Microwear Analysis of Lithic Artefacts from Willington Quarry

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Introduction

This study aims to identify the uses of lithic artefacts contained within a burnt mound excavated at the site of Willington Quarry to assist in the interpretation of the function of the feature. The site is located on an alluvial flood plain on the north side of the River Trent in the Middle Trent Valley. This part of the site encompasses 16 hectares of which four hectares have been examined in 1998 through 2001. The site consists of strata from the Neolithic through the Iron Age and investigations revealed evidence for post holes and pits associated with Peterborough ware pottery adjacent to a burnt mound (Beamish and Ripper 2000). About 40 lithic artefacts are among the small finds recovered from contexts sealed by the primary burnt mound layers from below and sealed by an alluvium layer from above.

The objectives of the lithic microwear analysis include:

1) Identify the kinds of uses performed by the artefacts;
2) Assess if there are any differences across the contexts;
3) Determine if the artefacts had been re-deposited from one or more contexts;
4) Assess if the lithic assemblage may relate to domestic economic activities, crafting and steam bathing (Barfield and Hodder 1987), or if they are associated with ritual behaviour or ceremonial food preparation (Ladle and Woodward 2003); and
5) Investigate site formation processes.

Background

Lithic microwear analysis is the microscopic examination of wear and fracture scars that form along the edges and surfaces of fine-grain siliceous stone such as flint and chert. Experimental studies demonstrate that use of stone tool edges causes microscopic wear and fracture scarring that systematically vary according to the material worked (e.g., hide, wood, meat, bone) and to the forces and motions applied (e.g., cutting, scraping, wedging). The development of principles regarding these relationships permits microwear analysts to infer the past use or uses of lithic artefacts with a greater degree of precision and accuracy than through reliance on either macroscopic attribute analysis, which has proved inadequate at identifying used pieces (Young & Bamforth, 2000), or ethnographic analogues of tool form. Natural processes also produce systematic microwear features. These surface modifications can hinder inferences regarding tool use (Keeley 1980; Levi-Sala 1986a, 1986b), yet can aid in the understanding of site formation processes (Burroni *et al*., 2002; Donahue 1994, 1998, 1999; Donahue & Burroni 2004).

Method

Of the 40 lithic artefacts recovered from the main layer associated with the burnt mound, 29 artefacts were sampled for lithic microwear analysis. These included 12 tool forms, six "good" flakes, and 11 small flakes as control specimens. The artefacts come from contexts 1487, 1759, 1817, 1850, 1895 and 1980. The sample is not representative, but includes all artefacts thought suitable for microwear analysis. Even so, numerous artefacts were partially patinated and some were either of coarse flint or had cortex on or near potentially useable edges.

The sampled artefacts were prepared by bathing in water for 10 minutes, brushing under running water with a soft bristle brush where sediment was obdurate, soaking in 10% hydrochloric acid for 10 minutes then bathing in water for a further 10 minutes. They were then rinsed with acetone and aired to dry. The artefacts were viewed principally at 200x magnification with an Olympus BHM-UMA metallurgical microscope with long working-distance objectives. Microscopic characteristics of edge fracture scars, striations, pitting, and surface polishing were recorded, categorised (following Donahue 1986, 1994), and interpreted.

In addition to traditional microwear variables that are recorded for assessing the causal mechanism for wear phenomena, measurements quantifying the post-depositional modifications were also collected. These data provided the means to further evaluate use-wear interpretations and to understand better the variation of post-depositional processes within and between contexts. It also improves the comparability of use-wear results between sites. Major disturbance events and processes will produce various kinds and degrees of edge fracture scarring, polishing, striations and other surface modifications. Severe thermal alterations will produce microcracking, potlidding, and crazing of surfaces. A principal concern here is to identify and measure the effect of processes causing the gradual loss of material through abrasion or attrition. One technique for achieving this is by measuring the amount of dorsal ridge rounding. Dorsal ridges are formed by the intersection of two flake scars on the dorsal surface. The technique is similar to that described by Shackley (1974), where the degree of rounding is calculated by averaging the breadth of intense reflected light measured at a magnification of 200x from a series of observations taken along one or more ridgelines. Where there is no rounding, the intersecting surfaces produce an almost invisible ridgeline. The minimum recordable measurement with this technique and equipment is approximately 1-2 μm. Experimental research in progress indicates that natural wear causing dorsal ridge rounding of 4.2 μm is already impacting upon use-wear. Most kinds of use-wear on most surfaces will be obliterated when natural wear has rounded ridges to a value of 14μm.

