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# Use Wear and Post-depositional Surface Modification: A Word of Caution

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This is a preliminary report on experiments designed to study the effect of stratigraphically invisible minor movement of artifacts in the sediment on flint surfaces. The hypothesis was that such prolonged movement could be responsible for post-depositional surface modifications which sometimes mimick use-wear traces and at other times obliterate them. The study was prompted by observation of the high incidence of these phenomena on a wide variety of sites. The results constitute a cautionary tale to those embarking on the microwear analysis of assemblages where these surface alterations are present.

*Keywords:* FLINT, MICROWEAR, EXPERIMENTAL ARCHAEOLOGY, NATURAL SOIL PROCESSES, POST-DEPOSITIONAL PROCESSES, FUNCTIONAL ANALYSIS, PREHISTORIC.

## Introduction

This paper presents the results of experiments designed to study the processes involved in post-depositional alteration of flint artifacts and their effect on use-wear traces. It forms part of a projected study prompted by the phenomena observed while analysing artifacts from a variety of sites according to the method developed by Keeley (1980). Assemblages from two Mesolithic sites in Britain and several Israeli sites were involved. The Israeli sites varied in age from the Middle Palaeolithic to the Chalcolithic and the environmental settings ranged from cave to desert, from north to south and from coastal to inland sites.

What all these assemblages had in common was a high incidence of "post-depositional surface modification" a term first used by Holmes (in press) and whose abbreviated form PDSM is now widely used in our Institute. PDSM seems to alter the surface of the flint and/or the polishes in such a way as to render difficult, if not impossible, their interpretation by the Keeley method. Most of these implements, when not patinated, had a macroscopic sheen attributed by many researchers to the effect of burial in the sediment. Bright spots, described below, were also very frequent.

The ubiquity of PDSM, especially with sheen and bright spots, prompted me to investigate the processes of its formation. After all, when the incidence of PDSM is high, the few artifacts on which use-wear traces might survive would not be in any way meaningful or representative of an assemblage or a tool type. Furthermore, use-wear

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polishes as described by Keeley (1980) and observed on experimental tools do not have exactly the same appearance on archaeological implements. It seems necessary to study the effect of taphonomic processes on these polishes.

The conjoining of artifacts (whether flint, pottery or bone) from several stratigraphic levels on a variety of sites has, of late, drawn the attention of archaeologists to the fact that artifacts can move in the sediment without there being clear stratigraphic evidence of such movement. The vertical and horizontal movement is much more widespread and frequent than previously imagined (Cahen & Moeyersons, 1980; Barton, 1981; Villa, 1982; Rowlett & Robbins, 1982; Villa & Courtin, 1983; and others). Such movement must have some effect on the flint surfaces and may be responsible for some at least of the PDSM observed. This was the hypothesis to be tested.

Consequently experiments were designed to shake artifacts in sediment: (a) to monitor whether sheen would appear and when; (b) to observe flint surfaces after movement in the sediment, with particular attention to the appearance of bright spots; (c) to observe the effect of movement in the sediment on the appearance of use-wear polishes; and (d) to document the amount of edge damage produced by movement in the sediment.

## The Problem

*Sheen*

Sheen has been referred to as "glossy patina" by Rottländer (1975: 101), "gloss patina" by Stapert (1976: 11–12), "surface sheen" by Plisson & Mauger (in press) and "soil sheen" by Moss (1983: 81). Moss (1983) reported that "all archaeological collections have some sort of soil sheen even when the flints seem to be in pristine condition." There was no specific mention of the problem this sheen creates for microwear analysis. Plisson & Mauger (in press) investigated chemical and mechanical alteration of microwear polishes, pointing out that Keeley (1980) and Anderson-Gerfaud (1981) had to "eliminate from their studies of palaeolithic flint tools not only tools having macroscopic natural alteration traces but also 25–40% more of the tools in the collections which had pronounced microscopic soil sheen."

Keeley himself (1980: 28–35) warns against the danger of ignoring naturally caused traces. He excluded the "majority" of Swanscombe Lower loam artifacts due to "weathering" including a "glaze on their surfaces". He describes the "slight edge damage and localized abrasions" caused by "minor soil movements" which constitute "a problem for the microwear analyst". He does not discuss the effect of soil sheen on microwear polishes.

Rottländer (1975) attempted to produce soil sheen, which he calls "glossy patina", through the action of "weakly acting solvents". He describes their effect as being "like a mechanical polishing". He encountered difficulties in trying to reproduce this sort of surface modification in a laboratory: when increasing the strength of the solvents to accelerate the process one risked patinating the flint.

Sheen is usually uniform over the whole surface of the flint though it tends to be more concentrated on edges and prominent parts of artifacts. It varies in degree of intensity from very faint to very glossy, as in windgloss. In his important review of naturally produced traces on flint artifacts from Dutch sites, Stapert (1976) distinguishes between sheen (gloss patina) and windgloss. Regarding sheen, he says "although it is sometimes suggested that a mechanical effect may be responsible (e.g. polishing in a sand matrix due to soil movements), most authors assume this smoothness is a result of chemical processes in the soil" (Stapert, 1976: 12), while for windgloss he feels it is "formed mainly mechanically as a result of polishing, though a chemical component may contribute to its formation"(Stapert, 1976: 18). In any case, he concludes that "it is not impossible

