Residue and microwear analyses of the stone artifacts from Schöningen

Article · January 2015
DOI: 10.15496/publikation.11830

CITATIONS
2

READS
30

4 authors:

Veerle Rots
Fonds de la Recherche Scientifique (FNRS)
83 PUBLICATIONS 976 CITATIONS

Bruce Hardy
Kenyon College
24 PUBLICATIONS 931 CITATIONS

Jordi Serangeli
University of Tuebingen
76 PUBLICATIONS 346 CITATIONS

Nicholas John Conard
University of Tuebingen
345 PUBLICATIONS 5,907 CITATIONS

Some of the authors of this publication are also working on these related projects:

The European saber-toothed cats (Homotherium latidens) of Schöningen View project

Large-scale excavation and research in the lower paleolithic Sites of Schöningen View project

All content following this page was uploaded by Veerle Rots on 27 November 2017.
The user has requested enhancement of the downloaded file.
Residue and microwear analyses of the stone artifacts from Schöningen

Veerle Rots a, *, Bruce L. Hardy b, Jordi Serangeli c, Nicholas J. Conard d

a Service de Préhistoire, University of Liège, Quai Roosevelt 18, 4000 Liège, Belgium  
b Department of Anthropology, Kenyon College, Gambier, OH 43022, USA  
c Institut für Ur- und Frühgeschichte, Eberhard Karls Universität Tübingen, Burgstrasse 11, 72070 Tübingen, Germany  
d Senckenberg Center for Human Evolution and Paleoenvironment, Burgstrasse 11, 72070 Tübingen, Germany

A R T I C L E   I N F O

Article history:
Received 16 July 2013  
Accepted 12 July 2015  
Available online xxx

Keywords:
Lower Paleolithic  
Tool use  
Hafting  
Functional analysis

A B S T R A C T

Stone artifacts from Schöningen 12 and 13 were examined microscopically to identify residues, wear, and manufacturing traces in order to clarify their possible anthropogenic origins and their function. We present evidence showing that the stone tools were used for working wood and hide and for cutting meat. The results from the use-wear and residue analyses proved complementary in several instances. Suggestive evidence of hafting was observed on a few pieces, which is particularly interesting given the identification of wooden hafts at the site. The positive results of this analysis demonstrate the efficacy and potential of these techniques for Lower Paleolithic sites such as Schöningen.

© 2015 Elsevier Ltd. All rights reserved.

1. Introduction

Schöningen is well-known for its preserved wooden artifacts and spears (Thieme, 1997); its main sequence likely falls in MIS 9 and dates to ca. 300 ka BP (Behre, 2012). Residue and microwear analyses were performed on a part of the stone artifacts of Schöningen, derived from both Locality 12 (Damm) and the waterlogged Locality 13 (Sockel). Eighteen stone artifacts were available for analysis from Locality 12, a low-density zone, next to 14 artifacts, mostly very small fragments or chips, from the high-density Locality 13. Preservation at Locality 13 is very good, but the number of recovered artifacts is very small. The artifacts from Locality 12 consist of flakes, tools, and one small core, but their preservation state is variable.

The two sets of analyses performed here were conducted independently (V.R.: microwear, B.H.: residue analysis). Previous research on both archaeological (Hardy et al., 2001) and ethnoarchaeological (Rots and Williamson, 2004) material has demonstrated that microwear and residue analyses can provide complementary information and a more complete understanding of tool function. Microwear is important in establishing the zone of use, action, and category of worked material, while residue analysis can potentially provide a more specific identification of the material being worked (Rots and Williamson, 2004). The analyses presented here were not initially envisioned as a comparison of methods. Indeed, the two analysts examined overlapping but not identical samples. In combining the two sets of overlapping results, we hope to provide a clearer picture of stone tool function at Schöningen.

