**ARCHAEOLOGY IN NEW ZEALAND**

# NOTES ON THE ANALYSIS OF USE-WEAR IN FLAKE ASSEMBLAGES

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## Introduction

Presented below are a number of observations I have made from the analysis of some twelve assemblages from various regions and sites in New Zealand. Most of this analysis has ended up or will end up in the 'grey literature' (Turner 1997; Clough and Turner 1998a, 1998b; Campbell 2005; Phillips 2005). In response to the growing concern within New Zealand archaeology that much of this literature is inaccessible, I present this informal paper. I also hope to draw attention to some of the problems I have encountered during my analysis of flake assemblages, and to invite comparison with assemblages analysed by others. Ultimately, consistency in analytical methods would enable comparison between assemblages analysed by different scholars.

The flake assemblages under discussion here include flakes of various materials including obsidian, chert, silcrete and adze flakes. A major and important characteristic of these collections is use-wear, and it is the one that is most problematic in terms of diagnostic approaches. In terms of information, however, it has major potential. Stone tools were probably involved in almost every activity undertaken by pre-European Maori, but many of these activities left no durable evidence in the ground except for the tools themselves. From what I can observe in the literature, and from my own experience, we are still far from being able to relate specific stone tool types to specific activities, particularly for the amorphous informal flake tools that often dominate artefact assemblages.

A major part of the methodology I employ to understand use-wear is replication experimentation. This has proven a very effective and direct method of observing cause and effect, for example, creating flakes and then using them on a variety of materials (wood, bone, stone, fibre) for varying periods (usually until the flake is no longer effective) in various ways (cutting, sawing, scraping, pecking) to observe the nature of the damage that appears (or does not appear) on the flake edge. Replication experimentation is also useful for understanding the various qualities of the raw materials and what they are optimally suited for. For example, obsidian is very sharp and hard, but brittle; it is weak and can break easily. As such, it is best suited to cutting, particularly soft materials like flesh and fibre.

There are some limitations with the replication experimentation method. One is that results are difficult to quantify. It is not possible to replicate flakes to precise standardised sizes and edge angles in order to accurately account for all the variables that may be involved. Also during replication experimentation, differences in material quality (toughness, hardness, flakeability) between rocks of similar types can be apparent. But these differences have proved difficult to quantify by independent mechanical engineering tests, primarily because these are not yet fine-grained enough to be useful (Turner in press). The methodology is also constrained by an archaeologically perceived range of uses, and experiments are not task-driven as would have been the case with activities in the past.

Comparison between data sets has not yet been attempted, so that what is presented below is more a set of observations and impressions that have yet to be tested and quantified.

## The influence of available raw materials

A major observation I have made is that the range of tool types observed in any particular stone often reflects the range of raw materials available for any particular task. Generally, certain materials are preferred for certain tasks, and this is a reflection of their basic physical properties, e.g., obsidian for cutting and stronger materials like chert for drill points. In a number of studies I have undertaken of stone tool assemblages, including those from Motutapu Island, Gisborne, Coromandel and Waitaki River Mouth (Turner 2000; Phillips 2005;Turner and Bonica 1994; Turner 1997), a pattern has emerged where locally available and plentiful materials appear to be used for a much wider range of uses than a material that has had to be imported, and these flakes also often dominate numerically. For example, in the Willets Collection from Waitaki River Mouth, obsidian was found in small size and quantity with a narrow range of tool types (as exhibited mainly by the variability, or lack of, in the types of edge damage). These were mainly cutting tools, probably reflecting the distance from the source, and thus the need to conserve the stone for what it was best suited to. In contrast, tools made of the (relatively) local material silcrete exhibited a wide range of types, which appeared to extend beyond moa butchery tools to include scraping, sawing, cutting and incising tools as well as points of all types and sizes, in huge quantities and with a wide size range, with some blades reaching 250 mm in length (Turner 1997). Similarly, at the settlement site R10/497 on Motutapu island (Irwin et al. 1996) there was a wide range of tools made from the local fine-grained greywacke, a range that extended well beyond adzes to include pounding, scrapping, pecking and chopping tools as well as hammerstones, anvils and points. Opportunistic behaviours and employment of the least effort principle can be seen in East Coast Coromandel sites with the use of Tahanga basalt flakes that were produced during the late flaking stages of adze manufacture and reworking. These flakes and reject or broken preform pieces provided ready made tools and blanks for a variety of other tools including the types mentioned above (Turner and Bonica 1994). This was also the situation with the silcrete blades at Waitaki River Mouth; large blades were initially made, and probably used as moa butchery tools, followed by a complex sequence of re-use (Turner 1997). In contrast to the obsidian flakes found at Waitaki, obsidian flakes commonly sourced to Mayor Island show a wide range of sizes and use-wear/modification patterns in local sites in the Bay of Plenty, Great Barrier Island and the Coromandel Peninsula. A conclusion to be drawn from these findings is that local and readily available materials were often put to a greater range of uses, including uses they were not optimally suited to. This is important to keep in mind when making inferences on use and, based on this, inferences on site function. It is important to identify the source of materials evident in a site as this may have a significant influence on how they were used and the state they were in when they were discarded.

