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DIRECT EVIDENCE FOR THE USE OF OCHRE IN THE HAFTINGTECHNOLOGY OF MIDDLE STONE AGE TOOLS FROM SIBUDU CAVE

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Direct evidence for the use of ochre in the hafting technology of Middle Stone Age tools from Sibudu Cave

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ABSTRACT

Microscopy was performed on tools obtained from the Middle Stone Age deposits of Sibudu Cave because previous observations suggested that there might be a possible functional role for ochre at the site. Analyses of the distribution patterns of ochre residues conducted on post-Howiesons Poort points and Howiesons Poort segments from Sibudu Cave show that ochre was an integral part of the hafting technologies for the duration of these techno-complexes. Close associations between ochre and resin on these tools strengthen the hypothesis that ground ochre was probably mixed into the adhesives that were used to glue the tools to hafts. The evidence presented here expands our understanding of the versatility and value of pigmentatious material in prehistory; it is not intended to be an alternative or replacement hypothesis for its possible symbolic role.

KEY WORDS: Middle Stone Age, southern Africa, Sibudu Cave, hafting technology, ochre, resin

INTRODUCTION

Ochre, in all its conditions, contexts and connotations, has become an intensely discussed topic as part of the amplified quest for early evidence of modern human behaviour (for example, Ambrose 1998; Barham 1998, 2002; Barton 2005; Conard 2005; d'Errico 2003; Hovers *et al*. 2003; Knight *et al*. 1995; Watts 1998, 2002; Wreschner 1980, 1982). The large quantities of ochre retrieved from sites such as Apollo 11, Boomplaas, Hollow Rock Shelter, Border Cave, Klasies River Cave 1, Umhlatuzana, Rose Cottage Cave, Bushman Rock Shelter, Olieboomspoort (Watts 2002) and Blombos Cave (where engraved ochre fragments dated to 77 ka were also found) ensured that the Middle Stone Age (MSA) of southern Africa became a focal point in these discussions (Henshilwood *et al*. 2002). Subsequently, meticulous excavations, analyses and replication projects, conducted to interpret the archaeological records at sites with long MSA sequences—such as Sibudu Cave and Rose Cottage Cave—have augmented our understanding of the applications of pigmentatious materials such as iron hydroxides and iron oxides, casually referred to as ochre (Gibson *et al*. 2004; Hodgskiss 2006; Lombard 2004, 2005; Wadley 2005*a*, *b*; Wadley, Williamson & Lombard 2004). In this contribution, I discuss the evidence for the use of ochre as a component in the hafting technology of the post-Howiesons Poort and the Howiesons Poort techno-complexes at Sibudu Cave. Separate research will highlight broader applications of ochre, and its association with mastic in the Later Stone Age (LSA) of South Africa (Lombard 2006). For background on the excavations, stratigraphy and dating of Sibudu Cave, please see Wadley & Jacobs (this volume).

BACKGROUND TO OCHRE AS AN INGREDIENT OF MASTIC USED FOR HAFTING AT SIBUDU CAVE

Some years ago, it was observed that many stone tools from Rose Cottage Cave had red ochre on them; either because they were deposited in ochre-stained soil, or used to scrape or grind ochre. However, these possibilities could not explain the observation that many tools had ochre on their bases or non-working edges and surfaces (Wadley 2005*a*). Preliminary residue analyses of stone tools from the cave revealed the presence of ochre on many tool types. A subsequent investigation of the distribution of residues on backed tools from the Howiesons Poort techno-complex of Rose Cottage Cave showed that ochre and plant material were often concentrated on or near the backed edges (Tomlinson 2001; Williamson 1997). This distribution suggested that ochre might be part of the hafting technology, but the sample was small and not ideal for residue analysis because it was previously handled and marked on the ventral sides of the tools (Gibson *et al*. 2004). Approximately 400 tools from post-Howiesons Poort occupation layers at Sibudu Cave, dated between 50 and 60 ka, were subjected to residue analyses, and the same phenomenon was recorded on many of these tools (Wadley, Williamson & Lombard 2004; Williamson 2004).

