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Front cover:

Particpants at the zoom webinar panel discussion by Traditional Owners at the 2021 Colloquium. Top row: Darren Griffin, Liz Foley, Dave Wandin—Wurundjeri Woiwurrung; bottom row: Racquel Kerr—Dja Dja Wurrung, Tammy Gilson—Wadawurrung, Ben Muir— Wotjobaluk and Jardwadjali. (Screenshot by Caroline Spry)e

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Contents

Editorial note

The papers included in this 10th issue of *Excavations, Surveys and Heritage Management in Victoria* were presented at the annual Victorian Archaeology Colloquium held on-line via zoom webinar between 1 and 4 February 2021. This allowed even more than our usual number of people to register as participants, including some from interstate and overseas: their commitment and involvement testifies to the importance of this fixture within the local archaeological calendar. Many were fortunate to be able to meet in person, under appropriate protocols, for an outdoor boxed lunch at La Trobe University on 5 February.

We have taken the opportunity of celebrating our 10th anniversay by looking back over the last decade, both through a more formal analysis and through a less formal panel discussion of the history of the Colloquium and this publication. Another panel discussion transcript allows space for some Traditional Owners to reflect on particular examples that they feel have been of value in the complex process of cultural revival through a form of experimental (perhaps better experiential) archaeology.

The other papers published here deal with a variety of topics and approaches that span Victoria's Aboriginal and European past. While some papers report on the results of specific research projects others focus on aspects of method, approach, education and the social context of our work and approach. These call demonstrate how our Colloquium continues to be an important opportunity for consultants, academics, managers and Aboriginal community groups to share their common interests in the archaeology and heritage of Victoria.

In addition to the more developed papers, we have continued our practice of publishing the abstracts of other papers presented at the Colloquium, illustrated by a selection of the slides taken from the PowerPoint presentations prepared by participants. These demonstrate the range of work being carried out in Victoria, and we hope that many of these will also form the basis of more complete studies in the future. Previous volumes of *Excavations, Surveys and Heritage Management in Victoria* are freely available through La Trobe University's institutional repository, Research Online <www.arrow.latrobe.edu.au:8080/vital/access/manager/Repository/latrobe:41999> and through Open at La Trobe (OPAL) <https://doi.org/10.26181/601a321a11c0d>. We hope that this will encourage the dissemination of ideas and information in the broader community, both within Australia and internationally. We have also now set up a website for the Colloquium <https://victorianarchaeologycolloquium.com>

For the first time we have included an obituary to mark the passing of a member of our community: David Rhodes of Heritage Insight, a long-time supporter of our activities. Here we should also mention that we have also lost Ron Vanderwal who made importatnt contributions to archaeology and the curation of heritage, although he was unable to participate in the Colloquia.

Once again we have been fortunate in the support given to the Colloquium by many sponsors: ACHM, Ochre Imprints, Heritage Insight, Biosis, ArchLink, Christine Williamson Heritage Consultants and Extent, while La Trobe University continued to provide facilities and a home for our activites, even if this year it was a virtual one. We would like to thank them, and all others involved for their generous contributions towards hosting both the event and this publication. Yafit Dahary of 12 Ovens was, as always, responsible for the catering, despite the limitations on her usual spread.

All papers were refereed by the editorial team. This year Deb Kelly managed this process and the sub-editing of this volume. Layout was again undertaken by David Frankel. Preparation of this volume was, like so much else in the last year, undertaken during the severe restrictions imposed because of the COVID-19 pandemic. We hope that 2022 will be a better year for all.

The presenters, editors and authors acknowledge the Traditional Owners of the lands and heritage discussed at the Colloquium and in this volume, and pay their respects to their Elders, past, present and emerging.

The durability of silcrete flakes: An experimental analysis on the rate of use–wear formation for fine–grained silcrete flakes

Grace Stephenson–Gordon[1, 2]

Abstract

Ethnographic studies indicate past widespread use of unretouched flakes as tools in Australia and the Oceanic region. However, artefacts in Australian lithic assemblages are rarely recorded as exhibiting use–wear. If there was a preference for using unretouched or modified flakes as tools, there is reason to expect use–wear to be present and recorded on these artefact types in Australian assemblages. The mechanical properties of silcrete, the most abundantly occurring material in Australian assemblages, show an intimate correlation between this material's resistance to compressive forces and its microstructure. This suggests that flakes made from fine–grained or microcrystalline silcrete, with a high matrix percentage, should have a high resistance to compressive forces. Studies of the relationship between mechanical properties and the formation of use–wear have found that this resistance to compressive forces, along with material hardness and microtopography, influences the formation rate and appearance of use–wear. It is therefore hypothesised that the low amount of use–wear recorded in Australian lithic assemblages is due to the highly durable edges of silcrete flakes. This paper presents the results of use–wear experiments that test the formation rate of use–wear on unmodified silcrete flakes. The results indicate that it takes a substantial amount of edge use for sufficient use–wear to form on the edges of fine–grained silcrete flakes to enable microscopic identification. This suggests that use–wear is likely to be substantially underreported in most Australian archaeological assemblages without the implementation of detailed microscopic analysis, and that the high durability for silcrete will further impact lithic artefact interpretations in Australia.

