The Limitations and Applications of Use Wear Analysis

Roger Grace

Grace, R., 1990. The limitations and applications of use wear analysis. *Aun 14*, pp. 9–14. Uppsala. ISBN 91-506-0827–4.

There are limitations to the way microwear analysis can be used in the evaluation of lithic assemblages, mainly due to variations in tool rawmaterials, post-depositional alterations and the unknown extent of low use rates.

It can be argued that different levels of analysis can be used in these different research situations. By means of examples from various use wear analysis, it is shown that edge analysis, edge wear analyses, and microwear analysis can be fruitfully applied. The selected level of analysis should always be related to research goals, and it is further stressed that, to be meaningful, microwear analysis must form an integrated part of the general framework of a research strategy.

Roger Grace. Institute of Archaeology, 32–34 Gordon Square, London W.C.I. England.

There are certain limitations placed on the use of microwear analysis due to a variety of factors. Apart from the percentage of tools in an assemblage which will have sufficient microwear traces on them in order to make interpretations of worked material, two of the other main limitations are post depositional effects and the raw material from which the tools are made. In cases of gross post depositional effects such as when all, or most, of the tools in an assemblage are covered in post depositional polish, by whatever mechanism, or when the raw material of the tools is of course grained rocks such as quartzite, the use-wear analysis may have to be limited to edge attribute and edge wear analysis at low power. This kind of analysis is not able to provide sufficient information on which to base interpretations of precise worked material, but can identify used from unused tools and the relative hardness of the worked materials.

Another major restriction is the amount of time required for use-wear analysis and replication experiments that are necessary in order to produce reliable results. These limitations mean that the analysis of total assemblages with the intention of producing specific results, especially of worked materials, is not feasible. This means that to produce archaeologically significant results, use-wear analysis should be adapted in order to answer specific problems, rather than producing lists of activities of individual tools that rarely can represent the total assemblage from all but very small sites. The most profitable use of use-wear analysis is to apply it to specific problems within the general framework of a research strategy.

The multi-dimensional approach to use-wear analysis (see Grace 1989), enables the analysis to be used at different levels. There are three levels of analysis that can be carried out. The first is based on the morphological attributes of used edges and macro wear, which might be called *edge analysis*. The second level, in addition to edge analysis would include micro edge wear and rounding with the use of low power microscopy (*edge wear analysis*). The third level of analysis is to use both edge analysis and edge wear analysis in conjunction with high power microscopy looking at polish distribution (*microwear analysis*). The level of analysis that would be undertaken would depend on the condition of the material and the specific archaeological questions that are being asked of the material. Therefore the level of analysis would be determined by the information required in order to answer the specific problem.

For example, if one is concerned with variability between assemblages in terms of activities that took place at the sites, then edge analysis can group the tools into types having similar functional capabilities. That is, groups of tools are held to be associated with a particular activity, but without necessarily specifying exactly what that activity is. Therefore, one can construct a functional typology that can be quantitatively compared with other assemblages in order to ascertain the similarities or differences in activities represented at different sites.

An example of this kind of application of use wear analysis is a project being carried out on quartzite material from Portugal. Because the assemblages are made of quartzite, high power microscopy is not very useful, because the grain size of the quatzite means that it is virtually impossible to focus on an area of the tool of any significant size at 200 magnifications. Most analysts will acknowledge that reliable polish information is not avail-

able using optical microscopy from quartzite tools, though polish information may be obtained with the use of scanning electron microscopes (see Knutsson 1988).

The archaeological problem here is that the material cannot be classified by the use of standard typological means. There are some retouched tools and the presence of Levallois technique, but the majority of the material would be classified as 'utilised flakes' or 'miscellaneous'. This kind of information tells us little about the relationship between sites within the area and prevents any comparison being made with assemblages from elsewhere that are made out of flint. The application of edge wear analysis would be appropriate in this case, so that the material can be classified by functional criteria. For comparisons between sites it is not necessary to know the precise worked material that individual tools were used on. It is proposed to classify the tools as being used on soft, medium or hard materials and used in transverse, longitudinal, rotational or percussive motions. Morphological aspects of the worked edges together with the anlysis of fractures and rounding will enable the material to be placed into these types (Fig. 1).

