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THE IMPACT OF MICRO-RESIDUE STUDIES ON SOUTH AFRICAN MIDDLE STONE AGE RESEARCH

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ABSTRACT

The Middle Stone Age of South Africa currently plays a central role in studies of the origins of symbolic behaviour. Micro-residue analyses on stone tools from sites with long Middle Stone Age sequences and good organic preservation are producing direct contextual evidence and detailed information about past technologies and associated behaviours. In this chapter we provide a brief and selected overview of some of our published contributions and demonstrate how micro-residue studies can now be used to assess hypotheses regarding hunting efficiency and hafting technologies. Compelling evidence is being produced that is contrary to the once-held notion that the Middle Stone Age shows little meaningful change through time. The cumulative results provide clear evidence for variability and change associated with anatomically modern humans. While our published work demonstrates our commitment to a multi-analytical approach to use-trace analysis, including micro-residue, use-wear and macrofracture analyses, we focus here on residues as it was also the focus of Tom Loy's research in South Africa.

KEYWORDS

Middle Stone Age, Howiesons Poort, Still Bay, Sibudu Cave, cognitive evolution, hunting technology, hafting technology

INTRODUCTION

There has been a marked increase in research interest in the African Middle Stone Age that spans the period of roughly 250 ka to 25 ka ago. The heightened awareness is due to new, multi-disciplinary data stimulating debate on the origins of anatomically and behaviourally modern humans, and while the archaeological record is nowhere near complete, progress is being made. Exciting but hotly contested interpretations of African origins now rival earlier interpretations of a Eurasian origin for modern humans (e.g. Marean and Assefa 2005; but also see d'Errico 2003; d'Errico *et al.* 2003; Shea 2003). Genetic and fossil evidence suggest that, from the anatomical perspective, humans in Africa were nearly modern by about 160 ka ago.

Fundamental questions are whether anatomical and cognitive modernity developed in tandem, and what criteria, if any, archaeologists should use to identify modern human behaviour

(Henshilwood and d’Errico 2005; Henshilwood and Marean 2003, 2006; Kuhn and Hovers 2006; McBrearty and Brooks 2000; Shea 2003; Wadley 2001, 2006a). New results seem to suggest that symbolic behaviour in Africa extends far earlier than the 50 ka ‘Rubicon’ (Henshilwood and Marean 2003; Marean and Assefa 2005; McBrearty and Brooks 2000; Mellars 1973, 1995, 2005, 2006; Minichillo 2005; Wadley 2006a, 2006b), and the Middle Stone Age of South Africa has claimed a central role in the quest for the origins of symbolic behaviour. It is against this background that the research of LW moved ever-deeper in time, first at Rose Cottage Cave in the Free State and more recently at Sibudu Cave in KwaZulu-Natal (Figure 1), and ML started exploring questions about Middle Stone Age hunting and hafting behaviour. These explorations and associated research questions and projects resulted in our approach to micro-residue analysis gaining its distinctive direction and momentum.

The first South African PhD in stone tool residue studies was completed in 2000 (Williamson 2000a) under the direction of Lyn Wadley and the late Tom Loy. This study introduced the basic principles and potential of residue analysis to Stone Age research on the sub-continent, where we have an approximately 2.5 million-year-old tool making tradition. From the start, our micro-residue work was deeply embedded in archaeological questions that have arisen during the course of excavations at Rose Cottage Cave and Sibudu Cave (see Gibson *et al.* 2004; Lombard 2004, 2005; Wadley, Williamson and Lombard 2004; Williamson 1996, 1997, 2000b, 2004, 2005). Some of these questions centred on the use and hafting of Howiesons Poort backed tools, the role of ochre during the Middle Stone Age and changes in subsistence strategies. Building on this initial work, experimentation, modern replication and blind testing became integral parts of our research design, without losing sight of the main goal – to improve our understanding of human behaviour during the Middle Stone Age (Hodgskiss 2006; Lombard *et al.* 2004; Lombard and Wadley 2007a, b; Pargeter 2007; Rots and Williamson 2004; Wadley 2005a, 2005b, 2005c, 2006a; Wadley and Lombard 2007; Wadley, Lombard and Williamson 2004).

