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Experimentation in the formation and variability of lithic use-wear traces on obsidian and chert implements

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RÉSUMÉ

Nous avons entrepris au Mexique une série d'expériences d'usure en utilisant des éclats de silex noir bélizéen et des segments de lames prismatiques en obsidienne pour amenuiser des bois conditionnés de duretés différentes, et en enregistrant l'évolution des traces d'usage après des laps de temps de 5, 10, 30, 45 et 60 minutes. Ensuite, l'analyse tracéologique a indiqué que pour un usage inférieur à 10 minutes il était impossible de détecter des traces fiables de travail du bois. Après 30 minutes d'utilisation, on a observé un schéma diagnostique. Les essais visant à distinguer les traces dues à du bois dur ou tendre n'ont réussi que dans le sens général où le bois dur a provoqué moins de poli abrasif, mais plus de dommages aux bords. La signification de l'usure lithique fait l'objet de discussions au sein du projet de recherche sur un site maya ancien de Belize.

ABSTRACT

A series of use-wear experiments was undertaken in Mexico, using Belizean chert flakes and prismatic obsidian blade segments to whittle seasoned woods of different hardnesses, and recording the development of use traces after intervals of 5, 10, 30, 45 and 60 minutes of use. Subsequent microwear analysis indicates that with less than 10 minutes' use it is not possible to reliably detect woodworking traces. After 30 minutes' utilization, a diagnostic pattern was observed. Attempts to distinguish traces provoked by hard and soft wood were successful only in a general sense, in that the hardwood provoked less abrasive polish but more edge damage. The significance of lithic use wear is discussed, within the research design for investigating an early Mayan site in Belize.

Introduction

This paper deals with the design and realization of a lithic use-wear experiment which was prompted by questions that arose some years ago during a previous lithic analysis. Extensive archaeological investigations during the 1970s and early 1980s at the Late Preclassic Mayan site of Cerros, on the

Caribbean coast of northern Belize, Central America, posed a number of interesting research questions, some of which I attempted to investigate by way of lithic experimentation and analysis of the chipped stone artifacts recovered at the site (Lewenstein, 1987).

Cerros is an important site for Mayan archaeologists because it yielded evidence of the rapid transformation of a small fishing and farming village to the hierarchical society of the Maya Classic period. We were able to recover these data because the Late Preclassic community at Cerros was never buried by subsequent building episodes, as was generally the case in the Maya area. On the basis of its geographic setting on the coast and near the mouth of a major river leading into the interior of the Peten region, and due to the quantity and variety of imported materials recovered during excavation, it was hypothesized that Cerros was an important trading center (Freidel, 1979). However, it was unclear what goods the site contributed to the regional exchange system in return for its imported stone, shell, ceramics and luxury items. The environmental setting of Cerros posed an interpretive challenge as well. Today this low-lying, seasonally inundated, area of coastal Belize is largely uninhabited, and is considered unhealthy and poorly suited for agriculture. Yet some 2 000 years ago the area supported a thriving populace during several centuries. Evidence for a successful environmental adaptation includes the construction and maintenance of an extensive drainage canal which encircles the site, and the investment in raised agricultural fields (Scarborough, 1983).

Extensive survey and excavations at Cerros, in both ceremonial and residential zones, yielded a vast amount of archaeological materials, including chipped stone tools and debitage of chert and obsidian. Interestingly, there is very little evidence of lithic manufacture at the site. The formal chert tool implements were apparently imported from the specialized workshops at Colha, some thirty kilometers to the south (Shafer and Hester, 1983), and obsidian was imported in the form of prismatic pressure blades, from two sources in the southern Guatemalan highlands. The debitage recovered represents tool maintenance activities and the production of casual tools made from low quality local chalcedonies.

Subsequent to completing fieldwork in Belize, I analyzed the chipped stone materials from a functional perspective, not just to determine how particular pieces had been used, but also to address the major research questions identified at Cerros. For example, How was the society organized in terms of subsistence activities ? What non-subsistence items were being produced for trade ? And, is there any evidence for specialization in production, one of the diagnostics of a hierarchically-organized society ?

The functional analysis consisted of the microscopic inspection of tool and debitage edges, at 100 and 200x, and the comparison of observed use traces with published use-wear studies (Keeley, 1980), but also with experimentally-induced wear traces on more than 100 tool replicas used at Cerros to perform a wide range of subsistence and artesanal tasks (Lewenstein, 1987). The experimental tool use in the field provided useful information on tool use-life, frequency of resharpening and breakage, suitability of specific forms for various tasks, but mainly served as a basis of comparison for the determination of the functions on the archaeological tools.