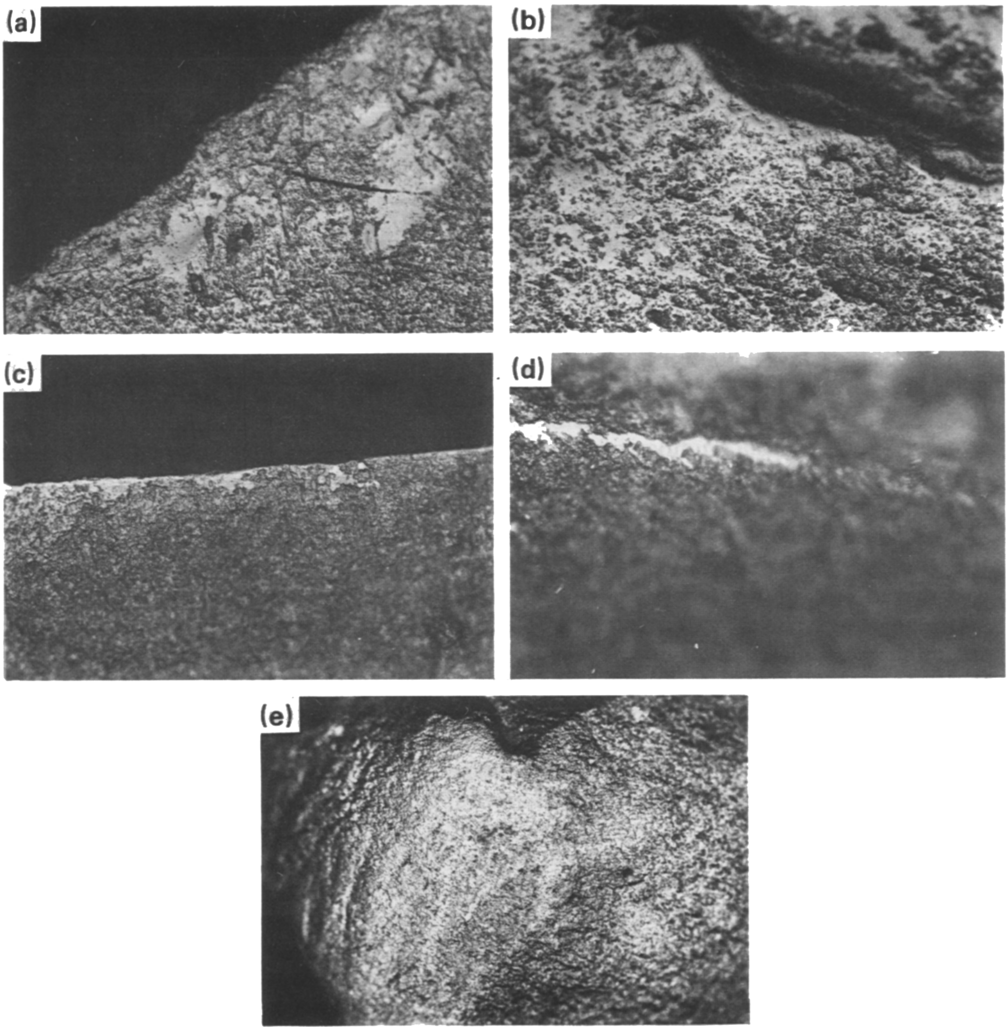

Figure 1. (a) Archaeological bright spot masking large area of edge, × 100. (b) Archaeological bright spot looking like use wear, × 100. (c) EXP/12, experimental bright spot, × 200. (d) Archaeological bright spot, × 200. (e) EXP/76 B, Diffuse polish on bulb , × 100.

that, in places where windgloss is highly developed, microscopic traces of use formerly present are completely or partly obliterated" (Stapert, 1976: 19).

*Bright spots*

Bright spots occur very frequently on archaeological artifacts of a variety of ages and provenances. They are a smooth, highly reflective polish (gloss) on flint surfaces, varying in size from the microscopic to the macroscopic, occurring singly and in clusters. Bright spots vary widely; they can be flat, raised, crossed by striations and not striated. Flat bright spots appear as a localized smoothing of the surface within the area of occurrence.

Bordes (1950) and other researchers have described them. Various hypotheses have been proposed for their formation but they remained "unexplained" to Semenov (1964), "mysterious" to Moss (1983: 81), and "enigmatic" to Vaughan (1981: 366) and Stapert (1976: 38). Shepherd (1972: 120) called the flat ones "friction gloss" and suggested they were easy to reproduce by rubbing two flints together. Stapert (1976: 29–39) noted that these bright spots, which he describes in detail, were far commoner on younger material than on older artifacts. He suggested that "friction gloss" may be a misleading name for them. Vaughan (1981: 365) and Moss (1983: 81) have both tried unsuccessfully to produce the gloss by following Shepherd's suggestion.

Vaughan (1981: 361: 66) has noted a high incidence of bright spots at the Magdalenian site of Cassegros level 10. He calls them "special micropolishes" and has noted a "flat" variety and a "ripply" variety. After SEM investigations at ×2000 he suggests that the flat kind were formed by "both friction and water" while he attributes the ripply variety to the "precipitation of ground water silicates" on the surface of the artifacts. Holmes (in press) carried out an experiment on modern artifacts of Egyptian flint. After two weeks of trampling, a number of microscopic bright spots appeared, comparable to those observed on her collection of pre-dynastic flint tools.

Bright spots occur on edges, ridges and flat areas of archaeological flint tools. However, they do not have a systematic relation to the probable used edges. Although they can generally be excluded as use wear, especially when isolated, flat and large, they do often mask large stretches of edge [Figure 1(a)]. The meaning of the variety of bright spots needs to be investigated and the correlation between bright spots and sheen on the same pieces needs to be examined. Furthermore, it is important to try and reconstruct their genesis in order to ascertain whether the other traces present on the edges are due to natural causes or not. Sometimes bright spots cluster at the edge and taper off, mimicking use-wear polishes [Figure 1(b)]. It is quite probable that the mechanisms involved in the formation of these bright spots are the same as those producing certain use-wear polishes and the investigation of one will inevitably shed light on the other.

## Experimental Programme

It was decided to start by trying to simulate the processes which may have occurred to implements from the Powell Mesolithic site at Hengistbury Head, Dorset (Barton & Bergman, 1982). The site is situated on a very windy headland covered by windblown sands overlying a well-developed podzol formation. The artifacts are found in fine sands with pebbles occurring within the lower levels. Vertical movement of artifacts in the sediment is inferred from the conjoining of artifacts separated by up to 39 cm.

Microdenticulates from another Mesolithic site were also examined. The site of West Heath, London, excavated by the Hendon and District Archaeological Society under the direction of Desmond Collins, has a soil environment very similar to that of the Powell site. The artifacts were also either patinated or covered with soil sheen and bright spots. Microscopically too, the flint surfaces were in a comparable condition to the Hengistbury Head material. Refitting of artifacts points to their "considerable vertical displacement" in the sediment (Maher, 1983).