Both Rose Cottage Cave and Sibudu Cave have yielded hundreds of thousands of stone tools occurring in varying contexts over time, and we have systematically excavated and curated tools with residue studies in mind. At both sites, but particularly at Sibudu Cave, we have extraordinary evidence for environmental and cultural change (Wadley 2006b). It is important to us to take a holistic view and to position micro-residue analysis within the broader framework of data derived from fauna, botanical remains and site sediments (for recent multi-disciplinary contributions from Sibudu Cave see Wadley 2006b and references therein). The micro-residue work on stone tools is closely linked to our multi-disciplinary approach to research on the other archaeological material, and is intended to crosscheck and strengthen behavioural interpretations. It is against this background that we are also consistently attempting to improve our methodology and interpretative skills.

Rose Cottage Cave appears to have been occupied, perhaps intermittently, over a period of about 90,000 years (Pienaar 2006; Soriano *et al.* 2007; Valladas *et al.* 2005). Sibudu Cave has a long series of Middle Stone Age occupations with stone tool assemblages that can be attributed to a pre-Still Bay phase at the base of the sequence, a Still Bay Industry, a Howiesons Poort Industry, a post-Howiesons Poort phase, and late and final Middle Stone Age phases. A preliminary OSL age for the Still Bay is calculated at ~ 73 ka, no ages for the Howiesons Poort are available yet, but a large suite of layers with post-Howiesons Poort assemblages has a weighted mean OSL age of 60.1 ± 1.5 ka, the late Middle Stone Age phase has a suite of ages with a weighted mean average OSL age of 49.7 ± 1.2 ka, and the final Middle Stone Age phase has an OSL age of about 37 ka (Jacobs *et al.* submitted; Wadley and Jacobs 2006) (Figure 2). The Howiesons Poort Industry, which contains many backed tools such as segments, appears to shift seamlessly into the younger ~60 ka post-Howiesons Poort industry lacking backed tools (Wadley 2006b). Stratigraphically, the Howiesons Poort succeeds the Still Bay, but it is not yet known whether there is a hiatus between these two industries at Sibudu Cave (Wadley 2006b).

Figure 1: Map with deep-sequence KwaZulu-Natal sites and Rose Cottage Cave.

SELECTED METHODOLOGICAL DEVELOPMENTS

In 2004 we published the protocols and results of our first two blind tests (Wadley, Lombard and Williamson 2004). The original aim was to assess ML's ability to identify a variety of plant and animal residues using light microscopy. However, issues and problems that arose during the testing process made it clear that greater value might be gained from the lessons that we learnt about methodology and the direction for future micro-residue research (for discussions see Lombard and Wadley 2007a, 2007b and Wadley and Lombard 2007). Addressing problems identified during our first tests stimulated

research and subsequently two more tests were conducted, and this time they were totally field-based (Lombard and Wadley 2007a).

The series of tests helped to evaluate and improve the quality of data that could be gained through micro-residue analysis using light microscopy. For example it was shown that, based on their microscopic morphological appearance, animal residues could have been previously mistaken for plant residues (Figure 3). This discovery has far-reaching implications for the interpretation of archaeological assemblages, site functions and associated behavioural hypotheses. The same tests also demonstrated that the rock types used to produce stone tools might influence the quality of functional interpretations based on micro-residue analysis (for example, highly reflective quartz makes recognition of residues challenging, and the smooth surfaces of quartz do not readily retain residues).

We introduced a multi-stranded approach (Lombard and Wadley 2007a, 2007b; Wadley and Lombard 2007). This requires that functional and hafting interpretations are based not only on the presence of single identified micro-residues, but also on their association with related residues, their frequency, distribution patterns, layering, orientation, and the way in which they adhere to the tool. We believe that this approach, in combination with use-wear and macrofracture analyses (see Lombard 2005, 2006b, 2007a for application of this approach), controlled curatorial circumstances and the microscopic study of associated sediment samples and potential contaminants, provides a cautious, but secure strategy for the detailed interpretation of archaeological residues (Lombard and Wadley 2007a, 2007b; Wadley and Lombard 2007). ML also developed a method for creating quantifiable, comparable data for the interpretation of micro-residue distribution patterns (Lombard 2004, 2005, 2006a, 2007a, 2007b, in press). Using this method it is shown that, with adequate tool samples and good organic residue preservation, sufficient data can be generated to compare results from different assemblages or micro-stratigraphic archaeological contexts. The results can also be statistically tested for the possibility of coincidental distribution patterns (Lombard 2005, 2007 b). Interpretations based on such data have the potential to enhance considerably the resolution of our knowledge of human behaviour in the distant past.

