

The gripping nature of ochre: The association of ochre with Howiesons Poort adhesives and Later Stone Age mastics from South Africa

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Abstract

This contribution provides direct evidence for the use of ochre in adhesive recipes during the Howiesons Poort of South Africa. Stone segments from two KwaZulu-Natal sites were microscopically analyzed to document ochre and resin microresidue occurrences. These microresidues show a clear distribution pattern on the tool portions that are associated with hafting. Results from a separate quartz and crystal-quartz sample may indicate that different adhesive recipes were applied to different raw materials. A possible functional application for ochre in association with Later Stone Age mastics is also explored. The evidence and suggestions presented here expand our understanding of the versatility, use, and value of pigmentary materials in prehistory; it is not viewed as an alternative or replacement hypothesis for its possible symbolic role during the late Pleistocene.

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Introduction

Since Wreschner (1980) opened the “red ochre and human evolution” debate, ochre and its role in the origin of symbolic behavior has been an intensely discussed topic (Butzer, 1980; Delporte, 1980; Malinowski, 1980; Masset, 1980; Miller, 1980; Ronen, 1980; Solecki, 1980; Stephenson, 1980; Thomas, 1980; Wreschner, 1982; Knight et al., 1995; Ambrose, 1998; Barham, 1998; Watts, 1998; Barham, 2002; d’Errico and Soressi, 2002; Watts, 2002; d’Errico, 2003; Henshilwood and Marean, 2003; Hovers et al., 2003; Godfrey-Smith and Ilani, 2004; Van Peer et al., 2004; Conrad, 2005; but also see Wadley et al., 2004b; Barton, 2005; Wadley, 2005a,b, 2006a). Sub-Saharan Africa is the one place with biological and therefore

at least some measure of cultural continuity, so that the African record is considered indispensable when following traces of human behavioral evolution (Kuhn and Hovers, 2006). Across southern Africa (South Africa and adjacent countries), large quantities of ochre have been retrieved from sites such as Apollo 11, Boomplaas, Hollow Rock Shelter, Border Cave, Klasies River Cave 1, Umhlatuzana Rock Shelter, Rose Cottage Cave, Bushman Rock Shelter, Olieboomspoort (Watts, 2002), and Sibudu Cave (Wadley, 2005a,b) (Fig. 1). These finds—together with the engraved ochre fragments excavated at Blombos Cave, with an age of about 75 kyr—ensured that the Middle Stone Age (MSA) of this region has become a focal point in the discussions (Henshilwood et al., 2002).

Early hafting and its role in the development of complex human behavior is also increasingly evident (Anderson-Gerfaud, 1990; Mellars, 1996; Ambrose, 2001; Hardy et al., 2001; Grünberg, 2002; d’Errico, 2003; Lombard, 2005a; Rots and Van Peer, 2006; Mazza et al., 2006). Hafting evidence in the form of macroscopic or microscopic use-wear

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Fig. 1. Locations of archaeological sites mentioned in the text.

or residues provides empirical data on past human behavior. Thus, parallel to the predominantly theoretical debate about early signs of symbolic behavior, a number of researchers are investigating whether ochre (limonite consisting of iron hydroxides and iron oxides) was used in MSA adhesive recipes. These studies have been prompted by the observation that many stone tools from Rose Cottage Cave had red ochre on their bases or nonworking edges and surfaces (Wadley, 2005a). Studies based on microresidue and use-wear analyses of samples from Rose Cottage Cave and Sibudu Cave (Williamson, 1997; Gibson et al., 2004; Lombard, 2004; Wadley et al., 2004b; Williamson, 2004; Lombard, 2005a; Williamson, 2005; Lombard, 2006a,b, in press) and replication and experimental work (Wadley, 2005a,b, 2006a; Hodgskiss, 2006) have generated data that can highlight cognitive and technological skills and facilitate the investigation of possible changes in the use of adhesives over time. This paper reports on further research within this suite of projects.

A brief introduction to the Howiesons Poort of South Africa

I have elsewhere provided a full review of research conducted since the Howiesons Poort was first identified (Lombard, 2005b). Here, I highlight the most relevant points concerning the technocomplex, its evolutionary themes, and dating. The Howiesons Poort is found primarily in sub-Saharan Africa, south of the Limpopo River. The name was

first used by Stapleton and Hewitt (1927, 1928) to describe a stone artifact assemblage from a small rock shelter in the eastern Cape. They gave the main characteristics for the “Howiesons Poort Series” as the presence of burins, large segments, obliquely pointed blades, and trimmed points. The Howiesons Poort stage at Klasies River (Fig. 1), one of the key reference sequences for the southern African MSA (Singer and Wymer, 1982; H.J. Deacon, 1995; J. Deacon, 1995; Deacon and Wurz, 1996; Wurz, 1999, 2000, 2002), is characterized by distinctive backed pieces, such as segments (also referred to as crescents or lunates) and trapezes reminiscent of, but generally larger than, those associated with Later Stone Age (LSA) industries (Thackeray, 2000; Wadley, 2005c). The Howiesons Poort has been recorded at more than 20 sites in South Africa, and a number of the sites have been comprehensively dated (Grün et al., 1990; Miller et al., 1999; Parkington, 1999; Grün and Beaumont, 2001; Vogel, 2001; Feathers, 2002; Tribolo et al., 2005; Valladas et al., 2005; Rigaud et al., 2006). Currently, dates obtained from a variety of methods on samples from Border Cave, Klasies River, Rose Cottage Cave, and Diepkloof indicate that Howiesons Poort assemblages fall within a range of potential ages from 70 to 53 kyr (Fig. 1). The similarities to LSA and Upper Paleolithic industries and the use of unusual raw materials have spawned far-reaching behavioral hypotheses concerning the Howiesons Poort as a model for the origins of behavioral modernity (Deacon, 1989; Deacon and Shuurman, 1992; Wurz, 1999), symbolic behavior (Wurz, 1999), the *hxaro* delayed gift-giving

partnership (H.J. Deacon, 1992, 1995; Deacon and Wurz, 1996), and San languages (Deacon, 2001). Previous assumptions about the hafting strategies and functions of backed Howiesons Poort tools were based almost entirely on recent ethnographic examples that are expected to bridge a 60-kyr gap. Recently however, Gibson et al. (2004) performed micro-residue analysis on a sample of Howiesons Poort tools from Rose Cottage Cave. Although this sample had been handled and labeled with indelible ink on the ventral faces, and was therefore not ideal for residue studies, it provided valuable evidence for the possibility of Howiesons Poort tools being hafted and for the use of ochre in the adhesive recipe. A macrofracture study conducted on backed pieces from the Howiesons Poort at Klasies River Cave 2 indicates that some of these tools could have been used to tip hunting weapons (Lombard, 2005c; Wurz and Lombard, *in press*), and the analysis of organic residues on a sample of stone segments from Sibudu Cave confirmed this interpretation (Lombard, *in press*).