2. Methods

Microwear and residue analyses aim to determine the use of stone tools based on a microscopic examination of stone tool surfaces. While both methods are complementary, they examine different types of functional evidence. Residue analysis focuses on the identification of the fragments of plant material (i.e., starch, fibres, etc.) or animal remains (i.e., hair, grease, collagen, etc.) that may still adhere to a stone tool after its use. Various methods exist to examine these residues on stone tools. A first step is generally the screening of stone tool surfaces during which the localisation of residues is mapped per area on the stone tool (e.g., Hardy, 1994, 2004; Lombard, 2008). This part of the procedure generally takes place under reflected light with a metallurgical microscope (magnifications up to 1000×), but it may be preceded by an examination under a stereomicroscope (magnifications up to 56×). Residue identifications are based on the visible morphological characteristics and a comparison of these with a reference collection. The

* Corresponding author.  
E-mail address: veerle.rots@ulg.ac.be (V. Rots).  

http://dx.doi.org/10.1016/j.jhevol.2015.07.005  
0047-2484/© 2015 Elsevier Ltd. All rights reserved.

Please cite this article in press as: Rots, V., et al., Residue and microwear analyses of the stone artifacts from Schöningen, Journal of Human Evolution (2015), http://dx.doi.org/10.1016/j.jhevol.2015.07.005
potential of other methods, for instance infrared spectroscopy, to aid in the identification of the residues in this stage of the procedure are currently being explored (Prinsloo et al., 2014). Subsequently, the localized residues may be extracted with pipets or with an ultrasonic cleaning device, after which they can be examined under transmitted light (e.g., Fullagar et al., 2006). This procedure allows for a larger variety of morphological characteristics to be observed, as well as the application of biochemical protocols that may assist in the residue identification (e.g., Matheson and Veall, 2014). Advantages are that extracted residues can be preserved for future analysis and that the stone tools can be handled without a further risk of residue contamination.

For microwear analysis, different procedures exist. In contrast to residue analysis, microwear studies focus on the actual stone tool surfaces and their transformation as a result of use. During use, the surface may be altered and polished yielding rounding and/or microchipping (edge scarring) that may be specific to the materials these tools were in contact with (e.g., Keeley, 1980; Vaughan, 1985). In contrast to residue analysis, tools generally need to be cleaned in order to remove adhering deposits or residues, explaining why a microwear analysis has to be performed after a residue analysis. Based on elaborate methodological explorations during the last century (e.g., Keeley, 1974, 1980; Odell, 1980, 1981), pressure may microwear studies commonly combine the use of a stereomicroscope and a metallurgical reflected-light microscope (e.g., Rots, 2010), but a scanning electron microscope (SEM) is also frequently used (e.g., Ollie and Verges, 2014). More recently, the potential of confocal microscopes in aiding distinctions between various use polishes is being explored (e.g., Evans and Donahue, 2008). Similar to a residue analysis, all wear identifications rely on comparisons with an experimental reference collection.

The microwear and residue analysis of the Schöningen tools were independently performed by two separate analysts (Table 1). To prevent contamination, tools were first examined for residues and subsequently for microwear traces. The researchers only compared results after both analyses were completed, thereby allowing for independence in the lines of evidence collected. Such a procedure strengthens the reliability of the results in cases of correspondence between both methods. Occasional disagreement in the results from the two analysts is informative in view of further developments of both methods.

The residue analysis was performed by Bruce Hardy using Dino-Lite Digital Microscopes with reflected light (AD-4132T, magnification 20–220×, AM40132T4, magnification 430–490×). Images were recorded using DinoCapture 2.0 software. Additional macrosopic images were recorded using a Nikon Coolpix 995 digital camera. The location of any possible residue was recorded on a line drawing of the artifact. Distribution of the residue on the artifact surface can provide valuable evidence to help determine if the residue is use-related. Residues that could be identified include hair, feathers, skin, bone, plant tissue, wood, and starch grains. Residues were identified based on comparison with a comparative collection of experimental stone-tool replicas and published materials (Brunner and Coman, 1974; Catling and Grayson, 1982; Brom, 1986; Beyries, 1988; Anderson-Gerfaud, 1990; Hoadley, 1990; Fullagar, 1991; Teering, 1991; Hather, 1993; Hardy, 1994; Kardulias and Verkes, 1996; Williamson, 1996; Hardy and Garufi, 1998; Pearsall, 2000; Haslam, 2004; Dove et al., 2005; Fullagar et al., 2006).

