Notae Praehistoricae 21-2001: 129-137

Experimental Hafting Traces
Identification and Characteristics

Veerle ROTS, Louis PIRNAY, Philippe PIRSON, Odette BAUDOUX & Pierre M. VERMEERSCH

1. Introduction

Microscopic functional research has mainly been centred on usewear traces visible on working edges (active tool parts). Non-active parts were largely neglected, although these parts may also carry traces worthwhile exploring. Not only technological traces, resulting from production, but also prehension or hafting traces can be observed. The latter has never been the object of a systematic study. In the past, the concept of hafting was merely described in rather general terms. Keeley (1982) is one of the few to have devoted more attention to the subject and he pointed to the importance of hafting for adequately interpreting the archaeological record. Traces that could be related to hafting were observed frequently (e.g. Keeley 1980, Vaughan 1985), but due to a lack of reference, they were rarely interpreted further. Practically no hafting experiments have ever been undertaken on a systematic basis. On some occasions, hafted tools were produced for usewear experiments, but the resulting hafting traces were hardly ever investigated (e.g. Kamminga 1982). Only a few analysts attempted to characterise hafting traces (e.g. Odell and Odell-Vereecken 1980, Odell 1980, 1981, Plisson 1982, Moss and Newcomer 1982). The first breakthrough in hafting research was the conference organised by Stordeur in 1984 (Stordeur 1987). For the first time a group of analysts sat together to discuss the problem of hafting. The conference also stimulated specific hafting experiments and the analysis of the hafting traces produced. Nevertheless, investigations remained limited and unsystematic in nature and often lacked a sound experimental basis.

Although the issue of hafting traces received little attention in the past, the fact they may be interpretable has significant consequences on archaeological interpretation. In the first place, it allows us to gain insight into a part of the tool that is rarely preserved, due to its organic nature. It can be established that the lithic tool in question is no tool in itself, but part of a more complex whole. At the same time, we can identify hand-held tools, where the stone implement alone forms the complete tool. Secondly, the choice to haft a tool has an important impact on the tool's life cycle. On the one hand, energy will have to be invested in the procurement of raw materials, the manufacture of the haft, etc. On the other hand, a haft has many advantages on the level of tool use. It increases the force that may be exerted during work and enhances the efficiency or precision of work. It also allows the production of composite tools with cutting edges of sizes or shapes unobtainable with hand-held implements. For some tools, hafting is even a prerequisite to allow use (e.g. projectiles). We can conclude that knowing whether or not a tool was used hafted contributes significantly to a comprehensive investigation of stone tools. A systematic study of potential wear that allows its identification is therefore highly needed.

2. Research Goal

The goal of our research is twofold. Firstly, based on a large body of experimental data, we aim at the differentiation of hafting traces from all other traces present on a tool's surface. Secondly, we attempt to link the hafting traces produced to specific variables, such as hafting arrangement, action, worked material, etc. A distinction between dominant and secondary variables is made. Here we will focus on the question whether haft wear can be distinguished from other wear on a tool's surface. Only flint tools are included.

3. Experimental Procedure

The information at hand for determining hafting traces is very limited, underscoring the need for an extensive experimental reference collection that can be used for the investigation of archaeological artefacts. The internal trace variability can only be investigated based on a reference collection that includes a sufficiently wide range of hafting materials, different uses, etc. The advantage of experiments is that we can control an important part of the intervening factors – the intrinsic factors – aiding us to gain insight in the variables influencing hafting trace variability (Beyries 1997). These intrinsic factors consist of hafting arrangement, use duration, worked material, etc. Other – extrinsic – factors cannot be controlled, as for instance use-context and know-how (Cauvin and Stordeur 1987, Beyries 1993, Beyries 1997).

We can try to overcome this problem as much as possible, but a control of all variables can only take place in ethnographical conditions. The artificial experimental use-context is excluded as much as possible by aiming at task completion rather than trace *production*. Lack of know-how in manipulating stone tools is a second drawback because of its influence on gesture and the resulting microscopic trace pattern. Most of our experimenters however, are sufficiently familiar with stone tools to reduce this factor to a minimum.

In practice, we can enumerate the following experimental procedure. All experiments were undertaken outside in order to avoid artificially clean laboratory conditions (Keeley 1974: 330). Most hafts were fabricated with the aid of modern-day equipment in order to speed up this time-intensive process. Only when the fabrication process itself was at issue, stone tools were used. All flakes or blades included in the experiments were freshly knapped, retouched if required, and immediately inserted in separate plastic bags to avoid any further friction. Details concerning this production process were recorded. Analyses took place at several stages of the experiment: after production, after hafting (but before use), after use, etc. This allowed us to gain insight into both hafting wear and other wear that is potentially present on a tool's surface. Criteria could thus be proposed for the identification of haft wear.