In this paper, I present and interpret the distribution patterns of ochre and resin microresidues documented on four samples of stone segments from the Howiesons Poort Industry in Kwa-Zulu-Natal, South Africa. New data are presented from Sibudu Cave and Umhlatuzana Rock Shelter (Fig. 1), providing direct evidence for the use of ground ochre in the adhesive recipes of hafted tools more than 60 kyr ago. I also start to explore the possible functional application of ochre associated with LSA mastics. Previously published LSA mastic artifacts are reintroduced, and a working hypothesis is presented for their association with ochre.

Samples and sites

Sample A ($n = 53$; controlled curation, see below) and Sample B ($n = 14$; uncontrolled curation, see below) were recently excavated at Sibudu Cave. Sibudu Cave has the potential to become one of South Africa's most important MSA sites. It has a long cultural sequence with pre-Still Bay, Still Bay, Howiesons Poort, post-Howiesons Poort, and late and final MSA assemblages. It has worked bone with an age of about 60 kyr, the sediments are suited for OSL dating, and it has excellent organic preservation. These characteristics allow for wide-ranging multidisciplinary research on a variety of technological, behavioral, and environmental aspects (see Wadley, 2006b; Wadley and Jacobs, 2006, and references in both). Although not yet dated (samples are currently being processed), the Howiesons Poort at Sibudu Cave is expected to be older than 61 kyr. This is based on the suite of OSL dates obtained from the overlying layers (Wadley and Jacobs, 2004, 2006). The backed tools include mostly segments, the majority of which are manufactured on hornfels and dolerite, but some quartz tools also occur (Wadley and Jacobs, 2004, 2006).

I excavated Sample A, and as soon as the segments were identified, they were placed individually in resealable bags, transported to a controlled laboratory environment, and only handled again during residue analysis. Sample B comprises segments excavated during a previous field season. After excavation, this sample was transported and curated with other

tools, lightly rinsed, marked on the ventral side, handled for technological analysis, and sketched before I conducted the residue analysis. The sample was analyzed separately as a control sample to establish the extent to which residue distribution patterns are affected by postexcavational handling. Only the unmarked dorsal sides of Sample B were analyzed.

Sample C ($n = 30$), nonquartz segments, and Sample D ($n = 25$), quartz and crystal-quartz segments, were excavated at Umhlatuzana Rock Shelter. The Holocene deposits from the upper units displayed visible natural stratigraphy, including hearths. The deposits below 1 m elevation varied in texture and color but were not interpreted as stratigraphic features; they were excavated in 50–100 mm spits. There is evidence that a 100–150 mm slipping of red-brown sand had occurred. A detailed analysis of the stone artifacts and waste assemblage was undertaken to resolve the stratigraphic problem (Kaplan, 1989, 1990). The results showed an internal consistency between the layers. The dislocation at Umhlatuzana Rock Shelter was probably the result of a single rotational slip. Had multiple or successive rotational slips occurred, the artifact assemblages would have been disturbed and the re-creation of the original deposition of the archaeological material would not have been possible (Kaplan, 1990).

Layers 1–4 represent the Holocene deposits and Layers 5–28 represent the late Pleistocene deposits. Fifteen radiocarbon dates have been obtained from charcoal. Layers 18–21 produced a suite of eight dates, seven of which fall between 40,000 and 35,000 BP. However, many radiocarbon dates for the MSA between about 40 and 35 kyr are now considered infinite (Parkington 2006), and future dating with new techniques might adjust or refine the Umhlatuzana dates. Kaplan (1990) identified pre-Howiesons Poort, Howiesons Poort, late MSA, MSA/LSA transitional, Robberg, and Holocene deposits at Umhlatuzana Rock Shelter. Although Kaplan lumped the pre-Howiesons Poort and Howiesons Poort in the discussion of artifacts, a clear increase of backed pieces is documented for Layers 24 (81.6%), 25 (73.4%), and 26 (62.2%), with a concurrent decrease in the frequency of unifacial and bifacial points in these layers. He interpreted Layers 22–26 as Howiesons Poort, and Layers 27 and 28 as pre-Howiesons Poort. Both segment samples for this study were selected from Layers 24–26. These layers contain the highest frequencies of segments. With respect to Layers 22–28, quartz is the dominant raw material, followed by hornfels, dolerite, and quartzite (Kaplan, 1990).

The segments from Umhlatuzana Rock Shelter were not excavated or curated with microresidue or use-wear analyses in mind. The tools were never washed, although some may have been lightly brushed (J. Kaplan, personal communication). They were all marked on the ventral side, and only the dorsal sides were analyzed. A preliminary feasibility study was conducted to assess whether microresidues were preserved on the tools. Preservation appeared to be good over a range of residues, and distribution patterns seemed to be intact. While it can be expected that some microresidues on the tools may have accumulated accidentally (pre- or postdepositional and postexcavational), it is unlikely that clustering of a microresidue type will happen coincidentally on identical portions of numerous

tools in a sample. Clear and repetitive distribution patterns can therefore be used as a preliminary feasibility indicator. During this preliminary study, brushed tools were readily recognized, as they showed white microscopic residues (either plastic fragments or toothpaste remains from the brushes) over their entire surfaces, and there was an absence of clear distribution patterns for other residues. Such tools were eliminated from the analysis. Sample D comprises only quartz and crystal-quartz segments. The aim is to assess whether these segments, which are generally smaller than those made from other raw materials, were hafted differently from the larger nonquartz segments.

