TIMS), but potentially as far back as >400 ka (Barham et al. 2000b)	Almost exclusively local	Not reported	Habitation site	(Barham 2000a, b; Barham et al. 2000b; Clark 1971; Clark and Brown 2001)
Mumbwa	Central Zambia	Caves	Several MSA layers, TL-dates ranging from 39 000±7000-172 000±21 000 (Barham and Debenham 2000)	Local and imported	Some burnt fragments associated with hearths	Habitation site	(Avery 1996; Barham 1995, 1996, 2000b; Barham and Debenham 2000; Barham et al. 2000a)
Masari	Caprivi Strip, Namibia	Open-air (surface collection)	Not directly dated	Local only	Not reported	Factory site	(Shackley 1986)
Neuhof-Kowas	Central Namibia	Open-air (partly surface collected)	Not directly dated	Local and imported	Not reported	No interpretation	(Viereck 1957)
Peperkorrel	Central Namibia	Open-air (test excavation)	Not directly dated	Local only	Not reported	Factory site	(MacCalman and Viereck 1967)

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*Figure 15. Selection of Middle Stone Age points from Rhino Cave test excavations (top row), White Paintings Shelter (middle row) and #Gi, located near the Aha Hills (bottom row) (photo by Sheila Coulson).*

methodology has not been applied to any of these sites. Therefore, selection processes for non-local lithic sources, number and variety of knapping sequences, breakage patterns, and ranges of raw material color, have seldom been addressed. Furthermore, although evidence of fire, such as the presence of hearths, is frequently reported, its effect on lithic artifacts is not commonly discussed. An exception to this is found at White Paintings Shelter, where Murphy (1999: 204) reports that less than 1% of the lithic assemblage showed indications of heat damage.

In summary, within the context of the surrounding sites the assemblage from Rhino Cave complies with the general pattern of technology and typology and of using both local and non-locally acquired fine-grained materials. However, Rhino Cave differs in the patterns of acquisition

(in what was selected and what was rejected), in the levels of curation and reworking, and especially in the eventual use and final disposal of these materials. This is particularly apparent for the MSA points. This begs the question of whether the reason for these differences lies within the applied methodology or whether it originates in behavioral differences during the MSA.

#### **RHINO CAVE — AN INTERPRETATION**

Although none of the individual features from Rhino Cave are conclusive in themselves, we suggest that the cumulative evidence presented in this paper supports a hypothesis for ritualized behavior in the Late Pleistocene MSA. This proposal is discussed in the following sections.

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*Figure 16. Partially bifacial Middle Stone Age artifacts from left to right: Rhino Cave 1995 excavation (RC2 114), recent excavations (W 150), and #Gi (Unit 4). Also note the point of impact in the center of the break in the middle example (photo by Sheila Coulson).*

#### **SUMMARY OF RHINO CAVE'S MAIN FEATURES**

A review of the outstanding features of this site begins with its physical attributes. Rhino Cave is hidden, difficult to access, and the interior is small, with a floor area of just 22m<sup>2</sup>. The cave receives virtually no direct sunlight and is one of the few places in the Kalahari where it is possible to be completely surrounded by rock. One wall of the cave is dominated by a virtually free-standing, massive, outcrop. The main face of this outcrop has been ground into hundreds of variously shaped cupules which are restricted to this panel in the cave. The outcrop would have been at head-height or higher during the MSA when the floor level was at least a meter lower, which would have further emphasized the prominence of this feature.

On the basis of present research in the MSA, as summarized in the wide selection of sites from throughout Africa presented by McBrearty and Brooks (2000), the findings from Rhino Cave are exceptional. A single cubic meter of MSA deposit, recently excavated directly beneath the carved outcrop, contained 88 complete, or virtually complete, MSA points, spread throughout the deposit. Refitting analysis confirms that many of the points were complet-

ed in the cave and remain in direct association with their knapping debris. Seventy percent of these tools have been manufactured from colorful blanks of raw materials collected from a minimum of 50km away. Once complete, the points were burned (along with their manufacture waste), abandoned, or intentionally broken. Over 10,000 pieces of debitage were also retrieved from the MSA deposit—these have yet to be analyzed in detail.