4. Method of Analysis

Both macro- and microscopic traces are considered and different types of analysis are combined, including macroscopic, low power and high power analyses. The low power analysis is undertaken with a stereoscopic microscope Wild (M5-22827, magnifications 6x-100x) according to the principles set out by Tringham *et al.* (1974) and further elaborated by Odell (1977). The high power analysis is undertaken with a metallographic microscope Olympus BX60M (MDPlan 10, MSPlan 20, MSPlan 50), using bright field illumination, according to Keeley (1980). For the latter type of analysis, all experimental tools were shortly immersed in a 10% hydrochloric acid-solution (0,1 N), to remove adhering residues. During the analysis, tools were cleaned with acetone.

5. Results

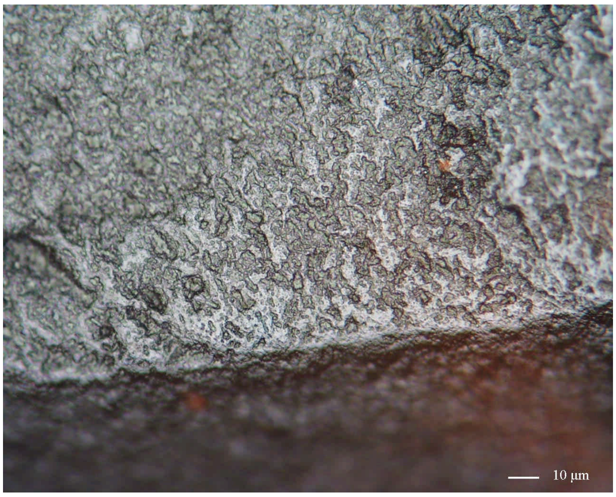
If one wants to characterise hafting traces, the first important step is to isolate them from all other possible wear that can be present on a tool's surface. After all, other processes can result in the same types of wear as will form during hafted use. On a macroscopic level, scarring and gloss can be produced. On a low power level, scarring is the main variable to be characterised, while polish, bright spots, striations and rounding are regularly visible. On a high power level, polish, bright spots, striations and rounding can be observed and characterised.

5.1. Basic traits of hafting traces

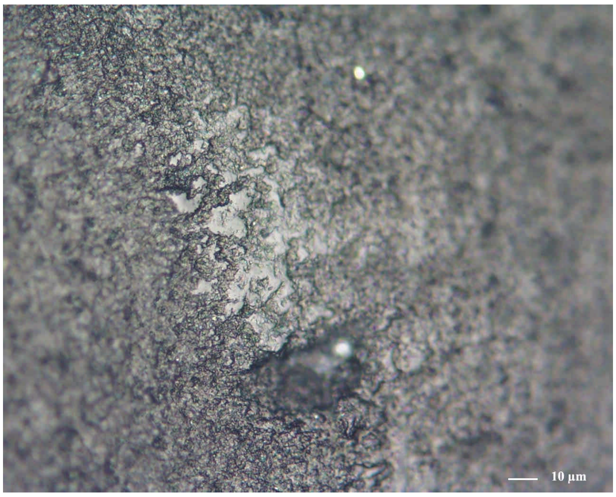
Before we can argue that hafting traces are distinctive, we should propose some key characteristics. If a tool was used hafted, a clear limit should be identifiable between the used and hafted tool portion. This limit can be formed by a number of traces, for instance, by the start of a distinctively different polish, the abrupt start of scarring, a series of bright spots, striations, or a combination of some of these. In general, polish, scarring and bright spots are the most distinctive traces to identify hafting, striations or rounding are less characteristic.

We argue that hafting polish is distinctive from polish produced as a result of other causes, and the following general guidelines can be proposed. Firstly, the use polish and hafting polish of one and the same tool are not necessarily due to the same material. This is in sharp contrast to what is observed in case of prehension (cf. infra). Secondly, the polish is distributed more or less equally along the microtopography and does not proceed gradually from the outer edge (Pl. 1: 1). Thirdly, its extent and development depend on the resistance of the material worked, the more resistant the worked material, the more extensive and developed the polish. Lastly, the localisation over the hafted tool part depends on the action undertaken. In case of scraping, it is concentrated around the haft limit and the most proximal part, while in case of adzing it can be present all along the edge. These two last features will similarly influence the formation process of bright spots and scarring.

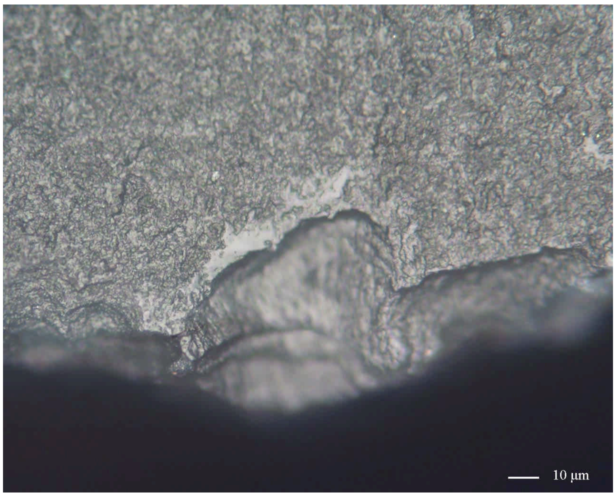
Bright spots are important for hafting (Rots and Vermeersch, in press). We believe that they are formed by the friction of a flint particle that detached within the haft with the lithic tool. They form an important criterion to identify hafting, which is an observation that stands in contrast with the long-standing belief that they were not interpretable (e.g. Moss 1983, Vaughan 1985) or due to post-depositional causes (e.g. Levi-Sala 1986). Bright spots can occur isolated (Pl. 1: 2), but in most cases they are associated with scarring (Pl. 1: 3).