Methods

I used microresidue analysis to investigate whether adhesives were used to attach the segments to hafts. The method is based on the morphological identification of microscopic residues and their distribution patterns on the tools. A stereo binocular metallographic microscope was used with analyzing and polarizing filters and bright and dark field incident light sources. Microresidues were identified *in situ* within the framework of a multistranded approach in which attendant and associated residue types were consistently used to cross-check and strengthen identifications. The entire dorsal and ventral surfaces, including the edges, of each tool were systematically scanned under the microscope at magnifications of 50 \times , 100 \times , 200 \times , and 500 \times enlargement and at different lighting conditions. All microresidues were recorded, plotted, and counted as occurrences in relation to their positions on the tool. More detailed discussions on aspects of methodology are presented in Lombard (2004, 2005a,b, 2006a, *in press*), Lombard and Wadley (2007), Wadley and Lombard (2007), and Wadley *et al.* (2004a). A micrographic record of residues on replicated tools from various experimental projects (Lombard *et al.*, 2004; Wadley, 2005a), blind tests (Wadley *et al.*, 2004a; Lombard and Wadley, 2007; Wadley and Lombard, 2007), and additional tools used to process plant or animal products served as a modern reference to aid in the interpretation of archaeological residues (see Fig. 2: a1 and a2). I have also previously published the various combinations and appearances of ochre and resin microresidues resulting from hafting experiments using this compound, and have shown how they compare to observations on archaeological tools (Lombard 2006a).

Where tool samples were excavated with microresidue research in mind, sediment samples were collected from the same layers as the tools. Microscope slides were prepared for each sediment sample and photographed under the same magnifications and lighting conditions as the residues on the tools. This procedure provides a record of the microscopic morphology of the matrix from which the tools were excavated, and it can be compared to the residues or matrix adhering to the tools. To establish whether there is a relationship between hafting and microscopic traces of resin and ochre on the tools, I divided each of the tools into six portions. Each portion included a dorsal and ventral side. The segments were placed with their dorsal sides facing upwards because proximal and distal ends were often difficult or impossible to distinguish; they were all placed with

their backed edges to the left. The portions were referred to as upper blade (portion 1), medial blade (portion 2), lower blade (portion 3), lower back (portion 4), medial back (portion 5), and upper back (portion 6) (Fig. 3). The backed portions 4, 5, and 6 were expected to show hafting traces. These expectations were based on previous use-trace analyses conducted on tools with similar morphology, as well as ethnographic and archaeological examples (Goodwin, 1945; Clark *et al.*, 1974; Phillipson, 1976; Clark, 1977; Becker and Wendorf, 1993; Bocquentin and Bar-Yosuf, 2004; Gibson *et al.*, 2004; Lombard, 2006a, *in press*). All the ochre and resin occurrences were plotted on line sketches and counted in relation to the portions described above. This method highlighted the possible existence of distribution patterns and served as a basis for further interpretation. Although it cannot be considered an accurate quantification of the residues, it does provide a realistic reflection of their actual distribution and concentrations on the tools.

Results

Sample A from Sibudu Cave

The analysis of this sample shows a clear concentration of ochre and resin residues on the backed portions (Table 1). On 53 tools, 502 ochre occurrences and 585 resin occurrences were documented. Most ochre (80%) and resin occurrences (87%) are located on the backed portions that are usually associated with hafting. The distribution of ochre could even be observed with the naked eye along the backed portions of some segments (Fig. 2b). The bar chart illustrates the association between the distribution of ochre and resin residues on the segments (Fig. 4). Statistically, there are significant differences between the observed distribution patterns of the ochre and resin residues on this sample and the distribution patterns that would be expected if all things were equal (ochre on the bladed portions χ^2 , $p = 0.001$; ochre on the backed portions χ^2 , $p = 0.01$; resin on the bladed portions χ^2 , $p = 0.001$; resin on the backed portions χ^2 , $p = 0.001$). Thus, the probability of the distribution patterns occurring coincidentally as a result of contamination or selective preservation can be rejected.

A further line of evidence that negates the possibility of selective preservation is the variation in distribution patterns for all the documented organic residues. In total, 1826 occurrences of organic residues were documented. If the ochre occurrences are included, 2328 residue occurrences were documented on the sample, and ochre and resin constitute 21.5% and 25%, respectively, of all the microresidues. The organic-residue counts do not include plant-residue types associated with evidence for rootlet or fungal growth on nine tools in the sample. Animal residues include animal tissue, fatty residue, collagen, bone residue, blood residue, and hair fragments (Fig. 5), while plant residues include plant tissue, plant fibers, starchy residue and starch grains, woody residue, and resin (Fig. 6). Most of the animal residues are concentrated on the blade (sharp, cutting) portions of the segments, while the distribution patterns of fatty and bone residues are less distinct. Plant residues are concentrated on the backed portions of the segments; 83.5% of all

