CHAPTER TEN
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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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CHAPTER TEN
THE GRIPPING NATURE OF OCHRE: THE ASSOCIATION OF OCHRE WITH HOWIESONS POORT ADHESIVES AND LATER STONE AGE MASTICS FROM SOUTH AFRICA

Abstract
This contribution provides direct evidence for the use of ochre in adhesive recipes during the Howiesons Poort, South Africa. Stone segments from two KwaZulu-Natal sites were microscopically analysed to document ochre and resin occurrences. These micro-residues 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 pigmented materials in prehistory; it is not viewed as an alternative or replacement hypothesis for its possible symbolic role during the Late Pleistocene.

Key words: ochre, resin, micro-residues, adhesives, hafting, Howiesons Poort, Middle Stone Age, Later Stone Age, South Africa

Introduction
Since Wreschner (1980) opened the ‘Red Ochre and Human Evolution’ debate, ochre and its role in the origin of symbolic behaviour, has become 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 & Soressi, 2002; Watts, 2002; d’Errico, 2003; Henshilwood & Marean, 2003; Hovers et al., 2003; Godfrey-Smith & Ilani, 2004; Van Peer et al., 2004; Conard, 2005; but also see Wadley, Williamson & Lombard, 2004; Barton, 2005; Wadley, 2005a, b, 2006). Sub-Saharan Africa is the one place with biological, and therefore at least some measure of cultural
continuity, so that the African record is imperative when following traces of human behavioural evolution (Kuhn & Hovers, 2006). Across southern Africa 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). These finds together with the engraved ochre fragments excavated at Blombos Cave dated to about 77 ka ago, ensured that the Middle Stone Age of this region became a focal point in the discussions (Henshilwood et al., 2002).

Early evidence for hafting and its role in the development of complex human behaviour is also increasingly presented (Anderson Garfaud, 1990; Mellars, 1996; Ambrose, 2001; Hardy et al., 2001; Grünberg, 2002; d’Errico, 2003; Lombard, 2005a; Rots & van Peer, 2005; Mazza et al., in press). By nature, hafting evidence presented in the form of macroscopic or microscopic usewear or residues provides empirical data on past human behaviour. Thus, parallel to the predominantly theoretical debate on early signs of symbolic behaviour, a suite of research projects are investigating whether ochre – limonite consisting of iron hydroxides and iron oxides – was used in Middle Stone Age adhesive recipes. These studies were prompted by the observation that many stone tools from Rose Cottage Cave had red ochre on their bases or non-working edges and surfaces (Wadley, 2005a). The projects include micro-residue and usewear analyses on samples from Rose cottage Cave and Sibudu Cave (Williamson, 1997, 2004, 2005; Gibson et al., 2004; Lombard, 2004; Wadley, Williamson & Lombard, 2004; Lombard, 2005a, in press a, b) and replication and experimental work (Hodgskiss, 2006; Wadley, 2005a, b). Data generated from these studies have the potential to highlight cognitive and technological skills, and investigate possible changes in the use of adhesives over time. This paper reports on further research within this suite of projects. It focuses on tools from the Howiesons Poort technocomplex in KwaZulu-Natal, South Africa, and explores the possible functional application of ochre associated with Later Stone Age mastics. New data are presented from Sibudu Cave and Umhlatuzana Rock Shelter, providing direct evidence for the use
of ground ochre in the adhesive recipes of composite tools more than 60 ka ago. Formerly published Later Stone Age mastic artefacts are re-introduced and a working hypothesis is presented for their association with ochre.