Dorsal ridges can be modified and rounded through cultural processes also. In most situations human manipulation of stone tools can be expected to have little impact. For example, the handling of a scraper during use is unlikely to produce much wear on a ridge, however, given that a scraper edge may be retouched (resharpened) numerous times, it is possible that hands, particularly if dirty or gritty, will produce ridges even more worn than the used edge. For such reasons, when attempting to assess the amount of natural disturbance to artefacts within a context, it is best to examine small, unmodified flakes.

For the purpose of this report 18 artefacts were identified from the microwear sample for detailed examination. The control flakes were measured for ridge wear and examined briefly for edge modification resulting from use or post-depositional modification.

Results

Of the 18 artefacts examined for use, five have microscopic wear and fracture scars on their edges that can be attributed to some category of use, three appear to have been unused and 10 had undergone post-depositional modification such that it could not be determined if the artefact had been used (Table 1).

Table 1. Use of lithic artefacts as identified through microwear analysis.

ARTEFACT	CONTEXT	TYPE	EDGE	MATERIAL	ACTION
SF174		Blade fragment		Undetermined	Undetermined
SF175		Burin on Truncation		Undetermined	Undetermined
SF299				Undetermined	Undetermined
SF375		Flake		Undetermined	Undetermined
SF447		Piercer?		Unused	Unused
SF448		Bifacial piece		Unused	Unused
SF456		Piercer		Undetermined	Undetermined
SF522	1759	Oblique arrowhead		Undetermined	Undetermined
SF531	1817	Serrated blade	Left lateral	Herbaceous plant	Cutting (Sickling)
SF535	1817	Utilised blade with gloss (Serrated flake)	Left lateral	Herbaceous plant	Cutting (Sickling)
SF539	1850	Utilised blade		Undetermined	Undetermined
SF614	1487	Retouched flake	Right	Greasy hide	Scraping
SF635		Broken blade		Unused	Unused
SF652	1895	Retouched flake (piercer?)	Left	Meat (Butchering)	(Cutting)
SF704		Flake		Undetermined	Undetermined
SF727	1980	Serrated flake	Right	Soft wood or plant	Sickling or scraping
SF773		Flake		Undetermined	Undetermined
SF889		Serrated blade		Undetermined	Undetermined

Post-Depositional Modification

The study of ridge rounding for the assemblage shows that there is much more post-depositional modification to the artefacts than originally suspected. Only one (SF448) of the non-control sample of artefacts has a ridge rounding value below the maximum threshold for good use-wear preservation. The remaining control and non-control flakes exhibit a range of rounding between 5.6 and 24.8 μm. This modification is highly variable across the assemblage with some ridges showing heavy battering (such as that on SF175) and braiding, and others display rough, pitted rounding (SF727). Some flakes show variation in the degree of rounding between ridges. In some cases this was suggestive of fresh fracture scars associated with post-depositional surface modification. Edges and other surfaces also show a variety of

post-depositional modification. Some of this has been very intensive. For example, the broken blade SF539, which has wear on both lateral edges somewhat characteristic of butchering also displays much intensive post-depositional fracture scarring (Photomicrograph 1). The overall effect is to make any interpretation of use unviable.

Artefact Types and Tool Use

Although a variety of technological types were included in the study, only two tool categories showed evidence of use-wear (Table 2). Figure x (over page) shows photographs of the artefacts with evidence of use-wear and indicates the areas in which this is discernable. These include serrated pieces and miscellaneous retouched pieces. The serrated pieces consist of one flake and two blades (one blade was previously identified as an "utilised" blade, but the serrations are quite distinct microscopically). These displayed evidence for probable use as sickle blades. Miscellaneous retouched flakes showed evidence for butchering (1) and hide scraping (1). The effects of post-depositional processes will have altered the frequency distribution of uses. Wear produced by herbaceous plants is both extensive and robust, thus it is identifiable even after severe post-depositional modification (see Donahue 1994). Thus it will survive when other forms of wear have been obliterated.

Table 2. Relationship of artefact categories and artefact use.