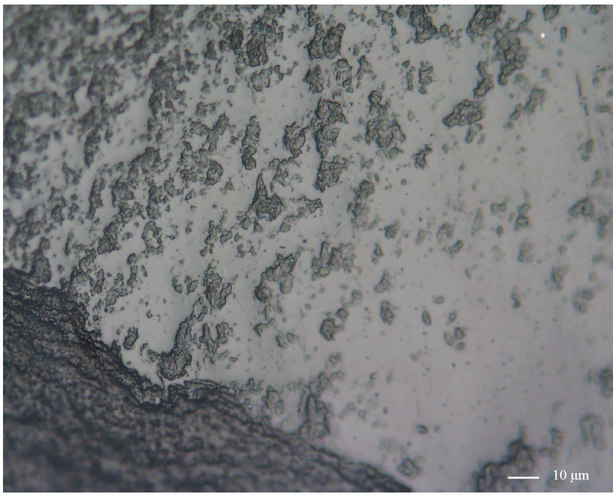
1



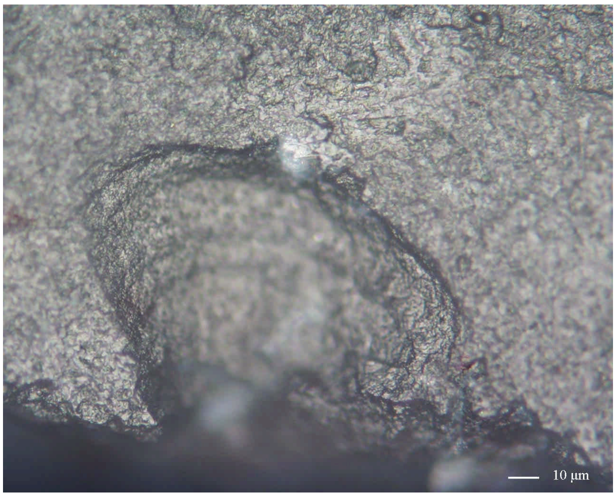
2



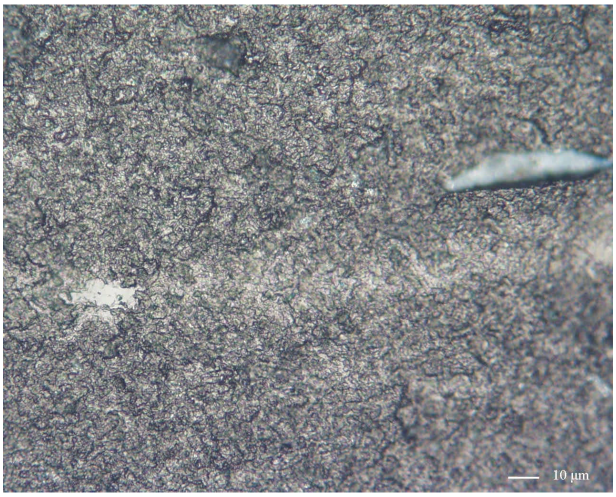
3



4



5



6

Pl. 1 – 1. Hafting polish from indirect contact with wooden haft (leather wrapping) on proximal ridge of tool used to adze wood; 2. Hafting bright spot on tool used to scrape wood; 3. Hafting bright spot associated with scar on ventral proximal edge of tool used to adze wood; 4. Hafting bright spot on dorsal medial surface of tool used to scrape wood; 5. Hafting striation associated with scar on dorsal proximal butt of tool used to adze wood; 6. Hafting bright spot associated with striation on ventral proximal surface of tool used to adze wood.

They can be very extensive and developed when the worked material is well resistant (Pl. 1: 4).

As stated, scarring is often associated with bright spots, occasionally also with striations (Pl. 1: 5). The more resistant the worked material, the more scarring will occur. When the butt of the lithic tool is in contact with the haft (e.g. stopping ridge), high pressure motions generally result in a crushed butt as the result of impact. Logically, a concentration of bright spots is usually associated.

Striations (linear features) are often associated with scarring (Pl. 1: 5) or bright spots (Pl. 1: 6). This is understated by their morphology, witnessing a flint-on-flint friction. Hafting striations are not numerous, but if they occur, they frequently mark the haft limit. In those cases, they are generally orientated perpendicular to the edge. Overall, their orientation depends on the action undertaken. High-pressure actions, such as adzing, provide the most consistent evidence, striations are preferentially orientated parallel to the tool's axe. Scraping motions do not result in preferentially orientated striations.