Experiments were carried out by the excavators of the Powell site to monitor taphonomic processes. An experimental flint scatter was exposed to the elements for several months. Movement in the sand and burial were observed and the flint tools were partially discoloured and patinated. No soil sheen developed on the surfaces of exposed flint artifacts nor did any bright spots appear. More information may be obtained when the artifacts are re-excavated.

An experiment was carried out by Unger-Hamilton (1984: 129–30), leaving flint artifacts in a stream for 5 weeks. She concluded that a "considerable amount of sediment had collected at the bottom of the basket ... the resulting wear traces were surprisingly very few and very weak ... this experiment was perhaps too short in duration." It was therefore hypothesized that the sheen present on the flint surfaces could be the result of a mechanical polishing caused by prolonged movement of the artifacts in the sediment; wind-blown sands; and/or trampling. Chemical factors which probably also have considerable influence are to be investigated at a later stage. Plisson & Mauger (in press) have shown that polishes can be removed by various alkaline chemicals.

To test the hypothesis of mechanical polishing, sediment from the excavation was used to shake experimental tools and observe the effect on the flint surfaces. The problems encountered in designing these experiments were: (1) the necessity to increase the speed of movement in order to obtain results in a manageable time scale; (2) the uncertainty whether artifacts had moved slowly or quickly in the sediment; (3) the unknown influence of bioturbation which, if present, could have moved artifacts up and down; (4) the difficulty in producing movement and pressure simultaneously in a laboratory. The variables in the shaking experiment were length of shaking time, quality of flint, presence/absence of water, presence/absence of gravel, addition of salt (table salt containing magnesium carbonate and sodium hexacyanoferrate), in a number of experiments.

Cleaning of all artifacts, whether experimental or archaeological, was done in warm water and ammonia-free detergent, followed by immersion in distilled water in an ultrasonic tank. Industrial methylated spirit and/or acetone were used to remove fingerprints. Whenever other cleaning methods were used they are specifically mentioned. Not all microwear analysts agree on the cleaning methods advocated by Keeley (1980: 10–11). Some people feel that the effect of immersion in solutions of sodium hydroxide (NaOH) and hydrochloric acid (HCl) on flint surfaces is not yet very well documented. It is well known that longer immersions even in weak NaOH can patinate flint. Furthermore, some researchers have reported the survival of organic residues on flint surfaces, hypothesizing that they may be trapped in the silica. It seems possible that bone and antler residues could survive on a site where there is preservation of bone remains even without being embedded in the silica. In such a case, immersion in NaOH to remove organic deposits would destroy valuable evidence when practised on archaeological artifacts. More perishable residues such as plant phytoliths and meat tissue would only survive if they were trapped in amorphous silica on the flint surface, as hypothesized by certain researchers (Anderson-Gerfaud, 1981; Hurcombe, 1985).

All artifacts involved in the experiments were examined and photographed before and after use and before and after shaking or tumbling. For the sake of brevity I will use the word "striation" to describe all linear indicators for direction of motion in use.

## Experiments

*Set No. 1*

Twenty-eight used and unused experimental artifacts of East Anglia flint were buried, individually, in a plastic bowl, 30 cm in diameter, filled to a depth of 8 cm with fine or gravelly sand, wet or dry, with salt and without. They were all bladelets under 6 cm in length. The bowl, placed in a sieve shaker powered by a small electric motor, was shaken for 5, 10, 30, 60, 90 and 120 min.

*Results:* The shaking times below 90 min did not seem to seriously affect the flint surfaces. No soil sheen developed even at 120 min. A few striations, randomly situated, and without a patterned relation to the edges appeared on the flint surface. They were readily recognized as post-depositional. On one piece, shaken for 90 min in wet gravelly sand with the addition of salt, a cluster of flat bright spots appeared astride the left lateral edge [Figure 1(c), (d)]. The bright spots were not macroscopic but appeared as highly glossy polish at × 100 and over. Other pieces were shaken for up to 120 min, with the other variables remaining unchanged, without another bright spot occurring. This underlined the random nature of the occurrence.

*Set No. 2*

To ascertain whether certain bright spots were due to friction, as suggested by Shepherd (1972: 120), two flakes of Brandon flint were carried for two months in a plastic bag, in a small pocket, tightly rubbing against each other. No bright spots, macroscopic or microscopic, were observed, although abrasion polish and striations formed. Water was then used as a medium, as suggested by Vaughan (1981: 366), whilst rubbing with pressure in the "same small area" as suggested by Shepherd (1972). After 5 min, intense macroscopic gloss appeared on the edge, as observed on archaeological artifacts. Microscopically the polish was very bright and flat, crossed by striation as described by Stapert (1976: 32) but with an untypical crushing of crystals. The experiment was repeated, rubbing with water for 2 min, on an area of fine-grained flint on the bulb and on an edge. In the first case the polish is diffuse, uncharacteristic of bright spots but more similar to soil sheen [Figure 1(e)]. In the second the bright spots are almost identical to the archaeological ones, [Figure 2(a), (b)] with macroscopic gloss and no crushing of crystals.

The results suggest that the appearance and distribution of the flat bright spots produced seem to depend not only on length of rubbing time but on the microtopography of the flint and on the pressure exerted, which is greater on the edges. Water seems to be an essential element. Whether other liquid media are as effective will be investigated.

*Set No. 3*

The brief shaking time, as described in the first set of experiments, did not alter the flint surface enough to produce sheen or any other generalized PDSM. It was therefore decided to use a tumble-polishing kit for jewellery, to affect the flint surface more realistically. Two plastic barrels measuring 8 cm in diameter are rotated at 60 rpm. The time needed to smooth stones for jewellery is given in weeks rather than hours with very rough grits. The length of 50 h eventually needed in the following experiments did not seem excessive. Furthermore, 60 rpm, though not as slow as in nature, is not a violent rotation. Shipman & Rose (1983: 77), to investigate "the effect of sedimentary abrasion" on bones, used a geologic tumbling barrel at a rate of 1800 rpm.

Two pairs of experimental artifacts were tumbled for 50 h.