The functional and contextual analysis of the lithic materials resulted in the identification and spatial distribution of subsistence-related tools, including agriculturally related implements such as axes and hoes, as well as knives used for butchering fish and terrestrial animals. I did not detect any concentrations of functionally related tools or other materials that would imply artesanal or other manufacture of trade goods. The types of lithic use-traces and their relative frequencies among all of the different residential loci at Cerros suggest that each household engaged in its own subsistence, maintenance, and limited scale production activities, to supply its own needs. There was no apparent concentration of tools or use-wear associated with any one residence or area of the site, that is, no evidence of specialized production, either for local consumption or for export. Apparently the occupational specialization that is obvious in the monumental architecture and the public art had not extended to include other productive activities, at least not any that involved the use of stone tools.

The research problem

Not surprisingly in this semitropical forest setting, almost half of the utilized lithic tools indicate woodworking traces, used for chopping, sawing, scraping, whittling, and perforating (Lewenstein, 1987). What does such a high proportion of wood traces mean ? It does not necessarily imply woodworking as a specialization, given :

– that woodworking traces are perhaps the easiest to identify during lithic analysis, a factor which may bias our sample in favor of woodworking functions ;

– that woodworking use-wear is easy to provoke on lithic tools, especially with use on soft woods ;

– the abundance of common uses for wood, for construction, fences, maintenance, storage, furniture, implements and tool handles, all in common use and many in need of frequent replacement.

The ubiquity of woodworking use-wear on the Cerros lithic implements, the variety of tool forms on which it is observed, and its spatial distribution across the site suggest that woodworking was a common everyday activity at Cerros, and not orientated toward a specialized production of wooden objects. However, the variability in woodworking use-trace intensity and development, as seen on both the experimental and archaeological tools, gave rise to a number of questions and doubts concerning the development and variability of woodworking use-traces :

1. How long does a tool have to be used for a woodworking task before it manifests diagnostic wear ? Is it possible that in the early stages of development woodworking wear is easily confused with use-damage from other contact substances ?

2. Do different types of wood, for example hard and soft woods, leave distinct use-traces, which the analyst might potentially detect ? This is of potential interest, given that both archaeologically and ethnographically the tropical hardwoods, such as cedar, mahogany, zapote, and siricote, are highly prized. They are seasoned as long as 1 year or more, and then reserved almost exclusively for the elaboration of long-lasting items that require skilled workmanship, such as carved lintels on monuments (Coe, Shook, Satterthwaite, 1961), canoes (Tozzer, 1907), sculpture (Coe, 1987), bows (Nations, 1989). Pine and other softwoods are generally used soon after cutting, and for less demanding, non-artesanal tasks, such as house construction and as casual implements useful in a host of daily activities (Barba, Manzanilla, 1987 ; Hayden, 1979 ; Moya Rubio, 1984 ; Villa Rojas, 1985). Thus, the possibility of distinguishing between hard and soft woodworking traces on lithic implements has implications for the detection of artesanal activities.

The 1990 experiments

In an attempt to address these issues, a second stage of lithic experimentation was undertaken during 1990, with the collaboration of anthropology students at the Universidad De Las Americas, in Cholula, Puebla. In a series of experiments we studied the formation of woodworking use-traces provoked by whittling for periods of 5, 10, 30, 45, and 60 minutes. A total of 80 stone tools employed, 40 to whittle seasoned hardwood (cedar), and 40 to whittle seasoned pine. Both cedar and pine are common throughout the lowland Maya area, including northern Belize. To make the experimental whittling knives we used flakes of Colha chert and fragments of prismatic blades of obsidian from El Chayal, Guatemala, that is, the same type of material recovered archaeologically at Cerros and the same raw materials used in my previous tool-using experiments in Belize. The working edge angles of the tools vary between 20 and 47 degrees (mean = 28, s. = 14) for the obsidian blade tools, and between 20 and 75 degrees (mean = 29, s. = 14) for the chert flakes.

Each tool was cleaned and examined microscopically before and after use. Use-traces were observed initially with a low power binocular microscope in order to record microflake scars and edge abrasion, and subsequently with a Nikon Optiphot (metallurgical) microscope, at 100 and 200x, to record the presence and distribution of linear features and abrasive polish along the dorsal and ventral surfaces (Keeley 1980 ; Newcomer, Grace, Unger-Hamilton, 1988).