IMPLICATIONS FOR OUR CURRENT KNOWLEDGE OF HUNTING AND HAFTING BEHAVIOURS

A brief background

Effective hunting with hafted weapons has long been part of the 'modernity' debate. Although evidence for active hunting or the presence of hafted stone tools was sometimes considered to imply modern behaviour (e.g. Ambrose 2001 and Klein 2000 and references in both), anatomically archaic humans also seem to have hafted tools and hunted (e.g. Rots and Van Peer 2006). This

Figure 2: North wall stratigraphy at Sibudu Cave showing the main occupational phases and associated approximate ages.

Figure 3: Selected images of replicated vegetal and faunal microresidues highlighting identification complications. (a) Inner epidermal cells of wet wood (*Combretum zeheri*) on a tool as a result of scraping bark, photographed at 200x. (b) Longitudinally orientated, striated muscle tissue on a tool as a result of cutting beef, photographed at 200x. (c) Plant fibres on the edge of a tool used to scrape fibrous leaf (*Sansevieria pearsonii*), photographed at 200x. (d) Collagen fibre on the edge of a replicated tool used to cut fatty cartilage of an *Aepyceros melampus* carcass, photographed at 200x. Figure originally published in Lombard and Wadley (2007a).

indicates a complex relationship between technological sophistication and behaviour that could be considered symbolic (and therefore modern). We know that symbolic behaviour can be traced with certainty to at least 82 ka in North Africa (Bouzouggar *et al.* 2007) and to a similar age in southern Africa (e.g. Henshilwood *et al.* 2002, 2004) because of personal ornaments that have been found at Taforalt (Morocco) and Blombos (South Africa). Thus we focus on hunting and hafting behaviour during the MSA not to provide further evidence for symbolic behaviour, but to increase our knowledge of past technologies, highlighting the complex, variable and multi-faceted nature of the archaeological record. Our brief overview of previously published results provides a summary of our contributions based on this approach. For more detailed and contextual discussions, please consult the primary publications.

Selected results for the post-Howiesons Poort

A multi-analytical functional study suggests that lithic points from the post-Howiesons Poort and late Middle Stone Age layers at Sibudu Cave, with ages between about 60 ka and 50 ka ago, were predominantly used as hafted spear tips. The quantification, plotting and chi-square statistical tests on the distribution patterns of 440 residue occurrences on 24 unbroken points show that the distribution of the residue types cannot be considered coincidental (Lombard 2004, 2005). The traces indicate the use of wooden shafts – revealing a hidden wood-working industry for which there is little additional evidence in the southern African Middle Stone Age (Figure 4). The stone points were probably glued to the shafts with an adhesive and then lashed with plant twine for added strength during use.

The evidence indicates that the spears were most likely used as thrusting or throwing spears. This impression is supported by technological and morphometric data that fall within the expected range of thrusting or throwing spears (Shea 2006; Villa and Lenoir 2006; Villa and Lenoir in press; Villa *et al.* 2005). Further indicators for effective hunting during this phase at Sibudu Cave come from the associated faunal assemblage (Cain 2006; Plug 2004; Wells 2006). The age profiles of the Sibudu Cave samples show that there are not many bones from juvenile or very old animals: most animals are adults, with some sub-adults. Carnivore-damaged bone is scarce in relation to the size of the sample. These factors indicate that the people using the cave between 50 and 60 ka actively hunted rather than scavenged, and were regularly targeting large animals in their prime (Plug 2004; Wells 2006).