The archaeological question is, are these Portugese assemblages representing the same range of activities whatever those activities might be? As explained above the precise determination of the function of each tool in a number of large assemblages would not be possible. Therefore the use of a lower level of analysis, such as *edge analysis* which does not require high power microscopic examination, would be more appropriate to this situation. In this case quantity is more important than quality of information because the problem is concerned with statistical comparisons which require large samples. The tools may be grouped into functional types and their percentage representation compared with other assemblages in a similar way to which Bordean morphological types are used (Fig. 2).

The difference between this and other attempts to cluster tools by function is that the unit of study here is that of used edges rather than the morphology of the whole tool and the placement of retouch. For example, the attempt by Binford and Binford (1966) to produce tool kits by statistical association through the use of factor analysis was misguided, not only in the failure to interpret the statistics correctly, but also because the basic data was of Bordean types which are not intended to be functional types: As Bordes said "the computer tells us that such and such tools co-vary; it does not say for what they were used" (Bordes 1972). Therefore, as the basic data are not primarily functional, the clustering of such types is not likely to produce functional associations. In Binford's factor analysis a side scraper is regarded as a functional type whereas the evidence from use-wear analysis strongly suggests that side scrapers were used for a number of activities and therefore cannot be considered as a functional type (see Panagopoulou 1985).

Another way in which use-wear analysis can be used on whole assemblages is to attempt to interpret the function of a site as a whole, in terms of the range of activities that were carried out at the site. Knowing the range of activities would help to interpret the function of the site as a home base, kill, site, hunting station, specialist activity site (such as a hide processing site) etc. For this kind of analysis the application of *edge wear analysis* could be used to ascertain the range of activities carried out at the site. *Edge wear analysis* would provide information about the motions of tools and the range of worked materials in terms of hardness. This information would be of the order of scraping soft and/or hard materials, boring/drilling, cutting soft and/or hard materials, use of projectile points etc.

Therefore it could be established whether an assemblage represents a whole range of activities or concentra-

	TRANSVERSE	LONGITUDINAL	ROTATIONAL	PERCUSSIVE
SOFT	A	B	C	- -
MEDIUM	D	E	F	G
HARD	H	I	J	K

Fig. 1.

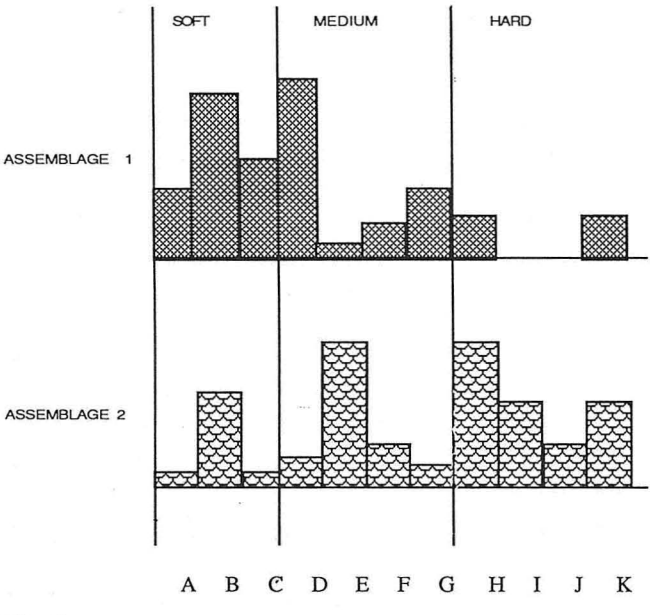

Fig. 2.