In our opinion, the above criteria are sufficient in order to distinguish hafting traces from other wear and to assess whether a tool was used hafted.

5.2. Are hafting traces significantly different from other wear?

External factors, use and prehension can all lead to the production of the same types of traces: polish, scarring, rounding, striations and bright spots. It is therefore important to be aware of the characteristics of these traces in order to be able to adequately identify and interpret hafting traces. This is illustrated by the fact that hafting traces were frequently incorrectly interpreted in blind tests (e.g. Unrath et al. 1986).

6. *External factors*

Rather extensive research has been undertaken concerning several kinds of external factors. Especially the influence of trampling (e.g. Shea and Klenck 1993, McBrearty et al. 1998), post-depositional processes (e.g. Levi-Sala 1986, 1993, 1996, Mansur-Franchomme 1986) and chemical actions (e.g. Plisson and Mauger 1988) have received a lot of attention. Most of the experiments undertaken in view of testing the impact of these factors were aimed at identifying how these factors altered microwear polishes and how they possibly influenced a correct interpretation of usewear traces. We focus on the specific characteristics of these traces and how they can be distinguished from haft wear. We include production and transport traces. With production, we refer to knapping and retouch. With transport we refer to the carrying around of tools and other equipment in a bag.

6.1. Production traces

Traces resulting from friction are rather limited, we can refer to the occurrence of a light friction polish, striations and scarring. The localisation of these traces is consistent with their cause. In case of knapping, traces occur on the butt, on the ventral butt or on the bulb. On the butt, traces are linked with the direct impact from the hammer (Pl. 2: 1). Their morphology will thus depend on the type of hammer used. On the ventral butt and bulb, traces are produced as a result of the short friction of the blade or flake against the core upon detachment. They thus always show a flint-on-flint in morphology (Pl. 2: 2). Knapping scars are rare and small. We can expect them in association with important macroscopic knapping radiations. At the point of a flake or blade, a (hinge-terminating) fracture regularly occurs.

Retouch traces occur on the edges opposite the face of retouch or – in case of retouch by counter-pressure – on the low ridge adjacent to the retouch. Since they are the result of a direct contact with a hammer, their morphology depends on the type of hammer used (Pl. 2: 3). Retouch scars are again rare, if they occur at all.

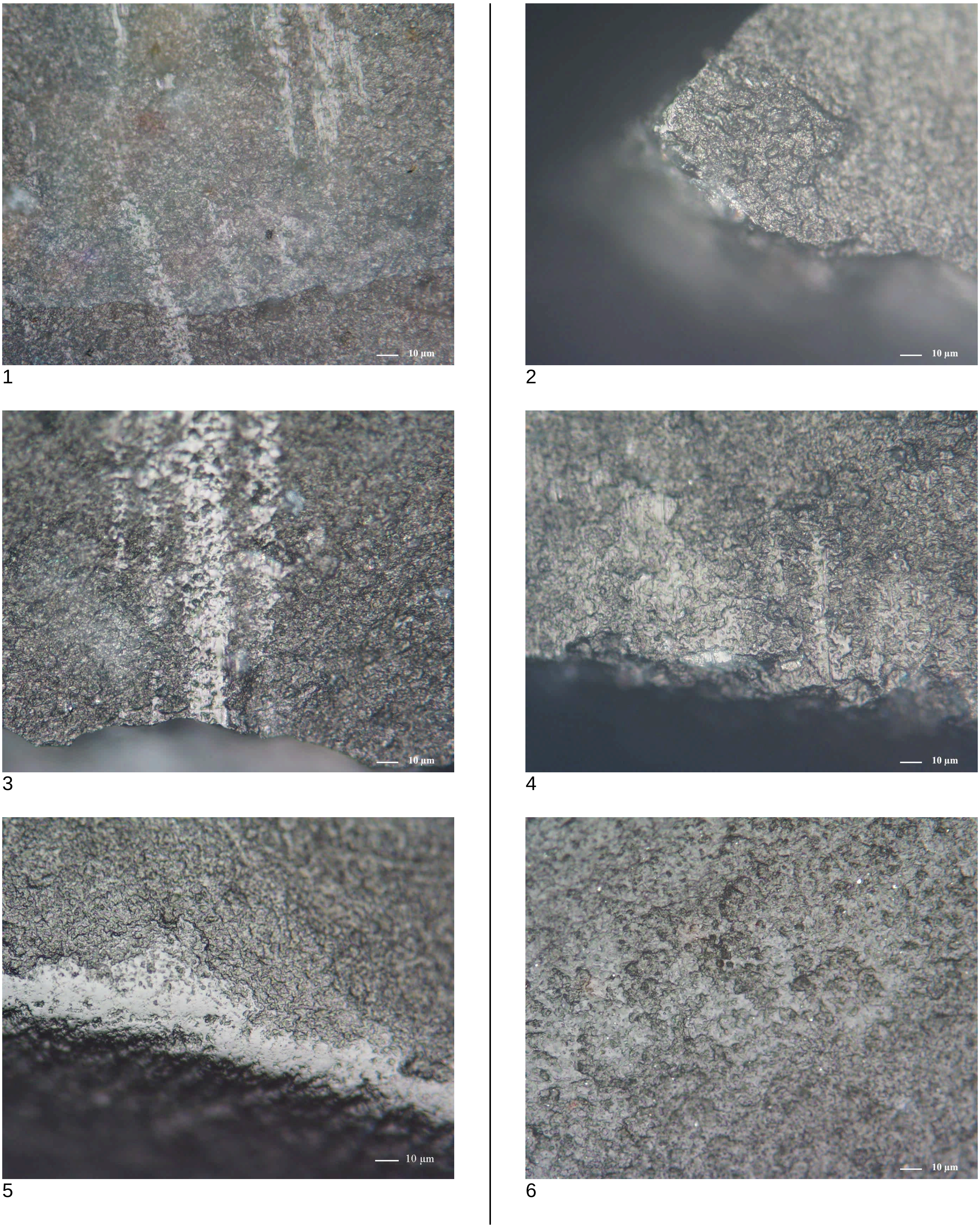
Traces resulting from an anvil contact are generally situated on the ridge and adjacent surface at the height of the retouched edges (Pl. 2: 4). This zone forms the main potential contact area with anvils. An important crushing of the ridge can be associated, due to the important pressure that is executed at each stroke.