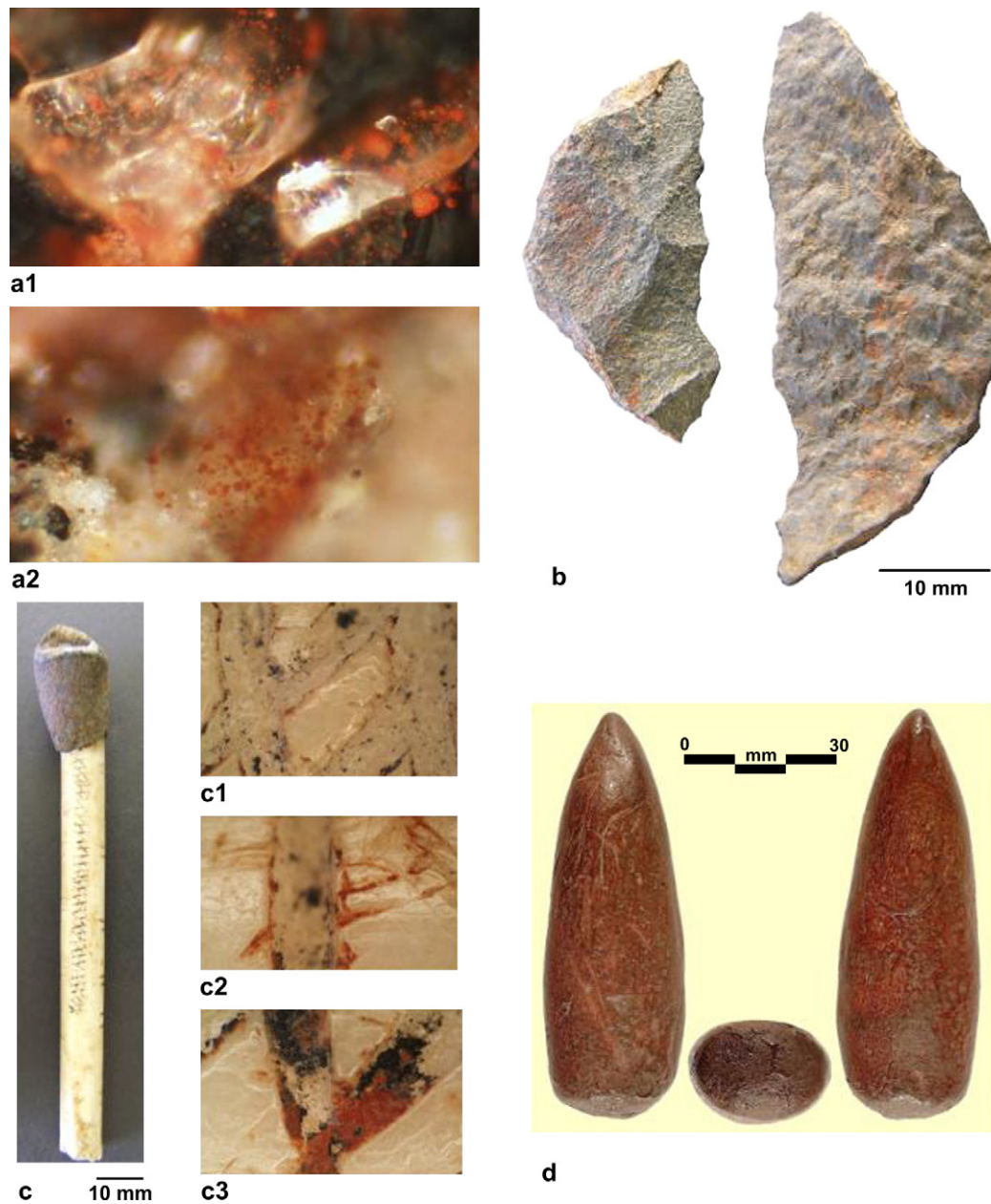


Fig. 2. (a1) Clear resin with red ochre grains micrographed at $200\times$ on a replicated stone tool that was hafted with a resin and ochre adhesive mixture (see Wadley 2005a). (a2) Clear resin with red ochre grains micrographed at $500\times$ on a segment from Sibudu Cave, Sample A. (b) Segments from Sibudu Cave, Sample A, with macroscopically visible ochre distribution on the backed portions. (c) Later Stone Age engraved bone haft with mastic lump and stone-tool impression, courtesy of Albany Museum. (c1) Micrograph at $50\times$ of engravings showing no evidence of being deliberately filled with ochre. (c2) Micrograph at $50\times$ of the haft showing ochre in surface scratches but not in the engraving. (c3) Where ochre is present in the engraved grooves, it is on top of a black resinous deposit and not continuous—possibly indicating contamination as a result of handling rather than deliberate application in the grooves (micrographed at $50\times$). (d) Later Stone Age mastic object from Steenbokfontein (photograph by D. Hallket).

the plant residues occur at this location, and resin or gum constitute 67% of the plant-residue component. For a full discussion and interpretation of these results, see Lombard (in press).

The sediment samples associated with Sample A show remarkably little ochre in the sediment. Microscopic ochre granules are very small in comparison with the residues found on the tools and are usually isolated single grains. It can therefore be expected that small, isolated ochre deposits on some tools may have accumulated accidentally. When a clear distribution pattern emerges over a representative sample of a tool

type, as is the case for this sample, it is possible to identify such accidental occurrences. Large concentrations of ochre may conceivably accumulate on a tool that has been deposited close to an ochre nodule, “crayon,” grinding stone, or an ochre patch in the sediment. Yet, it is unlikely that this will happen coincidentally on identical portions of numerous tools in a sample. It is therefore essential that wide-ranging interpretations for the function or hafting technology of a tool type are not attempted based on the residue distributions on a single tool. Where at all possible, the dispersal of ochre

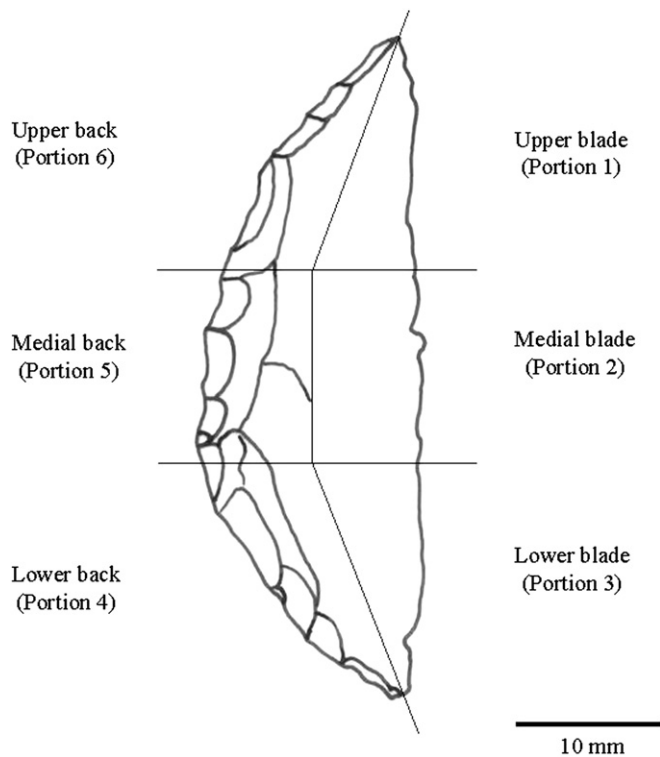


Fig. 3. Division of the segments for the interpretation of microresidue distribution patterns.

residues (or any other microresidues) on a sample of about 20 or more tools of a single type should be analyzed to generate quantitative and comparative data. This method establishes the possible existence of general distribution patterns or accidental residues as a result of coincidental contact. The results for Sample A are interpreted as compelling, direct evidence for the use of ground ochre in the adhesive recipe utilized for hafting Howiesons Poort segments at Sibudu Cave (Fig. 2: a2).