tion on particular activities. To establish the range and relative importance of activities it is not necessary to know the precise worked material on which each tool was used. Site interpretations from this kind of information could be that a whole range of activities would represent a base camp, whereas a restricted range of activities would represent, for example, a hunting station or kill site if the activities were limited to the use of projectile points and cutting (butchering) tools. In such an analysis, having used *edge wear analysis* in order to separate the tools into groups associated with a particular kind of activity, samples from these groups could be taken and analysed using *microwear analysis* to obtain more precise information about the specific worked materials. When studying large assemblages a hierarchy of analysis would be necessary to overcome the problems mentioned above. *Edge analysis* would be preliminary to *edge wear analysis,* which would be preliminary to *microwear analysis* in order to sample the otherwise unmanageable numbers of tools when studying the whole assemblage. The sample size used for a full microwear analysis would be dependent on the results of the lower levels of analysis, so that the sampling strategy would be based on the relative importance of activities represented, rather than an arbitrary number of tools that could be analysed within the limitations of time and money available.

The kind of analytical process described above could be applied to an assemblage in order to interpret the subsistence strategy associated with a particular site. The separation of the tools into those used on soft or hard materials would give an estimation of the importance of vegetable resources as opposed to hunting resources. For example, if most of the tools were used for cutting soft materials and there was an absence of hunting tools such as projectile points and tools used for cutting hard materials such as bone, then the interpretation would be that the subsistence strategy was concentrated on the procurement of vegetable resources rather than hunting. Conversely, if there was an absence of tools used for processing soft materials, yet plentiful hunting equipment and butchering tools, then the emphasis would be on hunting as the main subsistence strategy associated with that particular site.

The kind of assemblage that would be suitable for all levels of use-wear analysis is when the assemblage is sufficiently small. This kind of assemblage could be from a closed context where a small group of tools may be associated with a burial, for example. Then microwear analysis, including the use of extensive replication experiments, is appropriate in order to obtain as precise information as possible. The analysis of a group of tools from the closed context of a burial could attempt to answer questions such as, do the tools represent the tool kit of the buried person?, or are the tools ceremonial objects especially placed in the burial perhaps to denote the status of the individual?

An example is the analysis of the burial assemblages from two bronze age barrows from the Raunds Area Project in England (Halpin 1986). The flint assemblage from both barrows consists of 16 pieces of flint including scrapers and daggers. The analysis of the assemblage has involved all levels of analysis including high power microscopy and extensive replication experiments. Three flakes were unused. Of the remainder, three flakes and seven scrapers all display use wear consistent with the tools being used on wood. There is evidence for the use of scraping, cutting and whittling motions. The two daggers, one from each burial, have use wear evidence that is consistent with the tools being unused, but of having been kept in a sheath, the main evidence for this being the distribution of the polish not only on the edges but on the ridges of the bifacial retouch.

The polish is confined to the pointed end, the lack of polish on the other end is interpreted as being due to the daggers having been hafted. The only other dagger of this kind from Britain that has been subjected to microwear analysis was also interpreted as being hafted and kept in a sheath. This analysis was carried out by Keeley and published in 1982 (Green et al. 1982). The evidence for a sheath is to be rigorously tested by replication experiments by hafting and sheathing replicas of the daggers.

Replicas will also be used in other ways to compare the resulting wear traces from such activities as meat cutting, stabbing etc. and a variety of hafting techniques will also be tested. Given that the interpretation of these burial assemblages is preliminary, the archaeological interpretation of the Irthlingborough burial at this stage, is that the flakes and scrapers were probably used in the construction, or the finishing off of the wooden coffin used in the barrow, and therefore are not part of the grave goods, being discarded or mislaid during the construction of the barrow. The daggers are considered as being deposited with the dead and are probably ceremonial objects, perhaps denoting status (Fig. 3.) The evidence for sheathing would suggest they were status objects of the living person, not specially made for the burial. Otherwise the daggers should exhibit no use wear traces at all. The possibility that the daggers were used in some kind of sacrifice ritual is a possibility that will be tested by the experimental program.