We can conclude that a distinction with hafting traces is possible based on the specific location of production traces (e.g. bulb, butt), in close relation with a technological feature (e.g. platform, retouch). They also show a distinctive morphology, which depends on the hammer used, but most frequently we are dealing with a stone-on-stone morphology. The polish lastly has a very limited intensity and (spot-like) distribution.

6.2. Transport traces

Freshly knapped unretouched blades and tools were transported by a person in different circumstances and for different periods of time.

- in a loose hanging leather bag
- in a leather bag in the pocket of a pair of trousers.
- rolled individually in a leather wrapping and subsequently placed into a leather bag
- rolled one after the other in a large piece of leather and subsequently placed in a leather bag



Pl. 2 – 1. Knapping striations from stone hammer on butt; 2. Light friction polish from friction against core on ventral butt; 3. Retouch striation from antler hammer; 4. Anvil contact on dorsal ridge: light friction polish, crushing and striations; 5. Transport polish with integrated bright spots on dorsal ridge from transport of 18 days in loose hanging leather bag; 6. Transport polish from transport of 98 days in leather bag in pocket.

All artefacts were transported for a minimum of 7 days and a maximum of 204 days. The individuals frequently moved around during the experiment.

In the first situation, an all-round abrasion polish is produced after a few days. Bright spots are generally small, flat, smooth and highly linked. A rounding is clearly associated with the abrasive polish and bright spots. The more the latter two are developed, the more extensive the rounding. This rounding is especially visible on dorsal ridges. A transport of 18 days produces a heavily damaged artefact and a macroscopically visible gloss on dorsal ridges. This gloss consists of a series of bright spots on a microscopic level (200x) (Pl. 2: 5). Bright spots are present all over the tool without any organisation. Macroscopic retouches are numerous and their (indirect) link with the presence of bright spots is obvious. After a total transport of 88 days, macroscopic scratches are present all over the tool, as well as a macroscopically visible polish line on the ridges. On a microscopic level, an extensive well-developed abrasion polish and numerous bright spots can be observed. A clear rounding is present.

The same counts for the second case scenario, but here traces are produced much slower. Only after a transport of 14 days, a light, bright and smooth abrasion polish can be observed on the dorsal ridges, in some zones it is somewhat more extensive and forms a bright spot. The polish does not intrude much into the inner surface of the tool. A total transport of 98 days causes a relatively well-developed, but limited polish on portions of the tool's surface (Pl. 2: 6). A well-developed abrasion polish, as well as bright spots can be observed.

In the last two cases, hardly any traces are produced. After 79 days, a minor polish can be observed on the dorsal ridges of the third series of tools. This polish is hardly developed and is nothing more than what can be expected from friction during knapping. Similar observations were made on the last set of tools, with one remarkable exception. The zones corresponding with the location of the string around the leather wrapping show a light abrasion polish on ridges and edges and light abrasive striations corresponding with the string direction. Some minor damage is associated, but no bright spots are produced. The pressure executed by the string, amplified during transport, can account for these traces. Only in one case, bright spots were produced due to the position of the string on a protruding part of the tool's edge, resulting in more extensive damage and pressure, which lead to bright spot production on the edge. These bright spots, smooth and flat, remain very limited and small.