*(a) Brandon flint in fine sand:* Two microdenticulates of Brandon flint that were put in fine sand, 5 cm deep and tumbled for 50 h: EXP/9, used to whittle and cut dry reeds, in Barrel 1 filled with wet sand; and EXP/2, unused, in Barrel 2 filled with dry sand.

Soil sheen appeared earlier (47 h) on the artifact shaken in wet sand (EXP/9) than on the one in dry sand (EXP/2). All striations on the implement used to whittle dry reed for 10 min [Figure 2(c)] were removed after 50 h tumbling [Figure 2(d)]. Only the well-developed reed polish could still be observed on some parts of the edge, although its texture is dulled. The removal of all striations means that no confident reconstruction can be made of the direction of motion in use. Furthermore, the presence and absence of striations and their types are often used as distinguishing factors between polishes. The

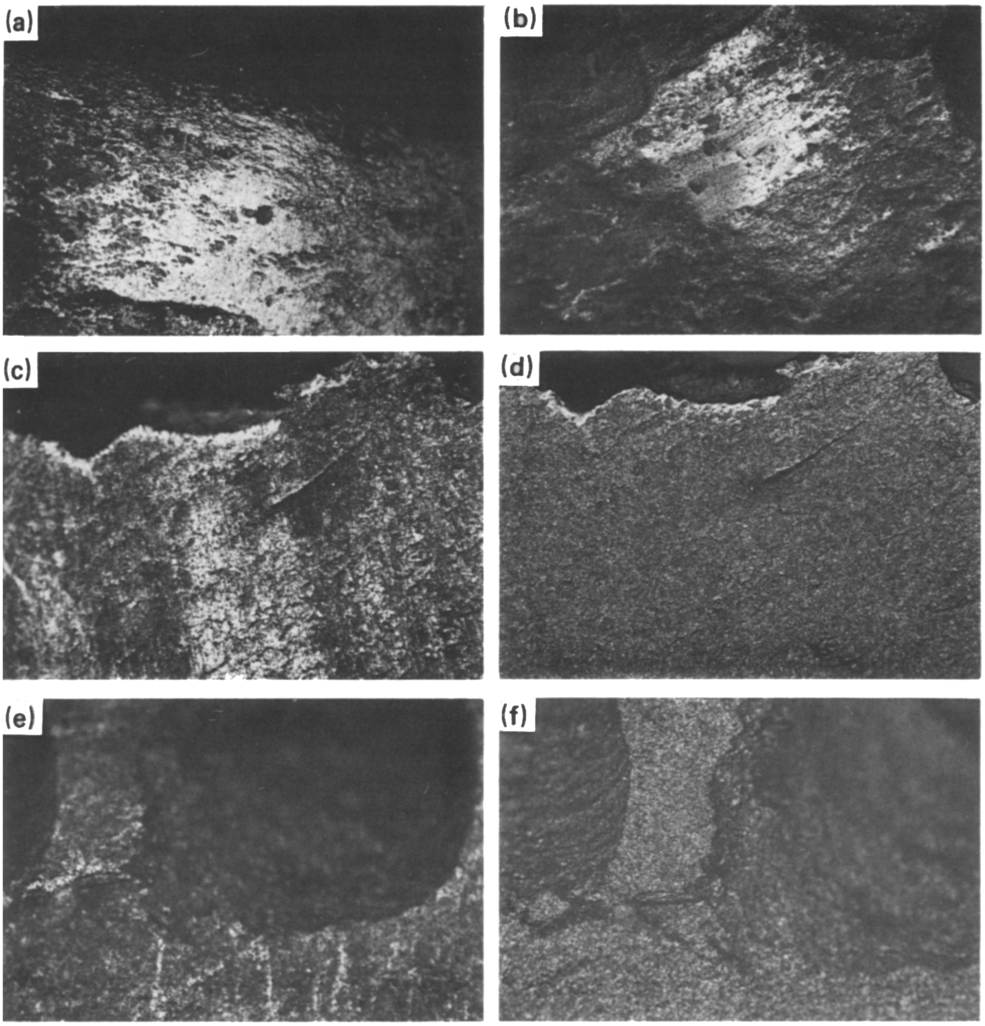


Figure 2. (a) EXP/77B, bright spot after 2 min rubbing flint/flint with water, × 100. (b) Archaeological bright spot, × 50. (c) EXP/9, whittling dry reeds 10 min, × 100. (d) EXP/9, polish on edge—no striations after shaking, × 100. (e) EXP/2, abrasion tracks from manufacture on unused flint, × 100. (f) EXP/2, after shaking no traces left, × 100.

unused microdenticulate (EXP/2) had abrasion tracks left by the manufacturing technique of rubbing another flint on the edge [Figure 2(e)]. After tumbling, the traces disappeared [Figure 2(f)] and the surface of the flint seems smoothed by the fine sand, a phenomenon sometimes observed on implements with microscopic sheen.

*(b) Brandon flint in wet gravelly sand:* The experiment was repeated on less developed polishes. Wet gravelly sand was used in which two artifacts of Brandon flint were embedded: EXP/12, used to cut bracken for 10 min [Figure 3(a)]; and EXP/27, used to incise green birch for 10 min [Figure 3(b)].