Furthermore, the full microresidue analysis of Sample A, focusing on the distribution patterns of plant and animal residues, and associated use-wear traces, shows that the segments were indeed hafted and that they were mainly used as inserts for hunting weapons (Lombard, *in press*). Use-trace analyses conducted according to the stratigraphic layers within the Howiesons Poort of Sibudu Cave indicate that there might have been variability in haft materials over time; the oldest

Table 1
Results of the ochre and resin microresidue analysis on 53 Howiesons Poort segments from Sample A, Sibudu Cave

Portion	Ochre occurrences		Resin occurrences	
	f	%	f	%
1	19	4	22	4
2	40	8	30	5
3	43	8.5	25	4.5
4	115	23	133	22.5
5	162	32	223	38
6	123	24.5	152	26
Totals	502	100	585	100

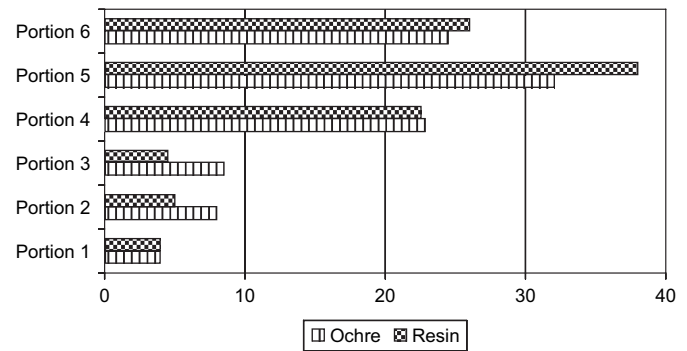


Fig. 4. Ochre- and resin-residue distribution patterns on the segments from Sample A, Sibudu Cave.

segments in the sample could have been hafted to bone and the youngest ones to wood. The segments were probably also hafted in different positions in their hafts (diagonally, transversely or in pairs as tips, or as barbs and cutting barbs along the shaft). There might have been variation in preferred hafting configurations during different phases of the Howiesons Poort at the site (see Lombard, *in press*).

Sample B from Sibudu Cave

Even though this sample was curated and handled under less than ideal circumstances for residue studies, the distribution patterns for both ochre and resin remained clear. In fact, it appears to be more pronounced than on Sample A. This may be a result of lightly rinsing the artifacts, which may remove loosely adhering residues that possibly resulted from ancient or postdepositional contamination. Although this appears to be the case for ochre and resin, it cannot be routinely expected for other residues. Only future comparisons of the full residue suites on both samples will highlight potential impediments as a result of curation and handling of the tools. On the 14 tools, 188 ochre and 118 resin occurrences were documented (Table 2). Again, most of the ochre (92.5%) and resin (97.5%) occurrences are located on the backed portions (chance probability of the recorded distribution patterns: ochre on the bladed portions χ^2 , $p = 0.001$;

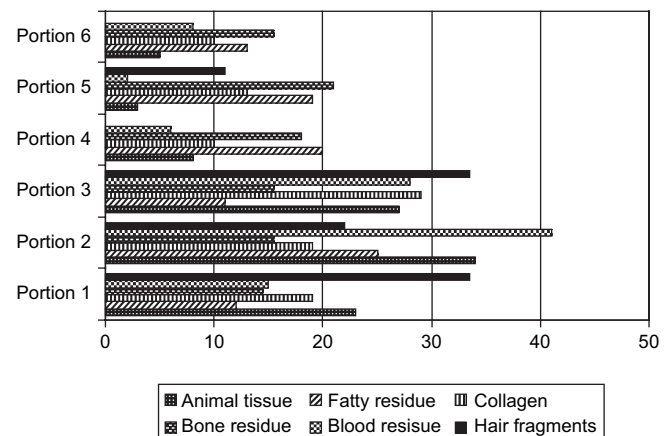


Fig. 5. Distribution of animal residues on Sample A, Sibudu Cave.

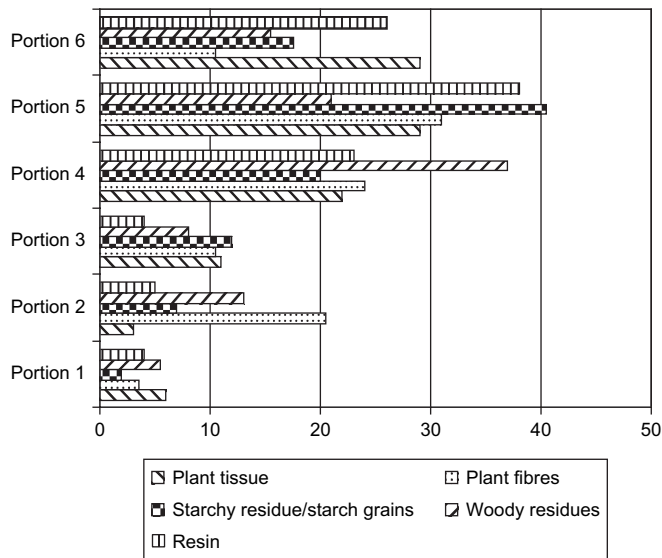


Fig. 6. Distribution of plant residues on Sample A, Sibudu Cave.

ochre on the backed portions χ^2 , $p = 0.05$; resin on the bladed portions χ^2 , $p = 0.001$; resin on the backed portions χ^2 , $p = 0.01$). The association between the distribution patterns of the two residue types is illustrated in Fig. 7. These results show that it is feasible to conduct residue analysis, at least for the detection of resin and ochre, on curated samples. However, it should be mentioned that Sibudu Cave has exceptional organic preservation and that similar residue frequencies may not be available for analysis on samples from other sites.

Sample C from Umhlatuzana Rock Shelter

Thirty nonquartz segments from Sample C were analyzed and 238 ochre occurrences and 269 resin occurrences were documented (Table 3). The backed portions of the tools contain 83% of the recorded ochre and 85.5% of the recorded resin. The distribution patterns for these two residue types are once again closely related (Fig. 8) and differ significantly from what could be expected if all things were equal (ochre on the bladed portions χ^2 , $p = 0.001$; ochre on the backed portions χ^2 , $p = 0.01$; resin on the bladed portions χ^2 , $p = 0.001$; resin on the backed portions χ^2 , $p = 0.01$). However, the results seem to deviate slightly from the patterns

Table 2
Results of the ochre and resin microresidue analysis on 14 washed and marked Howiesons Poort segments from Sample B, Sibudu Cave

Portion	Ochre occurrences		Resin occurrences	
	f	%	f	%
1	7	4	1	1
2	6	3	0	0
3	1	0.5	2	1.5
4	52	28	34	29
5	67	35.5	49	41.5
6	55	29	32	27
Totals	188	100	118	100

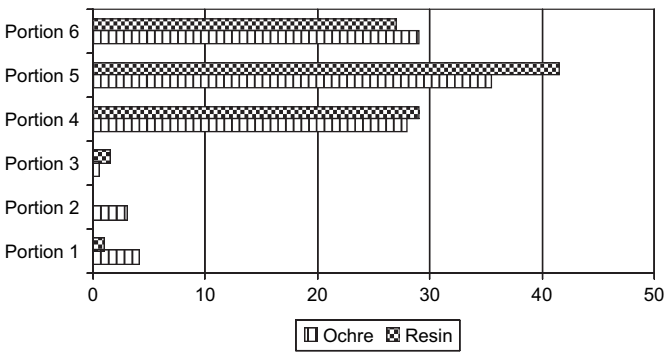


Fig. 7. Ochre- and resin-residue distribution patterns on the segments from Sample B, Sibudu Cave.

observed on the two Sibudu Cave samples in that both ochre and resin occur somewhat less frequently on the medial backed portions than on the upper and lower backed portions. This difference may be a result of a slightly different hafting technique practiced at Umhlatuzana Rock Shelter, different haft materials, or a sampling coincidence. The results of the complete residue analysis on these samples may elucidate this deviation. Evident from these data is that, similar to Sibudu Cave, an ochre and resin mix was used as an adhesive for nonquartz Howiesons Poort tools at Umhlatuzana Rock Shelter.

