Functional analysis of grinding stones: the blind-test contribution

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Summary. Western archaeology really adopted S.A. Semenov’s use-wear analysis method (Semenov 1964), with the blind-test of M.H. Newcomer and L.H. Keeley in 1977 (Keeley et al. 1977). Today, functional analysis on grinding and abrading stone tools is a promising field of research, especially for Neolithic studies. It requires a re-evaluation of the framework initially created for flint tools. This paper proposes an evaluation, through a blind-test, of the framework of grinding tools functional analysis. In this aim, H. Plisson took in charge the crushing of calcite and dry bone, the grinding of naked wheat, fresh bone and cartilage, dry meat and roasted acorn as well as the softening of dry hide. On the other side, the observation of these fourteen tools by C. Hamon helped her proposing hypothesis on the position of the tool, their action, the transformed matter, their condition and duration of use. Comparison of the hypothesis proposed and the effective experimentations help us discuss the reliability of each of these criterion.


Stakes for a blind-test on grindingstone tools

Most of the archaeological reasoning is based on a comparison between past remains and models involving present or ethnographical references. In these situations, similar material facts are connected to the technical, economical, morphological or symbolic systems they belong to, as elements linked by reciprocal relations. At the level of physico-chemical parameters, the safer inferences are not depending on cultural arbitrariness: in any place of the world, in any time, pure copper always melt at the same temperature. This is why technological studies are so common in archaeology and are now a major trend in prehistoric industries studies. Among them, and as shown by this congress, functional analysis is a dynamic and increasing mean of investigation.

Traceological analyses have to deal with the variations of many parameters before evidencing univocal meaningful cause-effect relationships. It is probably why, in our discipline more than in any other field of archaeological methodology, blind tests have played a so fundamental and regular role. The most famous one made by L.H. Keeley and M.H. Newcomer (Keeley et al. 1977), who really started traceological investigations in Western archaeology, demonstrated practically the validity of the methodology, of the selected criteria and of the experimental models involved in tool function identification. Since this historical blind test, this mode of evaluation has been used several times, either for methodological (Odell 1980, 1985; Newcomer et al. 1986; Unrath et al. 1986) or personal assessment (Plisson 1985; Shea 1987), with more or less satisfactory results.

Such tests do not reproduce the conditions of archaeological studies: no other data can put in perspective the conclusions or reduce the range of possible hypothesis. Besides, the limited number of artefacts emphasises any mistake. While not any archaeological conclusions are based on isolated results (see, for example, the evidencing of the oldest western threshing sledge insert carried out by integrating use wear analysis of a flint artefact with the cutting marks revealed on phytoliths from torchis of the same level - Khedhaier et al. 2003), the score of a blind test is a compilation of a finite number of binary results (true/false). The blind test principle itself is not unsuitable, but its realisation is, most of the time if not always, far from the archaeological reality, for obvious practical reasons: who is able to reproduce a complete Palaeolithic camp, for example? Consequently, the blind test gives a model, which is not more nor less “true” than any ethnarchaeological or experimental model applied to an archaeological situation: the relationships that occur inside the model are not necessarily working in a larger, more complex and/or different context, and have to be discussed.

Nevertheless, if not ideal, the blind test allows checking the least basic parameters and helps methodological improvements.

In the spirit of this meeting, coming back to the initial conception of S.A. Semenov (Semenov 1964), functional studies have definitely enlarged their focus and are no longer restricted to flint tools. These last ten years, western traceology has progressively included new
materials, such as quartz, obsidian, basalt or bone, but without any real re-evaluation of the framework previously adapted to flint tools analysis. Today, functional analysis of grinding stone tools is being integrated as a promising field of research, more especially for the study of Neolithic societies. However, most of our mental templates remain linked to the lithic cutting edges as done for the past twenty years by the Western school. The study of non-cutting tools, such as grinding tools, requires completely new references and produces images which are not so clearly understandable by other traceologists. Consequently, methodological assessment of this particular field of research may appear difficult from outside, because of the specificity of the criteria considered and of the relative inadequacy of the recording techniques.

This is the reason why the present blind test has been proposed to Caroline Hamon, who bravely accepted the challenge, without being sure to take advantage of such a risk.

