

# Small things in perspective: the contribution of our blind tests to micro-residue studies on archaeological stone tools

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## Abstract

Our blind tests are distinctive for they were conducted on replicated stone tools used for a variety of tasks that included the processing of animal remains and plants. The analyst was required to differentiate an array of residues from microscopic morphological characteristics, using light microscopy. The original aim of our first tests was to assess the analyst's ability to identify a variety of plant and animal residues, but 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. We show that problems identified during our first tests stimulated research. Amongst other things, we learnt to distinguish plant and animal remains more confidently than previously. Our residue analyses are firmly embedded in wider archaeological research and our tests help to explain why there are sometimes contradictions between the evidence from archaeologically recovered remains and residues on stone tools. A further outcome of the tests is that we have adopted a multi-stranded approach that provides a cautious, but secure strategy for identifying and interpreting use-residues. Our studies of contaminants through replications have also been invaluable for distinguishing incidental residues from use-related residues.

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## 1. Introduction

We thank Crowther and Haslam (2004) for the detailed critique of our 2004 blind test paper. We are grateful for this opportunity to clarify our approach to residue analysis and to blind tests for residue analysts. At the same time, we should like to record the long-standing intellectual debt of gratitude that we owe to the University of Queensland because the late Tom Loy introduced residue analysis to our institution and, by extension, to Stone Age studies in southern Africa. He generously gave

much time, both in Brisbane and in South Africa, to the training of South African archaeology students who were interested in pursuing residue analysis. He ran a detailed theoretical and practical course for staff and students in our department and his unpublished monograph on residue analysis is still a useful reference for us. He trained Williamson and was an advisor and mentor to her during the analysis stage of her PhD research as well as during the writing of her dissertation (Williamson, 2000). He was a fine teacher and his enthusiasm for residue research was infectious. He inspired in us a passion for, and belief in, replication work because he was able to demonstrate that this type of research effectively answers archaeological questions and also stimulates new enquiries. For us, this has been his greatest legacy; we pay tribute to Tom Loy here; his South African sojourns and his research collaboration are sorely missed.

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While we are convinced of the importance, particularly of replication, we do not regard replications or blind tests as ends in themselves; our experimental work is deeply embedded in archaeological questions that have arisen during the course of excavations and research projects, first at Rose Cottage Cave and subsequently at Sibudu Cave (Gibson et al., 2004; Lombard, 2004, 2005, 2006a, 2006b; Lombard et al., 2004; Tomlinson, 2001; Wadley et al., 2004c; Williamson, 1996, 1997, 2000, 2004, 2005). Some background will explain our stance. Rose Cottage Cave appears to have been occupied, perhaps intermittently, over a period of about 90 ka (Pienaar, 2006; Valladas et al., 2005) and Sibudu Cave has many finely separated Middle Stone Age layers that have been dated to between about 33 ka and 60 ka by optically stimulated luminescence (OSL) (Jacobs, 2004; Wadley, 2005c; Wadley et al., 2004a). Below the layers dating to 60 ka there are 2 m of Sibudu Cave deposits for which OSL dates are not yet finalized; they are currently being processed. Both sites have yielded hundreds of thousands of stone tools from long sequences containing multiple industries (Clark, 1997a,b,1999; Cochrane, 2006; Harper, 1997; Villa et al., 2005; Wadley, 1992, 1996, 1997, 2000a,b, 2001a,b, 2004, 2005c). Moreover, these stone tools occur in varying contexts over time. At both sites, but particularly at Sibudu Cave, we have extraordinary evidence for environmental change, for change in hunting and gathering patterns, for technological change and for change in the use of features such as hearths. It is within this context that we explore the potential uses of stone tools and investigate whether these were composite, hafted tools.

In her role as the primary investigator of the sites, curator of the collections and the director of research, LW has, amongst other projects, been consistently interested in the potential information that is to be gained from examining micro-residues, particularly those on stone tools. For more than a decade and a half, stone tools from Rose Cottage and Sibudu Caves have been collected with the specific intention of subjecting them to residue analysis. We removed hundreds of stone tools intended for residue analysis directly from the ground. These tools were individually stored in their own airtight plastic bags and not touched again until the analyst examined them under the microscope. Soil samples were also gathered from the corresponding stratigraphic layers and analyzed for comparison with residues on the tools (Lombard, 2006a; Williamson, 2000, 2004, 2005).

Like Wylie (1989) we subscribe to the use of multi-stranded evidence for archaeological interpretations (an issue to be discussed later in the context of residues). It is important to us to take a holistic view and position residue analysis within the broader framework of data such as fauna, plant and site sediments (for recent contributions from Sibudu Cave, see Allott, 2004; Allott, 2006; Cain, 2004; Plug, 2004; Plug, 2006; Rots, 2003; Therin, 1998; Wadley, 2005a). Our residue work on stone tools is linked to our multi-disciplinary approach to research on the other archaeological material, and is intended to complement it. Our replications and our blind tests are designed to answer specific archaeological questions and we acknowledge that other researchers may choose to

conduct replications differently from us because their aims are different from ours. We increasingly take the view that field-based tasks are imperative for creating replicated residues, both for comparative collections and for the testing of experienced residue analysts. We now regularly perform replications in the field in an attempt to imitate situations that might have taken place in antiquity (Lombard et al., 2004; Lombard and Wadley, 2006; Wadley, 2005a,b).