	LITHIC ARTEFACT CATEGORY			
USE	**Unmodified flakes & blades**	**Serrated flakes**	**Formal tools & modified flakes**	**Total**
Butchering			1	
Hide			1	
Soft				
Plant		3		
Wood				
Wedging				
Impact (Projectile)				
Used Subtotal	**0**	**3**	**2**	**5**
Unused	1		2	3
Undetermined	5	1	4	10
Total	**6**	**4**	**8**	**18**

Serrated pieces

SF531 is a cortical flake, but with one non-corticated edge which is serrated. These serrations are deliberately produced, probably by pressing the edge of another flint into its edge at intervals averaging about 0.9 mm. Between the serrations are numerous small fracture scars with point initiations and feather termination. The surfaces are bright but only roughly polished. This is incipient wear from the cutting of herbaceous, siliceous plant fibre. The edges and ridges are generally sharp or mildly rounded. There are numerous small fracture scars along the edge which mostly lie oblique to the edge, but vary in size and shape. In conclusion, the artefact was used for a short period of time for cutting cereal or equivalent grass-like material. The edge had originally been serrated, and was rapidly being scarred by use. The edge had not yet stabilised, thus although surface polishing was occurring, it was being chipped away by the fracturing of the edge.

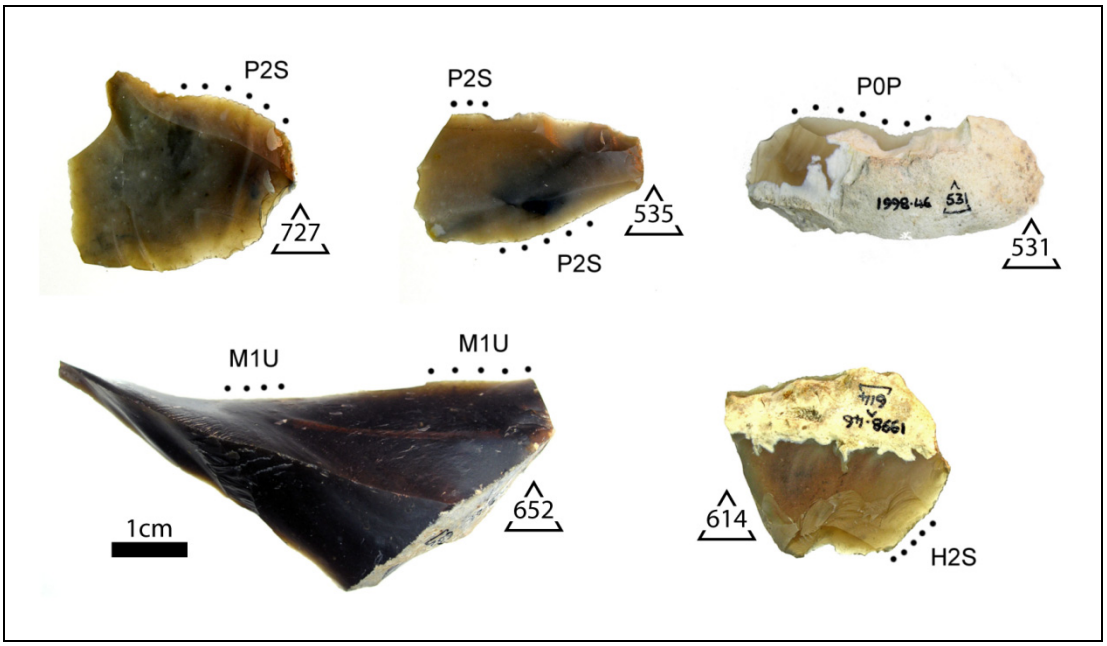

Figure 1. Location and categoriy of wear on artefacts from Willington Quarry; P2S, P0P, working of siliceous plant; M1U, butchering; H2S, fresh or greasy hide working (see discussions of individual artefacts for further details).

SF535 is a serrated flake with the left lateral edge displaying a surface that has been heavily polished. This region is very bright and smooth or with undulations aligned in the direction of use (oblique to the edge). Fracture scars are variably polished indicating that they were produced during use (Photomicrograph 2). They, along with fine striations, are oblique to the edge and aligned with the undulations. The right lateral edge has some severe fracture scars about midsection. There is no wear here, but there is intensive wear and rounding of edges along the distal third of the edge similar to that on the opposite edge (Photomicrograph 3).