**Basis for a functional analysis of grinding stone tools**

**A methodological framework**

Grinding stones, pounders and hammerstones as well as abrading and polishing tools play a great part in subsistence and technical processes from the beginning of the Neolithic. Examining Linearbandkeramik implements of the 5th millennium cal. BC. in the Paris basin, an experimental database was built using the same sandstones as the ones selected during the Neolithic for their highly natural abrasive properties (Hamon 2004). Our experimental referential consists of 92 working surfaces representing a number of activities and transformed materials: grinding cereals (wheat, hulled barley, spelt), legumes, hazelnuts and plants, crushing burnt flint and burnt bone for use as temper in ceramics, grinding clay and colouring, abrading dry or wet bone and antler, polishing shell, limestone and schist, defleshing and softening dry and wet skin (Hamon 2004).

Any functional approach must consider the whole system in which a tool participates, including all the interactions of the surfaces with which it comes into contact. From a tribological point of view, a grinding action involves two mineral surfaces and an intermediate substance, whereas in an abrading action, the stone and the substance transformed are directly in contact. Use-wear formation depends not only on one single raw material but also of its behaviour in the technical system. Use-wear can be described with several stages of observation on such tools, with the help of a stereoscopic microscope under 120x magnification (Adams 1998). The aspect, morphology and even nature of use-wear traces depend on the type of stone used (Dubreuil 2004; Procopiou 1998). The structural properties of sandstone help identify, at low magnification, distortions of the relief which are classified as use-wear traces on grinding stone tools (Hamon 2003). The main structural characteristics of sandstones are based on cohesiveness, texture and abrasiveness. Cohesiveness depends on the type of matrix and cement and on the proportion of pore spaces. Texture can be defined by the size and sorting of quartz grains. Natural abrasiveness is based upon the natural rounding of the grains and the proportion of the various minerals composing a rock (Adams et al. 1994, Schoumacker 1993).

As previously demonstrated (Hamon 2004), the morphological variations of use-wear features and their combination correspond to defined functional parameters, including both motions and transformed matters. Thrown percussion (percussion lancée) has the effect of crushing the stone surface, associated with a removal of the smallest grains from altered or low cohesive stones. Striations are created by removal of quartz grains in the case of low cohesiveness and a high proportion of pore spaces. At low magnification, use-wear appears as a smoothing of the surface, a levelling of the asperities due to rubbing. To the naked eye or at very low magnification (under 10x), a levelling of the surface can be described in terms of abrasion of the asperities and of removal of excess grains. At a second stage of observation, an indeterminate filling of the intergranular spaces can be distinguished. At higher magnification, distortions of the grains can be characterized by considering the modifications of their angles, edges and profiles.

At this stage of the research, the observer can determine the motion of the tool, the category (cereals, plant, hard or soft mineral, animal, etc.) and state of the transformed matter, and sometimes the duration of use. The aim of the present blind-test was to evaluate the reliability not only of criteria for use-wear identification but also of observation techniques, as well as our ability to determine the precise function of tools from archaeological contexts.

**The blind-test procedure**

The blind-test involved examination of samples from two experimental sessions, carried out by Hugues Plisson with the help of Selina Delgado in May 2004 and March 2005 (Fig. 1). Use-wear was identified by Caroline Hamon.

The tool blanks were chosen by C. Hamon from alluvial deposits in the main Paris Basin valleys where early Neolithic populations settled during the 6th millennium B.C. The blanks correspond both to the archaeological records and to the raw material used in C. Hamon’s original experimental database. The blanks were roughly shaped out, mostly by pecking of the active surface or of the sides to make manipulation easier. Their morphology corresponds neither to a known type of archaeological tool, nor to one with a specific purpose. The sandstone is generally similar in its characteristics to the
archaeological samples, but in some cases had undergone slight alteration which may have affected preservation of the experimental traces.

Once shaped, the tools were sent to H. Plisson for use. The transformed matters were chosen for their compatibility with the environment of the early Neolithic of the Paris Basin. The experiments totalize fifteen work surfaces, shared between eight tools which include both lower and upper parts. After use, the tools were washed to eliminate any organic residue. After a full day in a hydrochloric acid solution, they were rinsed with water and then placed for a half-day in warm water containing washing-up liquid, using an ultrasonic bath for the smallest items, before brushing under water. After several hours in a fresh solution of chlorohydric acid solution, they were rinsed again with water.