The remaining tool is a triangular bifacially retouched piece with no evidence of use. It resembles in shape a blank for a barbed and tanged arrowhead, of which there are a number in the barrow but not in the burial. Howev-

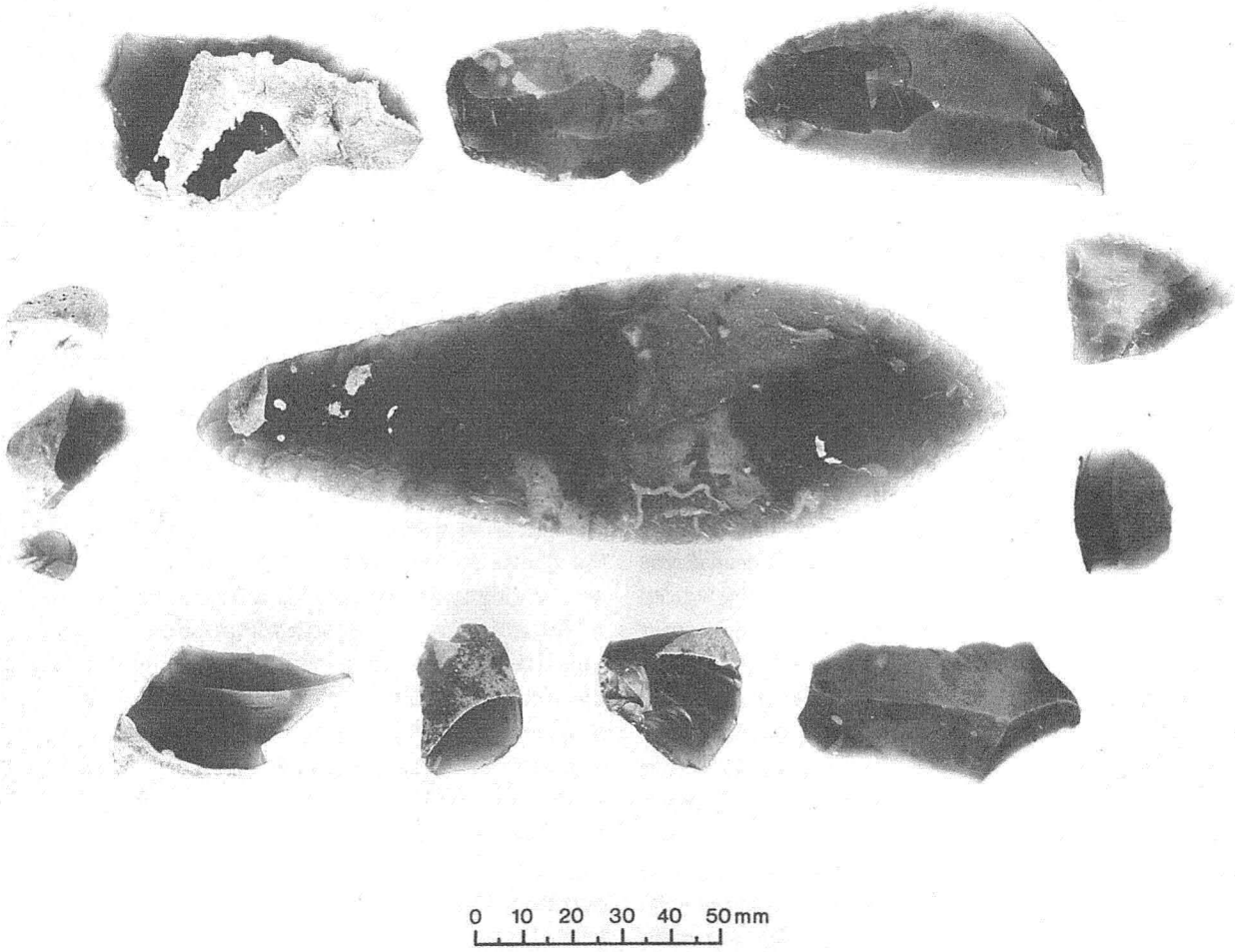

Fig. 3. *Flint assemblage from Ithlingborough Barrow. Copyright: English Heritage.*

er the thickness of the piece means that it would have been difficult, if not impossible, to complete the arrowhead. The other unused pieces (the three flakes at the bottom of Fig. 3) are merely fragments whereas this piece is the most carefully worked piece apart from the daggers. So why it should be so carefully worked but remain unused and deposited or discarded in the burial remains an enigma.