Introduction

In Australian lithic analysis, there is the ever–present obstacle of distinguishing a used flake from an unused flake. In addition to retouched artefacts, ethnographic reports in the Oceanic region suggest that Indigenous Australians often used unretouched and informal flakes as tools in the deep and recent past (Binford and O'Connell 1984; Holdaway and Douglass 2012; Horne and Aiston 1924; Tindale and Noone 1941). The acknowledgement of unmodified flakes as tools then creates ambiguity as to which of the unretouched flakes in Australian assemblages were used as tools and which are unused flaking debris. This then further hinders the development of methods for tool identification in the Australian Lithics discipline. A challenge for lithic analysts, therefore, is how to identify which unretouched flakes in Australian assemblages were used as tools.

By drawing on use–wear experiments conducted as part of a 2018 Honours thesis (Stephenson–Gordon 2018), this report aims to determine the rate of use–wear accrual on unmodified fine–grained silcrete flakes. These results will benefit understanding of how clear evidence of edge use may appear in Australian archaeological assemblages with the goal of assisting analytical approaches to lithic artefact analysis in Australia.

Current approaches to Australian lithic analysis

The current method of lithic analysis in Australia is a combination of both a typological approach instigated by Tindale and McCarthy in the 1930s and 1940s, and an attribute based metrical approach developed by Mulvaney in the 1960s (Holdaway 1995; Holdaway and Stern 2004:287–290). Globally, typological approaches to lithic analysis are used to identify cultural change, adaption and technological developments, which in turn are used for site analysis and relative dating (Holdaway and Douglass 2012:102). As retouched artefacts, and clear patterns in flake shape, are uncommon features of Australian lithic assemblages, an attribute based metrical approach allows for the numerous artefacts that are 'unclassifiable under any canon of typological procedure' (Mulvaney and Joyce 1965:175) to be included in lithic analysis (Dibble et al. 2017; Holdaway and Douglass 2012; Holdaway et al. 2015). The inclusion of these typologically unclassifiable artefacts made it clear that the Australian lithic archaeological record was far greater than the retouched and 'formal' components.

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Ethnographic studies of flake selection

The importance of unretouched "informal" flakes in the Australian archaeological record is supported by ethnographic studies in the region. A number of ethnographic and archaeological studies shed light on why retouched and/or standardised tools are rarely identified in Australian archaeological assemblages. They suggest that it was the unmodified flakes which were preferred for use as tools. While instances of core preparation and predetermined flake shapes have been reported in the ethnographic literature, a flake of unspecified shape, and without modified edges, was used most often for everyday tasks (Binford and O'Connell 1984:412, 418; Horne and Aiston 1924:87, 91; Tindale and Noone 1941:122). It is believed that the morphology and overall form of the implement was of minor importance to the creator and user of the implement (Holdaway 1995:787).

White (1967) determined that the flake feature of highest import was the suitability of the edge for the task at hand. Multiple ethnographic studies have supported White's finding, and specifically that an unmodified flake edge was preferred in many instances over retouched flakes (Binford and O'Connell 1984; Gould et al. 1971:154; Hiscock 2004; Holdaway and Douglass 2012:103–110; Holdaway et al. 2015). When retouch did occur to resharpen a dull edge, these studies infer that retouch was often applied as a last resort, and regarded as producing an inferior edge for the task (Gould et al. 1971:149; Hayden 1977:179; Hiscock 2004:75). Overall, these ethnographic studies suggest that unretouched, unmodified flakes were a major part of an everyday toolkit.

In addition to the above, only about 5% of lithic artefacts in Australian assemblages are recorded to display macroscopic evidence for retouch and use–wear (Dibble et al. 2017; Holdaway & Douglass, 2012; Holdaway et al. 2015). Recent use–wear and residue work on artefacts from Madjedbebe in northern Australia, have recorded that approximately 53% of examined flakes exhibited use–wear (Clarkson et al. 2015). These results suggest that the previously mentioned 5% amount of use–wear recorded in Australian lithic assemblages should be much higher. This provides additional support for the hypothesis that unretouched flakes were a preferred component of toolkits. It also raises the question of whether the mechanical properties of silcrete influence how use–wear accumulates, and presents macroscopically, on this material.