The microwear analysis was performed by Veerle Rots, using the equipment available at the Institut für Ur- und Frühgeschichte of the University of Tübingen. A Euromex binocular microscope (magnifications 10–60×) and a Keyence digital microscope VHX-500F were used for the first stage of the analysis, and where relevant an analysis under a Zeiss Axioslumer A1 microscope (magnifications 25–500×) was also performed (camera: AxioCam MRC). Some additional pieces were examined at Liège using a Zeiss V12 binocular microscope (magnifications up to 120×), a Zeiss V16 zoom microscope (magnifications up to 160×), and a Zeiss Axioslumer microscope with reflected light (magnifications up to 500×). While the analysis under low magnification focused mainly on scoring patterns and more general observations of polish, striations, and rounding, the analysis with a metallurgical microscope allows a more detailed analysis of these patterns. Interpretations relied on the experimental reference collection of the analyst consisting of about 2000 experimental artifacts (e.g., Rots, 2010). This reference collection is comprehensive and includes reference tools for traces of production, transport, use, prehension, and hafting. Experimental tools were used on a variety of materials, both in the hand and hafted in various arrangements for various durations.

Based on their preservation state, artifacts were subdivided into four categories: (1) very fresh, (2) light alterations, (3) moderate alterations, and (4) patinated and abraded. Items from the fourth category were not considered to be suitable for microwear analysis. This variable preservation is no doubt a factor of the site’s formation process (Stahlschmidt et al., 2015). Frost fractures are frequent and generally prove to be posterior to the tool’s production. As a consequence, the original working edge of some tools has disappeared entirely (e.g., ID 17961) or partially (e.g., ID 18606). Recent damage was observed to some degree, some of which could be directly attributed to the excavation based on the associated metal scratches. The latter damage has a more limited impact than frost damage and it did not affect the analysis.

3. Results

The functional analysis succeeded in identifying evidence of use on various artifacts, as well as providing clues towards their prehensile mode. Some pieces were too damaged by natural processes to allow interpretation.

3.1. Locality 12

Eighteen tools from Locality 12 were examined in total, by at least one procedure: 17 tools were submitted to residue analysis and 12 tools were examined for microwear evidence.

The first tool analysed was a core tool (ID 18628), which is slightly altered (category 2; Fig. 1a). This artifact was not examined for residues, but use-wear evidence was observed on one edge. It can be attributed to a scraping and perforating motion on a medium-hard to hard material.

Another tool analysed was a transverse scraper on flake that was proximally thinned (ID 18064). Its preservation is not ideal (category 3), but some wear evidence was observed (Fig. 2). The tool can be tentatively interpreted as a wood shave, similar to other examples that are regularly observed at Middle Palaeolithic sites (Rots, 2009). No wood-related residues were, however, observed. There is suggestive evidence of hafting, but it is insufficiently diagnostic to be certain.

A small flake with limited retouch (ID 15920) was well-preserved (category 1; Fig. 1b). It shows an irregular damage pattern with limited polish stains. However, there is no convincing evidence for use. This agrees with the observed absence of residues.

An intrusively retouched double sidescraper, proximally thinned (ID 18631) was altered (category 3). In spite of the alteration, use evidence was observed that corresponds to either an impact motion or a high-pressure perforation (Fig. 3). An impact motion is most likely, given the presence of a dorsal spin-off and a ventral large and intrusive step-terminating scar associated with a number of smaller impact scars. These distally initiated ventral scars seem
Table 1
Summary of the results from the residue and microwear analysis. Pieces with ID numbers in bold were examined for both use-wear and residues.