The tools were then returned to C. Hamon, who observed location, extent, intensity, texture and aspect of use-wear polish and striations with the naked eye and at low magnification with a stereoscopic microscope (Nikon SMZ 800). The recognition of the activity was based on identification of the active zone(s), the type of object (upper or lower part, single or matched pairs use), kinematics (handling, gesture, angle, orientation, direction) and the transformed matter (texture, state, category, type). An evaluation of the duration of use was attempted for each working surface. Taking all these information into consideration, one or two plausible functional hypotheses were proposed. Once the diagnosis had been made, the real function of each surface was finally revealed.

**Diagnosis of use-wear traces**

The description of use-wear and functional hypothesis for each tool are available in Figure 2.

**First series**

*Grinding naked wheat (lower tool 1 / upper tool 4)*

Dry seeds of naked wheat were ground on a small lower grinding stone for 2 h and 15 m (Fig. 3a).
**PREHISTORIC TECHNOLOGY** 40 YEARS LATER

<table>
<thead>
<tr>
<th>N</th>
<th>use-wear traces</th>
<th>distribution of traces</th>
<th>intensity</th>
<th>microwear</th>
<th>quartz grains</th>
<th>position</th>
<th>action</th>
<th>transformed matter</th>
<th>texture</th>
<th>condition</th>
<th>duration of use</th>
<th>notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>polish</td>
<td>reticle</td>
<td>polish</td>
<td>levelling and amalgamating grains</td>
<td>superificial alteration</td>
<td>lower</td>
<td>grinding</td>
<td>plant (corneas?)</td>
<td>green or wet</td>
<td>2.15 of dry naked wheat grinding (passive tool)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>polish</td>
<td>uniform, oly deposit</td>
<td>angularly, microtextured, superificial alteration</td>
<td>upper</td>
<td>softening</td>
<td>animal (hide or flesh?)</td>
<td>soft</td>
<td>greyish</td>
<td>hard</td>
<td>1.00 of fresh bone + marrow percussion (active tool)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>&quot;hard&quot; polish</td>
<td>reticle</td>
<td>levelling</td>
<td>no alteration of lower parts, separated grains</td>
<td>coarse fractures</td>
<td>undetermined</td>
<td>(rough middle hard material?)</td>
<td>very short</td>
<td>unused</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>smoothing and fine transversal striations</td>
<td>grey polish</td>
<td>levelling, superficial deposit, continuous grains</td>
<td>superificial alteration</td>
<td>grinding</td>
<td>hard mineral (diffluent very abrasive matrix)</td>
<td>hard</td>
<td>2.15 of dry naked wheat grinding (passive tool)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>use-wear</td>
<td>greyy aspect</td>
<td>well preserved, adhesion of talcum, coarse microstructures</td>
<td>animal (bone?)</td>
<td>half-hard</td>
<td>1.00 of fresh bone + marrow percussion (active tool)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>polish</td>
<td>asperities</td>
<td>amalgamating grains, full deposit</td>
<td>slightly altered</td>
<td>grinding</td>
<td>corals</td>
<td>2.01 of dry skin spraying (cow and horses)</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

| A | coarse impacts | edges | superficial impacts | star or triangular impacts | lower, matched | crushing, slab, precise brushing, percussion | undetermined | angulose fractions, crushing, hard matter | not greasy | 1 h+ | greasy touch | 1.75g of dry bone crushing (passive tool) |
| B | polish         | circular | polish and hard levelling | levelling and amalgamating grains, superimposition of surface | lower, matched | circular grinding | plant (between ligaments and nodes) | greasy and compact | 1 h? | organic deposit | 4 / 1 grilled acorn grinding (passive tool) |
| C | polish         | central, asperities   | low intensity and thin aspect | levelling and continuous grains, superimposition of surface | upper | grinding | hard mineral? | greasy | used? | 4 / 1 grilled acorn grinding (active tool) |
| C* | polish        | asperities, smoothing of edgels | well developed | levelling and well separated grains, continuous surface | upper, matched | softening (or grinding?) | animal matter (beavry greasy, dry hide, or bone?): | fine particles, slightly abrasive | 2 h? | 1.00 of dry meat grinding (active tool) |
| D | polish         | smoothing of edgels    | greasy aspect | levelling but superimposition of surface (protected and reflected) | upper, matched | grinding | organic (glass): | powdery, fine particles | mealy greasy | 2 h? | 1.00 of dry meat grinding (active tool) |
| F | coarse impacts and percussion cupulae | ovate and coarse impacts | torn off grains | crushing, precise gouging | not bone crushing | hard and angular fragments | not greasy | low duration | 1.2 kg of carbonate and grinding (passive tool) |
| Q1 | polish        | smoothing, even edges | levelling, amalgamating grains, superical deposit | smoothed edges, angular microstructures | upper, matched with F surface | grinding | cereals? | hard | 1 h - | varying shattering by HCL, not determinable use wear | 1.75 kg of dry bone crushing (active tool) |
| KL | polish        | edges and corners      | white smoothing | levelling of continuous grains, superical deposit | altered faces | upper | grinding | indeterminate | 30 min | strong shattering by HCL | 1.75 kg of dry bone crushing (active tool) |