The lateral right edge of artefact SF727 has a series of micro-serrations and a much “chewed up” appearance with no consistent patterning of fracture scarring. Most fracture scars are small. The surface polishing is very bright and smooth, and there is a "doming" appearance to the polished surface, which is typical of wood (Photomicrograph 4), but may also occur in earlier formation stages of herbaceous siliceous plant wear. There are numerous striations perpendicular to the edge and pitting, including comet shape pits. The surface wear is on or near the edge and is often broken up by post-depositional fracturing and wear. As it presents both wood and herbaceous plant characteristics, it is suggested to be woody plant, although the microserrated edge would support be more likely related to use as a sickle blade

Retouched Pieces

SF614 has an edge which is mildly to moderately rounded (blunting makes this hard to distinguish). The surface appears to have a mild sheen. Wear is most apparent along the distal 6.5 mm portion of edge. Here the edge varies in rounding, but can be heavy. The surface is rough but gleamy, and faint striations perpendicular to the edge occur that are narrow, shallow and short. The wear appears to be from fresh or greasy dry hide scraping. The use-wear is difficult to observe because of the

post-depositional modification. This includes mild wear, but also plastic deformation (Photomicrograph 5) .

A second retouched flake, SF652, has an edge with mild to moderate rounding. Along the midsection there are numerous fracture scars of variable form although at times there are continuous shallow medium size scars with point initiations and feather terminations. The surface polishing shows little contrast and the surface is rough. Striations are rare. This pattern also occurs along proximal end of edge where polishing has produced a slightly contrasting surface with more smoothing. See Photomicrograph 6. There occurs at a few intermittent locations along the immediate edge a smooth bright wear, similar to wood or bone, but could be the result of autoabrasion. This edge may have been used on meat. Near the distal end rounding becomes more moderate with few fracture scars. This pattern continues to the distal tip although fracture scarring increases. There are some brightly polished areas near the tip, but they are probably the result of post-depositional processes rather than use. The opposite edge is mildly rounded with numerous small fracture scars. The immediate edge often carries some bright polishing. This pattern continues to the distal end. There is no evidence that the motion was rotation here. Given the characteristics of much of the tool, it is concluded that the wear is primarily the result of post-depositional processes although the fracture scarring is indicative of cutting a soft material like meat.

Comparison with Other Sites

Lithic microwear analyses of artefacts from British Neolithic sites are no longer rare. Donahue has examined artefacts from the settlement site of Lismore Fields, Buxton, Derbyshire (Donahue 1991), pit features at Dragonby, Lincolnshire (Donahue 1994, May *et al*. 1996), Upper Ninepence, Walton Basin, Wales (Donahue 1999), and Eye Kettleby (Donahue 2002). These studies of unmodified and modified flakes and formal stone tools from very different kinds of sites and features indicate that a diverse range and frequency of economic tasks were being performed with stone tools during the Neolithic. These include: scraping, cutting and piercing of hides; butchering of animals; whittling, cutting, wedging, of wood; the scraping and chiselling of bone; the cutting (sickling) of cereals; and use of weapons such as arrows. The variety of economic activities indicated by microwear analyses conforms to the residential setting of these sites and the expected domestic activities to be found there. Specialist economic localities are exemplified by the results of a microwear study of the Bronze Age Royal Dock School site which consisted of a predominance of hide working tools in association with pits dug into peat (Donahue 2000b). The pits associated with Grooved Ware ceramics at Upper Ninepence were also predominantly associated with hide working artefacts (Donahue 1999). This is in contrast to the pits associated with Peterborough Ware ceramics which had a much more balanced distribution of activities represented. A recent microwear study by Donahue (n.d.) of the lithic artefacts from the Whitwell Neolithic Long Cairn site, Nottinghamshire produced some important implications regarding Neolithic funerary contexts. Firstly, there is a distinct assemblage associated with mortuary structures that comprises of finely worked tool forms, which may or may not have been used. Secondly, the distribution of used tool forms would support the hypothesis that boundary markers do seem to delimit areas of ritual significance from areas of secular activity. Finally, it was observed that those artefacts with use-wear indicative of economic activities that were recovered within the ritual area were all in secondary context. Table 6 shows the

results of the total assemblage, which inadequately demonstrates the uniqueness of the ritual context.

Table 6. Tool use distributions for a sample of Neolithic sites in Britain.