<table>
<thead>
<tr>
<th>ID</th>
<th>ID details</th>
<th>Macro preservation (1 – well to 4 – bad)</th>
<th>Residues recovered</th>
<th>Residues interpretation</th>
<th>Microwear traces</th>
<th>Microwear interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>104</td>
<td>Sch 13 II-4 402/29-16</td>
<td>–</td>
<td>None</td>
<td>0</td>
<td>Unknown/unused</td>
<td>–</td>
</tr>
<tr>
<td>995</td>
<td>Sch 13 II-4 682/28-7</td>
<td>–</td>
<td>None</td>
<td>0</td>
<td>Unknown/unused</td>
<td>–</td>
</tr>
<tr>
<td>2900</td>
<td>Sch 13 II-4 687/19-8</td>
<td>–</td>
<td>Wood, plant fibres</td>
<td>0</td>
<td>Scraping wood</td>
<td>–</td>
</tr>
<tr>
<td>3738</td>
<td>Sch 13 II-4 688/21-50</td>
<td>–</td>
<td>Bone or plant tissue, possible resin</td>
<td>0</td>
<td>Scraping bone or plant?</td>
<td>–</td>
</tr>
<tr>
<td>4114</td>
<td>Sch 13 II-4 689/17-1</td>
<td>–</td>
<td>Plant fibre, plant tissue</td>
<td>0</td>
<td>Scraping plant</td>
<td>–</td>
</tr>
<tr>
<td>10935</td>
<td>Sch 13 II-4 716/34-1</td>
<td>–</td>
<td>Bone or plant tissue, possible resin</td>
<td>0</td>
<td>Scraping bone or plant?</td>
<td>–</td>
</tr>
<tr>
<td>15654</td>
<td>Sch 13 II-4 689/22-44</td>
<td>–</td>
<td>Plant tissue</td>
<td>0</td>
<td>Scraping plant</td>
<td>–</td>
</tr>
<tr>
<td>15920</td>
<td>Sch 12 II-1 2/484-4</td>
<td>1</td>
<td>None</td>
<td>0</td>
<td>Unknown/unused</td>
<td>Limited polish stains, non-use</td>
</tr>
<tr>
<td>16402</td>
<td>Sch 12 II 14/489.3</td>
<td>1</td>
<td>Collagen, plant tissue</td>
<td>0</td>
<td>Cutting plant and animal</td>
<td>–</td>
</tr>
<tr>
<td>16403</td>
<td>Sch 12 II-1</td>
<td></td>
<td>Bone</td>
<td>0</td>
<td>Scraping bone</td>
<td>–</td>
</tr>
<tr>
<td>16520</td>
<td>Sch 12 II-2 19/486-4</td>
<td>1</td>
<td>Wood</td>
<td>0</td>
<td>Cutting wood</td>
<td>0</td>
</tr>
<tr>
<td>16575</td>
<td>Sch 12 II-7</td>
<td></td>
<td>Red staining</td>
<td>0</td>
<td>Unknown/unused</td>
<td>–</td>
</tr>
<tr>
<td>17444</td>
<td>Sch 12 II-4 904/616-1</td>
<td>1</td>
<td>None</td>
<td>0</td>
<td>Unknown/unused</td>
<td>Cutting use-wear</td>
</tr>
<tr>
<td>17922</td>
<td>Sch 12 II-4 674/1</td>
<td>1</td>
<td>Plant fibre</td>
<td>0</td>
<td>Unknown/unused</td>
<td>Scraping gymnosperm</td>
</tr>
<tr>
<td>17961</td>
<td>Sch 12 II-2 849/624-1</td>
<td>3</td>
<td>Wood fragment, plant fibre, plant tissue</td>
<td>0</td>
<td>– (Not examined)</td>
<td>– (Not examined)</td>
</tr>
<tr>
<td>17981</td>
<td></td>
<td>4</td>
<td>Plant tissue</td>
<td>0</td>
<td>– (Not examined)</td>
<td>– (Not examined)</td>
</tr>
<tr>
<td>18064</td>
<td>Sch 12 II-2 854/634-1</td>
<td>3</td>
<td>None</td>
<td>0</td>
<td>Unknown/unused</td>
<td>Suggestive but insufficiently diagnostic</td>
</tr>
<tr>
<td>18065</td>
<td>Sch 12 II-2</td>
<td></td>
<td>None</td>
<td>0</td>
<td>Unknown/unused</td>
<td>–</td>
</tr>
<tr>
<td>18060</td>
<td>Sch 12 II-1</td>
<td></td>
<td>Plant tissue, collagen, resin hair fragments, collagen</td>
<td>0</td>
<td>Cutting plant and animal</td>
<td>–</td>
</tr>
<tr>
<td>18613</td>
<td>Sch 12 II-1 22/490-2</td>
<td>2</td>
<td>Plant fibre, plant tissue</td>
<td>0</td>
<td>Cutting wood</td>
<td>0</td>
</tr>
<tr>
<td>18624</td>
<td>Sch 12 II-4</td>
<td></td>
<td>Wood</td>
<td>0</td>
<td>Hafted, scraping wood</td>
<td>–</td>
</tr>
<tr>
<td>18628</td>
<td></td>
<td>2</td>
<td>– (Not examined)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18631</td>
<td>Sch 12 II-4 859/639-1</td>
<td>3</td>
<td>Plant tissue, starch grain</td>
<td>0</td>
<td>Scraping plant</td>
<td>Impact wear (e.g., spin-off, step-terminating scars)</td>
</tr>
<tr>
<td>18632</td>
<td>Sch 12 II-2 855/622-1</td>
<td>4</td>
<td>Plant fibre</td>
<td>0</td>
<td>Unknown/unused</td>
<td>0</td>
</tr>
<tr>
<td>25487</td>
<td>Sch 13 II-4 639/14-30</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>– (Not examined)</td>
<td>0</td>
</tr>
<tr>
<td>25365</td>
<td>Sch 13 II-4 694/13-29</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>– (Not examined)</td>
<td>0</td>
</tr>
<tr>
<td>25364</td>
<td>Sch 13 II-4 694/13-28</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>– (Not examined)</td>
<td>0</td>
</tr>
<tr>
<td>25488</td>
<td>Sch 13 II-4 693/14-31</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>– (Not examined)</td>
<td>0</td>
</tr>
<tr>
<td>25365</td>
<td>Sch 13 II-4 695/24</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>– (Not examined)</td>
<td>0</td>
</tr>
<tr>
<td>25373</td>
<td>Sch 13 II-4 694/14-36</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>– (Not examined)</td>
<td>0</td>
</tr>
<tr>
<td>25373</td>
<td>Sch 13 II-4 694/14-37</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>– (Not examined)</td>
<td>0</td>
</tr>
</tbody>
</table>