Indication of the use of fire in the MSA levels of the cave is limited to the burnt artifacts. On the basis of results from earlier experimental work, the level of burning on these artifacts indicate fires of short duration. The results of refitting and chi-square tests confirms that it is most likely that only select groups of artifacts were burnt. Burning not only rendered the artifacts brittle and unusable but also changed the color of the pieces to various shades of red.

The pigment specularite also was recovered, as well as naturally corrugated slabs which are suggested to have been used for grinding this material. Some of the vein specularite has become ferromagnetic, a process which could also indicate heat alteration.

A naturally exfoliated section of the carved panel, containing elongated grooves matching those presently on the

wall, was found well within the MSA deposit, in association with grinding stones. The edges of these grinding stones correspond to the negative profile of some of these cupules.

### THEORY OF RITUALIZED BEHAVIOR

Although the fundamental question of why humans invest time and resources in performing rituals remains unanswered (e.g., Rappaport 1971: 66; 1999), the recurrent components of ritualized behavior are well-known (e.g., Rappaport 1979: 173–246; Rappaport 1999; Sperber 1975). These include actions that become highly controlled and require sustained attention and focus (see Knight 1999: Table 12.1 for a summary of traits). The actions performed are not completely novel behaviors but frequently combine familiar elements and actions into novel sequences. These include a specific way of organizing the flow of behavior, characterized by the following: compulsion (one must perform a particular sequence), rigidity (it must be performed the way it was performed before, with no deviation from the remembered pattern), goal demotion (the actions are divorced from their usual goals), redundancy (the same actions are often repeated inside the ritual), and a restricted range of themes. Acts involving artifacts are noted as ready-to-hand candidates to fulfil various ritual functions, as their normal function can be readily transformed—a feature which is likely to be salient and attention-grabbing (Liénard and Lawson 2008: 167; Liénard and Sørensen in press).

A new and important component of ritual behavior is proposed through costly signalling theory (Irons 2001; for a summary see Sosis and Alcorta 2003: 266–268). This posits that ‘rituals are costly-to-fake signals that advertise an individual’s level of commitment’ (Sosis and Alcorta 2003: 267). To thwart ‘free-riders’ (e.g., Sosis 2003: 93) actions must be effortful and essential to the practices—they involve the surrendering of hard-won resources and frequently take time and energy away from other necessary pursuits. Importantly, these pursuits become costly through their role in communal ritual. As stated by Knight (1999: 229) ‘in ritual performance, reverse pressures apply, driving signallers to prolong, to repeat and to incur heavy costs.’

Ritual practices generate belief and belonging in participants by activating multiple social-psychological mechanisms that interactively create the characteristic outcomes of ritual (Durkheim 1961[1912]). This encompasses an array of possible manifestations around three key constituent behaviors—assembly, attentional focus, and effortful action (also see Marshall 2002). Attentional focus, it is predicted, would include aspects such as spectacle, structure, and de-individualization (for example, through the ritual taking place in darkness). Darkness is a particularly common feature (Knight 1999: 230), and it is proposed that the smaller the number of people participating in the ritual, the more likely the use of darkness (Marshall 2002: 373). Products and paraphernalia of ritual, it is anticipated, will often be destroyed after use, an example of this is the monastic practice of weaving baskets only to immediately burn them (Marshall 2002: 376).

If ritual practices are sufficiently compelling or ‘natural’ (as defined by Liénard and Boyer 2006: 815) this will increase the likelihood of their being transmitted and repeated over time. It is anticipated that when ritual performance is successful, it generates a whole new cognitive domain—a virtual world discernible on another representational level from the currently perceptible or ‘real’ one (Durkheim 1961[1912]; Gellner 1992: 36–37; Knight 1999: 229; Turner 1970).