Another implication of material availability is the possibility that local materials may be discarded more readily than flakes of less available, and hence more valuable, materials. This may have an influence on use-wear and modification patterns (see below). When a material is rare and valuable the edge might be retouched once it became blunt but with readily available materials the blunt flake may be discarded and another selected.

Raw material quality is another important factor. For example, as tested in experiments, Coromandel and other local obsidian sources (Great Barrier, Bay of Plenty, Northland) are generally inferior in terms of purity, size and possibly availability and abundance compared to Mayor Island obsidian. Today Mayor Island has readily available large masses from which large chunks of pure material can be easily extracted close to the beach (personal observation, Sheppard 2004). The same can generally not be said for the other sources (Moore 1988). At least some of the sources of Mayor Island are surprisingly strong, though the size of the flake and the edge angle are influential.

## Obsidian: some experimental observations

### *Manufacture*

The flaking of obsidian is relatively straightforward and the technology is one often referred to as 'opportunistic' or 'expedient' (Nelson 1991). That is, flakes were struck when they were needed, as flakes were sharpest when fresh. Occasionally they were retouched and modified to improve/rejuvenate the working edge and/or hand holding, used, and then usually discarded. No formal obsidian tool types have been recognised in New Zealand.

In my analysis, I have identified *cores* as pieces taken from the parent block from which *flakes* have been struck. In pre-European Maori society it is likely that everyone of age had a core of obsidian or other high quality local stone always at hand as flakes were probably needed for a range of day-to-day and on-going tasks. Partly due to the mechanics of flaking and to the brittle nature of obsidian, tiny flakes (often broken) and slivers are produced as a by-product of flake strike, referred here as *shatter* (see also Holdaway 2004). Shatter is also produced by edge retouching and striking platform preparation, as shown by experimental results. *Chunks* are amorphous thick pieces which may derive from broken flakes or pieces of cores, but they lack diagnostic features to classify them further. Sometimes flaws can cause breakages that result in these pieces.

### *Flax working*

Flax fibre manufacture, particularly the production of the silken fibre known as 'muka', would have been a major use of small obsidian flakes. For most people, both men and women, the need for muka was probably constant and its production was a time consuming task. For example, men would need to frequently make new fishing lines because salt water caused a high attrition rate. Another requirement would be lashings for canoes, and items like adzes that needed hafting attachment, again requiring lots of prepared fibre. Other items like nets and traps, made from the raw leaf, would also require obsidian cutting tools or 'knives'. For women, the making and repairing of clothing like cloaks (even of the most basic kind) would necessitate an ongoing supply of muka.

Fibre preparation involves making a precise cut across the leaf to expose the silky fibre within. Very small flakes (less than 5 gm, and less than 20 mm maximum dimension) can be used for this as long as they have a sharp, low-angled edge and can be held comfortably between thumb and forefinger. The ideal is a projecting corner or point, often formed naturally on flakes. This activity does not generally leave any damage or use wear except possibly if used against a hard surface like an anvil. The next procedure, stripping or scraping the fibre from the outer leaf, is best done with a shell; the sharp edges of obsidian are more likely to cut and tear the fibre.