Blind-test description and hypothesis –

*(tool 1)* The macroscopic polish of the asperities is due to a levelling of the relief and to a slight amalgamation of the quartz grains whose superficial faces are altered. This could correspond to grinding plants such as cereals.

*(tool 4)* Flat zones are associated with fine transverse striations. Contiguous grains, striations and a superficial deposit on the surface of the grain complete the strong levelling. The grinding of a hard mineral could have created such traces.

Grinding fresh bone and cartilage (lower tool 2 / upper tool 5)

A slab was used to crush and grind fresh bone for one hour (Fig. 3 b). The transformed matter consisted of cattle and sheep bone and cartilage. Marrow seems to have influenced the aspect of use-wear polish, which was difficult to distinguish with the naked eye.

Blind-test description and hypothesis –

*(tool 2)* To the naked eye, the asperities tend to be uniform without any real levelling; the pecking pits are

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**Fig. 2:** Macroscopic and microscopic description of use-wear traces and proposal of a functional attribution.
Fig. 3: Experimental tests, 1st serie: a) naked wheat grinding – tool 1 x30, see the surficial smoothing of the grains; b) fresh bone and cartilage crushing – tool 2 x15, the grains are slightly levelled and show a greasy aspect; c) skin suppling and depilating – tool 6 x5, see the alteration of the upper asperities; d) manipulation pollution of acorn use-wear initial traces, tool C' x15, observe the shiny and greasy aspect; e) unused surface, tool 3 x30, the naturally smoothed grains don’t show any transformation.
also altered. The quartz grains are still angular, the edges are well preserved even when altered by microfracturation: supple animal matter (hide or meat) may have been transformed; this matter must have been quite greasy.

(tool 5) Use-wear is not very well developed, and a quite greasy shine can be distinguished. Quartz grains are well preserved, well separated, but their faces are slightly altered: their edges are slightly levelled and coarsely microfractured. This kind of wear evokes semi-hard animal matter, such as bone.

Unused (upper tool 3)

Blind-test description and hypothesis –

The grains are well separated and brilliant, their edges are not altered, the lower pits show no alteration (Fig. 3e). The use is impossible to determine and may be of short duration. It could only have involved a semi-hard matter with coarse fractions.

Softening dry hide (upper tool 6)

This upper tool was used on the internal side of dry and very hard cattle hide for one hour and then on the external side of a horse hide, the hair of which had been preserved by brain tanning (Fig. 3c). The sandstone was too fine to break the fibres and de-hair the hide. The heating effect from rubbing generally helps make the main hide supple. Use-wear was easily distinguishable to the naked eye.

Blind-test description and hypothesis –

Use-wear shows a hard texture and is only developed on the upper zones. The grains are amalgamated, slightly altered and a slight superficial deposit can be identified. All these traces evoke cereal grinding, possibly of hulled seeds.

Second series

Crushing calcite (upper tool edge LKG / lower tool F)

A fist-sized block of calcite was crushed and turned into powder with a polyhedric grinder on a coarsely pecked lower grinding stone set on grassy ground. The movements were varied but not violent, due to the low resistance of the calcite. The block was wedged in a small depression in the middle of the grindingstone, which became enlarged through use. Both tools were used less than one hour and showed use-wear readily identifiable to the naked eye (Fig. 4a).

Blind-test description and hypothesis –

(tool F) The coarse and ovoid impacts of thrown percussion have been created by removal of quartz grains. They evoke a delimited action of (active?) crushing of a solid but low resistant matter with sharp edges. The duration of use should not have been more than two hours.

(tool LKG) The continuous smoothing of the edge is made by a continuous levelling of amalgamated grains: this wear could be created either by cereals or more probably by an alteration by the hydrochloric acid solution.