	Sites							
Use	Willington Quarry	Wellington Quarry	Eye Kettleby	Lismore Fields	Dragonby Neo. Pit	Upper Ninepence	Royal Dock School	Whitwell Long Cairn
Meat/Butchering	20.0	11.1	38.1	41.4	28.6	24.1	0.0	18.8
Hide Working	20.0	38.9	38.1	28.6	14.3	44.8	80.0	6.3
Soft Material	0.0	5.6	9.5	0.0	0.0	0.0	0.0	12.5
Herbaceous Plant	60.0	22.2	0.0	17.1	35.7	3.4	6.7	18.8
Wood Working	0.0	5.6	4.8	0.0	0.0	17.2	6.7	0.0
Bone/Antler	0.0	0.0	0.0	10.0	21.4	3.4	0.0	0.0
Hard Material	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.3
Wedging	0.0	5.6	4.8	0.0	0.0	0.0	6.7	0.0
Impact (Projectile)	0.0	11.1	4.8	2.8	0.0	6.9	0.0	37.5
Percent Total	100.0	100.1	100.0	99.9	100.0	100.0	100.0	100.0
Total Used	5	18	21	70	15	29	15	16

These studies provide a framework for comparing the microwear results of the Willington Quarry assemblage, although it must be done cautiously because of the small sample sizes and the effects of post-depositional modification. It suggests that Willington Quarry contains an assemblage of artefacts indicative of various economic activities. Combined with the technological variability of the assemblage, it would tend to indicate that quite a varied set of activities are represented. The prevalence of sickle blades, indicative of the reaping of cereals (or other herbaceous plants) could result from loss in agricultural fields, but in conjunction with other tool uses and artefacts indicative of tool production, it is likely that sickle blades were being discarded and replaced at this location. These kinds of maintenance activities could be done within a domestic context, but could be done within the context of social gathering place where members of a sodality might meet. Given that the artefacts come from the context of a burnt mound, it is very possible that this alternative model best explains this location of craft activity.

Seasonality

It is worth briefly commenting on the presence of sickling activities in terms of seasonality. Harvesting is an activity that takes place during the late summer or early autumn. Whilst the evidence indicates that activities were being carried out during this period, it does not exclude the possibility of use of the site at other times of the year.

Conclusion

The microwear analysis of the lithic artefacts from the burnt mound at Willington Quarry provides evidence regarding tool use on a small sample of artefacts. There is evidence for cutting soft plant material, butchery and hide working. If representative of the kinds and intensity of activities performed at the site, then it is possible to suggest that this was an area of economic tool maintenance activities. This is not necessarily a domestic activity area, but could be a location where certain members of the society were

permitted to come, while others were excluded. There is evidence for occupation during late summer through early autumn, but it may extend for a much longer duration. Interpretation of tool use by means of microwear analysis is confounded by the high, albeit typical, percentage of artefacts that have undergone post-depositional modification.