Recently, Watts (2009: 62) proposed that “collective ritual— with its formal characteristic of amplified, stereotypical, redundant display—might be expected to leave a loud archaeological signature.” This proposition was made in connection to the role of ochre use within early ritual and its connection to the Female Cosmetic Coalitions model (e.g., Knight 1999, 2009, 2010; Power 1999, 2009; Power and Aiello 1997; Watts 1999, 2002, 2009). In this model it is proposed that, from the Middle Pleistocene, practices occurred in response to reproductive and mate-control stresses experienced by females. The use of artificial pigment, particularly ground red ochre, is one possibility suggested for scrambling the obvious biological signal of imminent fertility. It is proposed that reproductive taboos were enacted through rituals involving body painting and dance (Power and Aiello 1997: 165). A further discussion of the merits of this theory is outside the range of this paper. However, one overarching aspect can be investigated further—the role of the color red within these proposed collective rituals. Obviously, when replicating a ‘sham menstruation,’ as noted for the Female Cosmetic Coalitions model, the color range would be restricted. However, the role of color and a particular preference for hues of red has been noted in numerous studies (e.g., Barham 2002, 2005; Eriksen 2006; Hovers et al. 2003; Marshack 1981; McBrearty 2003; McBrearty and Stringer 2007; Morris 2005; Van Peer et al. 2004). Pigment plays a central role in virtually all of these studies. A notable exception is the investigations on the Early Mesolithic of Southern Germany conducted by Eriksen (2006), where it is argued that categories of lithic artifacts were intentionally heated to alter the brightness of the color of the stone. In common with intentional heat treatment to improve the knapping properties of a stone, this also involved terminating the alteration process before the blank or tool was too damaged to be used. Eriksen (2006: 152) argues that a conscious choice of color could have acted as a cultural marker.

### RHINO CAVE AND RITUALIZED BEHAVIOR

On the basis of the definitions presented above, it is possible to propose a list of indicators for ritualized behaviors that can be applied to archaeological materials, which will be relevant even in instances where the modernity of the prehistoric peoples are in question. These include evidence of the following: assembly, attentional focus, costly signalling, effortful behavior, and aspects of alternative attributions, as well as compulsion, rigidity, goal demotion, redundancy, and a restricted range of themes. In the following section these manifestations and behavioral patterns will be tested against the features of Rhino Cave.

### Physical Attributes of the Cave

As the only major outcrops for over a 100km in any direction, the Hills would have been an obvious point for *assembly*. Not only are they highly visible in this landscape but they also contain fresh water springs and rock shelters, as well as being a source of raw materials, such as quartz, quartzite, and specularite. In the Kalahari, being in close proximity to a rock formation is uncommon—being surrounded by rock is exceptional. Having to scramble uphill over massive boulders to gain access to the cave would have been an unusual occurrence that was by no means an everyday experience, making the journey an exerted effort. Once inside the cave, even on the best of days, the light is poor. The cave is not an obvious choice for habitation and even less apparent as a knapping location. However, the outstanding quantities of excavated lithic debitage—non-locally available, as well as locally acquired—testify to the fact that this cave was, nonetheless, visited repeatedly, particularly during the MSA.

### MSA Points

The results of the present investigations indicate that, in contrast to the other nearby sites, Rhino Cave was a site with unusual behavioral patterns involving the manufacture and abandonment or intentional destruction of artifacts. These acts were performed for the most part on non-locally acquired, colorful, raw materials that were selected and acquired from a distance of at least 50km. These behaviors are without question *effortful* and involve planning, as such brightly colored stones are not readily available. Once complete, these tools, which are normally associated with hunting or butchering, never left the cave. Instead, they were burnt (along with their waste debitage), abandoned, or intentionally broken.

This distinctive behavioral pattern applies to all of the MSA points from Rhino Cave recovered throughout the cubic meter of MSA deposit excavated during the most recent test excavation, as well as to those recovered from the earlier 1995–1996 excavations. This behavioral patterning provides evidence of *compulsion* (one must perform a particular sequence), *rigidity* (it must be performed the way it was performed before, with no deviation from the remembered pattern), *goal demotion* (the actions are divorced from their usual goals), *redundancy* (the same actions are often repeated), and a *restricted range of themes* (in this instance, the same artifact type was selected for particular treatment). Rhino Cave also provides an example in support of the view that for ritualized behavior the actions are not completely novel behaviors but have combined familiar elements and actions into novel sequences. Here a common MSA tool type was manufactured, but in an unusual setting, out of atypical raw materials and was then handled in one of three ways, before being left within the cave. It also can be argued that the treatment of the points in Rhino Cave suggests acts of sacrifice. These actions are also features of *effortful* behavior and the behavioral patterns associated with them gave these artifacts an *alternative attribution*.