Sample D from Umhlatuzana Rock Shelter

The results of the quartz sample were somewhat unexpected. While 269 resin occurrences were recorded, only 43 ochre occurrences were counted on the 25 segments in the sample (Table 4). The distribution patterns of both residues are very similar to those of the other samples, with 81.5% of all the ochre and 83% of all the resin located on the backed portions (chance probability of the recorded distribution patterns: ochre on the bladed portions χ^2 , $p = 0.01$; ochre on the backed portions χ^2 , $p = 0.05$; resin on the bladed portions χ^2 , $p = 0.001$; resin on the backed portions χ^2 , $p = 0.01$). Both residue types are thus probably related to the hafting technology of the tools, but much less ochre was used for these tools. In Fig. 9, the two residue types still seem related, but differences are more pronounced for portions 5 and 6 of the quartz

Table 3
Results of the ochre and resin microresidue analysis on 30 nonquartz Howiesons Poort segments from Sample C, Umhlatuzana Rock Shelter

Portion	Ochre occurrences		Resin occurrences	
	f	%	f	%
1	12	5	17	6
2	17	7	11	4
3	12	5	12	4.5
4	70	29.5	75	28
5	55	23	69	26
6	72	30.5	85	31.5
Totals	238	100	269	100

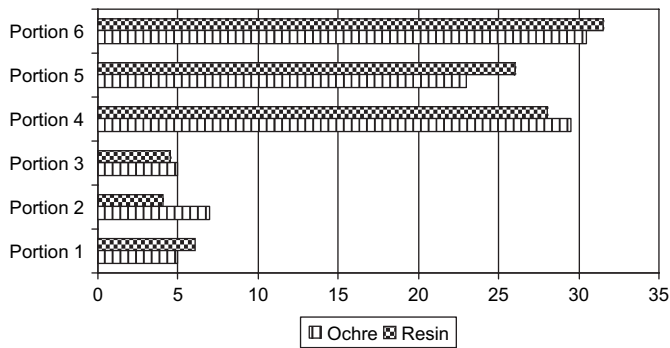


Fig. 8. Ochre- and resin-residue distribution patterns on the segments from Sample C, Umhlatuzana Rock Shelter.

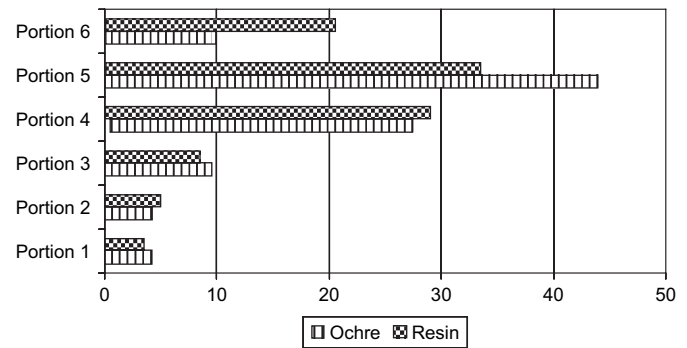


Fig. 9. Ochre- and resin-residue distribution patterns on the segments from Sample D, Umhlatuzana Rock Shelter.

tools than for the other three samples. I provide a possible explanation below.

Raw materials and adhesive recipes

The microresidue results for the quartz sample from Umhlatuzana Rock Shelter show that ochre was not used to the same extent in the adhesive recipe on quartz as on tools made from other raw materials (Fig. 10, Table 5). The number of segments with resin but without ochre on their backed portions is generally higher at Umhlatuzana Rock Shelter (23%, Sample C) than at Sibudu Cave (9.5%, Sample A). However, 68% of the segments in the quartz and crystal-quartz sample from Umhlatuzana Rock Shelter have resinous residues but no ochre occurrences (Fig. 11). This difference is noteworthy and deserves further exploration. The quartz and crystal-quartz segments are generally smaller and less elongated than those made from hornfels and dolerite (Fig. 12). Based on these morphological attributes, it was previously suggested that backed quartz tools from Howiesons Poort layers at Sibudu Cave could have been hafted differently from larger, longer segments produced using 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 glasslike. During replication and blind testing (Lombard and Wadley, 2007), 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, courser-grained raw materials. It is therefore

feasible to consider that a different, possibly “stickier” adhesive recipe may have been used for hafting quartz tools. This hypothesis needs to be tested with replication work. However, the data presented here could be the first direct evidence that people living in South Africa during the Howiesons Poort had the necessary skills and technological know-how to apply different adhesive recipes for different hafting requirements.

Discussion

Ochre as a component in adhesives

The notion that ochre was sometimes mixed into prehistoric adhesives or used as a component of the hafting technologies is not new (Audouin and Plisson, 1982; Allain and Rigaud, 1986; Webley, 1994; Ambrose, 1998; Rots, 2002; Gibson et al., 2004; Wadley et al., 2004b; Lombard, 2005a, 2006a,b). Still, archaeological assemblages are seldom systematically analyzed to test whether this was indeed the case, as interpretations of the presence of worked ochre in MSA contexts are often focused on evidence for symbolism (H.J. Deacon, 1995; Knight et al., 1995; McBrearty and Brooks, 2000; Watts, 2002). The data presented here confirm that powdered ochre was mixed into the hafting adhesives used during the Howiesons Poort at two sites in KwaZulu-Natal. Previous work shows that a similar recipe was used for hafting points during the post-Howiesons Poort period (Wadley et al., 2004b; Lombard, 2005a), and there are also

Table 4
Results of the ochre and resin microresidue analysis on 25 quartz Howiesons Poort segments from Sample D, Umhlatuzana Rock Shelter

Portion	Ochre occurrences		Resin occurrences	
	f	%	f	%
1	2	4.5	10	3.5
2	2	4.5	13	5
3	4	9.5	23	8.5
4	12	28	78	29
5	19	44	90	33.5
6	4	9.5	55	20.5
Totals	43	100	269	100

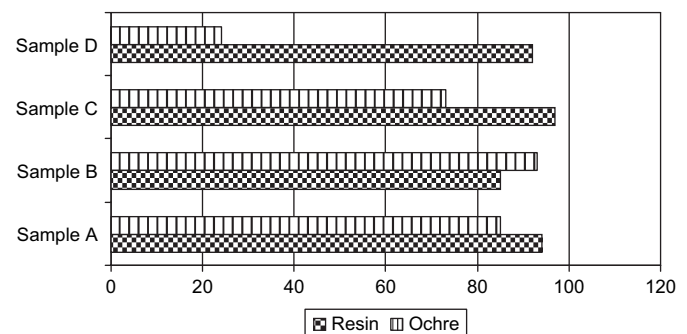


Fig. 10. Percentages of tools with ochre and resin residues from all four samples.