Crushing dry bone (upper tool edge KL / lower tool A)

Five slices of cattle bone were boiled and then dried for several days in the sun (Fig. 4b). They were crushed for an hour with a polyhedric grinder on a large lower grinding stone set on grassy ground. This action was sufficient to break the bone into small pieces but not to grind them. They were certainly too hard and the lower grinding stone too flat to obtain such a degree of fineness. The active surface became greasy here and there, due to a little fresh marrow still attached to the bone. Fairly violent thrown percussion broke the grinder edges. Also, the small depression on the lower surface, which trapped bone fragments, became enlarged. The active edges of the grinder became smoothed.

Blind-test description and hypothesis –

(tool A) Four distinct surfaces of use can be identified. Coarse impacts and a central depression lead us consider this tool as an anvil. Star shaped impacts of thrown percussion evoke semi-hard pieces of an angular matter. A slightly greasy touch is noted.

(tool KL) The smoothing seems to correspond to a superficial deposit or to a strong levelling of the surface. It may have been created by alteration from the hydrochloric acid solution.

Dry meat grinding (upper tool edge C’’/ lower tool D)

Strips of pork were dried in the shade at 10 °C with a cold air fan for several days. The flat surface of a cylindrical grinder was used on the convex face of a fully pecked lower grinding stone; the grinding stone was set in a plastic tray in order to recover the ground meat (Fig. 4c).

This one-hour work was effective as all the dry meat was turned into powder. The movement of the upper grinding tool was double: a vertical action to crush the meat fibres was followed by a turning movement to obtain powder. Both surfaces seemed worn at a macroscopic level.

Blind-test description and hypothesis –

(tool C’’) The well-developed polish runs over the edges. The levelling in process, the well-separated quartz grains whose faces are slightly altered and the rounding of their edges are associated with thin transverse striations. This use-wear corresponds to an active surface, used for the
Fig. 4: Experimental tests, 2nd serie : a) Crushing and grinding tools for calcite – detail of face F and of the depression created by throwing percussion; b) Crushing of dry bone– chloryhydric acid alteration of face I x45, see the “dissolution” of the edges of quartz grains; c) Dry meat grinding, tools and powder – tool C” x30, see the smoothing of the grains and the formation of levelled asperities; d) Acorn grinding – tool B x45, watch the separated quartz grains and the opaque deposit wich give that dark effect.
transformation of a greasy animal matter. Fine abrasive particles may correspond to hide softening or grinding bone. The duration of use may have been two hours.

(tool D) A greasy aspect characterises the macroscopic alteration of the surface. It largely overflows the asperities, which indicates a grinding action to obtain a powder. Grains are still separated but show slight microfracturations. This could correspond to active grinding of a greasy organic matter (possibly a plant?) for two hours.

Grinding roasted acorns (upper tool edge C′/ lower tool B)

Autumn-picked acorns were roasted in an oven before grinding on a large flat slab (Fig. 4d). A cylindrical upper grinding stone was used with the same gesture as for grinding dry meat. For one hour, four litres of roasted acorn were easily reduced into powder, even though sorting of the residual husks was necessary. Only the upper grinding stone seemed to be slightly modified to the naked eye.

Blind-test description and hypothesis –

(tool C′) The surface, used for less than an hour, nonetheless shows signs of grinding of a greasy matter. The levelling is in process, the grains are contiguous, the faces are flat. A secondary shiny aspect can be distinguished: it could be linked to manipulation of C″ during use (Fig. 3d). Lastly, this surface could have ground a mineral matter, but use-wear seems to have been polluted by secondary use or by manipulation.

(tool B) Use-wear associates both a polish and a general levelling of the surface. Whereas an opaque deposit on the well-separated quartz grains is clearly visible, the grain faces are very altered. This passive surface has been used for a circular grinding, shown by the location of polish. A vegetal greasy matter, certainly close to nuts or legumes (Dubreuil 2004), may have been ground and for a duration close to an hour.