Subsequently, Wadley (2005*a*) conducted replication studies to test the working hypothesis that many tools were hafted using an adhesive in which red ochre was an ingredient. Her work confirmed some of the observations made by other researchers, such as Allain and Rigaud (1986), that ochre is an excellent filler for resins and resin and wax mixtures. Ochre-loaded adhesives prove far easier to work with than sticky resins alone, and are more easily moulded to accommodate tools and hafts. These adhesives also dry faster than unloaded resins. Importantly, unloaded adhesives are hydroscopic, and thus become tacky under damp conditions. Ochre-loaded adhesives are not hydroscopic after they have been properly dried. Furthermore, the experiments showed that tools mounted with ochre-loaded resin were more likely to complete tasks successfully than those without. Calculations of ochre mass, based on this replication work, indicate that the hafting hypothesis may also account for a large proportion of pigmentatious material from MSA archaeological sites (Wadley 2005*a*). Subsequent hafting experiments conducted by Hodgskiss (2006), using no loading agents or different loading agents in the adhesives of 60 replicated stone tools, also indicated that ochre is a successful loading agent or aggregate. Furthermore, it was shown that adding beeswax or sand to the resin may produce resilient tools. These observations provide valuable guidelines for future work aimed at unravelling Stone Age adhesive recipes.

In a further study by Wadley (2005*b*) the ochre nodules that were ground to use in the replicated glues were analysed. They showed that when ochre is obtained from nodules with a hard stone core, the powder is most efficiently extracted by rotating the nodules on coarse stone. This rotation creates facets and some nodules develop a crayon-like shape at the stage when they need to be discarded. Microscopic examination of these discards reveals striations and polish identical to those on archaeological ochre ‘crayons’ recovered from the MSA layers at Sibudu Cave (Wadley 2005*b*). This background provides the context for the meticulous documentation and plotting of ochre residues on all the stone tools on which I conduct microscopy.

SAMPLES AND METHODOLOGY

The samples used for this study comprise 24 post-Howiesons Poort points and 53 Howiesons Poort segments. Most of the tools were not touched, washed or marked subsequent to excavation. Most of the post-Howiesons Poort points were removed during excavation with plastic tweezers and sealed on-site in individual plastic bags (B. Williamson pers. comm.). I excavated the Howiesons Poort tools and placed them in airtight plastic bags immediately after removing them from the matrix. Soil samples were collected from the excavated Howiesons Poort layers. Microscope slides were prepared of each soil sample and these were 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 allows comparison between sediments, the residues of associated tools and any matrix adhering to the tools. The tool samples were microscopically examined at magnifications ranging from 50x to 500x using an Olympus BX40 stereo binocular metallographic microscope with analysing and polarising filters, and bright and dark field incident light sources. A digital camera attachment was also used.

To establish whether there is a relationship between hafting and ochre on the tools, I divide each of the tools into six portions. Each portion includes a dorsal and ventral side. The post-Howiesons Poort points are placed with the dorsal sides facing upwards and divided into right distal (portion 1), right medial (portion 2), right proximal (portion 3), left proximal (portion 4), left medial (portion 5) and left distal portions (portion 6). Portions 2, 3, 4 and 5 represent the areas where hafting traces can be expected on the point sample. The segments are also placed with their dorsal sides facing upwards, but because proximal and distal ends are often difficult or impossible to distinguish, they are all placed with their backed edges to the left. Their portions are 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). The backed portions 4, 5 and 6 are expected to show hafting traces on the segments. The expectations of where hafting traces should occur were generated by previous use-trace analyses conducted on tools of similar morphology, as well as experimental work in the case of points (Gibson *et al*. 2004; Lombard 2004, 2005, Lombard *et al*. 2004; Williamson 2005).