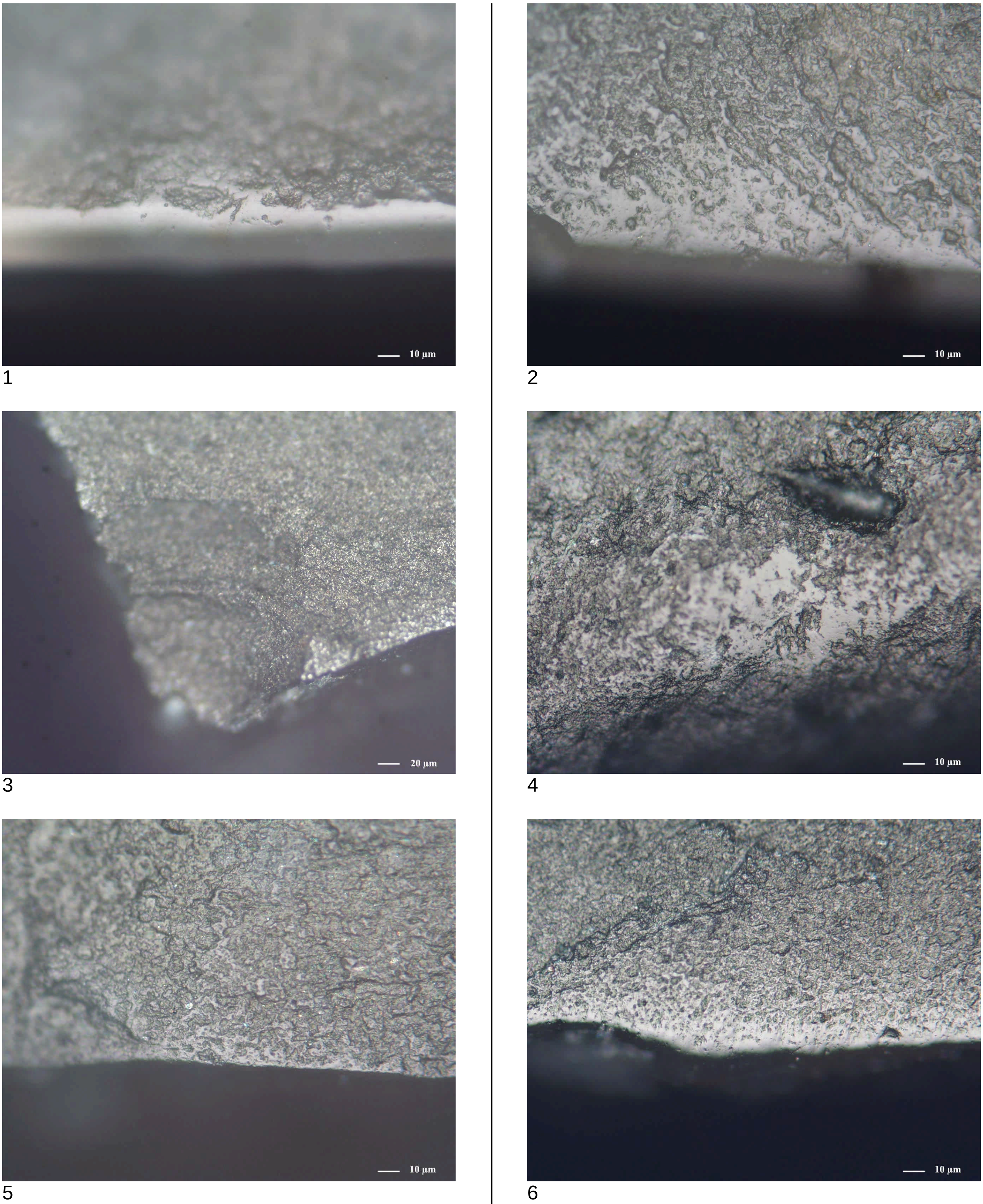
It is clear that abrasion polishes are more frequent on transported tools than bright spots. This can be explained by the fact that friction is rarely sufficiently intense to allow bright spot production. A constant low-pressure friction can perfectly explain an all-round abrasion polish. Such an interpretation is further confirmed by the high frequency of bright spots in the first case scenario. In a loose hanging bag, tools are "smacked" against each other with high pressure, allowing bright spots to be produced. Such transport bright spots are easily distinguishable, due to their association with abrasion polish and their all-round random distribution.

We can conclude that transport traces can be distinguished from hafting based on their random orientation and localisation all over the tool. There is no limit or restriction to a specific tool zone and several trace types are integrated while an association of scarring with other traces is absent. Rounding can be very intensive in loose-hanging bags, while they are practically absent (or at least limited) in case of hafting.

7. Use

Usewear traces enjoyed a lot of attention in functional research. They formed the object of several systematic investigations (e.g. Semenov 1964, Keeley 1980, Vaughan 1985). A number of characteristics can be proposed that allow the distinction of usewear and hafting traces. For usewear traces, polish and scarring are the most distinctive features, while striations and rounding are often associated. Bright spots are rare.