Please cite this article in press as: Rots, V., et al., Residue and microwear analyses of the stone artifacts from Schöningen, Journal of Human Evolution (2015), http://dx.doi.org/10.1016/j.jhevol.2015.07.005
to have resulted in a complex distal dorsal fracture (terminating in the dorsal spin-off). Suggestive evidence of hafting was observed, but it remains very uncertain given the alteration. Nevertheless, there appears to be a clear separation between a distal zone with distally initiated damage and a proximal zone with laterally initiated damage, which is consistent with hafting. Based on the residue analysis, this piece was interpreted as having been used for scraping plant material. However, this interpretation does not seem to correspond to the observed edge wear pattern. A fragment of plant tissue found on the distal left ventral edge could be due to impact contact with wood or could be incidental to use.

A sidescraper (ID 17961) proved difficult to analyse due to frost actions that removed the entire ventral surface (e.g., it cuts through initiations of the retouched edge), as well as a large part of the right tool part (category 3: Fig. 1c). Recent damage was also observed. There are no indications of hafting. Wood residues were observed on the dorsal face and these were interpreted as resulting from a use as wood scraper (Fig. 4a). Such an interpretation would be confirmed by the dorsal edge wear pattern, the initiations of which are cut through by the ventral frost fracture. However, plant tissue and fibres were also observed on the ventral face where they are not linked with use; they are positioned on a surface that detached by natural processes following the manufacture and use of the piece (Fig. 4b). It is therefore doubtful that all of the residues observed on this tool are use-related.

Another sidescraper on a flake (ID 18606) proved heavily damaged due to frost action (category 3). Frost fractures occur on the distal left edge and the entire right edge (Fig. 5). On the preserved functional edge (proximal and medial left edge), the use-wear evidence corresponds to a use as a dry hide knife (Fig. 5).
There are no indications of hafting. This interpretation is confirmed by the residues that were observed on the same edge, hair fragments on the ventral left edge, and hair and collagen on the dorsal left edge. Based on the sometimes extensive nature of the dorsal damage associated with this knife, in particular in the proximal zone, it is possible that this artifact could have first functioned as a butchering knife and that most traces of this use could have been removed by a subsequent use on hide. The dorsal wear pattern would not contradict such an interpretation and the use of one tool through different stages of the processing of animal remains would seem logical, in particular given the small size of the lithic assemblage. It nevertheless remains a mere assumption in the absence of more supporting wear evidence or residues.