The points manufactured in Rhino Cave and then aban-

doned also provide evidence of *costly signalling*—their production took time and energy away from other necessary pursuits and their manufacture in non-locally acquired materials involved the surrendering of hard-won resources. These actions would thwart free-riders—they could not be faked. It also can be argued that the intentional breaking and burning of the points would have required *attentional focus* and would have been *attention-grabbing*. For example, the large bifacially-worked point made from unusual white, silcretized, organic material (see Figure 16, center) is carefully and elaborately worked, with parallel removals on the dorsal surface (not shown). As one of the finest examples of this artifact type encountered, its intentional destruction, by a well-directed blow to the center of the ventral surface, would have been *attention-grabbing*. The same can be said for any number of the points that were burnt. As shown in the examples illustrated in Figure 7, many of these tools were delicately worked. These points and their associated debitage have not suffered accidental prolonged exposure to fire or to high temperatures; they were selectively burnt. As a result, virtually all of these tools are now unusable but still recognizable. It also can be argued that one of the reasons for the low-level intentional burning was to change the color, to make them pink/red or red/purple. This particular color range is well recognized for its symbolic associations (e.g., Barham 1998; Barham 2002, 2005; Hovers et al. 2003; McBrearty 2003; Watts 1999, 2002, 2009). It is difficult to imagine that the placement of these points and their debitage into low-level flames would not have been *attention-grabbing*.

How long these patterns of behavior were practiced at Rhino Cave is difficult to estimate, particularly as there are as yet no reliable dates for the MSA deposits. However, the variety of shapes and forms of the various MSA points and the uniqueness of the diverse raw material types further supports the interpretation that the manufacture and subsequent pattern of disposal were individual occurrences, which took place over a considerable period of time. The variety within the point forms also makes it likely that these tools were produced by a range of different knappers—this concurs with an observation made by Phillipson (2007: 22) for the MSA points from the 1996 excavation. The wealth of materials from the MSA deposit, virtually all of which had to be transported to the cave, also supports the interpretation that this pattern of behavior either occurred over a longer period of time or, alternatively, took place more intensively within a somewhat more limited timeframe. Regardless, these behavioral patterns provide evidence for *rigidity*, to a pre-determined pattern with a prescribed manner of behavior, and adherence to a ‘script’ which has a *restricted range of themes*.

Results of the present investigations have placed the MSA points in a central role in the behavioral patterns recognized at this site. Although this artifact type is normally associated with strictly utilitarian activities, its alternative role at Rhino Cave is not seen as a contradiction. As noted (Liénard and Lawson 2008: 167; Liénard and Sørensen in press), artifacts are ready-to-hand candidates to fulfil vari-

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Figure 17. Rhino Cave, night-time experiments with flickering light on the front of the carved panel (photo by Sheila Coulson).

ous ritual functions, as they are immediately recognizable and their normally intended function can be readily transformed— a feature which is likely to be salient and *attention-grabbing*.

#### **Pigments: Ochre and Specularite**

The pigments within the MSA layers of Rhino Cave consisted of small flecks of ochre and larger quantities of specularite in the form of rounded and polished slabs, as well as unworked pieces. Their association with naturally corrugated stone slabs can be interpreted as the remains of pigment processing. It is also possible that the rounded pieces of specularite were used on the cupuled wall panel. If the colorants were used in conjunction with the carved wall the actions would be *attention-grabbing*, as well as complying with the predicted use of a *restricted range of themes*, whereby the use of a particular color often is featured. It is not hard to imagine that the metallic sparkle of ground specularite, particularly under flickering light, would have fulfilled this requirement.