A further test for the link between ochre and hafting is to establish whether the ochre occurs in close association with a compelling hafting indicator such as resin. Although resinous residues can also result from processing wet wood, their distribution patterns, that is, where they occur on the tools, should indicate whether they accumulated from working such material, or from a resin-based adhesive. Thus, for the purposes of this study, all ochre and resin occurrences were recorded. They were plotted on line sketches and counted in relation to the portions described above. This method highlights the possible existence of distribution patterns and serves as a basis for further interpretation. Although it cannot be considered an accurate quantification of the residues, it does provide a realistic reflection of the actual distribution and concentrations of residues on the tools.

As a further control measure, a series of blind tests are being conducted at intervals to improve the interpretation of microscopic residues (Lombard & Wadley in press; Wadley, Lombard & Williamson 2004). Some of the tools, prepared for the Wadley

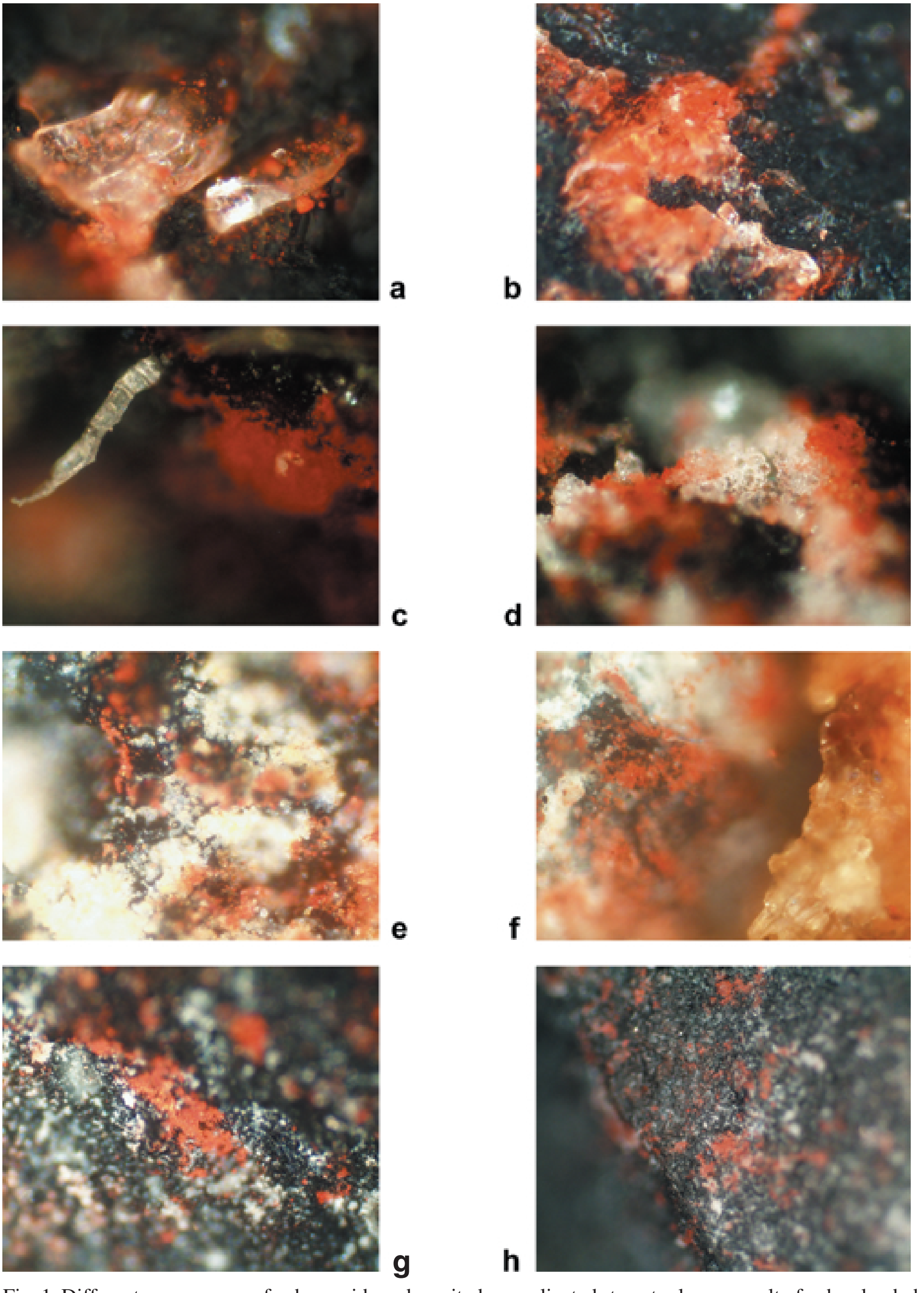

Fig. 1. Different appearances of ochre residues deposited on replicated stone tools as a result of ochre-loaded adhesives being used for hafting the tools to wooden hafts: (a) Ochre grains in clear resin, 500x; (b) ochre resin and plant tissue, 100x; (c) ochre and plant fibre, 500x; (d) ochre and degrading resin or plant tissue, 500x; (e) ochre and degrading resin or plant tissue, 100x; (f) ochre (left) with resinous bark cells (right), 200x; (g) powdery ochre deposit, 100x; (h) ochre distribution on the proximal edge of a tool 50x.