**A brief introduction to the Howiesons Poort of South Africa**

I have provided a full review of research conducted since the Howiesons Poort was first identified elsewhere (Lombard, 2005b). This introduction highlights the most relevant points concerning the technocomplex, its evolutionary themes and dating. The Howiesons Poort technocomplex is found primarily in sub-Saharan Africa south of the Limpopo River (Fig. 1). The label was first used by Stapleton and Hewitt (1927; 1928) to describe a stone artefact 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, one of the key reference sequences for the southern African Middle Stone Age (Singer & Wymer, 1982; H.J. Deacon, 1995; J. Deacon, 1995; Deacon & Wurz, 1996; Wurz, 1999, 2000, 2002), was characterised 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 industries (Thackeray, 2000; Wadley, 2005c). The technocomplex has been recorded at more than twenty 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 & Beaumont, 2001; Vogel, 2001; Feathers, 2002; Tribolo et al., 2005; Valladas et al., 2005). Currently, dates obtained from a variety of dating methods on samples from Border Cave, Klasies River, Rose Cottage Cave and Diepkloof point to the placement of Howiesons Poort assemblages firmly within the period of 70 ka to 60 ka ago. Recent radiometric data support this consensus, indicating that the Howiesons Poort technocomplex appeared about 70 ka ago and that it was still in use at 54 ka to 62 ka ago at sites such as Rose Cottage Cave (Valladas et al., 2005).
The similarities to Later Stone Age and Upper Palaeolithic industries, and the use of unusual raw materials, resulted in far-reaching behavioural hypotheses concerning the origins of human modernity (Deacon, 1989; Deacon & Shuurman, 1992; Wurz, 1999), symbolic behaviour (Wurz, 1999), the *hxaro* delayed gift-giving partnership (H.J. Deacon, 1992, 1995; Deacon & Wurz, 1996), San languages (Deacon, 2001) and the origins of spirituality (Lewis-Williams & Pearce, 2004) being modelled for the Howiesons Poort. Many of these hypotheses remain inadequately tested or evaluated. 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 60 000 year
gap. Recently however, Gibson (Gibson et al., 2004) performed micro-residue analysis on a sample of Howiesons Poort tools from Rose Cottage Cave. Although this sample had been labelled and was therefore not ideal for residue studies, it provided valuable evidence for the possibility of tools from the Howiesons Poort being hafted and the use of ochre in the adhesive recipe. A recent macro-fracture 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 & Lombard, in press).

**Samples, sites and method**

*Samples and sites*

A total of 122 segments, the type fossil of the Howiesons Poort, from four samples were analysed for this study. Sample A (n = 53) and Sample B (n = 14) were recently excavated at Sibudu Cave (Fig. 1). The site is situated 40 km north of Durban on a forested cliff overlooking the Tongati River, about 15 km inland from the coast of KwaZulu-Natal. The part of the cave floor that is being excavated lies at an altitude of approximately 100 m above mean sea level. The southern entrance is 12 m lower than the excavation, so that the 55-m-long cave floor slopes abruptly from north to south. The cave is about 18 m in width, and was formed by the river lowering its channel, eroding the sandstone and shale cliff (Wadley & Jacobs, 2004). Sibudu Cave is considered significant because it has a deep, well-dated MSA sequence and good organic preservation that allows for wide-ranging, multidisciplinary research on a variety of technological, behavioural and environmental aspects (for example: Wadley 2001; Allott, 2004; Cain, 2004; Lombard, 2004; Plug, 2004; Schiegl et al., 2004; Wadley, 2004; Wadley & Jacobs, 2004; Williamson, 2004; Lombard, 2005a; Villa et al., 2005; Wadley, 2005c; Williamson, 2005; Delagnes et al., in press; Lombard, in press a, b; Lombard & Wadley, in press; Plug, in press; Wadley & Jacobs, in press). Although not yet dated (samples are currently being processed), the Howiesons Poort at Sibudu Cave is expected to be older than 61 ka. This is based on the suite of OSL dates obtained from the overlying layers (Wadley & Jacobs, 2004; Wadley & Jacobs, in press). The backed tools mostly include segments, the
majority of which are manufactured on hornfels and dolerite, but some quartz
tools also occur. A higher proportion of blades and large sandstone flakes than the
more recent Sibudu Cave material accompanies the backed tools (Wadley &

I have excavated Sample A, and as soon as the segments were identified, they
were placed individually in re-sealable 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 analysed separately as a control sample to
establish the extent to which residue distribution patterns are affected by such
handling. Only the unmarked dorsal sides of Sample B were analysed.

Sample C (n = 30), non-quartz segments, and Sample D (n = 25), quartz and
crystal quartz segments, were excavated at Umhlatuzana Rock Shelter. The site
was excavated during 1985 with the objective of rescuing material endangered by
the building of the national toll road between Pietermaritzburg and Durban,
KwaZulu-Natal (Kaplan, 1989, 1990). This north-facing shelter is about 100 km
south-west of Sibudu Cave and located in a steep cliff some 100 m above the
Umhlatuzana River (Fig. 1). Six one-metre squares were excavated, four of which
reached bedrock. The Holocene deposits from the upper units displayed visible
natural stratigraphy, including hearths. The deposits below 1 m varied in texture
and colour, but were not interpreted as stratigraphic features, and 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 artefacts 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 artefact assemblages would
have been disturbed and the recreation of the original deposition of the archaeological material would not have been possible (Kaplan, 1990).