<table>
<thead>
<tr>
<th>position</th>
<th>action</th>
<th>transformed matter</th>
<th>texture</th>
<th>condition</th>
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<td>7</td>
<td>9</td>
<td>4</td>
<td>5</td>
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<tr>
<td>partial</td>
<td>2</td>
<td>1</td>
<td>3</td>
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<tr>
<td>false</td>
<td>1</td>
<td>2</td>
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</tr>
<tr>
<td>absent</td>
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<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>total</td>
<td>14</td>
<td>7</td>
<td>12</td>
<td>10</td>
</tr>
</tbody>
</table>

Fig. 5: Synthesis of the score obtained for this blind-test for each criterion of determination.
The most reliable parameter, and also the one which shows the most surprising results, is the texture of the transformed matter. Here there is only one mistake (tool 4) and three approximate answers (tools 2, 5, GIJ), out of nine proposals. Two of the incomplete proposals (tools 2 and 5) are linked with grinding of a composite matter: pounding and grinding fresh bone and marrow produce two types of traces, i.e. impacts from the crushing of hard matter (bone) and the grinding of tender matter (marrow). For the other cases of transformed matters not included in previous experiments (tool GIJ), the calcite texture (between hard and tender) and the deformation due to hydrochloric acid solution may be the cause.

The state of the matters as well as the duration of use of the tools were also proposed. As these parameters rely for the moment on subjective criteria, we prefer to consider them as a complement, or as a regulation, for the main functional hypothesis. The recognition of a greasy state was generally correct (except C’), whereas the state of the cereals ground by tool 1 was mistaken (wet cereals). The duration of use was not too badly assessed, but many adjustments must be made before obtaining any real accuracy for this parameter.

In fact, gesture, motion and activities constitute the most reliable parameters of determination, followed by the determination of the texture of the transformed matter. The most perfectible field is still the transformed matter, even though the score shows four unforgivable mistakes.

**Limits of the test and reliability of determination**

The first difficulty with which we were confronted was the choice of suitable sandstones, as the blanks found in the alluvial deposits were often altered. This may have slightly modified the reaction of some surfaces during work, as well as the formation of some diagnostic use-wear traces.

Similarly, several alterations due to washing seem to have significantly altered the smoothed surfaces: the hydrochloric acid solution has modified the superficial aspect of the polish and even its characteristics at high magnification (tools GIJ and KL).

The duration of use also seems to be an important factor of variability. Considering all the variations linked with motion and the nature of the transformed matters, the tools show a generally low rate of use. This could have affected the development of various stages of use-wear traces.

In addition, several surfaces have only been partially defined: the non-recognition of thrown percussion impacts is due to a lack of experimental referentials.

Despite all these obstacles, many positive aspects deserve to be mentioned.

One pleasant surprise is the complementarity of information provided by the naked eye and the macroscopic or microscopic levels of observation. While motion and gesture can be deduced mainly from low magnification observations, the transformed matter is generally identifiable at higher magnification. The activity, motion and kinematics of the tools benefit from a good rate of determination, based on the first macroscopic clues. The hesitations concern only the surfaces used with two different gestures (firstly back-and-forth and then circular, for example).

The “real” mistakes generally involve incorrect interpretation of use-wear traces, even though their actual description is quite sound. Unworked surfaces were identified as such, although there was some hesitation about tool n° 3. The texture of the transformed matter was identified either by the polish texture or by the impacts of thrown percussion.

Of particular interest is the approximate identification of matters that were not in the experimental referential, such as the grinding of meat and bone, dry meat or the roasted acorns (tool 5, B, C”). In our opinion, this demonstrates the reliability of the method itself.

These remarks underline, if this is necessary, the importance not only of “sampling” in archaeological assemblages but also of the recording of experimental parameters. The analysis of an archaeological assemblage is guided by and depends on these methodological filters. The most astounding outcome of the test is the difficulty in identifying tools working in pairs: does this imply that use-wear develops in a very different way on upper and lower parts of a grinding system, or does this simply reflect the poorer quality of the sandstones chosen for the lower parts? The short length of time involved probably accentuates this difference.

**Improvement of the method**

This test proves the overall reliability of the identification method: the goal has been reached and some indication has been provided on the way accuracy could be improved. For more effective determination, we need more precise definitions of the associations of determination criteria and their degree of correspondence with one specific use. Some contradictory traces seem to characterize single surfaces: their origin could be identified through a better understanding of the mechanism of surface deformation and of its various stages. For example, do some actions possibly destroy or hidden previous use-wear traces? How does the addition of an intermediate substance condition and distort the appearance of some traces? Improvement of the method must also rely on use of higher magnifications, over 120 x, and the development of observation techniques. In order to obtain more accurate recognition of the transformed matter, these improvements must include...
precise criteria of determination, specific to each type of transformed matter.

Lastly, such a test should be extended to other raw materials and carried out in collaboration with other use-wear specialists working on grinding and abrading stone tools.

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Bibliography