We know, from abundant bone fragments in the Middle Stone Age deposits of Sibudu, that a wide variety of animals were processed in the cave (Plug, 2006). From cut marks and other traces on bone we know that meat was cut and bones were smashed around hearths. We have tried to replicate such actions in natural surroundings for we assume that when animals were butchered in the past, this would have been done on the ground, on a hide, on rocks or on grass. In field situations tools acquire incidental residues ('contamination') and a residue analyst must be able to recognize these if archaeologically recovered residues are to be dealt with competently. We now have a large database of modern residues gathered from field-based tasks to supplement our more conventional residue catalogue (Williamson, n.d.) that contains, for example, single plant and animal residue types on microscope slides. Our replicated assemblage of animal and plant residues has been considerably enlarged as a result of exploring issues that arose from Tests 1 and 2. Hunting and butchery experiments (Lombard et al., 2004) contributed a large and valuable set of animal residues on stone tools. This set has added substantially to the understanding and recognition of animal residues and it has helped to resolve some of the identification problems that were acknowledged in Test 1.

## 2. The usefulness of our blind tests

Crowther and Haslam, 2006 conclude that the value of our first blind tests was compromised because of the flaws in the tests themselves. The flaws in the tests were, of course, acknowledged in the 2004 paper and we pointed out there that lessons were learnt from our mistakes. We now appraise these first tests and show how they advanced our understanding of micro-residues, both directly and indirectly. Since the first tests we have conducted two more blind tests (Tests 3 and 4) (Lombard and Wadley, 2006) that were entirely field-based. These address some of the problems that we became aware of during the previous tests and they identify more areas that need work in the future. We refer to the new tests here when appropriate. The more important lessons learnt from our blind tests are separately discussed in detail. Here we list the main points.

1. From Test 1 we learnt that plant and animal residues could sometimes be confused. Subsequent research has concentrated on resolving these identification difficulties (Lombard and Wadley, 2006).
2. As an outcome of distinguishing plant and animal residues we confirmed that multi-stranded evidence provides for more secure identifications and that multiple, attendant

residues are best for recognizing use-related residues and isolating incidental residues (Lombard and Wadley, 2006).

3. We learnt that contaminants should be expected on stone tools, even when precautions are taken to prevent their accumulation, and that the recognition of ‘incidental residues’ on archaeologically recovered tools is a skill that analysts can and must develop.
4. We learnt that the residue distribution patterns of some contaminants, which resulted, for example, from handling tools with ‘dirty’ hands, can potentially be recognized. This has been enabled by the database of handling marks that is now available on the Test 1 and 2 tools in the form of distribution patterns of starch from the powdered gloves.
5. We learnt that large numbers of variables in a test are, on the one hand, disadvantageous for testing the analyst’s skill and, on the other hand, advantageous in that they provide new and unexpected avenues for future research. Sometimes influential variables are not recognized as such until a test is underway. Test 3 (Lombard and Wadley, 2006) is a good example: here we discovered that reflective rock types provide challenges for seeing residues under a microscope.
6. We learnt that blind tests are of even greater value for isolating problems of identification and methodology than they are for testing an analyst’s skill. Our future work will concentrate on issues of identification and methodology.
7. We learnt from Test 2 that diagenesis of residues is highly complex and that we need to do much more research in this regard before we can address the problems that we identified.

### 2.1. Distinguishing plant and animal residues

Test 1 highlighted problems in the morphological distinction of plant and animal residues. Most identification mistakes in the tests were made on faunal material and this suggested that some archaeological faunal residues might, in the past, have been erroneously interpreted as plant material. This issue is one of particular interest in our broader archaeological investigations because Sibudu Cave has large faunal assemblages yet, prior to 2003, we found relatively few animal residues on stone tools. This seemed counter-intuitive. Errors of identification may have contributed to the perception that plant materials were processed more often than animal materials, or that animal residues did not preserve well. Although this may be true for some archaeological sites, it cannot be the case for all sites and all tool types. Contradictory evidence in the form, for example, of large faunal assemblages and few animal residues on stone tools should sound a warning signal and, under such circumstances, residue analysts need to accept that residues may not be telling the full story (Hardy, 2004; Lombard and Wadley, 2006).