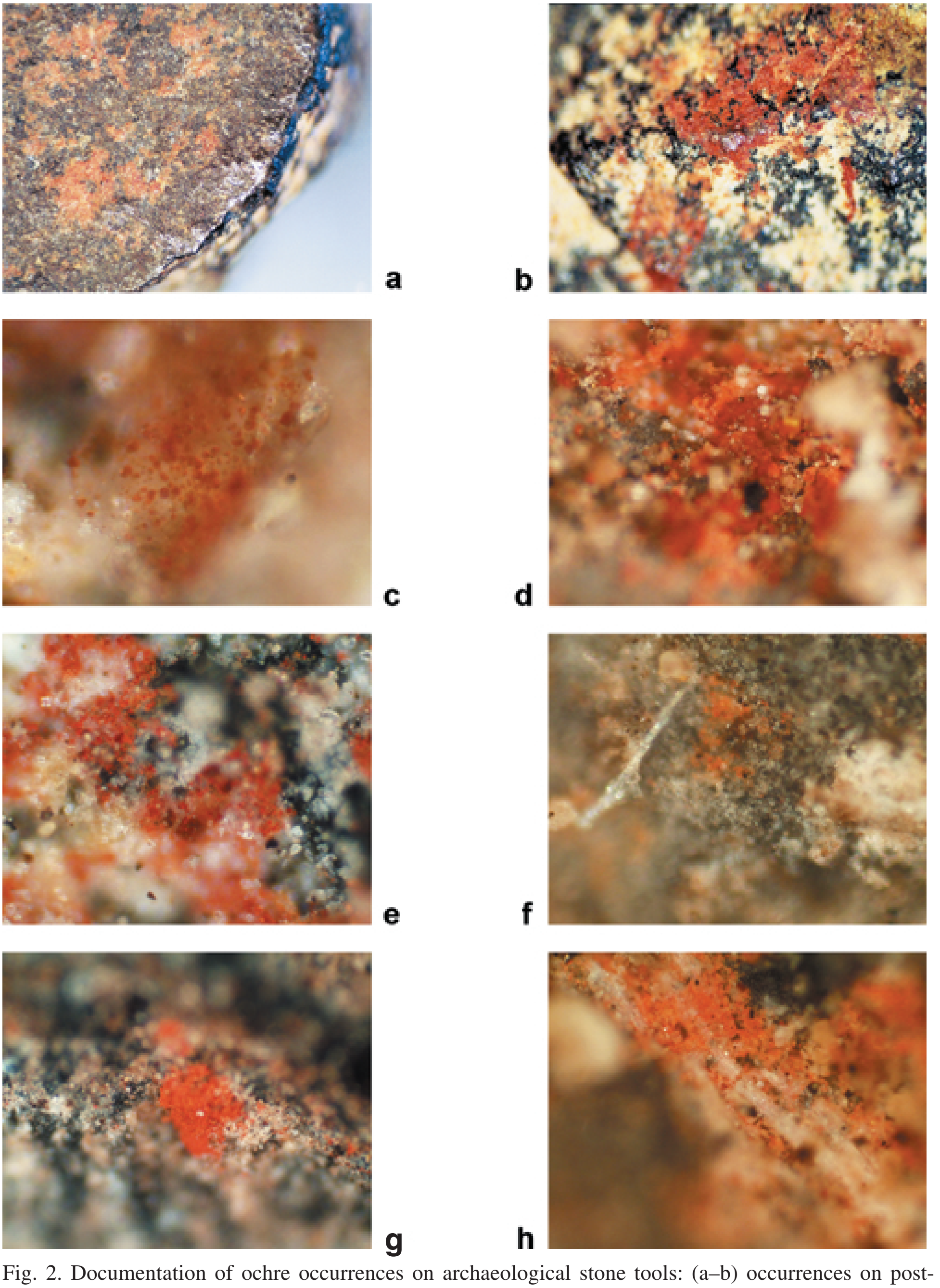

Fig. 2. Documentation of ochre occurrences on archaeological stone tools: (a–b) occurrences on post-Howiesons Poort points from Sibudu Cave; (c–h) occurrences on Howiesons Poort segments from Sibudu Cave. (a) ochre and resin mix on the proximal edge of a point, with bright polish caused by friction with a wooden haft, 50x; (b) ochre, resin and degraded plant material, with bright polish caused by friction with a wooden haft, 100x; (c) ochre grains in clear resin, 200x; (d) ochre and resin mix, 500x; (e) ochre and degraded resin and plant tissue, 200x; (f) ochre resin and plant fibre, 100x; (g) powdery ochre deposit, 200x; (h) ochre and resin with degrading wood fibres, 200x.

(2005*a*) replication project, were used in such a blind test. Additional tools that were included in the test were not hafted. Some were rubbed with ochre, or handled with ochre-stained hands (Lombard & Wadley in press). A micrographic record of the residues on these objects serves as modern reference to aid in the recognition of ochre accumulated as a result of various applications on stone tools (Fig. 1). This source of reference, together with other replicated tools, also applies to resin and other residue types.

RESULTS

Soil samples

Soil samples for the post-Howiesons Poort layers were not available for analysis, but samples are being collected from the same layers in adjacent squares during the current excavation seasons for future analysis. The stringent testing of the data derived from the residue analysis conducted on the tools from these post-Howiesons Poort layers significantly reduces the possibility of coincidental distribution of ochre and resinous residues (Lombard 2004, 2005). Soil samples from the Howiesons Poort layers, from which the tools for this study were excavated, show remarkably little ochre in the soil. 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. However, should clear distribution patterns emerge over a representative sample of a tool type, 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' or grinding stone in the soil. It is unlikely that this will happen coincidentally on identical portions of numerous tools in a sample, though, and it is therefore essential that wide-ranging or assemblage-level 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 residues (or any other residues) on a sample of at least 20 or more tools of a single type should be compared to establish the possible existence of general distribution patterns or accidental residues as a result of coincidental contact.