The 78 excavation units at Umhlatuzana Rock Shelter were condensed into 28 layers. Layers 1-4 represent the Holocene deposits and layers 5-28 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. Therefore a large portion of the Middle Stone Age deposit, including the Howiesons Poort, remains undated at this site. Kaplan (1990) identified pre-Howiesons Poort, Howiesons Poort, late Middle Stone Age, Middle Stone Age/Later Stone Age transitional, Robberg and Holocene deposits at Umhlatuzana Rock Shelter. Although he lumps the pre-Howiesons Poort and Howiesons Poort in the discussion of artefacts, 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 interprets 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. For 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 residue or usewear analyses in mind. The tools were never washed, although some may have been lightly brushed (J. Kaplan, pers. comm.). They were all marked on the ventral side, and only the dorsal sides were analysed. A preliminary feasibility study was conducted to determine whether micro-residues were preserved on the tools. Preservation appeared to be good over a range of plant and animal residues, and distribution patterns seemed to be intact. During this preliminary study, brushed tools were readily recognised as they showed white microscopic residues (either plastic or toothpaste remains from the brushes) over their entire surfaces and a lack 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, that are generally smaller than those made from other raw materials, were hafted differently from the larger non-quartz segments.

Method

I use micro-residue analysis to investigate whether adhesives were used to attach the segments to hafts. The analytical method applied to the samples is the same as described in previous publications and therefore not discussed here (see Lombard, 2004; Wadley, Lombard and Williamson, 2004; Lombard, 2005a, b; Lombard, in press a; Lombard & Wadley, in press). A micrographic record of residues on replicated tools from various experimental projects (Lombard et al., 2004; Wadley, 2005a), blind tests (Wadley, Lombard & Williamson, 2004; Lombard & Wadley, in press), and additional tools used to process plant or animal products serves as modern reference to aid in the interpretation of archaeological residues (see Colour plate 1a1 & 1a2). For this study, I only discuss the ochre and resin occurrences documented on the samples.

To establish whether there is a relationship between hafting and microscopic traces of resin and ochre on the tools, I divide each of the tools into six portions. Each portion includes a dorsal and ventral side. The segments are placed with their dorsal sides facing upwards, because proximal and distal ends are often difficult or impossible to distinguish; they are all placed with their backed edges to the left. The 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) (Fig. 2). The backed portions 4, 5 and 6 are expected to show hafting traces. These expectations are 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 & Wendorf, 1993; Bocquentin & Bar Yosef, 2004; Gibson et al., 2004;). All the ochre and resin occurrences are 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 preserved residues on the tools.

![Figure 2](image.png)

Figure 2. Division of the segments for the interpretation of micro-residue distribution patterns.

**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 (Colour plate 1b). The line graph illustrates a clear association between the distribution of ochre and resin residues on the segments (Fig. 3). The sample is ideal for residue analysis as it was controlled from excavation to analysis; post-excavational contamination, or the disturbance of residues due to handling, can thus be eliminated as factors contributing to the results.
Colour plate 1. (a1) Clear resin with red ochre grains micrographed at 200x, 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 500x 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 Albany Museum. (c1) Micrograph at 50x of engravings showing no evidence of being deliberately filled with ochre. (c2) Micrograph at 50x 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 50x. (d) Later Stone Age mastic object from Steenbokfontein, photograph by D. Hallket courtesy Dr. A Jerardino.
Table 1. Results of the ochre and resin micro-residue analysis on 53 Howiesons Poort segments from Sample A, Sibudu Cave.

<table>
<thead>
<tr>
<th>Portion</th>
<th>Ochre occurrences</th>
<th>Resin occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>40</td>
<td>8</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>8.5</td>
</tr>
<tr>
<td>4</td>
<td>115</td>
<td>23</td>
</tr>
<tr>
<td>5</td>
<td>162</td>
<td>32</td>
</tr>
<tr>
<td>6</td>
<td>123</td>
<td>24.5</td>
</tr>
<tr>
<td>Totals</td>
<td>502</td>
<td>100</td>
</tr>
</tbody>
</table>

Soil samples were collected from the same layers. Microscope slides were prepared of each soil 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 can be compared to the residues, or matrix adhering to the tools. The samples 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, when a clear distribution pattern emerges over a representative sample of a tool type, as in the case of 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 soil. 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 residues (or any other micro-residues) on a sample of about 20 or more tools of a single type should be analysed 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 utilised for
hafting Howiesons Poort segments at Sibudu Cave (Colour plate 1a2). The processing of data generated during the full residue, usewear and macro-fracture analyses on the same sample have 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.