The high status of the burial is indicated by the other grave goods, there being large well made jet buttons, bone artifacts, stone bracer and a beaker pot (Fig. 4).

Recently during laboratory examination of the beaker a bifacially worked flint knife was discovered inside the pot, but this has not yet been submitted to microwear analysis. Therefore the total assemblage now consists of 17 pieces in a closed context together with other non lithic artifacts and under conditions of good preservation without any major post depositional effects. In such a case it is appropriate to use all levels of use wear analysis and extensive replication experiments in order to gain as accurate and complete information as possible. In this case the time taken for such an analysis is justified.

Another dagger has been found in the area as a surface find which is thought to come from a nearby ploughed out barrow. This dagger has not yet been examined microscopically but it is slightly patinated and being a surface find will probable have post depositional surface modification which will be useful as a control for such effects on the other daggers.

Another area in which use-wear analysis can be profitably utilised is to approach specific problems associated with a particular tool type. For example, there has been extensive analysis on the use of projectile points (Barton and Bergman 1982, Moss and Newcomer 1982, Fischer

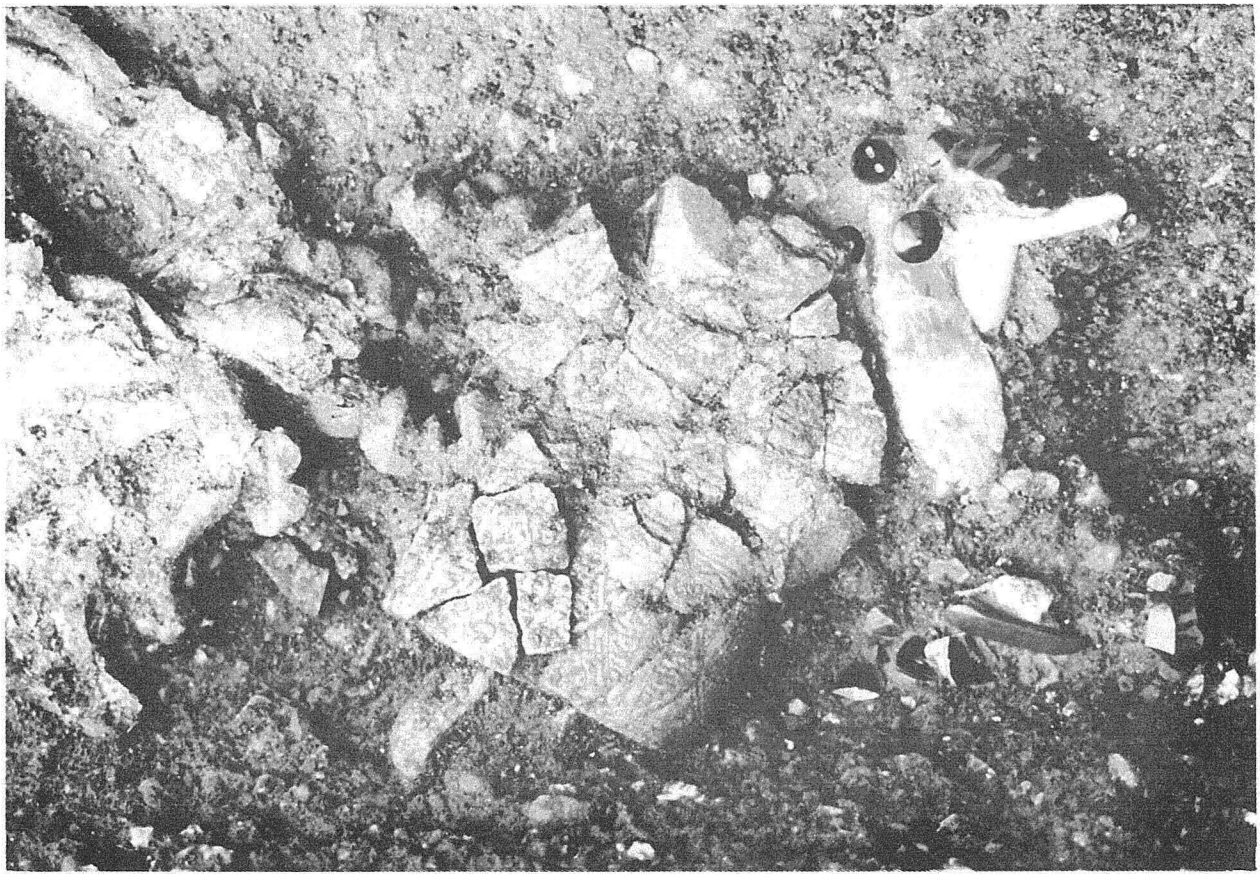

Fig. 4. *Grave goods from Ithlingborough Barrow. Copyright: English Heritage.*

et al. 1984) not only to establish whether typological projectile points were actually used as such, but on the kind of target that might have been involved. For example, are the different types of projectile points designed for use on specific targets? The contention that transverse arrow heads were designed for bringing down birds could be tested by use-wear analyses.

Another example of where use-wear analysis could be applied to a particular tool type is the analysis of microborers from Kumartepe (Calley and Grace 1988). This is an example of where use-wear analysis has been employed to determine the technology of carnelian bead production, which can be compared with the technology employed elsewhere for the same activity (Chevalier et al. 1982).