#### **The Carved Wall**

Archaeological evidence indicates that the rock outcrop that dominates one wall of the cave was being ground during the MSA. An exfoliated piece of this panel and a number of grinding stones were recovered from the MSA deposit. As this outcrop would have been at head-height or higher during the MSA, any alteration of this surface would have involved planning and would have been *effortful*, as well as requiring *attentional focus*. Obviously it is impossible to determine how this carved outcrop was interpreted in the distant past but to modern eyes, even without the cupules, it can be seen as a zoomorphic form, such as a snake or a tortoise head. The ‘head’ of this figure ‘rears up’; there is an elongated crack for a ‘mouth’ and a natural circular depression for the ‘eye’ (see Figure 11).

As there are burnt artifacts within the MSA deposits at Rhino Cave, and the natural light in the cave is restricted, it is highly likely that it at times would have been illuminated by firelight. It has been suggested that natural features of rock surfaces are not only used in depictions, but since the light source in a cave would have been a flickering flame,



the depictions also were intended to serve as animations (Chalmers 2002: 9–10). Therefore, a series of night-time experiments (conducted by contributor SC) were carried out using clusters of glass-enclosed smokeless candles to observe the effect of flickering light on the panel (Figure 17). The ‘eye’ is not particularly distinct in daylight but is prominent in firelight (see Lewis-Williams 1997: 331 for use of shadows to complete images). Keeping in mind that, in earlier times, the increased depth of the floor surface would have altered the viewing angle, care was taken to assure that both the ‘mouth’ and ‘eye’ could be easily seen, even from directly beneath the outcrop. Furthermore, the present configuration of cupules, with their varying shapes and depths, combined with the natural color variation of the formation, created the effect of movement in the flickering light.

If the spalled section of the carved wall and the grinding stones had been recovered in the LSA deposits it would have been natural to discuss them in relation to research concerning the choice of surface for rock art (Taçon and Ouzman 2004: 39), where the rock is by no means a ‘neutral support for imagery’. In European Upper Paleolithic rock art (e.g., Clottes and Lewis-Williams 1998: 86–91; Lewis-Williams 1997: 328–334) incorporating natural formations or protuberances on cave walls into the depiction of animals is a well-recognized phenomenon (also see Keyser and Poetschat 2004, for North American examples, including snakes). As noted by Lewis-Williams (2002: 211, 213), the use of a particular rock panel as a prop brings to life a seemingly ‘dead’ cave wall: it becomes a living entity where the rest of the body is inside the wall. Numerous researchers have interpreted more recent rock art surfaces as points of access to the spirit world—integral parts of ritual (e.g., Campbell et al. 1994a; Lewis-Williams 2002; Lewis-Williams and Pearce 2004; Lewis-Williams and Dowson 1990; Ouzman 2001; Van der Ryst et al. 2004; Walker 1998; Yates and Manhire 1991). However, to date these finds from Rhino Cave are unique in an MSA context; we simply as yet have no suitable framework within which to discuss MSA rock art.

### CONCLUDING REMARKS

The Stone Age of Botswana is, as yet, poorly understood, partly because of the nature of the landscape, which offered little incentive for people to repeatedly visit the same locations. Rhino Cave, in Tsodilo Hills, is a place to which they returned. As presented above, the features from this cave fulfil the requirements of the proposed list of indicators for ritualized behaviors. This list includes evidence for assembly, attentional focus, costly signalling, effortful behavior, and aspects of alternative attributions, as well as compulsion, rigidity, goal demotion, redundancy, and a restricted range of themes. It is also apparent that the attributes, manifestations, and ritualized behavioral patterns identified from this cave were sufficiently compelling or natural to contribute to their transmission, as in all probability they repeatedly co-occurred over a considerable period of time. These combined traits create the anticipated ‘loud archaeo-

logical signature’ of collective ritual.

It has been argued that the study of Stone Age technology reveals only the lower limits of hominid cognitive capacity (McBrearty and Brooks 2000: 532). As has been demonstrated through the results of the present investigation, it is now possible to expand the list of possible traits that provide evidence for ritualized behavioral patterns into the late Pleistocene MSA. This has significant consequences both for the antiquity of human ritual and for the origin of complex cultural behaviors in Africa.