Results

Question 1 : The rate of formation and development of woodworking use-traces

Five minutes' use for whittling wood provoked very few microflake scars on either the chert or the obsidian tools, especially on those specimens with the steeper edge angles. Nor did any linear features appear along the utilized margins. Further, it appears that this brief period of use is insufficient to provoke surface abrasion or polish on these materials. Abrasive polish is present on only one of the 16 specimens in the group, an unusually fine-grained Colha chert (fig. 1). It is unlikely that archeological tools of obsidian or of Colha chert would be identifiable as such if they were used as whittling knives for such a short time.

The experimental tool sample used for *ten minutes* showed somewhat more use damage. Isolated microflake scars can be identified on the chert flakes, more on the ventral than on the dorsal surface, but no linear features or striations are present. On the obsidian blades there is little trace of utilization dorsally, but small groupings of scalar microflake scars appear along the ventral edge (fig. 2). It is the basic asymmetrical whittling wear pattern in its incipient form (Lewenstein, 1981). Some of the utilized obsidian edges have lost their sharpness, and some margins look irregular. No other trace is evident on the obsidian sample of 8. On the chert specimens, however, small polished areas can be detected microscopically. In one case, an area of abrasive polish is highly developed, this on a flake of very finely grained chert (fig. 3). On the basis of this small sample of 16 tools, I infer that the identification of woodworking traces on chert tools is unlikely after only 10 minutes' use, unless the lithic raw material is very fine-grained. On obsidian blade tools, I believe that it is possible to tentatively identify the whittling activity after as little as 10 minutes. The establishment of wood, rather than bone or some other substance, as contact material is another matter, although it should be possible to judge the relative hardness of the substance worked.

A sample of 8 obsidian blade tools and 8 chert flakes was used for whittling during a *30 minute* period. The resultant damage on the chert implements was an intensification of the asymmetrical microflake pattern noted above, that is, an almost continuous row of shallow scalar scars on the ventral surface, with a few isolated, and sometimes quite large, flake scars on the tool's opposite or dorsal face. The pattern is similar on the obsidian blades, except that their dorsal margins have become more irregular than observed after 10 minutes' whittling use. An occasional striation, or linear feature, was noted on chert tools, often within an area of abrasive polish. Such polish is observable on the chert pieces in varying degrees. In some cases it occurs on crests or protuberances back from the margin (fig. 4), but it is mainly present in patches or as a band along a utilized chert margin, or alongside a microflake scar.

The sample used to whittle for *45 minutes* shows a more highly developed use-wear pattern. On the chert tools it consists of more microflake scars, mainly along the ventral margin, and more extensive areas of abrasive polish, some of which bear linear features within the polish, oriented perpendicularly to the working edge. The polish is more prominent dorsally, opposite the microflaked ventral margin. On the obsidian sample the whittling traces also appear more prominently. Many of these knives have irregular and dulled margins, and their ventral faces show a continuous line of overlapping scalar scars, generally present in more than one superimposed row.

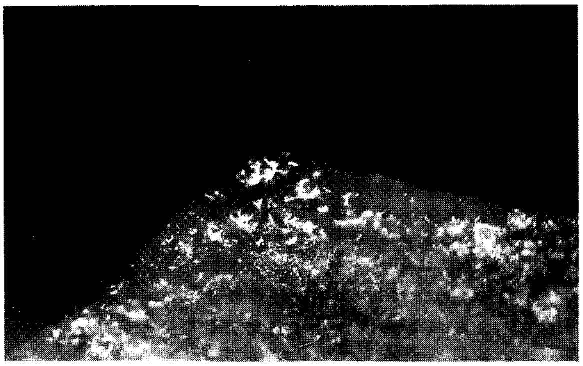

Fig. 1.– Abrasive polish on a fine-textured chert flake used to whittle pine for five minutes. 200x.

Fig. 2.– Isolated microflake scars on ventral surface of obsidian blade used for ten minutes to whittle cedar. 200x.