ML’s research thrust after Test 1 was to work at the recognition of animal residue types and the comparison of these with a variety of plant residues. An important outcome of

Test 1 was the confirmation that birefringence (the double refraction of incident light) is not an exclusive characteristic of cellulose plant residues; certain faunal tissues are also highly birefringent during the cross polarization of incident light (Lombard and Wadley, 2006; Wadley et al., 2004b). Another outcome was the recognition that there are morphological similarities between some plant and faunal residues, such as ordered cell structures, the characteristics of fibers, and the color and translucency of residues. Degraded residues make the distinction between plant and animal even more difficult, and degraded residues will be present on most archaeological tools. These issues are discussed and illustrated in Lombard and Wadley (2006). We suggest that a secure and cautious way of solving such identification problems is to rely on multi-stranded evidence. We expand on this proposition later.

### 2.2. Contaminants

As we have already implied, not all residues on stone tools represent tool function. Contaminants collect easily on tools and we confirmed this during our first tests, partly as a result of mistakes, but also because of using materials collected in the field. Replicated tools used in the field will invariably accumulate contaminants, just as ancient tools would have done in the past. Thus residue analysts need to give as much attention to the recognition of potential contaminants as to other residues. ‘Dust’ is a case in point: it is always in the air around us (particularly so in arid environments such as ours) and minuscule particles such as starch grains, pollen, spores, ash, fibers, hair and feather or down fragments are regularly found in this dust. Fig. 1 shows a ‘dust collector’ with some micrographs of dust residue types. To simulate wet residues, such as freshly butchered meat or plant juices, double-sided tape is placed on a microscope slide and left in the open to accumulate dust. These potential contaminants are micrographically recorded for our reference collection, and the microscope slides are curated in airtight slide containers for future three-dimensional reference purposes.

In addition to inclusions from ancient dust, archaeologically recovered tools may have accumulated other kinds of contaminating residues post-depositionally, prior to excavation. There are several ways to address this issue; amongst these soil samples can be tested using distillation (Williamson, 2004) or flotation (Fullagar et al., 1998; Therin, 1998) processes. More often than not, a large amount of matrix is present on unwashed samples and it is critical that the analyst is aware of its composition and its microscopic morphological appearance. This is especially important in cases where the deposit is mainly anthropogenic, for example, at Sibudu Cave. The deposits may contain large quantities of organic substances, such as fossil plant ash, phytoliths, silica skeletons and bone (Schiegl et al., 2004). Thus, soil components that are not use-related may affect the results of residue analysis. Test 2 was originally intended to examine this type of issue, but because of the problems that arose during the design of this test we postponed diagenesis studies for future research.