An inversely retouched sidescraper on a large hinge-terminating flake was very well-preserved (ID 17922). The hinge termination is a result of production. The right edge (retouched) shows evidence of use, even though traces are not very explicit (Fig. 6). Evidence is more prominent on the dorsal right extremity that appears to correspond to a use in hide working. There are no indications of hafting. Based on the residues, a use of the same edge on plants was
proposed based on plant fibres on the dorsal face inward from the right edge. Plant use is not supported by the use-wear evidence. It is possible that the plant fibre was incidental or could have been part of additives used in hide working.

A well-preserved small flake (ID 17444, category 1) shows use-wear evidence on its distal edge caused by use as a hand-held knife for cutting soft material, possibly meat (Fig. 7). On the ventral proximal right edge, sliced scars associated with a distinct polish were observed. These traces could be the result of use; however, these traces could also be linked with prehension (Rots, 2004, 2010). No residues were preserved on this piece. Previous research has suggested that animal residues may be underrepresented due to differences in preservation (Hardy et al., 2001).

A small core (ID 18632) with some preparation preserved on the left edge was heavily altered and patinated (category 4; Fig. 1d). There were no indications of use based on wear traces. Residues (plant fibres on the ventral distal extremity) were nevertheless observed. One of these was observed within a recent removal, suggesting that it is not related to the original use of the piece. It is therefore likely that the plant fibres were incidental and that the core remained unused.

The analysis of a double sidescraper on a medial flake fragment (ID 17981) was significantly hampered by the weathered preservation state of the piece (category 4; Fig. 1e). Nevertheless, edge damage was observed in association with a distal fracture and seems to have occurred under heavy pressure. In combination with additional damage on the edges, it appears that this piece could have been part of a (hafted) percussion implement. Unfortunately, its preservation state is too poor for any firm conclusions. This piece was not examined for residues.

A well-preserved small flake (ID 16520) did not show any reliable wear evidence of use (Fig. 1f). Some faint polish stains were observed that do not appear to be functional in cause. Significant metal wear was observed, caused by the contact with excavation tools or the sieve. Based on the presence of a wood residue on the dorsal distal end, this piece was interpreted as used for cutting wood. However, the specific edge damage pattern that

Figure 4. Macroscopic picture with residue evidence on ID17961: a) wood residues from wood scraping, b) plant tissue and fibres not related to use (due to natural processes).

Figure 5. Macroscopic picture with wear and residue evidence on ID18606: a) small feather- and step-terminating scars from use on ventral medial left edge (200×), b) use polish and rounding on ventral medial left edge (200×), c) minor scarring from use on (retouched) dorsal proximal left edge (20×), d) hair fragment on ventral proximal left edge (220×).
should be associated with such a use was not observed, nor do the faint polish stains correspond to such a use. Given the lack of correspondence between the methods here, the function of the tool is unknown.

A small flake (ID 18613, category 2) did not show any reliable evidence of use (Fig. 1g). Only some metal gloss was observed that is a result of contact with excavation equipment. Plant fibres and plant tissue were observed on the ventral face of the retouched
edge (distal area) that were attributed to use in cutting wood. The use-wear analysis did not reveal any polish formation in that area. Perhaps the plant residues could be linked with production or use contact must have been so limited that no use polish formed. Alternatively, it resulted from incidental contact.

Three remaining artifacts from Locality 12 were only examined for residues. A small flake (ID 16402) has collagen along one edge and plant fibres scattered along the same edge on both the dorsal and ventral surfaces. The distribution suggests that the artifact was used to cut plants and possibly animals as well. Another flake (ID 16403), unfortunately heavily weathered, has bone fragments along one edge on both the dorsal and ventral surfaces suggesting that it was used on bone or contacted bone repeatedly during butchery (Fig. 8). A final flake (ID 16575) has an area of additive red residue from an unknown source. No other evidence is visible and the patterning of the residue is not indicative of use.

3.2. Locality 13

For this locality, both analysts did not examine the same set of tools due to the fact that only a portion of the tools was available in Tübingen at the time of the microwear analysis. Part of the residue analysis was performed in Schöningen, where a different set of tools from Locality 13 could be analysed. In spite of their good preservation, the artifacts (n = 7) of Locality 13 that were examined for microwear traces were very small and did not deliver relevant observations in terms of use or hafting. It appears to be production waste. The set of tools (n = 7) examined for residues, by contrast, did provide indications of use. The observed residues consist of plant fibres, bone fragments, and possible evidence of resin.