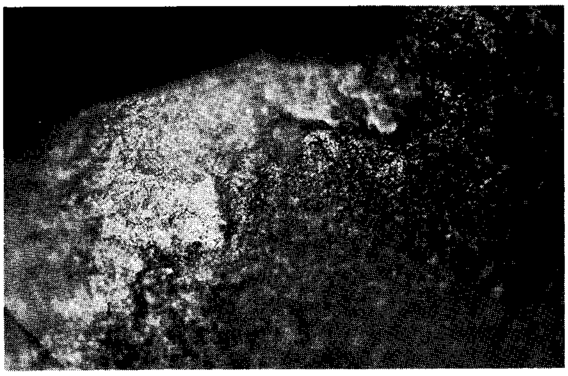

Fig. 3.– Abrasive polish at 200x on a fine textured chert flake used for 10 minutes to whittle cedar. 200 x.

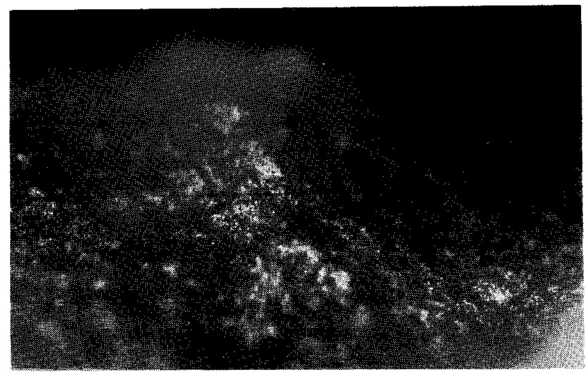

Fig. 4.– Spots of abrasive polish on protuberance of chert tool used for whittling cedar for thirty minutes. 200x.

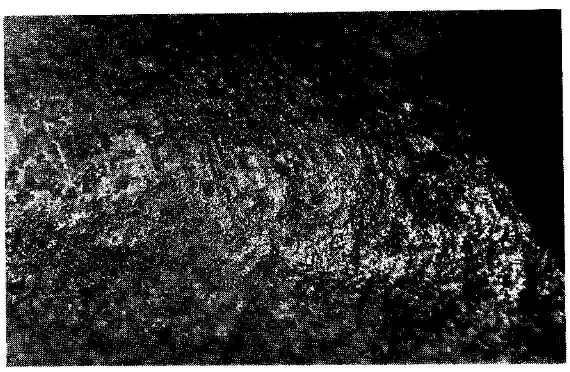

Fig. 5.– Surface abrasion on chert flake used to whittle pine for sixty minutes. 400x.

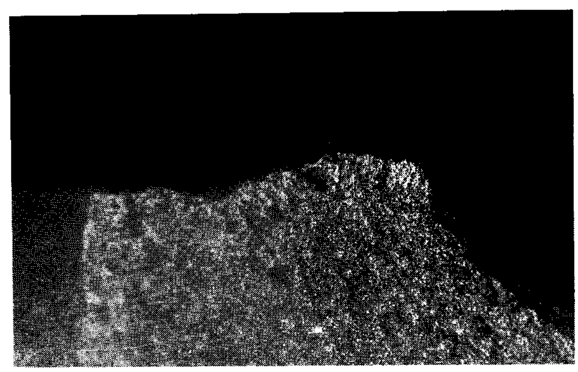

Fig. 6.– Band of abrasive polish on chert flake used for whittling pine for sixty minutes. 200x.

Fig. 7.– Continuous band of scalar microflake scars, ventral surface of obsidian blade used for sixty minutes to whittle cedar. 200x.

Sixty minutes' whittling damage provoked the most extensive patches of surface abrasion observed during this experimentation, in particular on the chert flakes used to whittle pine (fig. 5 and 6). Some increase in the frequency of flake scars and linear features was also noted. In the case of the obsidian tools, the basic asymmetrical whittling pattern has stabilized, that is, the tools present irregular margins, dulled or abraded edges, isolated dorsal flake scars of various sizes, and a multitiered row of continuous shallow scars ventrally (fig. 7). The pattern is an intensified version of the traces described above, after 45 minutes' use.

Evaluation of question 1. On the basis of observations on how experimentallly induced woodworking traces develop over time on the medium-grained Colha cherts, I suggest that, using a variety of functional attributes, the use-wear analyst will be able to identify woodworking knives that have been used for half an hour or more. The distribution of abrasive polish may be more important for identifying chert specimens, but microflake scar morphology and general edge condition will be more useful for distinguishing wood traces on obsidian woodworking implements. I suggest that, for analyzing Belizean cherts for tool function, raw material texture is an important variable to consider, since the very fine-grained materials develop abrasive polish after a few minutes' use, while the less fine textures abrade only after a considerable period of use. Figures 8 and 9 illustrate the intensification of wood whittling edge damage on obsidian blades that occurs between 10 and 60 minutes of utilization.