The post-Howiesons Poort

Analysis of the post-Howiesons Poort sample of 24 whole points shows that 80.5 % of all the ochre occurrences (n = 164) are located on the proximal and medial portions (Fig. 2). The same portions contain 87 % of all the resin occurrences (n = 146) (Table 1). The line graph (Fig. 3) shows how little the distribution patterns of the two residues differ over the six portions used for this analysis, indicating a clear association between the two residue types. Detailed analysis and chi-square statistical tests of the distribution patterns of 807 residue occurrences on these points showed that the distribution of residue types, including ochre and resin, cannot be considered coincidental (Lombard 2004, 2005). Other use traces such as microwear and macro-fractures contributed to the interpretation that these tools were hafted to wooden shafts and used as hunting tools. Of all the points with ochre concentrated on their proximal and medial sections, 68 % exhibit compelling physical evidence for hafting in the form of macro-fractures and microwear (Lombard 2004, 2005; Wadley, Williamson & Lombard 2004). Thus, for the post-Howiesons Poort points from Sibudu Cave, I propose that an adhesive of ochre-loaded resin was used to hold the stone points in place. Additionally, there is

TABLE 1

Ochre and resin frequencies and percentages on the various portions of post-Howiesons Poort points from Sibudu Cave. n = number; f = frequency.

Portion	n of portions	Ochre occurrences		Resin occurrences	
		f	%	f	%
1	24	14	9	10	7
2	24	27	15	19	13
3	24	35	23	42	28.5
4	24	40	24.5	39	26.5
5	24	30	18	28	19
6	24	17	10.5	8	6
Totals		164	100	146	100

evidence that they were bound with plant twine to the shafts, probably in order to withstand impact use, for which there exists generous evidence (Lombard 2005).

The Howiesons Poort

The analysis of the Howiesons Poort segments shows a clear concentration of ochre and resin residues on the backed portions (Table 2). On the 53 tools, 502 ochre occurrences and 585 resin occurrences were documented. A total of 80 % of the ochre occurrences and 87 % of the resin occurrences are located on the backed portions that are usually associated with hafting (these percentages are almost identical to those associated with hafting traces on the post-Howiesons Poort points). In some instances the distribution of ochre could even be observed with the naked eye along the backed portions of the segments (Fig. 4). The line graph (Fig. 5) illustrates a clear association

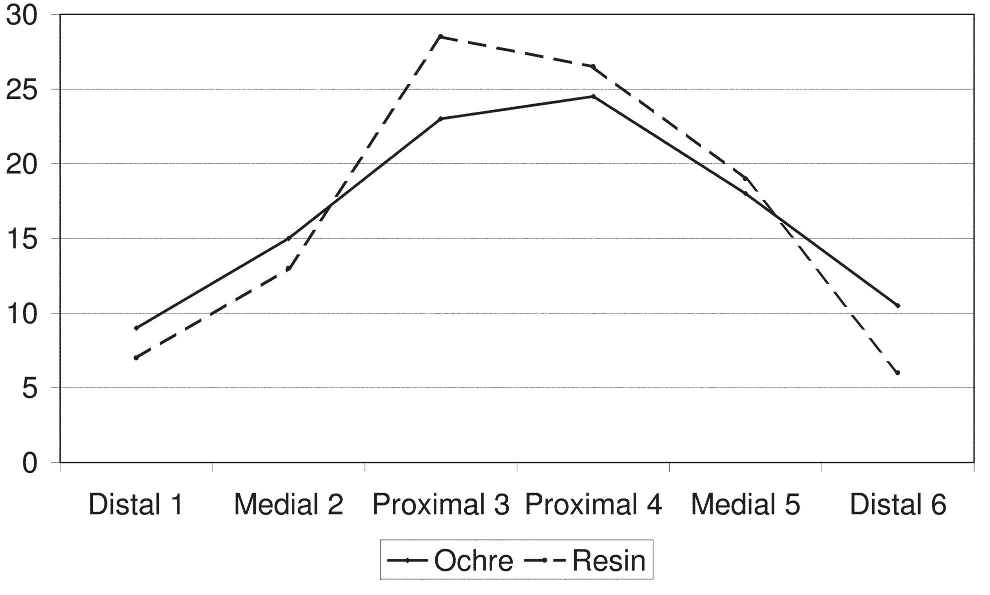

Fig. 3. Line graph of ochre and resin distribution patterns on post-Howiesons Poort points from Sibudu Cave.