Use-wear analysis can be used to approach problems of technological association. For example, the use of Levallois technique was once regarded as culturally significant, in that its presence denoted the Levallois Culture. The discovery of Levallois technique in contexts that are different typologically in other ways, and separated both chronologically and geographically, has led to the interpretation that Levallois is a technique rather than a cultural indicator. The use-wear analysis of Levallois flakes might explain this phenomenon if, for example, it was found that Levallois flakes, from whatever context, were always used for similar activities, or for different activities within a particular cultural or chronological context. It has been suggested that the Levallois technique was used in order to produce flakès with long cutting edges with the implication that this was for functional reasons. This could be tested by use-wear analysis. Another aspect of the use-wear analysis of Levallois debitage would be to ascertain whether Levallois points were projectile points or merely pointed Levallois flakes.

As mentioned at the beginning of this paper use-wear analysis should be employed within a general archaeological strategy, not only in terms of attempting to answer specific questions but also incorporating use-wear analysis with other techniques. Use-wear analysis should not be seen as a technique that is intended to supplant existing methods, but to supplement lithic analysis as a whole.

The examination of drill bits from Kumartepe is an example of use-wear analysis being used in conjunction with technological analysis (Calley and Grace 1988). The

technological analysis of the material was carried out independently by Calley but led naturally to the question of how the drill bits were used. The manufacturing techniques used at Kumartepe involved a consistent strategy in order to produce a very specific tool type. The inference that this material represents a manufacturing site, derived from the use-wear analysis because of the advanced drilling techniques, is supported by the whole process of the manufacture of drill bits from raw material selection, through core reduction techniques to the use of an anvil for retouching the tools. The inference is that these technological processes were designed to produce a specific tool for a specific task. The use of a burin-like technique in the core reduction sequence is an example of a specific process used in order to produce the desired blanks, a technnique which is absent, for example, at Larsa in Iraq, which appears to be a small scale operation. The use of mechanical drilling for the production of carnelian beads is also absent at Larsa (Chevalier et al. 1982). Therefore at Kumartepe we have a very consistent manufacturing process of the drill bits and of the beads, almost like a production line for a sophisticated industry, probably intended for the manufacture of export goods.