Only faint sheen developed on EXP/12. The striations present before tumbling,

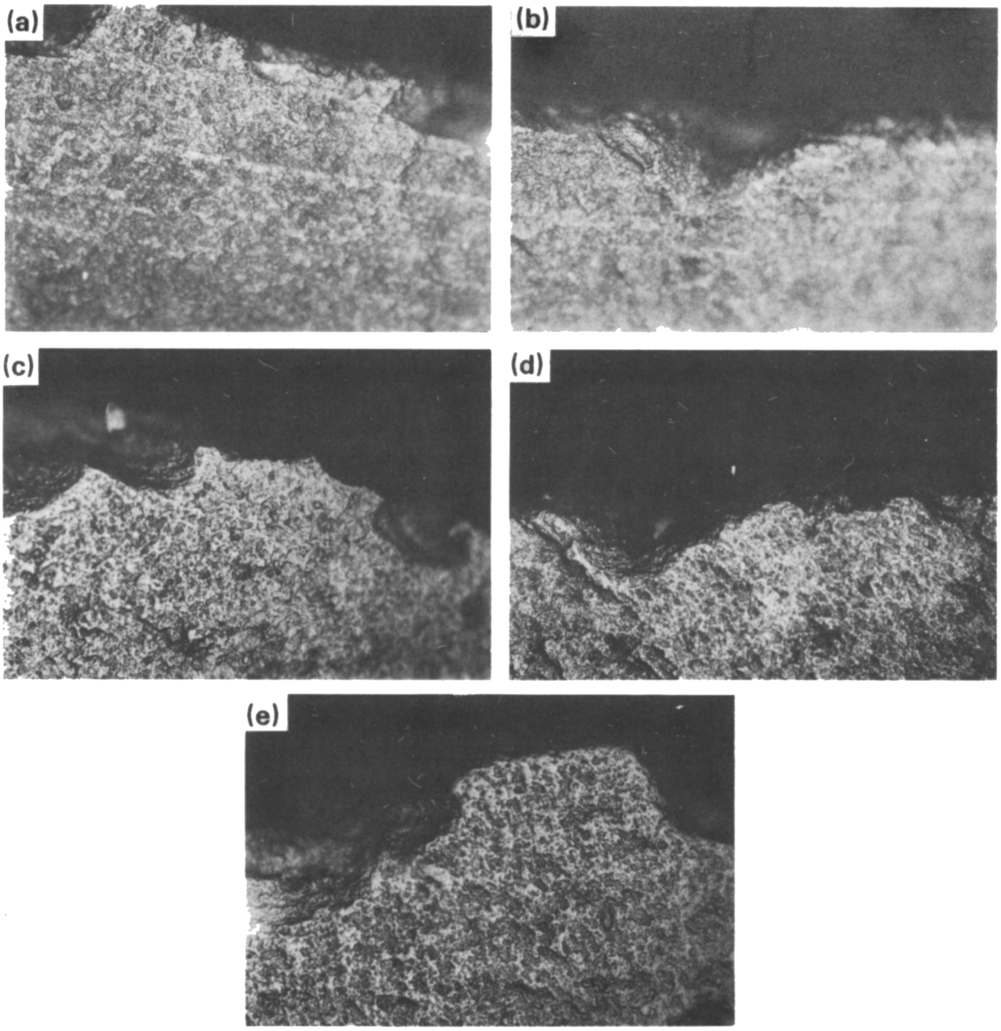


Figure 3. (a) EXP/12, traces from 10 min cutting bracken, × 100. (b) EXP/27, traces from 10 min incising birch, × 100. (c) EXP/12, after tumbling—no striations, more polish, × 100. (d) EXP/27, increased polish after tumblings, similar to cutting bracken, × 100. (e) EXP/27, polish after tumbling, looking like "bone" polish, × 200.

parallel to the edge, disappeared [Figure 3(c)]. The weakly developed polish produced by cutting bracken was increased in extent and intensity, by contact with wet sand and gravel, and its distribution was, in places, now perpendicular to the edge. Edge damage scars were added on both edges.

The sheen on EXP/27 was macroscopic and best developed on the prominent areas of the bladelet. The faint polish produced by incising wood [Figure 3(b)] was now increased, in some areas appearing similar to polish experimentally produced by cutting bracken [Figure 3(d)] and in other areas similar to polishes usually attributed to use on bone or antler [Figure 3(e)].

This casts grave doubts on Keeley's principle that polishes vary in relation to the worked material. Use-wear experiments have led Unger-Hamilton (1984: 139) to conclude that "totally different materials can cause virtually identical polishes". It is worth mentioning that someone trying to analyse these two artifacts functionally would not be able to detect that there had been two polishing events. The absence of the true striations would make it difficult to reconstruct motion. It is interesting that two implements from the same flint quality, subjected to identical experimental conditions developed sheen of a totally different intensity.

*Set No. 4*
It has been suggested to me that the striations on EXP/9 could be residue from bracken, although the implement had been cleaned as mentioned above. Such a residue would not have survived on an archaeological artifact. Consequently, the artifacts involved in the following set of experiments were immersed for 20 min after use in a solution of 20% (w/v) NaOH in water, as suggested by Keeley (1980: 11). The appearance of the use-induced traces was recorded photographically before and after this cleaning process.

*(a) 24 h in wet gravelly sand:* Wet gravelly sand was used and tumbling carried out for 24 h, for reasons explained below, on the following specimens: EXP/E5, a rather coarse Potter's Bar flint flake used for 20 min to whittle fresh willow [Figure 4(a)]; EXP/59, a fine-grained Brandon flint bladelet used for 30 min on dry oak [Figure 4(b)]. Even after washing with warm water and detergent and several months after use, EXP/E5 had a macroscopic gloss on the area of use. This gloss is often observed on experimental wood working but is usually removed by washing. Microscopically, the appearance of the gloss [Figure 4(c)] is not in any way similar to use-wear traces. EXP/59 did not develop gloss, probably due to its use on dry wood.

After cleaning for 20 min in the NaOH solution, the area of macro gloss on EXP/E5 disappeared and only a few striations survived [Figure 4(d)], while use-wear polish on other areas of the edge remained unchanged [Figure 4(a)]. Microscopically, these remaining striations are quite similar to those on EXP/9 [Figure 2(c)] and their direction is quite compatible with the whittling movement of the tool. On EXP/59 the polish observed was not affected by the NaOH solution [Figure 4)b)].

After tumbling no sheen developed on the coarser parts of EXP/E5, while it did on the finer-grained edges. The striations which had survived the NaOH bath disappeared [Figure 4(c)]. Scar removal caused by edge damage changed the profile of the used edge. In EXP/59 sheen developed macroscopically but was not as intense as on the artifacts tumbled for 50 h. The appearance of the polish caused by work on wood [Figure 4(b)] was now totally altered [Figure 5(a)].

Striations parallel to the working edge, produced by incising wood, and surviving the NaOH bath [Figure 4(b)] had disappeared, replaced in places by traces perpendicular to the working edge. The polishing of the flint surface was now generalized, as in archaeological examples of PDSM. The edge damage scars had removed areas of well-developed polish and striations.