TABLE 2

Ochre and resin frequencies and percentages on the various portions of Howiesons Poort Segments from Sibudu Cave. n = number; f = frequency.

Portion	n of portions	Ochre occurrences		Resin occurrences	
		f	%	f	%
1	48	19	4	22	4
2	52	40	8	30	5
3	48	43	8.5	25	4.5
4	48	105	23	133	22.5
5	52	162	32	223	38
6	48	123	24.5	152	26
Totals		502	100	585	100

between the distribution of ochre and resin residues on the Howiesons Poort segments (Fig. 2). These data are interpreted as compelling direct evidence for the use of ochre in the adhesive recipe utilised for hafting Howiesons Poort segments at Sibudu Cave. The processing of data generated during the full residue, usewear and macro-fracture analyses on the same sample has not been completed and interpreted yet, but it is foreseen that it may provide more detailed information on the hafting technology, haft materials and function(s) of Howiesons Poort segments. Comparisons with the analyses of the post-

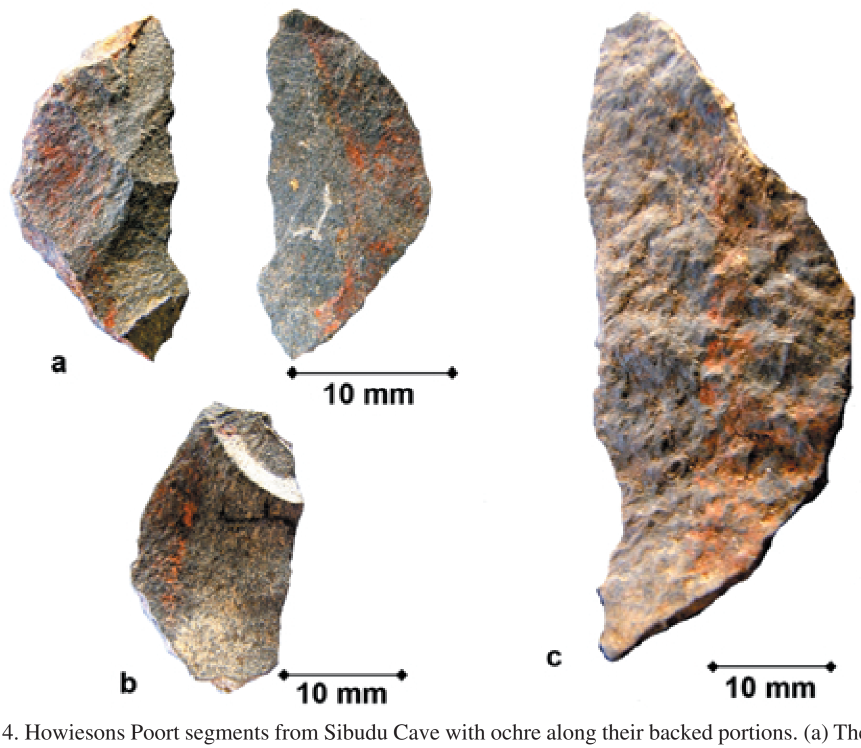

Fig. 4. Howiesons Poort segments from Sibudu Cave with ochre along their backed portions. (a) The dorsal and ventral sides of the same tool (b & c). Ventral sides of two individual tools.