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## Appendices

**Appendix 1. Results of chi-square test on artifact counts (see Table 2) for MSA level from recent test excavation (2004–2006), confirming that the burning of the non-locally acquired material being coincidental is highly unlikely.**

	<i>Observed values</i>				<i>Expected values</i>	
	<b>Local</b>	<b>Non-Local</b>	<b>Total</b>		<b>Local</b>	<b>Non-Local</b>
<b>Unburnt</b>	104	120	224	<b>Unburnt</b>	81.3	143.0
<b>Burnt</b>	2	66	68	<b>Burnt</b>	24.7	43.3
<b>Total</b>	106	186	292			

Chi-square=42.663  
Degree of freedom=1  
p=<0.0001

**Appendix 2. Results of chi-square test for MSA points from recent test excavation (2004–2006), confirming that the burning of points produced in non-locally acquired material being coincidental is highly unlikely.**

<b>MSA points</b>	<i>Observed values</i>			<b>MSA points</b>	<i>Expected values</i>	
	<b>Unburnt</b>	<b>Burnt</b>	<b>Total</b>		<b>Unburnt</b>	<b>Burnt</b>
Local material	26	0	26	Local material	18.3	7.68
Non-local material	36	26	62	Non-local material	43.7	18.3
<b>Total</b>	62	26	88			

Chi-square=15.476  
Degree of freedom=1  
p=<0.0001

Appendix 3. Results of chi-square test on artefact counts (see Table 3) for MSA level from previous excavations (1995–1996), confirming that the burning of the non-locally acquired material was unlikely to have been coincidental. Combination of previous excavations (1995–1996) and recent test excavation (2004–2006) reinforces this pattern.

*Previous Excavations (1995-1996)*

	<i>Observed values</i>			<i>Expected values</i>		
	<b>Local</b>	<b>Non-Local</b>	<b>Total</b>	<b>Local</b>	<b>Non-Local</b>	
<b>Unburnt</b>	90	86	176	<b>Unburnt</b>	73.33	102.67
<b>Burnt</b>	0	40	40	<b>Burnt</b>	16.67	23.33
<b>Total</b>	90	126	216			

Chi-square=35.06

Degree of freedom=1

$p < 0.0001$

*Combined - Previous Excavations and Recent Test Excavation*

	<i>Observed values</i>			<i>Expected values</i>		
	<b>Local</b>	<b>Non-Local</b>	<b>Total</b>	<b>Local</b>	<b>Non-Local</b>	
<b>Unburnt</b>	194	206	400	<b>Unburnt</b>	154.33	245.67
<b>Burnt</b>	2	106	108	<b>Burnt</b>	41.67	66.33
<b>Total</b>	196	312	508			

Chi-square=78.09

Degree of freedom=1

$p < 0.0001$

Appendix 4. Results of chi-square test for MSA points from excavations (1995–1996), confirming that the burning of points produced in non-locally acquired material was unlikely to have been coincidental. Combination of previous excavations (1995–1996) and recent test excavation (2004–2006) reinforces this pattern.

*MSA Points from Previous Excavations (1995-1996)*

MSA points	<i>Observed values</i>			MSA points	<i>Expected values</i>	
	Unburnt	Burnt	Total		Unburnt	Burnt
Local material	21	0	21	Local material	14.11	6.89
Non-local material	20	20	40	Non-local material	26.89	13.11
<b>Total</b>	41	20	61			

Chi-square=15.62

Degree of freedom=1

p=<0.0001

*MSA Points from Combined Excavations - Previous and Recent Test*

MSA points	<i>Observed values</i>			MSA points	<i>Expected Values</i>	
	Unburnt	Burnt	Total		Unburnt	Burnt
Local material	47	0	47	Local material	32.49	14.51
Non-local material	56	46	102	Non-local material	70.51	31.49
<b>Grand Total</b>	103	46	149			

Chi-square=30.66

Degree of freedom=1

p=<0.0001