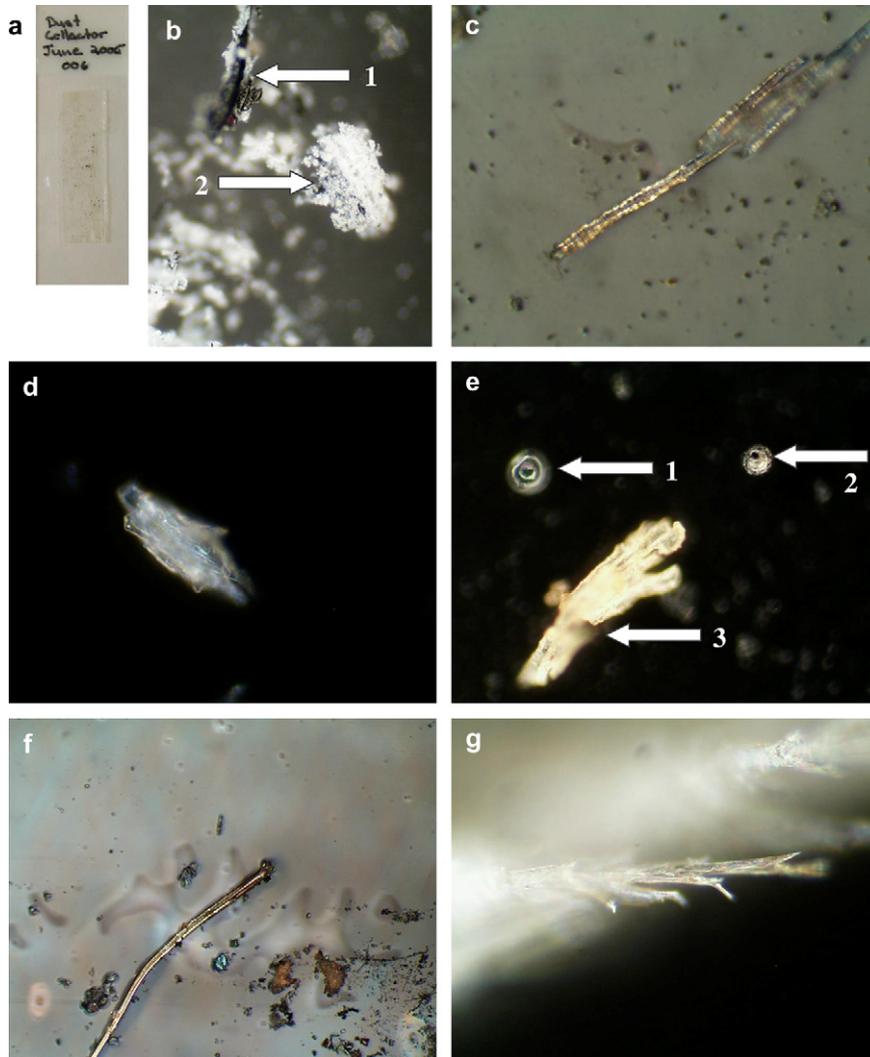


Fig. 1. Examples of 'dust' particles recorded on dust collecting slides. (a) Microscope slide with double-sided tape. (b1) Charcoal and (b2) ash photographed at 100 $\times$ . (c) Dried plant fibers probably from wood or rigid grassy stalks photographed at 200 $\times$ . (d) Possible plant cellulose tissue photographed at 500 $\times$ . (e1) Spore, (e2) pollen grain and (e3) woody plant tissue photographed at 500 $\times$ . (f) Hair photographed at 50 $\times$ . (g) Feather fragment photographed at 500 $\times$ .

Soil studies are useful as part of the holistic approach to analyses, but, on their own, they do not represent the full range of morphological observations made during residue analysis using light microscopy. ML has a strategy to address this shortcoming. During excavation, soil samples are retrieved from each layer that yields tools for residue analysis. The samples are stored in airtight bags. In the laboratory a strip of double-sided tape is applied to a microscope slide. The slide is then agitated in the bag with the soil sample until a thin layer of soil adheres to the tape. Each slide is provided with a loose protective membrane that can be peeled away during microscopy. The slides are sealed in airtight specimen containers to avoid modern contamination. Before analysis of a tool, the slide with the appropriate soil sample is microscopically studied and a micrographic record of its morphological characteristics is created. Such images are frequently referred to during the residue analysis of a tool. The method provides the analyst with a replica of the matrix as seen through the microscope. The soil residues can be compared with putative use-related

residues. This approach can also be used to identify and isolate some 'accidental' residues (contaminants), because such residues seldom occur in high frequencies or with distinct and repetitive distribution patterns.

### 2.3. Using multi-stranded evidence

As a result of our experience with a series of four blind tests we suggest that using multi-stranded evidence is a satisfying solution for distinguishing between some plant and animal residues, and for isolating residues that are potential contaminants. We believe that minuscule fragments of plant tissue, fibers, starch grains, feathers or hair can only be securely interpreted as use-residues when there are supportive strands of evidence. This applies to archaeological tools as well as to experimental ones. Supportive evidence could come from repetitive clustering of a variety of plant residue types, such as tissue, fiber and starch grains in attendance with other plant residues such as wood, bark cells, resin or plant exudates.

The same principal holds for faunal residues, which can be most convincingly identified when hair, animal tissue, fat, bone, blood and collagen (or several of these elements) are found as associated residues. Single faunal elements, such as collagen fibers alone, provide less confident identifications. The results of our most recent tests (Lombard and Wadley, 2006) show that the most reliable way to identify residues, and therefore to interpret tool function, is by recording combinations of residues.

A single residue or residue type seldom determines the use of a stone tool. Our cumulative replication, experimentation, testing and archaeological work, on more than 1000 tools, shows that when use-related residues preserve, they often preserve collectively. Not once has ML encountered only one residue type (or one single residue) on used replicated tools or on ancient tools from Sibudu Cave, which were unquestionably used because of tell-tale use-wear traces and macro-fractures present on them. This being said, we acknowledge that the organic, and therefore residue, preservation at Sibudu Cave is probably exceptional. Comparable residue frequencies (Lombard, 2004; Lombard, 2005; Lombard, 2006a) may not be present on tools from other sites or in other contexts.

Our work on the repetitive clustering of residues suggests that single or isolated micro-residues should not be employed for interpreting the use of a tool (Lombard, 2006b). Some interpretive inaccuracies about tool use would not have been made in the first tests if we had then employed the rule of using repetitive combinations of residues as the criteria for tool use. Tools 22 and 28 are a case in point: although they were used only for scraping *Acacia* wood, ML found animal residues on the tools in addition to plant residues. In trying to explain the puzzling contamination we suggested that bush babies (*Galago*) living in the tree from which the wood was cut may have caused the animal traces. Later we discovered that kudu rub themselves against this same tree and that giraffe regularly browse leaves from amongst its thorns, so the potential for animal traces is greater than we realized in 2004. Nonetheless, Crowther and Haslam, 2006 are right that we do not know exactly what happened to produce the animal traces on the tool. These enigmatic test tools imitate precisely the type of situation faced by an analyst dealing with archaeological tools and it seems best to face the situation rather than discard the test results. Importantly, the issues that arose from this perplexing case lead to ML's research into contamination, into the study of animal versus plant residues and into distinguishing use-traces from incidental traces. With hindsight, wood from the same *Acacia* tree can be avoided for future replications, but we can never guarantee that contaminating residues of one sort or another will be absent from products used in field replications. This is why we chose to tackle head-on the issue of identifying contamination, rather than to discard the results of our tests. If we had met with no problems in our first tests we would not have explored the issues discussed here and our research would not have advanced as much as it has. The valuable lessons learnt from resolving issues that arose during the first tests were almost entirely responsible for the 100% score recorded in Test 4 (Lombard and Wadley, 2006).