It seems, therefore, that fine-grained flint develops sheen faster than the coarse-grained kind. This is the same phenomenon empirically observed by many analysts regarding the development of use-wear polishes. It would seem to suggest that sheen and polish can be formed by similar processes, in which the abrasion factor is very important if not predominant. On both tools, striations which survived the 20 min NaOH bath were removed by movement of the artifacts in the sediment. The new polish formed is similar to that observed on archaeological artifacts with soil sheen. The reconstruction of tool use is hindered by the removal of the well-developed polish through edge damage, and the appearance of striations unrelated to the direction of motion in use.

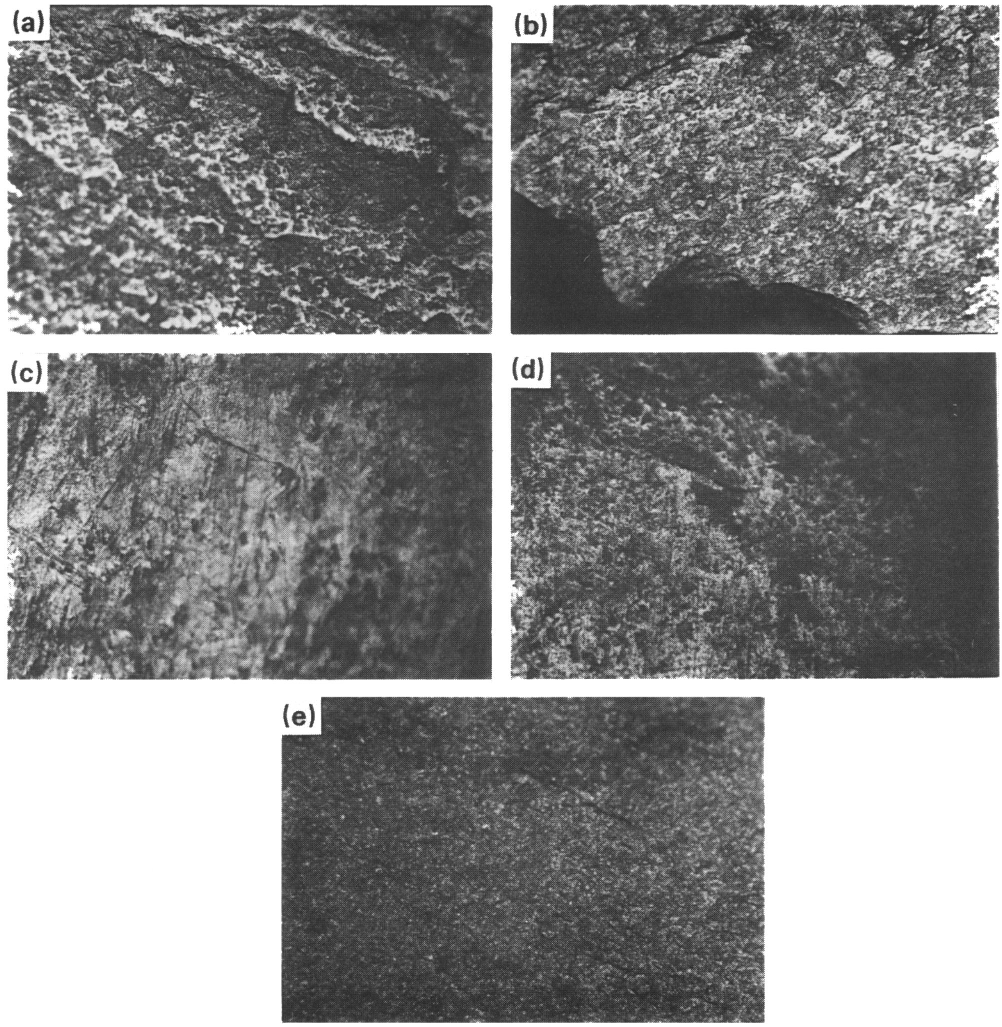

Figure 4. (a) EXP/E5, polish from whittling fresh willow for 20 min after NaOH bath, × 200. (b) EXP/59, 30 min working on dry oak and 20 min NaOH bath, × 200. (c) EXP/E5, gloss not similar to use wear, × 100. (d) EXP/E5, after NaOH bath a few striations remain, × 100. (e) EXP/E5, striations disappear after tumbling, × 100.

*(b) 15 h in wet gravelly sand:* The 50 h tumbling time was not an arbitrary limit but was dictated by the appearance of macroscopic sheen in experiment 3(a). However, to observe the effect of a more limited and shorter movement in the sediment, experiments 4(a) and (b) were planned for 24 and 15 h, respectively.

The two artifacts involved in this experiment were of two new flint types not used in previous experiments. They were tumbled for 15 h in wet gravelly sand, and both were cleaned after use by immersion in 20% NaOH for 20 min. The two artifacts used were: EXP/1, a finely denticulated bladelet made from Dorset flint used for 30 min to cut wet rushes (i.e. dry rushes soaked in water) [Figure 5)b)]; EXP/75, an unretouched bladelet of light brown Israeli flint used for 65 min to whittle dry oak [Figure 5(c)].