Table 5
Howiesons Poort segments with resin but no ochre on the backed portions

Sample	Number of tools	Resin but no ochre on backed portions	
		<i>n</i>	%
Sample A	53	5	9.5
Sample B	14	1	7
Sample C	30	7	23
Sample D	25	17	68

indications for this practice during the Still Bay at Sibudu Cave (Lombard, 2006b). The use of ochre as component in MSA adhesives may have been a regional trait, but observations on tools from Enkapune Ya Muto, Kenya (Ambrose, 1998), and some Paleolithic sites in France (Audouin and Plisson, 1982; Allain and Rigaud, 1986), and the results of the replication work reported below indicate that this may have been a widespread technology. More archaeological assemblages should therefore be microscopically analyzed to test this prospect. Even if organic residues are not preserved as well as at the KwaZulu-Natal sites, traces of ochre can be expected to remain on stone tools. If used as an adhesive ingredient, the ochre will show clear distribution patterns, as demonstrated here. Wadley (2006a) fittingly pointed out that it is highly suggestive that, in African MSA sites, quantities of ochre appeared at the same time as the first evidence for hafted tools.

Although ochre could have been mixed into the MSA adhesives as a coloring agent, replication work has firmly established its functional role in creating more effective adhesives. Allain and Rigaud (1986) found that when ochre is used as an additive it aids in the successful mixing of the other ingredients such as wax and resin. It also helps to harden the adhesive during drying. Using local raw materials that are comparable with those excavated at Sibudu Cave, Wadley (2005a,b, 2006a) conducted further replication studies. The replications show that *Acacia karroo* gum can be used alone as mastic to attach tools to hafts, but it is not easy to manipulate, dries slowly, and the end product is brittle, cracked, and sometimes crumbly. A combination of gum, ochre, and beeswax is pliable and easy to work with. Such tools performed well during use episodes. However, the

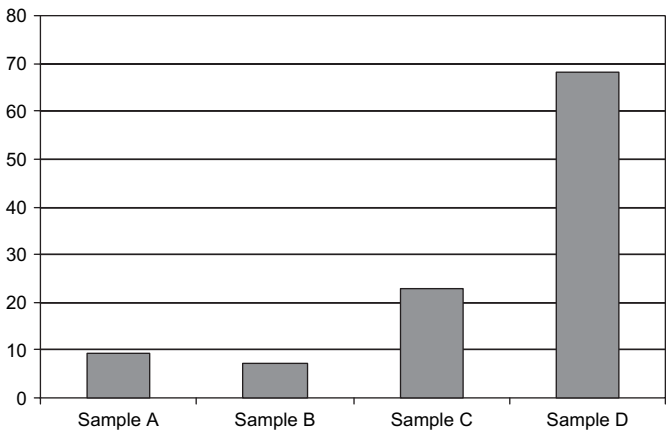


Fig. 11. Percentages of tools with resin but no ochre residues from all four samples.



Fig. 12. Selected segments from Umhlatuzana Rock Shelter illustrating the differences in size and morphology between some quartz and nonquartz segments.

wax shrinks after some weeks, resulting in the tools becoming loose in their hafts with time. Wax-laden adhesives can be reused because it softens on reheating. A combination of equal quantities of ochre and gum proved less easy to handle than the recipe including wax, but the tools were strong and most of them survived chopping branches without signs of wear on the hafting composition. When the red-ochre-and-gum adhesive has been properly dried, it does not seem to be adversely affected by damp conditions in the same way as plain gum. Gum and resin are water-soluble and hygroscopic. Damp conditions cause such adhesives to become tacky and the tools to become dislodged from their hafts. In this respect, adhesives containing ochre have a considerable advantage over pure gum adhesives (Wadley, 2005a, 2006a). Calculations of ochre mass, based on this replication work, indicate that the hafting hypothesis may also account for a large proportion of pigmentitious material from MSA sites (Wadley, 2005b).

Investigating symbolic explanations

The inclusion of ochre in the Howiesons Poort adhesives may indeed have had symbolic value. However, this might be more difficult to establish than its functional use. Currently, I interpret the possible symbolic role that ochre may have had in the hafting technology of MSA tools as “added value” over and above its functional application. The possible ritualization

of ochre in this context can perhaps be linked to a suggestion made by Hovers and Belfer-Cohen (2006). They proposed that, under certain circumstances, behaviors and their associated material culture are incorporated into rites and myths and canonized as part of the group's cultural heritage and social identity as a means of preventing the loss of eminent knowledge. If the ochre on the Howiesons Poort tools was used in association with adhesives purely for symbolic purposes, similar to some ethnographic examples, one would expect a different distribution pattern. Wadley (2006a) noted that a symbolic use for ochre that might explain its presence on stone tools is the Australian Aboriginal practice of coating ceremonial stone tools with ochre and other substances to instill in them life and vitality (Wallis and O'Connor, 1998). As an expression of active style, the /Xam (a southern African hunter-gatherer tribe) marked some of their arrows with a mixture of resin and ochre so that the hunters could identify their arrows (Bleek and Lloyd, 2001; Wadley, 2006a). In both instances, ochre is applied to completed tools, and would therefore not be present on the tool portions that were glued into the hafts (Wadley, 2006a). The data presented here illustrate that the ochre on the Howiesons Poort tools was mixed with resin, and that the mixture is concentrated predominantly on the backed portions of the tools. The location of the ochre on the segments, its association with the distribution patterns of resinous residues, and the demonstrated value of ochre as an ingredient in successful adhesives all support a deliberate functional application in addition to any potential symbolic or ritual role the ochre may have had.