Figure 3. Ochre and resin residue distribution patterns on the segments from Sample A, Sibudu Cave.

**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 artefacts as this action may remove loosely adhering residues that possibly resulted from ancient or post-depositional 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. The close association between the distribution patterns of the two residue types is illustrated in the line graph (Fig. 4). 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.

Table 2. Results of the ochre and resin micro-residue analysis on 14 washed and marked Howiesons Poort segments from Sample B, Sibudu Cave Segments

<table>
<thead>
<tr>
<th>Portion</th>
<th>Ochre occurrences</th>
<th>Resin occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>52</td>
<td>28</td>
</tr>
<tr>
<td>5</td>
<td>67</td>
<td>35.5</td>
</tr>
<tr>
<td>6</td>
<td>55</td>
<td>29</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>188</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Figure 4. Ochre and resin residue distribution patterns on the segments from Sample B, Sibudu Cave.

*Sample C from Umhlatuzana Rock Shelter*

Thirty non-quartz segments were analysed and 238 ochre occurrences and 269 resin occurrences were documented on them (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. 5). However, they seem to deviate slightly from the patterns 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 may be a result of a slightly different hafting technique practised at Umhlatuzana Rock Shelter, different haft materials, or a sampling coincidence. It is hoped that the results of the complete residue analysis on these samples will elucidate this deviation. Evident from these data is that, similar to Sibudu Cave, an ochre and resin mix was used as an adhesive for Howiesons Poort tools at Umhlatuzana Rock Shelter.

Table 3. Results of the ochre and resin micro-residue analysis on 30 non-quartz Howiesons Poort segments from Sample C, Umhlatuzana Rock Shelter.

<table>
<thead>
<tr>
<th>Portion</th>
<th>Ochre occurrences</th>
<th>Resin occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>12</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>7</td>
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<tr>
<td>3</td>
<td>12</td>
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<td>4</td>
<td>70</td>
<td>29.5</td>
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<tr>
<td>5</td>
<td>55</td>
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</tr>
<tr>
<td>6</td>
<td>72</td>
<td>30.5</td>
</tr>
<tr>
<td>Totals</td>
<td>238</td>
<td>100</td>
</tr>
</tbody>
</table>

Figure 5. Ochre and resin residue distribution patterns on the segments from Sample C, 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 that of the other samples, with 81.5% of all the ochre and 83% of all the resin located on the backed portions. Both residue types are thus probably
related to the hafting technology of the tools, but much less ochre has been used for these tools. The line graph (Fig. 6) of the two residue types still follow the same basic curve, but differences are more pronounced for Portions 5 and 6 of the quartz tools than for the other three samples. I provide a possible explanation below.

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

<table>
<thead>
<tr>
<th>Portion</th>
<th>Ochre occurrences</th>
<th>Resin occurrences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>f %</td>
<td>f %</td>
</tr>
<tr>
<td>1</td>
<td>2 4.5</td>
<td>10 3.5</td>
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<td>2</td>
<td>2 4.5</td>
<td>13 5</td>
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<td>3</td>
<td>4 9.5</td>
<td>23 8.5</td>
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<td>4</td>
<td>12 28</td>
<td>78 29</td>
</tr>
<tr>
<td>5</td>
<td>19 44</td>
<td>90 33.5</td>
</tr>
<tr>
<td>6</td>
<td>4 9.5</td>
<td>55 20.5</td>
</tr>
<tr>
<td>Totals</td>
<td>43 100</td>
<td>269 100</td>
</tr>
</tbody>
</table>

Figure 6. Ochre and resin residue distribution patterns on the segments from Sample D, Umhlatuzana Rock shelter.