Removing the flax leaves from the plant, cutting strips and cutting off ends might require larger, more robust cutting tools, and, again, no visible damage may result from their use. Large flakes some 50–100 gm in weight and 100 mm long or wide, such as those found at Kohika (Holdaway 2004, personal observation), would have been ideal for this purpose; many of these had no visible use damage.

The cutting of other soft materials like flesh (food preparation, ritual scarification) would require similar flakes, but generally larger than the very small ones able to used in preparing muka.

### *Wood working*

The above uses do not explain obsidian tools with obvious use wear and edge damage. From experimentation with Dante Bonica it was found that the use of obsidian for scraping smooth round shafts, like those found on spears, adzes, paddles, beaters and digging tools, was very effective, more so than using sand stone files, as obsidian produces a more even finish. It was also effective in removing bark. The sharp projecting edges of obsidian flakes were probably also good for cleaning out the corners and narrow deep grooves in fine carving. The wooden artefacts recovered from the site of Kohika illustrate the range of wooden items that could have employed an obsidian tool during some stage of the finishing process, for example, carvings, the insides of bowls, paddles, ko, spears, digging sticks and beater shafts (Wallace and Irwin 2004). But Wallace's experiment using obsidian flakes to make the teeth on combs (Wallace and Irwin 2004:108) found obsidian too brittle for this particular process, although Bonica's experiments suggest that obsidian can be used to cut thin sheets of softer types of wood, (Dante Bonica pers. comm.). Again, the effectiveness of an obsidian flake in any given task may reflect the quality of the particular obsidian source as well as the size of the flake and its edge qualities.

Figure 1 shows the results of a wood scraping experiment using a small thin flake weighing 5 gm. Use against a hard surface resulted in visible edge damage occurring quite rapidly. This type of damage results in a serrated edge. Once this serration occurred the flake became blunt and less effective. This practice could, therefore, use up quite a large number of flakes. If obsidian was in scarce supply, however, an alternative would be to rejuvenate the edges by retouching them or use a more common local material if available; chert, silcrete and adze flakes are equally effective for this task. Another finding was that all manner of edges could be used for this purpose. The experimental flake had some blunt broken edges not ideal for cutting yet they proved quite adequate for scraping. Size is also not a constraint as long as the flake is large enough to grip comfortably. The edges of small flakes, however, are more difficult, if not impossible, to rejuvenate.

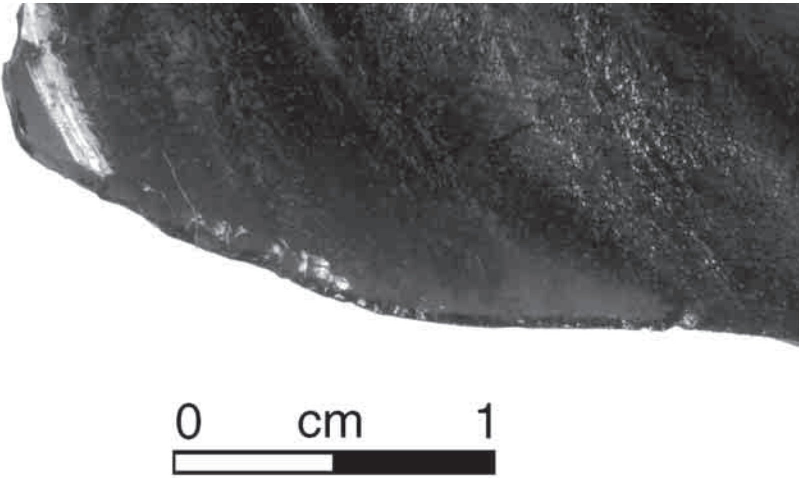


*Figure 1. Wood scraping edge damage on obsidian flake*

While not common, a few assemblages have what could possibly be 'eyes' for carvings. These are small 'discs' where all edges have been chipped and blunted steeply to form a rounded sphere of ideally even proportions. Those observed are generally between 10–20 mm across and around 10 mm thick. While speculative, the use of obsidian for eyes has been documented for the statues in Easter Island (Flenley and Bahn 2003).