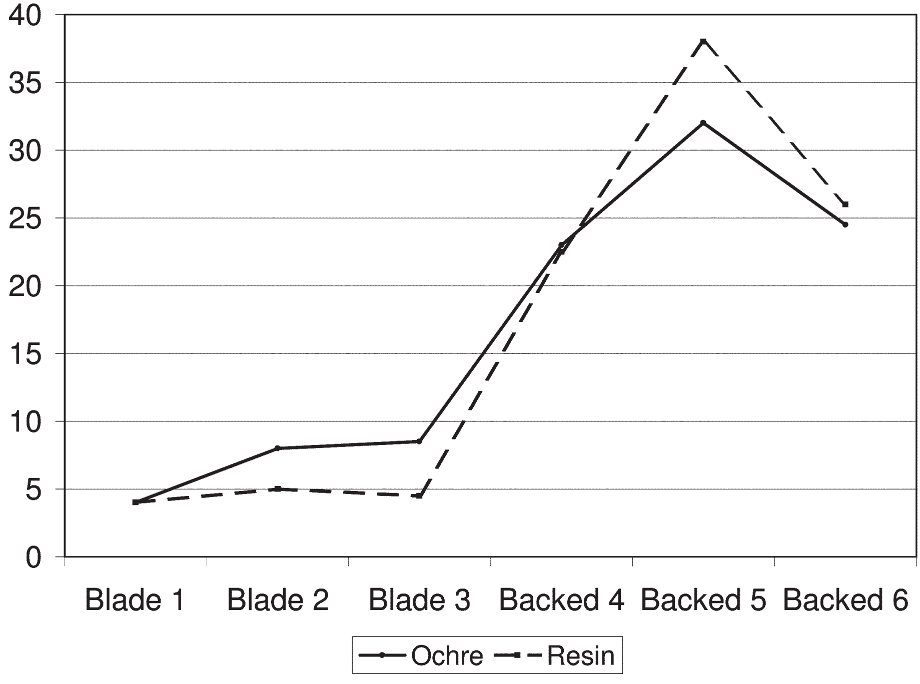

Fig. 5. Line graph of ochre and resin distribution patterns on Howiesons Poort segments from Sibudu Cave.

Howiesons Poort points have the potential to highlight subtle differences in the hafting technologies of the two techno-complexes. Differences may include variations in adhesive recipes, methods of application and materials used for binding, hafting materials, and tool functions.

DISCUSSION

These results convincingly substantiate the hypothesis that ground ochre was used as a component of adhesives in the hafting technologies of post-Howiesons Poort points and Howiesons Poort segments at Sibudu Cave. The direct evidence provided here for the functional application of pigmentatious materials during the MSA in southern Africa expands our understanding of its versatility and value in prehistory. The evidence is not interpreted as an alternative explanation for the possible symbolic role of ochre. Past human material culture contains many examples of objects or features that possessed layered purposes ranging from utilitarian to symbolic (for example, Deacon 1992; Lombard 2002, 2003; Lombard & Parsons 2003; Ouzman 1997; Tilley 1999; Wadley 1987; Whelan 2003; Wonderley 2005). Thus, one hypothesis or interpretation can seldom encompass all the meanings that an item, substance or feature represented for the diverse societies who used it over time.

Developing various hypotheses, or using different methodologies to investigate the roles of ochre found in archaeological contexts, has the potential to contribute to a more comprehensive understanding of past complexities in human behaviour—both technological and symbolic. Each method or avenue of investigation leads to data or insights that may underscore particular aspects rather than others. By downplaying, disregarding or eliminating the possible functional value of a commonly preserved, excavated and analysable material, such as ochre, we may impoverish the scope of our knowledge of past human behaviour.

The series of studies conducted to understand the functional application of ochre as part of MSA hafting technology, such as residue analyses, replication work and experimentation, has increased our comprehension of the technological behaviour of humans during this period in southern Africa. Results obtained from these projects imply that the toolmakers had considerable technical skill and that they understood the properties of the ingredients that are suitable for the manufacture of adhesives (Wadley 2005*a*). Furthermore, the research shows that these skills and insights were applied to the production of a variety of composite tools over the span of at least two MSA techno-complexes at Sibudu Cave.

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