Raw materials and adhesive recipes

The micro-residue results of 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 on other raw materials (Fig. 7, Table 5). The number of segments with resin but without ochre on their backed portions is generally higher at Umhlatuzana Rock Shelter than at Sibudu Cave. Sample A from Sibudu Cave shows 9.5% for this tendency while the Umhlatuzana equivalent, Sample C, shows 23%. However, 68% of the segments in the quartz and crystal quartz
sample from Umhlatuzana Rock Shelter has resinous residues but no ochre occurrences (Fig. 8).

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

<table>
<thead>
<tr>
<th>Sample</th>
<th>Number of tools</th>
<th>Resin but no ochre on baked portions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Sample A</td>
<td>53</td>
<td>5</td>
</tr>
<tr>
<td>Sample B</td>
<td>14</td>
<td>1</td>
</tr>
<tr>
<td>Sample C</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>Sample D</td>
<td>25</td>
<td>17</td>
</tr>
</tbody>
</table>

Figure 7. Percentages of tools with ochre and resin residues from all four samples.

This difference is noteworthy and deserves further exploration. The quartz and crystal quartz segments are generally smaller and less elongated than those made on hornfels and dolerite (Fig. 9). Based on these morphological attributes we have previously suggested that backed quartz tools from Howiesons Poort layers at Sibudu Cave could have been hafted differently from larger, longer segments produced on other raw materials (Delagnes et al., in press). Quartz is also very hard, Moh’s scale 7 (Bishop et al., 2001), and the surface is smooth and glass-like. During replication and blind testing (Lombard & Wadley, in press) 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 more ‘sticky’, adhesive
recipe may have been used for hafting some quartz tools. This hypothesis needs to be tested with replication work. However, the data presented here could be the first direct evidence that Howiesons Poort people had the necessary skills and technological know-how to apply different adhesive recipes for different hafting requirements.

Figure 8. Percentages of tools with resin, but no ochre residues from all four samples.

Figure 9. Selected segments from Umhlatuza Rock Shelter illustrating the differences in size and morphology between some quartz and non-quartz segment
Discussion

Ochre as a component in adhesives

The notion that ochre was sometimes mixed into prehistoric adhesives or used as component of the hafting technologies is not new (Audouin & Plisson, 1982; Allain & Rigaud, 1986; Bülter, 1998; Webley, 1994; Ambrose, 1998; Rots, 2002; Gibson et al., 2004; Wadley, Williamson & Lombard, 2004; Lombard, 2005a). Still, archaeological assemblages are seldom systematically analysed to test whether this was indeed the case as interpretations of the presence of worked ochre in Middle Stone Age contexts are often focussed on evidence for symbolism (H.J. Deacon, 1995; Knight et al., 1995; McBrearty & 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 showed that a similar recipe was used for hafting points during the post-Howiesons Poort period (Lombard, 2005a; Wadley, Williamson & Lombard, 2004), and there are also indications for this practice during the pre-Howiesons Poort Still Bay at Sibudu Cave (Lombard, in press b). The use of ochre as component in Middle Stone Age adhesives may have been a regional trait, but observations on tools from other sites in Africa and Eurasia, and the results of replication work indicate that this may have been a wide-spread technology, and more assemblages should be analysed 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. If used as adhesive ingredient, the ochre will show clear distribution patterns as demonstrated here. Wadley (2006) fittingly points out that it is highly suggestive that, in African Middle Stone Age sites, quantities of ochre appeared at the same time as the first evidence for hafted tools.

Although ochre could have been mixed into the Middle Stone Age adhesives as a colouring agent, replication work firmly established its functional role in creating more effective adhesives. Allain and Rigaud (1986) found 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, 2006) 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. Several tools became dislodged after very short use episodes. A combination of gum, ochre and beeswax is pliable and easy to work with. Such tools performed well during use episodes. However, the wax shrinks after some weeks, resulting in the tools becoming loose in their hafts with time. Wax-laden adhesives can be re-used 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 is affected. Gum or resin is water-soluble and hydroscopic. 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, 2006). 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 Middle Stone Age archaeological sites (Wadley, 2005b).