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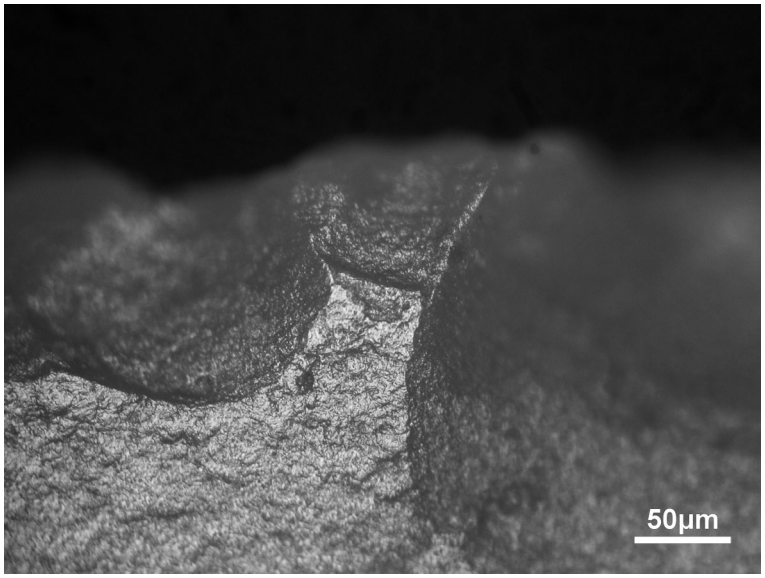
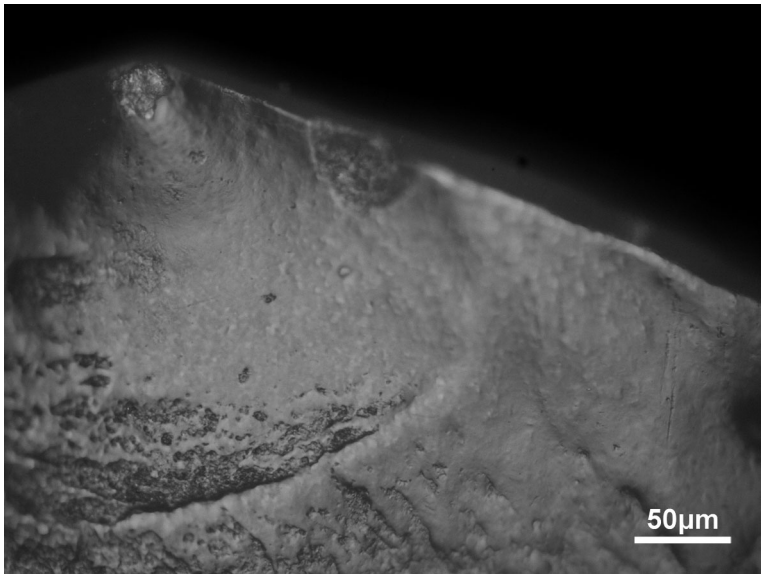
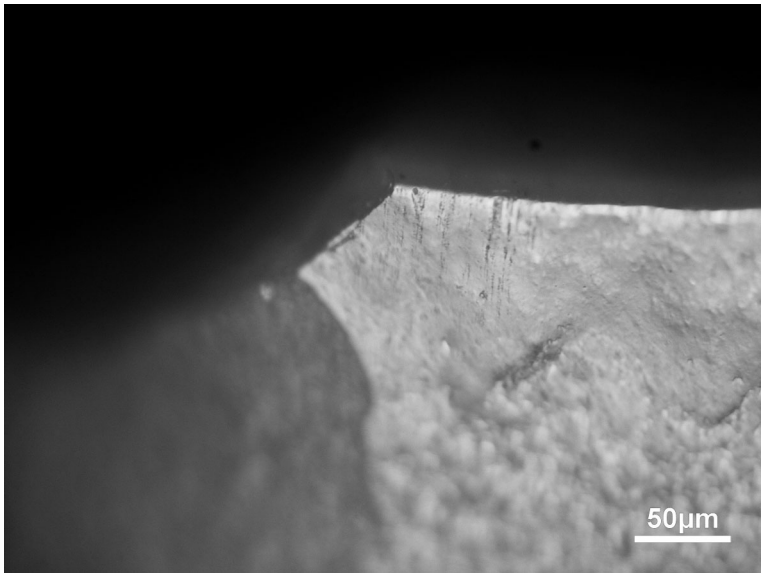
Appendix 1. Photomicrographs



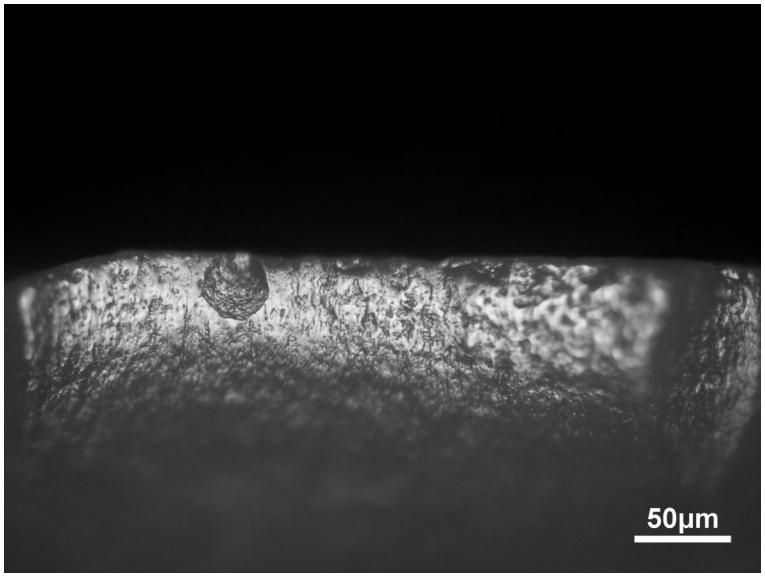
Photomicrograph 1. The original surface of this blade (SF539) has been roughened and loss its graininess, probably from mild post-depositional wear. Large fracture scars post-date this episode (note the surface graininess of the two large fracture scars) indicating some severe post-depositional processes later in the artefact's history.