### *Bone working and other possible uses*

From experimental results, very small flakes and those of obsidian other than Mayor Island proved unsuitable for sawing bone (note however, that experiments have been limited to samples of each source and have not accounted for the possible variability in quality within these sources, and, due to the small size of the cores, only small flakes could be produced). Generally these flakes were too brittle, and chipped and blunted almost immediately. Yet damage on some larger flakes in archaeological collections suggested use on very hard materials like stone or bone, and prompted further experiments with similar sized flakes and flakes from the same source; Mayor Island. The flake in Figure 2 (55 gm and 75 mm long) was used to saw scarf-lines on a modern animal jawbone (Figure 3). It proved surprisingly effective and the damage, while visible, is relatively minor 'serration'. Edge A and Edge B were both used: Edge A (Figure 4) was retouched after 10 minutes and re-used, and the retouching immediately rendered it effective again in this task; Edge B (Figure 5) was not retouched in order to illustrate the nature of the damage. This experiment was specifically undertaken in response to observations of damage on similar sized Mayor Island obsidian flakes in an assemblage from Tryphena on Great Barrier Island (Turner and Prince n.d). Again, this may be an outcome of using a readily available material for a wider range of uses even though stronger materials like basalt and chert were also locally available, as was a local source of obsidian. Factors such as the size, flakability and purity of these raw materials may have been influential here. A smaller 6 gm flake of Mayor Island obsidian with finer edges was used to saw a scarf in the same jawbone for 10 minutes. Again it did this with surprising efficiency. When used in a manner that applies direct pressure rather than impact, the sharpness of obsidian should not be under-estimated. It may have been particularly useful in intricate delicate tasks like the incising and notching often seen on archaeological bone ornaments and fishhooks.

Notching is a quite common type of damage on obsidian flakes and often takes the form of small 'nicks' with the edge crushed and chipped. One experiment that produced similar damage on a flake was the sawing of a tooth, in this case the tooth still in the jaw shown in Figure 3. While a slower procedure than sawing bone, within a minute or two a fine groove began forming. Flakes of materials like chert and fine-grained adze materials like Tahanga basalt and Nelson-Marlborough argillite proved more effective in this task but in the absence of sizable flakes of these materials obsidian may have been used. One possibly significant advantage obsidian has over other materials is that retouching an edge to restore sharpness is very easy and quickly achieved.

The Tryphena collection also has local Great Barrier Island obsidian cobbles being used as pecking tools, as evidenced by the bruising and crushing wear. This type of damage is also sometimes seen on the edges opposite the working edge. In this case, edges are crushed to assist handling, that is, to avoid cutting the palm. Such evidence is useful as an aid in understanding how the tool was used (this was done to the experimental flake in Figure 2 at the striking platform).

Pointed tools, either utilizing a natural projection or retouching to shape, are often common in collections.

## Use-wear: some classification problems and solutions

With obsidian in particular, but also relevant to other materials like chert, the above results suggest that classifying a flake as used or not used on the basis of visible damage is likely to result in a bias in the data, and from this unreliable


*Figure 2. Flake used in bone sawing.*

*Figure 3. Jawbone showing sawn scarf-lines cut by the flake in Figure 2.*

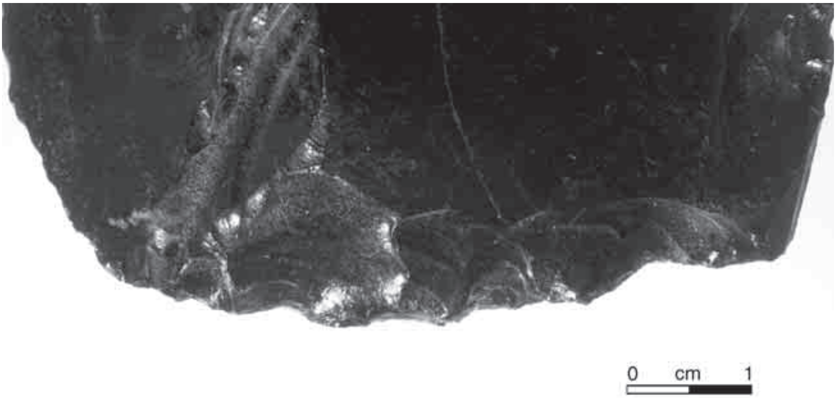


*Figure 4. Edge of flake in Figure 2 (right) retouched after bone sawing then re-used.*