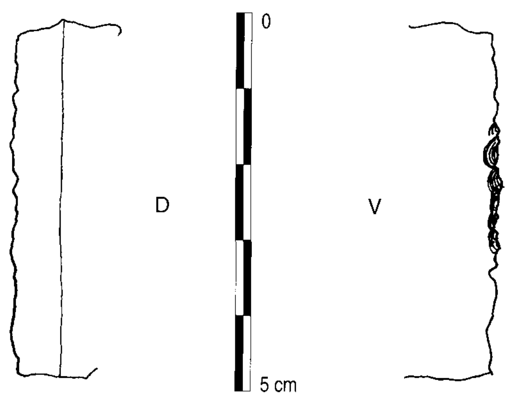

Fig. 8.– Edge damage (dorsal and ventral) on obsidian blade used for ten minutes to whittle cedar.

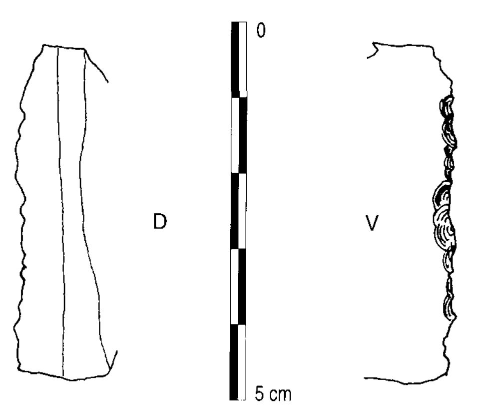

Fig. 9.– Edge damage (dorsal and ventral) on obsidian blade used to whittle pine for sixty minutes.

Question 2. Can one distinguish between use-wear provoked by hard and soft woods ?

Some years ago Hayden and Kamminga (1973) demonstrated experimentally and by ethnographic observation that the development of abrasive polish on chert woodworking tools decreases with wood hardness. This phenomenon can be attributed to the higher density of the hardwoods, which is further intensified when the wood is seasoned. Since a stone tool does not penetrate a hard contact surface to the same extent as a less resistent material, less of the tool margin will suffer surface abrasion from contact with the wood.

Regarding the chert tools in this experiment, I observed a moderate difference in the rate of polish development and intensity between those used on pine and cedar. For a given period of use the chert flakes used on pine show more extensive polish, sometimes forming an abraded band along the margin. The specimens used on cedar may also present abrasive polish, but typically this is restricted to the tool crests or protruding irregularities close to the working edge. This difference is not marked, however, and not as obvious as the differential polish intensity due to variability in lithic raw material texture (compare fig. 6 with fig. 4).

The use-wear provoked on the obsidian blades after working pine and cedar is similar. The principal difference is the rate of destruction of the working edge, which becomes more quickly deformed and dull when used to whittle the harder substance, cedar.

Evaluation of question 2. Overall, these experiments suggest that it would be difficult to distinguish correctly between lithic implements used to work hard versus soft wood. Some differences can be documented, but they are less pronounced than the variability due to other factors, such as raw material texture, or to length of tool use.

Final Comments

The 1991 use-wear experiments indicate that the chert and obsidian artifacts that are identifiable as woodworking tools have been used for a considerable time, at least 10 minutes for obsidian, and perhaps more for chert. This suggests that the many flakes and prismatic blades that I classified as unutilized for lack of sufficient use-trace evidence (76 % of the chert and 31 % of the obsidian artifacts) may in fact have been utilized casually, that is for a few minutes, to shape a wooden implement or to smooth a tool handle. That probability is intuitively satisfying, given that both the chert and obsidian at Cerros represent imported rather than locally available articles.

The possibility of determining the length of woodworking tool use based on the intensity of use-wear allows the analyst to compare the intensity of utilization of imported and local lithic raw materials. This is of potential use for inferring the accessibility of imported materials in the archaeological record, and for understanding strategies for recycling and otherwise conserving a scarce substance.

Although this series of experiments did not detect reliable diagnostics for distinguishing hard and softwood use-damage, this is a topic of interest to archaeologists analyzing and interpreting the function of stone tools in complex societies. The spatial distribution and concentrations of hard and soft woodworking implements can assist in the detection of areas of casual wood working and also artesanal manufacture of hardwood objects.

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