Investigating symbolic explanations
The inclusion of ochre in the Howiesons Poort adhesives could indeed have had symbolic value, however, this may be more difficult to establish than its functional use. Currently I interpret the possible symbolic role that ochre might have had in the hafting technology of Middle Stone Age tools as ‘added value’ over and above its functional application. The possible ‘ritualisation’ of ochre in this context can perhaps be linked to a suggestion by Hovers and Belfer-Cohen (2006). They propose that under certain circumstances, behaviours and their associated material culture are incorporated into rites and myths, and canonised as part of the group’s cultural heritage and social identity as a means to prevent 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 (2006) mentions 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 give them life and vitality (Wallis & 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 & Lloyd, 2001; Wadley, 2006). 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, 2006). The data presented here illustrate that the ochre on the Howiesons Poort tools was mixed with resin, and that the mixture is predominantly concentrated 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 could have had.

**Ochre associated with Later Stone Age mastic**

The symbolic and ritual use of ochre during the Later Stone Age 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 & Lloyd, 2001; James, 2001). However, closer inspection of two previously published objects where ochre is associated with mastic may indicate that ochre also had a practical function during this period, albeit different from its Middle Stone Age application. The first object is a remarkably well-preserved, ornamented bird bone haft with a lump of resin at one end (Colour plate 1c) (Hewitt, 1912). This object was collected from an unidentified cave near Plettenberg Bay on the South African south coast 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 Later Stone Age (Deacon, 1966). Deacon (1966) describes the mastic as asymmetrical and
supporting the broken fragment of a stone flake in one side. No mention was made of the stone fragment in the original description (Hewitt, 1912), and I could see no such fragment when I studied the tool recently (it could be that it is only visible with X-ray exposure). There is, however, a clear impression of a tool in the thickened portion of the mastic, so that it can be accepted that the artefact represents a bone hafted stone tool (Colour plate 1c). Deacon (1966) examined the tool by X-ray photographs 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 colouring was purely for decorative purposes based on the mastic and ochre crust ‘infill’ in a number of the incisions. My own microscopy on the object shows that very few of the incisions are actually filled with mastic and ochre, and some are remarkably clean (Colour plate 1c1). It is 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 (Colour plate 1c2 & c3). If the mastic, and subsequently the ochre, were deliberately rubbed into the incisions 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 (Colour plate 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, pinkie and palm.

The second object was excavated by Jerardino (2001) at Steenbokfontein on the Cape west coast of South Africa from a layer dated to about 2200 years ago. It comprises a single curated, mastic artefact of about 8 cm long resembling a thick cigar (Colour plate 1d). One end tapers to a smooth tip, while the other end is more abrupt and shows evidence of utilisation. Ochre staining is extensive on the surface of the object, but none was recognised on the used end. Jerardino (2001) observed that the marks on the used end most likely resulted from small quantities
of mastic being removed, most 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 is seen by Jerardino (2001) as evidence of prolonged handling contamination, rather than a component of the mastic formula.

Both these objects would have required extensive handling of the mastic while they were used for their respective purposes. Such handling with warm, possibly clammy, hands or during damp weather conditions may have resulted in the mastic becoming uncomfortably sticky. Williamson (pers. comm.) suggested that ochre powder could have been used to dust mastic in order to render it less sticky during handling. Some of the other mastic-encased tools from the South African Later Stone Age do not seem to have ochre on them (Jerardino, 2001; Wadley, 2006). If ochre was purposefully applied to the surfaces of some Later Stone Age 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 old at Adam’s Kranz Cave, Eastern Cape, South Africa (Binneman, 1994), contains no ochre, but seems to have been mixed with charcoal and fine-grained sand. These three Later Stone Age artefacts are too few to confirm or negate the possibility that ochre could have had a functional application in association with Later Stone Age 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 pigmentatious materials in the adhesives of composite Howiesons Poort tools from two sites in KwaZulu-Natal, South Africa. Data is provided that could 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 furthermore suggest that despite the fact that ochre is well-known for its symbolic and ritual applications during the Later Stone Age of southern Africa, we need to consider that it may have also had a functional value when associated with mastic. The Later Stone Age function was probably different from the Middle Stone Age application. During the Middle Stone Age ochre was mixed into adhesives as an integral part of the recipes, while, during the Later Stone Age it was probably applied on 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 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 (for example: J. 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 the full functional and/or symbolic range that any item, substance or feature represented for the diverse societies who used it 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 & Belfer-Cohen 2006). Therefore we need to acknowledge that developing various hypotheses, or using different methodologies to investigate the roles of ochre found in archaeological contexts, all have the potential to contribute to a more comprehensive understanding of past complexities in human behaviour – both technological and symbolic. Evidence for the complex hafting technology provided here informs on 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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