#### 2.4. Distribution patterns of related residue types on archaeological tools

In addition to the recording of multiple related residue types, distinctive distribution patterns of such residues on archaeological tools may provide supplementary information on tool use and on technological aspects such as hafting strategies (Lombard, 2004; Lombard, 2006b). When other use-traces, such as use-wear and macro-fractures, are detected, even more strands of evidence can be drawn on to crosscheck and strengthen interpretations based on micro-residues (for example, Fullagar, 1991; Hardy et al., 2001; Lombard, 2005; Rots and Williamson, 2004). As an example of our multi-stranded approach, and the detailed information that can be gained by its application, we present the results of a recently analyzed pre-Howiesons Poort tool interpreted as a butchery knife with a wooden handle (Lombard, 2006b).

The distributions of related residue types and other use-traces are exceptionally clear on this tool; patterns on other tools are sometimes more complex and are more difficult to interpret. The tool was excavated by ML in 2005, placed in an airtight bag immediately after excavation, and was handled again only when she conducted the residue and use-wear analyses. Archaeological and post-depositional contaminants could be isolated as a result of the previously described method for analyzing soil samples. Ninety-three micro-residues were recorded (Fig. 2). Some residues were interpreted as evidence for use and others for evidence of hafting technology. For definitions and criteria by which these residues are defined please see Wadley et al. (2004b) and Lombard (2005). Animal residues ( $n = 41$ ) are represented by five types that include animal tissue ( $n = 7$ ), bone ( $n = 9$ ), collagen ( $n = 6$ ), fat ( $n = 17$ ) and hair ( $n = 2$ ) (Figs. 2a and 3). Recorded plant residue types ( $n = 36$ ) include macerated woody residue ( $n = 2$ ), woody residue ( $n = 3$ ), resin ( $n = 24$ ), plant tissue ( $n = 2$ ) and plant fibers ( $n = 5$ ) (Figs. 2b and 3). Sixteen ochre occurrences were also recorded (Fig. 2c). The distribution of several types of animal residue along the edges of the distal half of the tool indicates that it was used to process animal material (Fig. 2a). No traces of plant processing were recorded on this distal portion. The fact that residues are concentrated along the edges, and not on the surfaces of the distal portion, implies that the tool was probably not used as a spearhead (Lombard, 2004; Lombard et al., 2004). Longitudinal striations along the same edges, and parallel to them, signify cutting motions (Fig. 2c). No signs of scraping were observed. The combination of residue and use-wear traces, their distribution on the tool laterals and the pristine condition of the tip itself, all indicate that the distal edges of the tool were used to cut an animal product. All plant residues and ochre are concentrated on the proximal half of the tool (Fig. 2b and c). This evidence, together with the extensive bright polish over the proximal surface, the edge rounding, edge damage and transverse striations along the proximal edges, supports the suggestion that the tool was hafted to a wooden handle (Fig. 2c) (Lombard, 2005; Lombard, 2006b; Rots, 2003; Rots et al., 2006).