A retouched flake (ID 2900) shows numerous plant and wood fragments along the retouched edge on the dorsal (trapped in flake scars) and ventral surfaces. This suggests this tool was used for woodworking.

A second flake (ID 4114) has plant fragments located in the same areas on the dorsal and ventral surfaces. The plant fragments are not diagnostic of any specific category of plants.

ID 3738 is a scraper with two plaques of additive residue visible macroscopically (Fig. 9). Under magnification, the plaques lack internal structure and appear to be resinous in nature when compared to other experimental and archaeological material (Hardy and Garufl, 1998; Hardy and Svoboda, 2010). Some fragments of bone or plant material are trapped in the resin but lack diagnostic specificity. Given the distribution of the resin and other residues, it is not possible to determine if the resin is related to hafting or to some other use of the tool. No other use-related residues were observed.

ID 10935, a large pointed flake, has additive residues similar in appearance to those on ID 3738. Similar residues that may be bone or plant are also seen. The distribution of resin on this piece is not suggestive of hafting and may therefore be present due to use in scraping plants.

One small flake (ID 15654) has plant fragments adhering along one edge on both the dorsal and ventral surfaces (Fig. 10). The patterning of these residues (along the same edge on both dorsal and ventral surfaces) suggests that they may be related to use in plant processing.

The final two artifacts (ID 104 and ID 995) have no residues.

4. Discussion

While only a few pieces showed diagnostic evidence of use, the analysis did provide interesting results. Preservation is quite good given the age of the sample. Microwear and residue analyses on sites this age are still rarely performed. Only a few sites provide comparative data in terms of preservation. Initial microwear analyses already proved successful for older assemblages, such as the analysis of the early stone tools (1.5 million years ago) from Koobi Fora (Kenya; Keeley and Toth, 1981). Hand axes from the Lower Palaeolithic open-air site of Boxgrove (UK; about 500 ka) provided identifiable use-wear evidence (Mitchell, 1998). More recently, older assemblages have received renewed evidence from use-wear analysts, such as the Oldowan from Kanjera South (Kenya; Lemorini et al., 2014), the Acheuleo-Yabrudian laminar assemblage of Qesem Cave (Israel; 382–207 ka; Lemorini et al., 2006), and the early Middle Palaeolithic assemblage of Biache-St-Vaast (France; about 250 ka; Rots, 2013). These sites are located in quite different
environments and in spite of some post-depositional alterations, wear traces proved to be sufficiently preserved to allow interpretations. Residue analyses on early sites are extremely rare: both the Oldowan assemblage of Sterkfontein (South Africa; 1.7–2.0 million years ago; Loy, 1998) and the Acheulean hand-axes from Peninj (Tanzania; 1.5 million years ago; Dominguez-Rodrigo et al., 2001) showed residues of plant remains. These studies were not combined with use-wear analysis and the association of the residue with the actual use of the tool (e.g., production, use, hafting) could not be confirmed.

Use-wear features and residues observed on the Schöningen tools reveal the working of different materials, such as wood and hide, as well as revealing evidence for cutting meat. Evidence of hide working has rarely been observed for this time period, so this requires a follow-up in the future. The hide working at Schöningen appears integrated within a more elaborate processing of animal tissue. The evidence for the processing of animal matter corresponds to earlier use-wear observations indicating a predominance of butchering activities on early sites, such as at Boxgrove (Mitchell, 1998), Qesem Cave (Lemorini et al., 2006), and Biache-St-Vaast (Rots, 2013). The woodworking evidence is very similar to what was observed for early and later Middle Palaeolithic sites (Beyries, 1988; Anderson-Gerfaud, 1990; Rots, 2009, 2013; Hardy and Moncel, 2011). Woodworking evidence in the Schöningen sample includes a piece used as a kind of ‘shave,’ which corresponds to the motion required for sharpening spears or manufacturing other wooden tools. For later periods, such tools proved to have been hafted (Rots, 2009, 2013). While suggestive evidence of hafting was also observed on the wood shave from Schöningen, it is insufficiently diagnostic to reliably infer hafting. Two other pieces from Schöningen also showed suggestive hafting evidence. In spite of the uncertainties, the mere observation of potential hafting evidence from this time period is unique and extremely interesting. A larger tool sample will need to be examined in order to evaluate whether similar observations can be made on other implements. This could shed an entirely new light on the evolution of hafting and the expertise of the early humans who were doing it (Barham, 2013).