Other techniques of analysis can be used in conjunction with use-wear analysis. Re-fitting enables a group of tools that were made contemporaneously to form a sample for examination by use-wear analysis. Spatial analysis, again to provide an archaeologically significant sample for the use-wear analyst. It is also important to know the environmental background to the site from which a sample may come. Knowing the environmental resources available, such as the plant materials and potential prey, would help the microwear analyst to eliminate some worked materials.

Referring back to the burial assemblages, the Irthlingborough barrow had over a hundred ox skulls deposited over the burial. This suggested the possibility that the oxen were sacrificed and this might have been of relevance to the function of the daggers. However the subsequent faunal analysis revealed that some of the teeth were missing from the skulls and no cut marks were present, so that the current interpretation is that skulls were collected and deposited on the burial mound rather than recently slaughtered ox heads. Therefore the hypothesis that the daggers may have been sacrificial knives was not supported by the faunal analysis.

These are examples of other techniques that can help the use-wear analyst; the reciprocal is that the results of any use-wear analysis should be integrated with the results from these other techniques in order to interpret a site, or to research a particular problem, in as complete a way as possible. No one technique provides all the answers, but each technique provides clues that help to reconstruct and understand the past. Use-wear analysis is a new and developing technique that can provide unique information about the past, as long as its limitations are appreciated and understood.

Acknowledgements

I would like to thank Jon Humble of English Heritage for his invaluable contribution to the research on the Raunds Area material.

References

Barton, R. and Bergman, C., 1982. Hunters at Hengisbury; some evidence from experimental archaeology. *World Archaeology* 14 (2), pp. 237–48.

Binford, L. R. and Binford, S., 1966. A Preliminary Analysis of Functional Variability in the Mousterian of Levallois facies. *American Anthropologist* v. 68. no. 2, pp. 238–295.

Bordes, F., 1972. *A Tale of Two Caves*. London.

Calley, S. and Grace, R., 1988. Drill bits from Kumartepe, Turkey. In *Industries lithique: Tracéologie et technologie.* B.A.R. International Series 411 (1), pp. 69–82.

Chevalier, J., Inizan, M-L. and Tixier, J., 1982. Une technnique de perforation par percussion de perles en cornalin (Larsa, Iraq). *Paleorient* 8 (2), pp. 55–65.

Fischer, A., Hansen, P. V., and Rasmussen, P., 1984. Macro and micro wear traces on lithic projectile points. *Journal of Danish Archaeology* 3, pp. 19–46.

Grace, R., 1989. *Interpreting the Function of Stone Tools: The quantification and computerisation of microwear analysis.* B.A.R. International Series 474.

Green, H. S., Houlder, C. H. and Keeley, L. H. 1982. A flint Dagger from Ffair Rhos, Ceredigion, Duyfed, Wales. In Proceedings of the Prehistoric Society 1982; pp. 492–501.

Halpin, C., 1986. Irthlingborough Bronze Age Barrow Excavation. From Raunds Area Project: second interim. Northants Archaeological Journal v. 21.

Knutsson, K., 1988. *Patterns of Tool Use: Scanning electron microscopy of experimental quartz tools.* Societas Archaelogica Upsaliensis (AUN) v. 10.

Moss, E., and Newcomer, M. H., 1982. Reconstruction of tool use at Pincevent: Microwear and experiments. Tailler! pour quoi faire: Préhistoire et technologie lithique 2. Recent progress in Microwear studies. Studia Prehistorica Belgica 2 D. Cahen ed. Terveuren: Musee royale de L'-Afrique central 289-312.

Panagopoulou, H., 1985. *Form versus Function: lithic use-wear analysis and its application to a class of Levantine Mousterian tools.* Ph. D. Thesis. Colombia University.