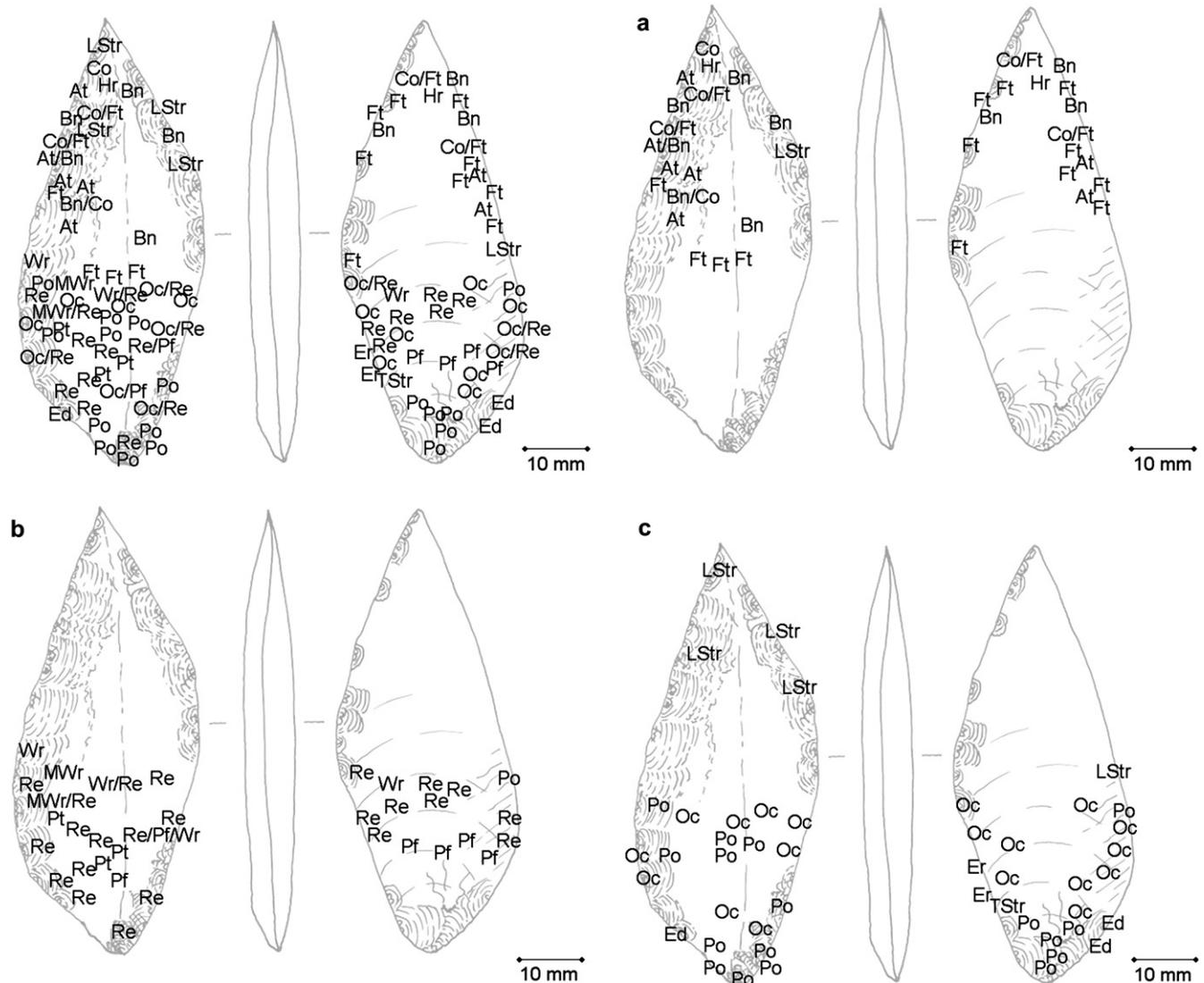


Fig. 2. Use-traces on a pointed tool from pre-Howiesons Poort layers at Sibudu Cave. This image illustrates the repetitive combinations and associations of residues, and the density of distribution on the tool. Key to use-trace abbreviations: At, animal tissue; Bn, bone; Co, collagen; Ed, edge damage; Er, edge rounding; Ft, animal fat; Hr, hair; LStr, longitudinal striations; MWr, macerated woody residue; Oc, ochre; Pf, plant fiber; Po, polish; Pt, plant tissue; TStr, transverse striations; Wr, woody residue. (a) Distribution patterns of animal residues only on the same tool. (b) Distribution patterns of plant residues only on the same tool. (c) Distribution patterns of ochre residues and usewear traces on the same tool.

### 2.5. The glove story

According to Crowther and Haslam, 2006 the use of the starched gloves should have invalidated Tests 1 and 2 from the outset. However, this fortuitous mistake provided unexpected and, indeed, very useful information. We have already discussed one useful outcome. In addition, we were able to record and publish the morphological appearance of starch grains used to manufacture powdered gloves (Wadley et al., 2004b). We now expand on our published record, and hope that other researchers will find the information equally useful. The starch grains from this source did not clearly show the expected, characteristic extinction crosses under cross-polarized light. Extinction crosses will not always be visible on starch grains if they have been modified as a result of degradation, heating or chemical exposure. It is possible that during the

manufacture of powdered gloves starches used for this purpose are processed in various ways that might render extinction crosses less visible. These starch grains are also homogeneous in size (see Fig. 2 in Wadley et al., 2004b), while use-related starch grains from other sources could vary considerably in their size range (for illustrations see Fullagar et al., 2006; Pearsall et al., 2004; Piperno and Holst, 1998; Piperno et al., 2004; Therin, 1998). A further example is clearly illustrated in the documentation of potato starch grains on a tool from the first test (see Fig. 4d in Wadley et al., 2004b), which is easily distinguished from the glove starch.