Ochre associated with Later Stone Age mastic

The symbolic and ritual use of ochre during the LSA in southern Africa is well established in the ethnographic, archaeological, and rock art records (J. Deacon 1992; Lebzelter, 1996; Wadley, 1997; Watts, 1998; Marshall, 1999; Bleek and Lloyd, 2001; James, 2001). Closer inspection of two previously published objects on which ochre is associated with mastic may, however, indicate that ochre also had a practical function during this period, albeit different from its MSA application. The first object is a remarkably well-preserved, ornamented bird-bone haft with a lump of resin at one end (Fig. 2c) (Hewitt, 1912). This object was collected from an unidentified cave near Plettenberg Bay (Fig. 1) and accessioned during 1908 at the Albany Museum in Grahamstown (Deacon, 1966). It was found in association with sherds of Cape coastal pottery, probably removed from a midden that may be as recent as the eighteenth century, indicating a late phase of the LSA (Deacon, 1966). There is a clear impression of a stone tool in the thickened portion of the mastic, so that it can be accepted that the artifact represents a bone-hafted stone tool (Fig. 2c). Deacon (1966) examined the tool by X-ray and microscopy. He established that the mastic itself is resinous and black, and the mottled red surface appearance is simply due to "over-painting" with red ochre and not due to the use of a red-clay filler as initially supposed. He concluded that this coloring was purely for decorative purposes based on the mastic

and ochre crust "infill" in a number of the incisions. My own microscopic examination of the object shows that very few of the incisions are in reality filled with mastic and ochre, and some are remarkably clean (Fig. 2: c1). It is therefore my interpretation that the mastic and ochre in the incisions and on the surface of the bone tube are accidental residues resulting from handling the tool during ancient times with mastic and ochre contaminated hands (Fig. 2: c2 and c3). If the mastic, and subsequently the ochre, were deliberately rubbed into the incisions, then more distinct and repetitive evidence for this might be expected. On the other hand, the mastic lump itself is covered with a thin, evenly distributed ochre layer (Fig. 2: 1c). It is thus possible that the ochre was applied deliberately to the mastic and not to decorate the bone haft. Using the tool would have resulted in the user gripping the mastic lump between thumb and middle finger, with the index finger providing pressure on the mastic from the top. The bone haft would have been steadied between the ring finger, little finger, and palm. I return to the possible consequences of handling this tool and the application of powdered ochre below.

The second object was excavated by Jerardino (2001) at Steenbokfontein (Fig. 1) from a layer dated to about 2200 years ago. It comprises a single curated, mastic artifact, about 8 cm long, resembling a thick cigar (Fig. 2d). One end tapers to a smooth tip, while the other end is more abrupt and shows evidence of utilization. Ochre staining is extensive on the surface of the object, but none was recognized on the used end. Jerardino (2001) observed that the marks on the used end most likely resulted from small quantities of mastic being removed, probably in a soft and near-molten consistency. The mastic was probably used for gluing and small repair applications. Three finger impressions on the side of the tool indicate that the object was gripped and the working end exposed to a heat source to soften the mastic before use (Jerardino, 2001). The presence of ochre on the surface, and not on the working end, was seen by Jerardino (2001) as evidence of prolonged handling contamination rather than a component of the mastic formula.

Both of these objects would have required extensive handling of the mastic while they were used for their respective purposes. Such handling with warm, clammy hands or during damp weather conditions may have resulted in the mastic becoming uncomfortably sticky. Williamson (personal communication) suggested that ochre powder could have been used to dust mastic in order to render it less sticky during handling. Apart from being an exceptional coloring agent, ground red ochre also provides an excellent fine powder for such dusting. Ground yellow ochre, for example, is generally siltier, and microscopically, the single grains are larger and more separated than the grains obtained from grinding red ochre. Some of the other mastic-encased tools from the South African LSA do not seem to have ochre on them (Jerardino, 2001; Wadley, 2006a). If ochre was purposefully applied to the surfaces of some LSA mastic objects or lumps to render them less sticky during use, one may not expect ochre on those objects where the handling of the mastic itself is not required during use. For example, the mastic of a small transverse arrowhead excavated

from a layer dated to about 1760 years at Adam's Kranz Cave (Fig. 1) (Binneman, 1994) contains no ochre but seems to have been mixed with charcoal and fine-grained sand or clay. These three LSA artifacts are too few to confirm or negate the possibility that ochre could have had a functional application in association with LSA mastics. Nevertheless, I suggest it should be considered a working hypothesis to be tested with future analyses.

Conclusion

This study has provided direct evidence for the application of pigmentary materials in the adhesives of hafted Howiesons Poort tools from two sites in KwaZulu-Natal, South Africa. Data are provided that may indicate variation in adhesive recipes to accommodate different raw materials during the same period. Previous studies showed that adhesive recipes containing ochre were also applied during the pre- and post-Howiesons Poort at Sibudu Cave. I suggest that, despite the fact that ochre is well known for its symbolic and ritual applications during the LSA, we need to consider that it may have also had a functional value when associated with mastic. The LSA function was probably different from the MSA application. During the MSA, ochre was mixed into adhesives as an integral part of the recipes, while during the LSA it was probably applied to the surfaces of mastic objects to facilitate handling. The differences could illustrate developments in adhesive recipes and a shift in the use of ochre over time, other than symbolic or ritual. These data and considerations are perceived as an expansion of our current understanding of the versatility and value of ochre in prehistory rather than as an alternative or replacement hypothesis for its possible symbolic role.

Past human material culture is inundated with examples of objects or features that possessed a multiplicity of layered purposes, ranging from utilitarian to symbolic (e.g., Wadley, 1987; J. Deacon, 1992; Ouzman, 1997; Tilley, 1999; Lombard, 2002, 2003; Lombard and Parsons, 2003; Whelan, 2003; Wonderley 2005). Thus, one hypothesis or interpretation can seldom encompass the full functional and/or symbolic range that any item, substance, or feature represented for the diverse societies in which it was used over time. Each method or avenue of investigation leads to data or insights that may underscore particular aspects rather than others. Mundane and ritual domains may be interrelated (Hovers and Belfer-Cohen, 2006). Therefore, we need to acknowledge that developing additional hypotheses and using different methodologies to investigate the roles of ochre found in archaeological contexts have the potential to contribute to a more comprehensive understanding of past complexities in human behavior—both technological and symbolic. Evidence for the complex hafting technology provided here informs us about cognitive and technological skills and planning abilities. It shows that, more than 60,000 years ago, people understood the characteristics of various raw materials and adapted their adhesive technologies accordingly.

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