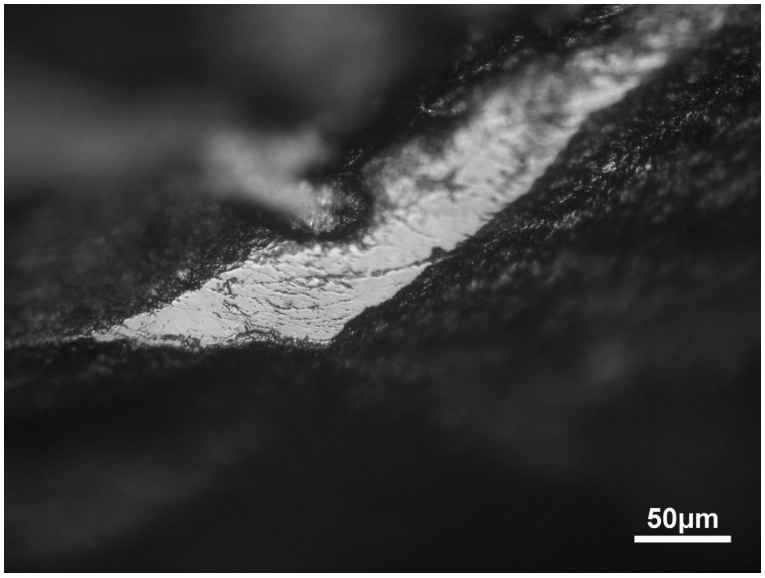
Photomicrograph 2. Example of siliceous plant polishing of fracture scar surface of artefact SF535.



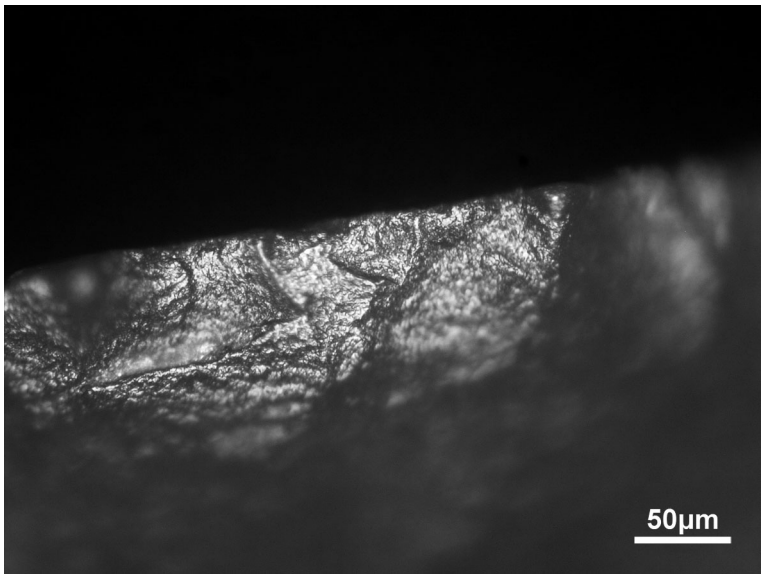
Photomicrograph 3. Example of siliceous plant polishing along the right edge of artefact SF535. Note the striations perpendicular to the edge.



Photomicrograph 4. Artefact SF727 with surface modification indicative of siliceous plant cutting with motting perpendicular to the edge. Note the small fracture scar lacking surface polishing. This is indicative that the scar was produced near the end or after use (Donahue & Burroni 2004).



Photomicrograph 5. An example of plastic deformation where a section of the surface along the left edge of the artefact has been "flattened". At low magnification, this kind of wear will appear similar to "sickle gloss."



Photomicrograph 6. This section of the lateral edge of this artefact (SF652) displays a consistent sequence of small shallow flake scars. Most scars have point initiations and feather or step terminations. These are typical of working soft material. The surface wear is rough, slightly "greasy" in appearance. The edge and scar ridges are mildly rounded. These wear characteristics are typical of butchering and fresh hide cutting, but can be mimicked by post-depositional processes.