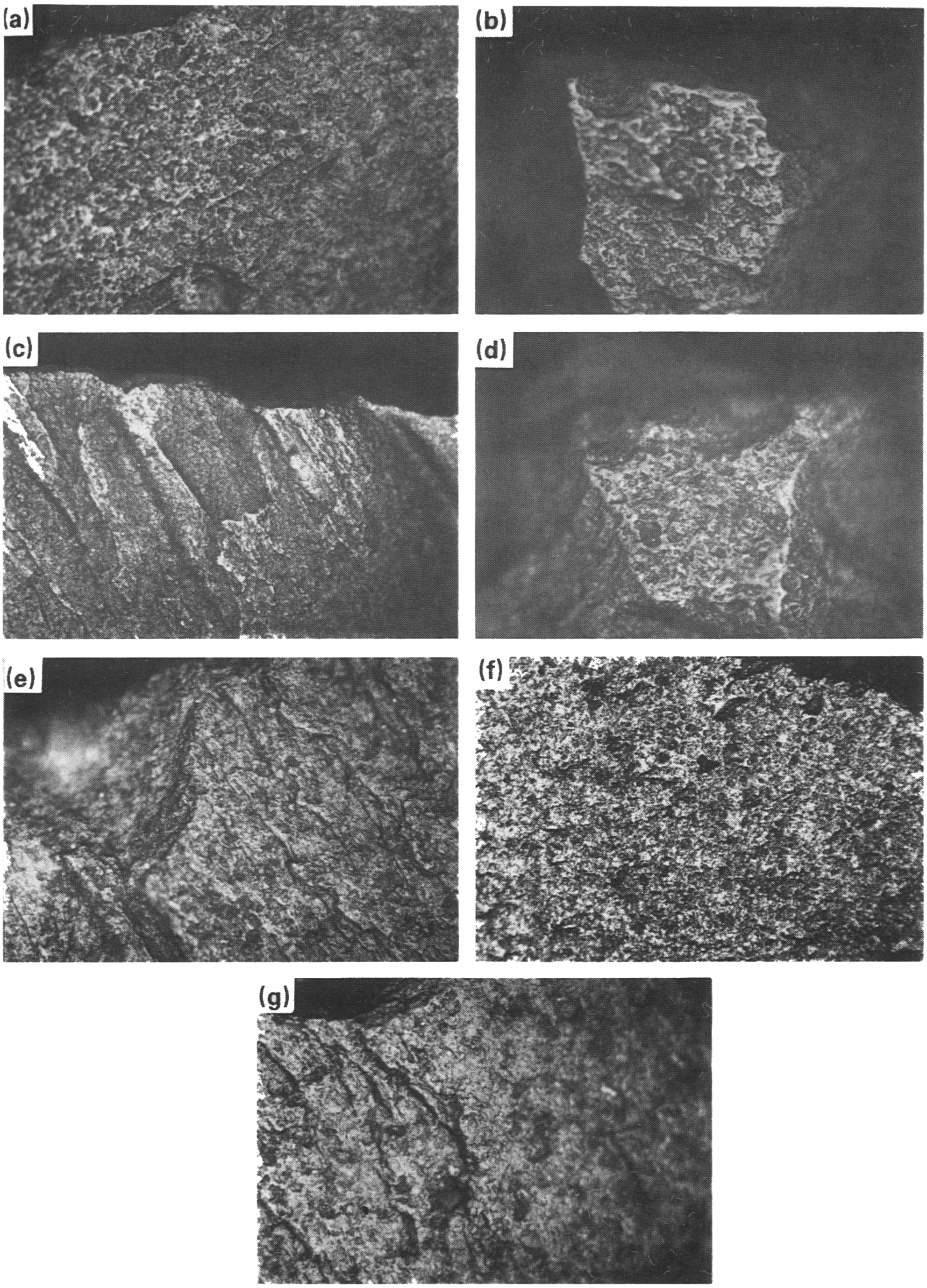


Figure 5. (a) EXP/59, altered polish after tumbling, × 200. (b) EXP/1, traces after cutting wet rushes and cleaning with detergent, × 200. (c) EXP/75, traces after whittling oak and cleaning with detergent, × 100. (d) EXP/1, edge damage changed profile of edge—note micropit cf. 5(b), × 200. (e) EXP/75, new edge profile and new polish after tumbling, × 200. (f) EXP/59, after tumbling, polish similar to PDSM, note micropits, × 100. (g) EXP/75, after tumbling, polish similar to PDSM, note micropits, × 200.

After tumbling very little sheen developed in EXP/1 except on the prominent parts of the tool. Edge damage occurred on both edges and the scar removal changed the profile of the edge [Figure 5(d)]. New micropits appeared that were not present before use [cf. Figure 5(b)].

It is interesting to note that this polish, very similar in appearance to sickle gloss, was not affected by the shaking as other polishes were. Nowhere was it "increased" as had occurred with the polish produced by cutting bracken and incising wood. It disappeared only where a new scar removed that part of the edge, and its brightness was slightly dulled by the abrasion. This is an encouraging confirmation of what I had observed empirically. That is to say that "sickle gloss" is the only polish that survives on the archaeological artifacts which I have examined so far, particularly from the Near East. Unger-Hamilton (1984: 156) also noted that while polish on other artifacts "may have been removed ... polishes on most of these (i.e. sickle blades) were relatively intact".

In EXP/75 also, very little sheen developed except on the edges. Much macroscopic edge damage, which could have been mistaken as use-induced, occurred on the unretouched cutting edge. New polish has been added [Figure 5(e)], making the flint surface very similar to archaeological artifacts affected by microscopic PDSM while appearing very fresh to the naked eye. The polish produced by whittling oak for 65 min was examined after cleaning with detergent and again after 20 min in the NaOH solution. There was no change in the appearance of the polish. The macroscopic gloss and striations observed on the edge after use and before cleaning were removed by washing with warm water and detergent only.

The Israeli flint used in this experiment is fine grained but heavily grooved, as often occurs with Near Eastern flint. The effect of tumbling on this flint was comparable to other fine-grained flints such as the black chalk flints from East Anglia.

## Discussion of Results

*Sheen*

Macroscopic sheen appears only after prolonged movement of the artifacts in the sediment and it develops faster when water and/or gravel are present. Coarse flint develops sheen more slowly than fine flint (cf. EXP/E5). However, two bladelets of the same type of flint need not develop the same amount of sheen when subjected to the same processes. Future experiments will show whether a combination of chemical and mechanical actions will produce sheen after less prolonged movement.

The disappearance of use traces on artifacts showing soil sheen and the appearance of new ones has serious implications for microwear analysis undertaken on such collections. A case in point is the Meer Mesolithic site (Van Noten, 1978), the artifacts of which had also undergone extensive vertical movement in the sediment. Prof. Van Noten very kindly allowed me to examine the artifacts, which are macroscopically so lustrous that they appear varnished. Plisson & Mauger (in press) describe soil sheen by remarking "in pronounced cases, the surface of the tool appears to be varnished. It is usually fruitless to search for microwear polishes on such pieces". In fact, two Meer artifacts which I examined under the microscope suggest that previous analysis may have interpreted post-depositional traces as use wear.