The association of these tools with wooden implements, some of which have been interpreted as handles (Thieme, 1997), makes these observations all the more interesting.

The results from the use-wear and residue analysis proved to be complementary in several instances; this is a significant and informative result given the age of the assemblage. However, in a number of cases no agreement was obtained. In all these cases, the residues concerned plant fibres. Experiments are on-going to examine in detail how this pattern could be explained and whether it concerns a kind of use that does not result in diagnostic wear traces (e.g., very short use) or whether other causes (e.g., production strategies, transport of pieces in vegetal containers) could be responsible for the deposition of these plant fibres. Based on ethnographic examples, it is known that plant residues on artifacts can easily result from incidental contact given the abundant plant material that is generally lying around (Rots and Williamson, 2004). The fact that some plant residues were observed within recent scars or on frost fractures faces (formed after the tools’ manufacture and use) suggests they have a non-functional, post-depositional origin. It confirms the utility of combining residue analysis and use-wear analysis, preferably independently performed by different analysts, as is presented here. Given the complementary nature of the techniques, more reliable and powerful results can be obtained when they are used together. With regard to microwear, residues have the advantage of providing more detailed data. With regard to residues, wear traces provide the opportunity to confirm the association of the residues with the actual use of the tool. In addition, wear traces help to distinguish between residues that are linked with the direct use of the tool and those that are linked with their production, hafting, or manipulation. Our results stress that care needs to be taken with all plant fibres observed on tool surfaces;
not all of these fibres should be necessarily attributed to a use on plants. Therefore, a thorough and critical examination of the location and frequency of each residue is essential, before attributing it to use, hafting, or other causes.

5. Conclusion

The two different localities at Schöningen offer varied views of the past. The main find horizon of Locality 13 (Soccket) represents a research excavation with greater internal site structure and comparatively high densities of anthropogenic material. This locality offers the possibility of understanding behaviors in a larger context and seeing how artifacts, features, and ecofacts relate to one another. Locality 12 (Damm), by contrast, is characterized by low density scatters of isolated objects. These data result from salvage excavation over large surfaces. As such, the locality offers the opportunity to investigate individual events by looking at the life history of singular artifacts. Both kinds of data help to complete the picture of hominin lifeways in northern Europe during the Middle Pleistocene. The fantastic preservation at Schöningen, combined with its varied archaeological nature, allows us a unique insight into the behavior of our remote ancestors. Our analysis shows a variety of activities with a particular emphasis on animal processing and woodworking. The positive results of the microwear and residue analyses demonstrate the efficacy of these techniques, in particular when combined, for Lower Paleolithic sites such as Schöningen. Continued excavations and functional analyses will contribute further insight into the tasks performed at Schöningen and into the associated behavioral complexity. In particular, the suggestive evidence for hafting will require more detailed examinations in the future. If confirmed in future analyses, it would indicate a much earlier appearance of hafted tool technology than commonly believed in Europe, but also elsewhere. While early hafting technology has been argued to have been present at Kathu Pan in South Africa (Wilkins et al., 2012), this evidence is very questionable (see Rots and Plisson (2014) for a discussion). The evidence at Schöningen is not convincing at this stage, but if confirmed in the future, it would once again prove that complex technological behaviors are not associated exclusively with modern humans.

Acknowledgements

Veerle Rots is indebted to the Fund for Scientific Research (FNRS-FRS) and to the European Research Council under the European Union’s Seventh Framework Programme (FP/2007-2013)/ERC Grant Agreement n. 312283 (EVO-HAFT). Work at Schöningen was funded by the Ministry of Science and Culture, State of Lower Saxony and the Deutsche Forschungsgemeinschaft, CO 220/22-1.

References


Hardy, B.L., 2004. Neanderthal behaviour and stone tool function at the Middle Palaeolithic site of La Quina, France. Antiquity 78 (301), 547 –565.