Selected results for the Howiesons Poort

Based on their small size and apparent standardisation, it has often been hypothesized that backed tools from the Howiesons Poort were hafted (H.J. Deacon 1989, 1993; J. Deacon 1995; Wurz 1999). Initial micro-residue evidence for the hafting of such tools from the Howiesons Poort at Rose Cottage Cave (between about 68 and 60 ka old), was provided by Gibson *et al.* (2004). The spatial distributions of ochre, plant tissue, plant fibres and white starchy residue on 48 backed tools were seen as indications for hafting. The data were interpreted to indicate that backed blades could have been hafted laterally, segments (the type fossil of the Howiesons Poort Industry and also called crescents or lunates) might have been placed transversely into their hafts, while obliquely backed blades were possibly hafted with their short axis in the haft (Gibson *et al.* 2004).

A more recent study of the micro-residues and other associated use-traces on all the unwashed Howiesons Poort segments from Sibudu Cave provides further resolution for hafting technologies during this industry (Lombard in press). Here it is shown that most segments were indeed hafted, but that it might be difficult to distinguish whether they were hafted transversely, longitudinally or as pairs to form a point. When cumulative use-trace data (micro-residues, use-wear and macrofractures) are considered, however, it is shown that segments were probably hafted in a variety of positions and that there might have been differences in preferred hafting configurations during sequential phases of the Howiesons Poort at Sibudu Cave.

Interpretation of the micro-residues through the Howiesons Poort sequence also shows that there might have been time-related variability in haft materials; the oldest segments seem to have been hafted to bone and the youngest ones to wood, with a transitional phase where either bone or wood may have been used as shafts (Figure 5). These outcomes provide crucial evidence for relatively quick change and variability in technological behaviour during the Howiesons Poort, thereby contradicting the notion of slow change or even stasis during Middle Stone Age industries. Bone-hafting during the Howiesons Poort adds a new dimension to our understanding of hafting technologies and the composite tools of which segments were components (Lombard in press).

The micro-residues showed that segments were mostly used throughout the Howiesons Poort sequence to process animal material, and based on associated macrofracture and use-wear data, there are strong indications that they were predominantly used as inserts (tips, barbs or cutting inserts) for hunting tools (Lombard 2006b, in press) (Figure 6). Preliminary impressions of the Howiesons Poort faunal material indicate a wide range of species, with the little blue duiker well-represented (Clark and Plug submitted). Wadley (2006b) suggests that such tiny forest dwellers could have been trapped rather than hunted with spears or arrows. If we accept the interpretation for the principal hunting function of segments and Wadley's suggestion for the use of traps as reflecting real scenarios for meat procurement, it implies that people used highly variable and specialised hunting technologies more than 60 ka ago.

Selected results for the Still Bay

Recently a study was conducted on a sample of Still Bay pointed tools from Sibudu Cave (older than 70 ka). The sample size is still small, so that assemblage-level studies similar to those conducted on the Howiesons Poort segments are not yet possible. However, a detailed tool-by-

Figure 4: Selected tools and micrographs from the post-Howiesons Poort point sample, Sibudu Cave, indicating hunting and hafting. (a) A thick blood residue deposit, photographed at 200x. (b) A diagonally deposited ochre smear, photographed at 200x. (c) A transverse striation associated with ochre and plant exudate, photographed at 50x. (d) Bark cells or epidermal cell tissue, photographed at 500x. (e) Animal tissue, photographed at 500x. (f) Animal hair, photographed at 200x. (g) Woody residue trapped under a resin deposit, photographed at 100x. (h) A thick ochre and macerated wood deposit, associated with a diagonal striation and bright wood polish, photographed at 200x. (i) Bone and or sheet collagen, photographed at 500x. (j) Fatty residue, photographed at 100x. (k) Thick resinous deposit with wood cell imprint, photographed at 200x. (l) Woody fibres and resin associated with bright wood polish, photographed at 100x. Figure originally published in Lombard (2005).

Figure 5: Bone residues superimposed on resinous residues on the backed portions of four different Howiesons Poort segments from Sibudu Cave; (a) photographed at 100x, (b) photographed at 200x, (c) photographed at 500x, (d) photographed at 200x. Figure originally published in Lombard (in press).

a

b

Figure 6: (a) Selected Howiesons Poort segments from the Umhlatuzana assemblage. (b) Potential hafting configurations re-drawn by L. Davis after Nuzhnyj (2002).

tool analysis made it possible to test existing hypotheses and generate new working hypotheses for the functions and hafting technologies of these tools (Lombard 2006b). For example, Wadley (2006b) suggested that Sibudu's double-pointed, bifacial points with asymmetrical bases were not intended to be reversible in their hafts, but that the bases were pointed to facilitate a type of hafting that was favoured at the time. The micro-residue distribution patterns and other use-traces on the two unbroken points of this type support this suggestion (Figure 7). Furthermore, both tools show signs of having been used as knives for butchering activities. It is thus possible that the asymmetrically-pointed bases were an adaptation to facilitate the effective hafting of the tools as knives (see Lombard 2006b) (Figure 8). This also supports Minichillo's (2005) and Shea's (2006) suggestions that some Still Bay points from the Cape were used as knives.