*Flint surfaces*

These preliminary experiments could not hope to produce too many examples of PDSM; they have, however, produced some [Figure 5(f), (g)]. Future research will be directed towards understanding the causes of the diversity of PDSM. So far it has been observed that there is a difference in results in the tumbling experiments using sand alone and sand with gravel. It is probable that while sand scours the surface of the flint, making it look like unused flint away from the edge, the sand with gravel seems to polish the surface in the Keeley sense.

I had noticed that archaeological artifacts with PDSM often had a large number of micropits. These experiments have also produced frequent micropitting [Figure 5(d), (f), (g)] while no such micropitting was observed before the shaking experiments [Figures 4(b), 5(b), (c)]. These micropits are probably produced by the flattening of the asperites in the microtopography. They also occur when flint tools are used on hard materials.

*Bright spots*

Flat bright spots, very similar to those observed on archaeological artifacts, can be produced by friction of flint on flint with water as a medium. They are easier to produce on edges and ridges where more pressure can be exerted. They occur only very randomly during experimental movement in the sediment where no pressure can be exerted. Their appearance and distribution is affected by the microtopography of the flint surface. In the soil, flat bright spots could occur during a brief but intense movement while the implement is rubbing against another implement or stone. Flat bright spots with striations could be diagnostic of trampling, movement in the sediment or similar post-depositional factors. Polishes present on artifacts with these spots should be viewed with suspicion, as they too may be the result of friction in the sediment. These experiments would also suggest that flat bright spots with striations are related to the particular taphonomic circumstances occurring during burial, rather than exclusively to length of burial. The conditions which caused the other kinds of bright spots need to be investigated.

*Edge damage*

Predictably, a certain amount of edge damage is produced by the movement of artifacts in gravelly sediment. Its amount and distribution can mislead if it is the only criterion used to reconstruct tool use, as is done in the low-power approach. Furthermore, the removal of microflakes affects amount and distribution of polish on the edge, hindering a correct reading of the traces.

*Cleaning method and residues*

There seem to be two kinds of "striations" observed after use on wood (and bone or antler): (1) those which are accompanied by macro gloss are very different from use-wear striations in appearance, and are removed by washing and/or immersion in diluted NaOH; and (2) those which survive 20 min in 20% NaOH are very similar in appearance to experimental use-wear striations, but are removed by movement in the sediment. It does not seem possible from these experiments to conclude whether they are residues or not. But since they disappeared after tumbling, it can be suggested that on sites where artifacts undergo post-depositional trampling or where they move vertically in the sediment, these striations would not survive.

*Use-wear polishes and traces*

Weakly developed use-wear polishes such as those produced by cutting bracken, and probably by cutting meat and scraping fresh hide, can disappear after movement in wet gravelly sediment. The surface of the flint is probably re-polished by the matrix, causing an increase in the extent and distribution of the polished areas. On such artifacts a variety of polish "types" are produced by the movement of artifacts in wet gravelly sediment. This has thought-provoking implications on the variability of polishes in relation to the worked material, since one contact material, wet gravelly sand, can produce a variety of polishes.

Well-developed polishes such as those produced by cutting reeds and rushes are not affected in the same way. They are only slightly dulled. A possible explanation is that polishes, of which the best-developed example is "sickle gloss', are the result of smoothing of the flint surface by removal of all micro asperities and probably by infilling the micro depressions. If this is true, no more smoothing or polishing can be done by the sediment, but some of its more abrasive agents may produce fine scratches which would be responsible for the duller appearance of tumbled polishes.

"Striations" seem to disappear during movement in the sediment. Those which are actually linear features of the polish itself are just polished over. Others, which may be stubborn organic remains adhering to the flint even after an NaOH bath, are removed by friction with the sediment. Manufacturing tracks which are flint on flint abrasions and cannot in any way be residues [EXP/2, Figure 2(e)] are also removed by movement in fine sand. Other types of striations exist which were not present in the experiments described above.

Keeley (1980: 34–35), though warning of the traces caused by natural agencies, concluded "most natural pressures, then leave traces which are unlikely to cause much confusion for the microwear analyst." I beg to differ: some post-depositional traces can be very similar to use wear. A very critical approach is required to distinguish one from the other. Recent microwear reports do not seem to take enough notice of the problem, which is rarely mentioned. In the presence of PDSM, polishes are generally so altered that they cannot be replicated experimentally. Errors are therefore easily made and an objective assessment cannot be made with confidence as polish identification becomes guesswork.

## Conclusions

There is no doubt that movement of artifacts on archaeological sites is quite common. Movement is caused not only by periglacial soil processes, including cryoturbation, gelifluction, soil creep or other disturbances which leave stratigraphic evidence, but other movements occur which are quite minor and are therefore invisible stratigraphically. They are probably caused by trampling, bioturbation, and the settling of the sediment under pressure. Only now that refitting of artifacts is practised more frequently has it become obvious how common this phenomenon is. The question is whether such nonviolent movement can affect flint surfaces to cause PDSM—and that is the justification for these experiments.

It is not possible to recreate experimentally the exact conditions of thousands of years of movement in the sediment; one has to increase the speed of movement to telescope time and substitute pressure. But imperfect as this method is, it gives insight into what could be happening in nature. Furthermore, the backbone of the Keeley method is experimental replication of observed polishes. I feel that these experiments have successfully reproduced certain polishes observed on the archaeological implements, and shown that they can be caused by post-depositional processes.

This does not mean that all soil sheen is produced by movement of artifacts in the sediment. Other processes are being investigated; but when soil sheen has been caused by friction, it is important to remember how it alters microwear traces. Stapert (1976: 8) advocated the need for research into the genesis of natural surface modification because the same traces attributed to use wear "may be the result of natural processes". The present paper is only a preliminary report of an ongoing study, but it was necessary to submit it in order to: (1) stress how widespread PDSM is; (2) show the effect of friction in the sediment on certain microwear traces; (3) reiterate warnings about ascribing traces to particular tasks, unless they have been reproduced experimentally; (4) suggest that the presence of bright spots, especially flat ones, might indicate that the pieces have undergone friction; (5) point out that when PDSM imposes a selection on the artifacts which can be analysed, one is not dealing with a representative or random sample and no meaningful conclusions can be drawn; and (6) suggest that further research is necessary into the variability of polishes, i.e. whether the observed varieties are due to the different contact materials or rather to specific tasks in a combination of factors.

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