As previously curated tools are increasingly subjected to residue analysis, and it is conceivable that starch grains from laboratory gloves could be present on such tools, we welcome the ability to be able to identify starch from this source. Furthermore, the lack of clear extinction crosses as a result of

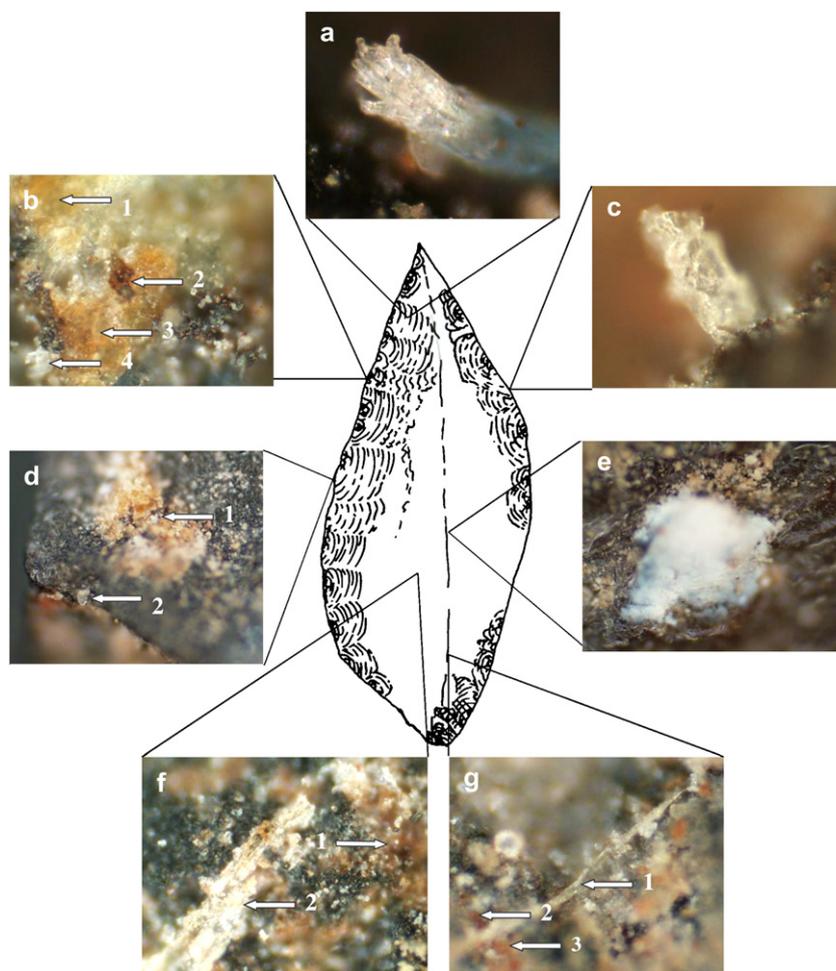


Fig. 3. Selected micrographs of residues on the pointed artefact. (a) Collagen bundle photographed at 500 $\times$ . (b) Associated animal residues with (b1 and b3) thin animal tissue films, (b2) thick muscular tissue residue and (b4) collagen photographed at 200 $\times$ . (c) Bone fragment photographed at 500 $\times$ . (d) Associated animal residues with (d1) animal tissue and (d2) bone fragment photographed at 50 $\times$ . (e) Smeared animal fat photographed at 200 $\times$ . (f) Degrading woody residue photographed at 200 $\times$ . (g1) Plant fiber associated with (g2) resin and (g3) ochre photographed at 200 $\times$ .

the modification of starch grain surfaces may, in future, aid the interpretation of residues on tools that could have been exposed to hearths, bush fires or similar events. This observation has potential for forthcoming research. Furthermore, we found that by observing the distribution patterns of the glove starch on the tools from Test 1 it was possible to recognize when residues accumulated on tools as a result of handling, as opposed to those resulting from use-related activities (see results of Tests 1 and 2 in Wadley et al., 2004b). The documented distribution patterns of these ‘handling’ residues can be compared with the distribution of residues on archaeological material. For example it may be possible to establish whether a powdery residue, such as ground ochre, is distributed on a tool as a result of processing, handling or hafting (Lombard, 2006a).

Even though we have learnt valuable lessons from the use of powdered gloves, we agree with Crowther and Haslam, 2006 that powdered gloves should not be used for micro-residue studies, unless the purpose is to examine the distribution patterns of ‘handling’ residues. But, should the unqualified use of gloves (Weisler and Haslam, 2005) be encouraged at all? After our glove quandary ML requested that no gloves be used for future

tests, in fact, she requested that the tools should not be treated or cleaned in any way: “make them and use them like you think a hunter-gatherer would have”. This request was made after thorough deliberation, and after observing the use of gloves in general laboratory environments. Gloves seem to provide a false sense of sterility. Often the objects they seem to keep cleanest are the hands wearing them. Thus, if gloves are used for micro-residue analysis it can only be considered of value when:

- The full curatorial history of the tool sample is unequivocally established without any caveats, and it is well known that the tools were protected from dust or any other contaminants, and that each tool was always handled with clean gloves.
- A new pair of gloves from a sealed sachet is used for each tool because residues or contaminants may transfer from one tool to the other, especially if the tools are unwashed archaeological samples. Such tools are not ‘clean’ by any standards.
- The gloves are from sealed plastic sachets and not from open boxes or paper sachets which may contain

microscopic paper fibers or laboratory dust (where the workplace is not a dust-free zone).