There is one triangular bifacial point in the Sibudu sample that is similar in morphology to post-Howiesons Poort points. Macro-fractures and the distribution of animal residues on this point, and also on distal fragments of other points, show that they could have been used as hunting weapons. Thus, a current working hypothesis is that the asymmetrical points with pointed bases were hafted as knives, while symmetrical, triangular points were possibly hafted as hunting weapons. Continued work at Sibudu Cave and other sites with Still Bay assemblages will test this hypothesis. The preliminary results imply, however, that Middle Stone Age points from Still Bay contexts might have been used and hafted differently from points from the younger Middle Stone Age phases.

The use of ochre during the Middle Stone Age

Ochre has been intensely discussed in the literature because its presence is sometimes regarded as evidence for early symbolism (e.g. Ambrose 1998; Barham 1998, 2002; Barton 2005; Conard 2005; d'Errico 2003; Hovers *et al.* 2003; Watts 1998, 2002; Wreschner 1980, 1982). The large quantities of ochre retrieved from Middle Stone Age sites (Watts 2002) and the engraved ochre fragments from Blombos Cave with an age of about 77 ka (Henshilwood *et al.* 2002) mean that the Middle Stone Age of South Africa is central to any debates about ochre. The research conducted on the tools from Sibudu Cave and Rose Cottage Cave and related experimental work has considerably augmented our understanding of the applications of pigmentary materials such as iron hydroxides and iron oxides, casually referred to as ochre (see Gibson *et al.* 2004; Hodgskiss 2006; Lombard 2004, 2005; Wadley 2005a, 2005b, 2006a; Wadley, Williamson and Lombard 2004). For example, when micro-residue analysis was used to establish the relationship between resin and ochre on a sample of 53 Howiesons Poort segments from Sibudu Cave it was demonstrated that most of the ochre (80%, total n of occurrences = 502) and resin occurrences (87%, total n of occurrences = 585) are located on the backed portions (Lombard 2006a) (Figure 9). These portions of backed tools are generally associated with hafting based on ethnographic and archaeological examples from a variety of contexts (e.g. Becker and Wendorf 1993; Bocquentin and Bar-Yosef 2004; Clark 1977; Clark *et al.* 1974; Goodwin 1945; Phillipson 1976).

The results are interpreted as compelling, direct evidence that the tools were hafted, and that ground ochre was used in the adhesive recipe. It supports the hafting evidence for backed tools from the Howiesons Poort at Rose Cottage Cave and previous observations about the association of ochre with Middle Stone Age hafting technology (Gibson *et al.* 2004; Wadley, Williamson and Lombard 2004). A similar trend for the distribution of ochre and resin residues on the Sibudu segments was documented on a sample of 30 non-quartz Howiesons Poort segments from Umhlatuzana Rock Shelter, about 100 km south-west of Sibudu Cave in KwaZulu-Natal (Lombard 2007b). However, when a sample of 25 quartz segments from Umhlatuzana Rock Shelter was analysed using the same methodology, 269 resin occurrences and only 43 ochre occurrences were counted. Although both residues were concentrated on the backed edges, 68% of the quartz segments have resin but no ochre on them. The same is true for only 23% of the non-quartz sample from the shelter, and 9.5% of the Sibudu Cave sample (Lombard 2007b).