Use polish can not be mistaken for hafting polish. It shows a clear impact on the edge (Pl. 3: 1) and the best-developed zones are situated on the outer edge from where the polish gradually develops towards the inner surface (Pl. 3: 2). It also shows a distinct directional aspect. These traits are all lacking in case of hafting polish. Further, other traces occur in close association, such as rounding, striations, scarring (Pl. 3: 3) and occasionally bright spots. The latter only occur when a flint particle is stuck in the worked material due to which a short friction with the working edge can occur, or when abrasive particles are added to the worked material (e.g. ochre and hide). These bright spots are always integrated within a distinctive use polish (Pl. 3: 4). The specific characteristics of the traces observed are determined by the worked material and influenced by the action undertaken (e.g. Tringham et al. 1974, Odell 1977, Keeley 1980, Odell and Odell-Vereecken 1980). Usewear is obviously limited to the used edge only.



Pl. 3 – 1. Usewear polish from cutting reed, on medial left edge; 2. Usewear polish from cutting reed, on ventral medial left edge; 3. Usewear polish associated with scarring from grooving antler, on ventral distal point (100x); 4. Usewear polish with integrated bright spots from scraping hide with abrasives, on ventral scraperhead; 5. Prehension polish from scraping schist, on dorsal medial ridge; 6. Prehension polish from grooving antler, on ventral proximal edge.

8. Prehension

With prehension traces we refer to traces resulting from manual grasping, understood as a direct contact between tool and hand (e.g. no leather pad). It is important to distinguish prehension traces from hafting traces as they both occur on the non-active part of a tool. Without understanding their nature and variability, we cannot reliably distinguish them from hafting traces, a central issue within our investigation.

Based on our experiments, we can determine that the intensity of prehension traces is largely dependent on the activity undertaken and especially on the amount of "dirt" produced during use. Bone, antler and schist working are all uses that can result in a lot of dust, quickly covering the hands during use. These particles are thus the determinant factor in trace production. The morphology of prehension polish is consequently always consistent with the material worked apart from a minor influence from the flesh of the hand (Pl. 3: 5). This polish can be very well developed and no limit between a used and hafted tool part can be identified (Pl. 3: 6). Prehension wear intrudes far into the distal part in an irregular fashion. Well-developed polish spots – comparable to bright spots – can occur integrated within the prehension polish. They are not the result of a friction with a flint particle, which is understated by their morphology (an identical morphology but a better development stage). If scarring occurs, it is small and generally feather-terminating and scalar.

In general, we can state that in all experimental cases observed, the trace distribution over the tool allowed the reconstruction of the position of the hand during use. In none of the observed cases, the trace distribution was the same over both lateral edges (in contrast to hafting), preventing the identification of a limit. We can thus confidently argue that the characteristics of prehension wear are clearly distinct from hafting traces.

9. Conclusion

We can conclude that hafting traces are produced and can be distinguished from other traces present on the tool's surface. All other causes investigated here resulted in a totally different wear pattern. This implies that hafted tools can be identified on an archaeological level.

This conclusion has far-reaching implications for future archaeological interpretations. It implies that we are finally able to identify hafted tools within an assemblage. This allows more adequate interpretations of the tool's life cycle, and of assemblage variability. It opens up investigations with regard to the relation between standardisation and hafting, the cause for certain morphological adaptations (e.g. tangs, bulb reductions), etc. It remains without doubt that this research needs to be elaborated in the future. Hopefully, our results are sufficiently encouraging to counter-act the strong disbelief towards the interpretative possibilities of hafting traces that reigned in the past. The application of our experimental results to archaeological assemblages will be discussed elsewhere.

10. Acknowledgements

We are indebted to the *Onderzoeksfonds* of the *Katholieke Universiteit Leuven* (OT 97/25) for their financial support of this research. We also thank *Les Chercheurs de la Wallonie* and the *Préhistosite de Ramioul* for providing a favourable experimental environment and the necessary accommodation.

11. Bibliography

BEYRIES, S. 1993. Expérimentation archéologique et savoir-faire traditionnel : l'exemple de la découpe d'un cervidé. *Techniques et Cultures*, 22 : 53-79.

BEYRIES, S. 1997. Ethnoarchéologie : un mode d'expérimentation. *Préhistoire Anthropologie Méditerrannéennes*, 6 : 185-196.

CAUVIN, J. and D. STORDEUR. 1987. Quelques réflexions sur l'évolution préhistorique des emmanchements. In: D. Stordeur (ed.) *La main et l'outil: manches et emmanchements préhistoriques*. Maison de l'Orient Mediterranéen, Lyon, 331-336.

KAMMINGA, J. 1982. Over the Edge: Functional Analysis of Australian Stone Tools, University of Queensland Anthropology Museum. *Occasional Papers in Anthropology*, 12.