- All objects that the analyst will be touching during the analysis are sterilized before each tool is analyzed; this includes microscope controlling knobs, buttons, keyboards, reference material and writing utensils for taking notes. The analyst should also be the only person touching any of these objects.

For practical reasons and because of the physical limitations of our laboratories, we cannot fulfill these conditions. As ‘dirt’ archaeologists, familiar with excavation conditions, we also consider that the use of gloves in the field, where the contamination possibilities are much greater than in the laboratory, is even less reasonable. For the purposes of our work, we are more comfortable with the challenging—and sometimes painful—process of finding ways to deal with the realities of studying archaeological micro-residues than to make-believe we are working in sterile, controlled conditions. We suggest that analysts wash and air-dry their hands thoroughly and repeatedly during the analysis of each tool. We also no longer insist that excavators remove tools from the excavation with sterilized plastic tweezers. The hands of excavators are covered with the sediment from which the tools originate, and therefore, the tools can be dropped into a resealable plastic bag by the excavator with no threat of greatly disturbing any residues. However, we do recommend the cleaning of hands after field meals are enjoyed.

### 3. Discussion

It would have been simple for us to have abandoned our initial tests, to leave them unreported, and to have started again, but we learnt so much from them that we decided to share our experience with other researchers. The title of the 2004 paper was intended to indicate this learning process. We called them ‘first residue analysis blind tests’. These tests were noticeably different from earlier immunological tests conducted at commercial laboratories on blood residues (Leach and Mauldin, 1995) or plant residues (Leach, 1998). Hardy and Garufi (1998) conducted previous tests to identify woodworking activities, but their work was focussed on this single residue type and on use-wear traces (with their residue work they aimed to establish the presence or absence of wood residues on tools that were used to process wood, and they aimed to identify wood classes and species). As far as we are aware, no attempts prior to 2004 were published to test an analyst’s ability to identify and differentiate an array of residues based only on the microscopic morphological characteristics of such residues using light microscopy, and our new tests are explicitly and deliberately field-based to complement our archaeological research (Lombard and Wadley, 2006). There has not been any attempt to mask the flaws of Tests 1 and 2 and a number of methodological and identification obstacles were reported in the publication (Wadley et al., 2004b). Incorporating the words ‘lessons learnt’ in the title of the paper

underscored our intent. As we have attempted to show here, our subsequent efforts to overcome the initial difficulties have led to valuable insights about micro-residue identification in addition to improved methodology. This type of feedback approach is also well illustrated in the work of Rots et al. (2006), who conducted a series of blind tests for the interpretation of use-wear traces resulting from hafting and prehension.

Blind tests can be intimidating and threatening for researchers who feel pressurized to score highly. This is probably why analysts are not undertaking these tests (or are not publishing results of such tests). The perception that mistakes discredit the analyst denies researchers the opportunity for growth. We are encouraged by the recent work of Rots et al. (2006) because their blind tests concentrate almost entirely on lessons learnt from errors made during their tests. Their method of scoring is considerably more refined than our simple system and it leaves less potential for debate about the way in which the analyst’s results should be calculated. Our primary aim of the first tests was to address issues regarding the accurate visual identification of residues (Wadley et al., 2004b, pp. 1491), and this was used as the scoring criteria. It was not, however, adequate for scoring the descriptive response that the analyst provided (also see results of Test 4 in Lombard and Wadley, 2006). Considering the variables and the difficulty of scoring interpretations accurately, our future work will follow the Rots et al. (2006) example, as an established way for isolating and addressing problems encountered within our methodology. Thus, forthcoming research will focus on working towards improved methodology and interpretative criteria, rather than on the ‘scoring’ of skills or correct identifications.

It was the detailed commentary that ML provided in response to the tests that made us realize that, flawed though the tests were, they provided us and others with a valuable learning opportunity. If ML had been presented with micro-slides of residues prepared under sterile laboratory conditions we may have satisfied the expectations of some laboratories, but in the process we are likely to have learnt less about some of the complicated issues involved in residue analysis that we report here and elsewhere (Lombard and Wadley, 2006). The challenges that arose by serendipity forced our research in directions that we might not otherwise have pursued. Our mistakes were, for us, probably the most valuable part of the testing process. Perhaps this point was not made clearly enough in 2004. We believe that we have now demonstrated this more convincingly with the publication of our second set of blind tests (Lombard and Wadley, 2006), the results of archaeological work (Lombard, 2004, 2005, 2006a, 2006b) and this response to Crowther and Haslam, 2006. We now have a far more secure strategy for distinguishing plant and animal residues and we have made advances in the identification of incidental as opposed to use-related residues. We feel that the learning experience that resulted from our first tests made their reporting worthwhile. We believe, furthermore, that our outcomes have improved our chances of correctly identifying and interpreting residues on archaeological

tools, and that other researchers will find our explorations informative.

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