The quartz and crystal quartz segments are not only generally smaller than those made on hornfels and dolerite, but they are also less elongated. Based on these morphological attributes

Figure 7: Example of the use-trace plots on a double-pointed, asymmetrical bifacial point from the Still Bay at Sibudu Cave. At = animal tissue, Bl = blood, Bn = bone, Bs = brown stain, Co = collagen, Ed = edge damage, Er = edge rounding, Ft = animal fat, Hr = hair, LStr = longitudinal striation, MWr = macerated woody residue, Oc = ochre, Pf = plant fibre, Po = polish, Pt = plant tissue, Re = resin, TStr = Transverse striations, Wr = woody residue. Figure originally published in Lombard (2006b).

Figure 8: Hypothetical reconstruction of a double pointed, asymmetrical bifacial Still Bay point as a butchering knife with a wooden haft based on use-trace analysis. Drawing by P. Letley.

Figure 9: (a – c) Howiesons Poort segments from Sibudu Cave with macroscopically visible ochre residues on their backed portions. (d) Ochre grains in a clear resin deposit recorded on the backed portion of a Howiesons Poort segment from Sibudu Cave, photographed at 200x. (e) Ochre grains in a clear resin deposit on a replicated stone tool that was hafted to a wooden haft with an ochre-loaded adhesive.

we have suggested that they could have been hafted differently from the larger, longer segments produced on other raw materials (Delagnes *et al.* 2006). Quartz is also very hard (Moh's scale 7; Bishop *et al.* 2001) and the surface is smooth and glass-like. During replication and blind testing (Lombard and Wadley 2007a) it was found that residues do not adhere to the hard, smooth surfaces of quartz to the same degree as they seem to adhere to more porous, coarser-grained raw materials. It is therefore feasible to consider that a different, possibly more 'sticky', adhesive recipe may have been used for the hafting of quartz tools. Our ochre research reported here and elsewhere does not necessarily conflict with interpretations of Middle Stone Age ochre-use as symbolic. Instead, our findings imply that at least from about 70 ka ago, and probably before, people had sophisticated knowledge of the properties of ochre, which made it a suitable aggregate for use in strong glues. Our findings enrich understanding of past technologies, which were by no means primitive.

CONCLUSION

The aim of this paper is to illustrate how stone tool micro-residue analysis in South Africa has evolved in close correlation with Middle Stone Age excavations, experimental research projects and international research trends. The methodology and reference collections, which were developed during replication for experimental projects and blind tests, enable us to generate quantitative data. Such data can be used for comparison with archaeologically recovered assemblages from various contexts at the same site, or even assemblages from different sites. One example is the

comparison of the ochre and resin distribution patterns on quartz and non-quartz Howiesons Poort segments from two KwaZulu-Natal sites (Lombard 2007b).

Both the Howiesons Poort and Still Bay technocomplexes are central to the debate about the emergence of modern cognitive behaviour (Ambrose 2006; H.J. Deacon 1989, 1995, 2001; Deacon and Wurz 1996; Henshilwood *et al.* 2001a, 2001b; Lombard 2007a; Minichillo 2005; Wadley 2007; Wurz 1999; Wurz and Lombard in press). Micro-residue analyses conducted within the context of these bigger focus areas are starting to provide detailed, empirical evidence for hunting and butchery activities as well as insight into the complexities of hafting technologies practised during the Middle Stone Age.

Micro-residue analyses provide evidence to support other data that imply effective and innovative hunting (e.g. Marean and Assefa 1999). The results of these focused research projects inform on ancient technological skills and planning abilities. More than 70 ka ago, people understood the properties of various raw materials and tool shapes, sizes and weights, and they seem to have adapted their hunting, butchery and adhesive technologies accordingly. We have generated evidence for change and variability during the Middle Stone Age that might indicate cumulative advances in cognition from at least 70 ka ago. If we accept that people in South Africa behaved symbolically before 70 ka ago (e.g. Henshilwood and d'Errico 2005), we ought to expect that the evidence for change and complexity in behaviours will become increasingly evident in the archaeological record after about 70 ka.

It is understood here that the mere existence of, or evidence for, changes in technologies such as hunting weapons or hafting strategies do not provide evidence for or against symbolic behaviour. The discernible technological variability in the Middle Stone Age record helps, however, to dispel previous notions of simple, unchanging technologies and subsistence patterns. The closer that we get to understanding everyday life in the remote past, represented in tasks such as hunting and hafting, the more it seems that these ancient hunter-gatherers may have behaved similarly to their more recent counterparts.

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