KEELEY, L.H. 1974. Technique and Methodology in Microwear Studies: a critical review. *World Archaeology*, 5: 323-336.

KEELEY, L.H. 1980. *Experimental Determination of Stone Tool Uses: a Microwear Analysis*. Chicago and London, University of Chicago Press.

KEELEY, L.H. 1982. Hafting and Retooling: effects on the archaeological record. *American Antiquity*, 47: 798-809.

LEVI-SALA, I. 1986. Use Wear and Post Depositional Surface Modification: A Word of Caution. *Journal of Archaeological Science*, 13: 229-244.

LEVI-SALA, I. 1993. Use-wear traces: processes of development and post-depositional alterations. In: P.C. Anderson, S. Beyries, M. Otte and H. Plisson (eds) Traces et fonction: les gestes retrouvés. Actes du colloque international de Liège, 8-9-10 décembre 1990. *ERAUL*, 50. Vol. 2: 401-415. Liège.

LEVI-SALA, I. 1996. A Study of Microscopic Polish on Flint Implements, *BAR International Series* 629, Oxford.

MOSS, E. 1983. The Functional Analysis of Flint Implements. Pincevent and Pont d'Ambon: Two Case Studies from the French Final Paleolithic. *BAR International Series*, 177, Oxford.

ODELL, G.H. 1977. *The application of micro-wear analysis to the lithic component of an entire prehistoric settlement: methods, problems, and functional reconstructions*. Unpublished PhD thesis, Harvard University, Cambridge (Mass.).

ODELL, G. 1980. Toward a more Behavioral Approach to Archaeological Lithic Concentrations. *American Antiquity*, 45: 404-431.

ODELL, G. 1981. The Mechanics of Use-breakage of Stone Tools: some Testable Hypotheses. *Journal of Field Archaeology*, 8: 197-209.

ODELL, G. and F. ODELL-VEREECKEN. 1980. Verifying the Reliability of Lithic Use Wear Assessment by "Blind Test": the Low Power Approach. *Journal of Field Archaeology*, 7: 87-120.

PLISSON, H. 1982. Analyse fonctionnelle de 95 micro-grattoirs « Tourassiens ». In: D. Cahen (ed.) Tailler ! pour quoi faire: Préhistoire et technologie lithique II. Recent Progress in Microwear Studies. *Studia Praehistorica Belgica*, 2: 279-287, Tervuren.

PLISSON, H. and M. MAUGER. 1988. Chemical and Mechanical Alteration of Microwear Polishes: an Experimental Approach. *Helinium*, 28, 1: 3-16.

MANSUR-FRANCHOMME, M.E. 1986. Microscopie du matériel lithique préhistorique. Traces d'utilisation, altérations naturelles, accidentelles et technologiques. Exemples de Patagonie. *Cahiers du Quaternaire*, 9. Editions du Centre National de la Recherche Scientifique, Paris.

McBREARTY, S., L. BISHOP, T. PLUMMER, R. DEWAR and N. CONARD. 1998. Tools underfoot: human trampling as an agent of lithic artifact edge modification. *American Antiquity*, 63, 1: 108-129.

MOSS, E. and M.H. NEWCOMER. 1982. Reconstruction of tool use at Pincevent: microwear and experiments. In: D. Cahen (ed.) Tailler ! pour quoi faire: Préhistoire et technologie lithique II. Recent Progress in Microwear Studies. *Studia Praehistorica Belgica*, 2: 289-312, Tervuren.

ROTS, V. en P.M. VERMEERSCH. In press. Bright spots reconsidered. New experimental data related to microscopic hafting traces. *Conference in honour of Sergei Semenov, Saint-Petersburg, 30th of January – 4th of February 2000*. Valbonne - Saint-Petersburg.

SHEA, J.J. and J.D. KLENCK. 1993. An Experimental Investigation of the Effects of Trampling on the Results of Lithic Microwear analysis. *Journal of Archaeological Science*, 20: 175-194.

STORDEUR, D. 1987. Manches et emmanchements préhistoriques: quelques propositions préliminaires. In : D. Stordeur (ed.) *La main et l'outil: manches et emmanchements préhistoriques*. Maison de l'Orient Mediterranéen, Lyon, 11-34.

TRINGHAM, R., G. COOPER, G.H. ODELL, B. VOYTEK, A. WHITMAN. 1974. Experimentation in the Formation of Edge-damage: a new approach to Lithic Analysis. *Journal of Field Archaeology*, 1: 171-196.

VAUGHAN, P. 1985. *Use-wear Analysis of Flaked Stone Tools*. Tueson.

Veerle Rots & Pierre M. Vermeersch
Laboratorium voor Prehistorie
Katholieke Universiteit Leuven
Redingenstraat 16
B - 3000 Leuven
veerle.rots@geo.kuleuven.ac.be

Louis Pirnay, Philippe Pirson & Odette Baudoux
Les Chercheurs de la Wallonie
Préhistosite de Ramioul
128, rue de la Grotte
B - 4400 Flémalle