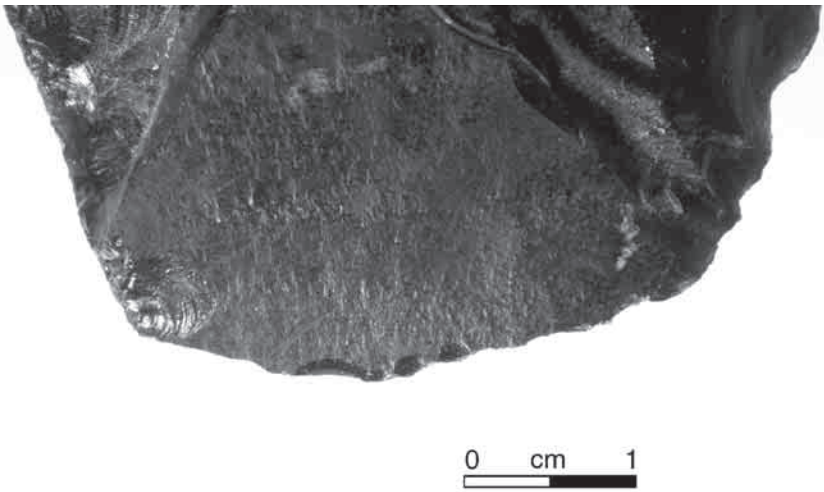


*Figure 5. Edge of flake in Figure 2 (lower), showing bone sawing damage on unretouched edge.*

interpretations. Flakes commonly provide suitable edges and sharp projections without necessitating any modification.

My solution in this case, is to create a category that evaluates the suitability of a flake for use, a 'probability of use' rating. For example, low-angled, sharp edges on flakes of obsidian, and sharp corners, have a high probability of being used providing they are large enough to enable efficient handling. It also, therefore, becomes necessary to qualify why a piece is not likely to have been used, e.g., because it was too small or too flawed.

Other categories are required to define the nature of, and presence or absence of, visible use damage. Because of our limitations in knowing precisely what flakes were used for it is better to define the nature of the damage rather than to simply assign a functional label such as 'scraper' or 'knife.' Also, from my observation of obsidian tools and of flake tools made in other stone materials in other assemblages, multi-purpose tools are not uncommon. An example of this is on flakes where projecting points and straight or curved edges are used. Especially with broken tools it can be difficult to identify the retouch associated with edge rejuvenation or shaping from retouch that enhances hand holding. Tool classifications such as 'scraper' or 'knife', without any further classification of what qualifies the flake for this term, suggests a specific function (and furthermore, from a possibly Eurocentric perspective), so I tend not to use such terms unless the intended use is quite obvious, and a singular rather than multi-purpose use is indicated. Otherwise the preference is to have one category to describe the nature of the damage, for example "high angled bifacial serration" and another to assign possible uses, for example "bone/wood scraping", based on experimental results.

With brittle materials, in particular obsidian, the possibility of post-depositional damage may account for some of the damage seen on artefacts, particularly random chipping to the edge.

## Summary

- Flakes could be used without any visible damage occurring, especially when used on soft materials.
- The range of raw materials available may influence how flakes of different materials were used.
- Local materials were likely to be used for a wider range of uses, including those they may not have been optimally suited for.
- Flakes provided suitable edges for cutting, sawing and scraping without necessitating any retouch or modification.
- The decision to rejuvenate/retouch edges may have been influenced by

the rarity of the raw material.

- The range of activities reflected by flake assemblages may be gauged by the variation in use-wear patterns and variation in other attributes, like size.
- Degree of use could produce different edge wear patterns.
- Edge damage from use can be difficult to identify from post-depositional damage and modification to enable ease of handling.
- Attributes such as the size of the flake and the nature of its edges could make a difference in terms of effectiveness in use in any given task.


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