Mechanical properties of raw materials

The mechanical properties of a lithic raw material will determine how it behaves under an applied force (Amick and Mauldin 1997:18; Greiser and Sheets 1979; Lerner et al. 2007:711). Experimental studies have shown that the mechanical properties affecting the durability of stone tools also influence the appearance and formation rate of use–wear. Variables such as the hardness of materials, resistance to compressive forces, and microtopography are the main influences on the location and appearance of use–wear features (Amick and Mauldin 1997; Goodman 1944; Greiser and Sheets 1979; Lerner et al. 2007).

These studies have tended to focus on homogenous raw materials that were commonly exploited around the world, such as flint, chert and obsidian (Conte et al. 2015:60; de Lombera–Hermida and Rodríguez–Rellán 2016:5; Kononenko et al. 2010:13). However, silcrete is a heterogeneous, sedimentary rock characterised by quartz grains cemented by a microcrystalline silica matrix. Silcrete is common in Australia and South Africa, but less so elsewhere, which may explain the paucity of research into its mechanical properties (Hutton et al. 1978:23; Nash and Ullyott 2007:101).

In Australia, the textural characteristics of the parent soil in the formation of silcrete is often highly variable, resulting in considerable variability in the texture and colour of silcrete, both between deposits and within a single deposit (Nash and Ullyott 2007:106; Webb and Domanski 2008:557; Kurpiel 2017). Therefore, it is essential to understand the general mechanical properties of silcrete, and the heterogeneous nature of this material, to investigate the formation rate and appearance of use–wear in Australian lithic assemblages.

Webb and Domanski's (2008:571) study on the relationship between the mechanical properties of Australian silcrete and tool manufacture found that the microstructure of this material correlates directly with its stiffness and resistance to compressive forces (Cotterell and Kamminga 1987). There is a negative correlation between compressive strength and increasing grain size, and a positive correlation between the compressive strength and increasing matrix percentage (Webb and Domanski 2008:571). These correlations mean that a fine–grained silcrete with a high matrix percentage will have a higher compressive strength when compared to a large–grained silcrete with a low matrix percentage.

Experiments comparing the compressive resistance for different lithic raw materials have shown a direct correlation between use–wear attrition and the material's stiffness and resiliency to compression (Goodman 1944:432–433; Greiser and Sheets 1979:294). Therefore, based on the mechanical properties of silcrete, and their correlation with the material's microstructure, it can be hypothesised that flakes made from fine–grained or microcrystalline silcrete, with a high matrix percentage, should be more resistant to the development of use–wear because they should have a greater resistance to compressive forces, thus maintaining their edges for longer during use.

Methods

The experiments presented here aimed to determine the attrition rate and physical appearance of use–wear on unmodified flakes made on fine–grained Australian silcrete and flint. Flint flakes were included in the experiments as a visual comparison with previous studies that focused on the appearance and presentation of use–wear and lithic mechanical properties. The fine–grained silcrete was sourced from Stoney Pinch Quarry, a modern commercial quarry located near the Victoria–South Australia border. The flint was Australian Coastal Flint provided by La Trobe University. The silcrete flakes were created by the author and the coastal flint flakes were from a previous knapping demonstration provided by La Trobe University.

A total of 32 experimental flakes, comprising 26 silcrete and six flint flakes, were each used to process one of three resources for a total of 60 minutes: eucalyptus wood *(Eucalyptus globulus*), sweet potato (*Ipomoea batatas*) or raw kangaroo meat. These materials were selected as comparable examples of wood, tubers and meat, which are common processed materials in ethnographic studies. Seventeen silcrete and four flint flakes were used in a cutting motion to process eucalyptus wood, sweet potato or raw kangaroo meat, while the remaining 15 silcrete and two flint flakes were used in a scraping motion to process eucalyptus wood or sweet potato (**Table 1**). This experimental study was designed to identify the presence or absence of wear traces, rather than determining the wear traces produced by specific actions applied to specific materials. Therefore, the experiments focussed on differences between key raw material textures related to a wide range of materials. Due to time constraints, the flakes were not used until their edges were exhausted (or dulled). The flake's edges were still considered usable for cutting and scraping purposes after the experiments had concluded.

Processed material	Cut	Scrape	Total no. of flakes
Meat	**10**	**–**	**10**
Flint	2	–	2
Silcrete	8	–	8
Sweet Potato	**4**	**7**	**11**
Flint	1	1	2
Silcrete	3	6	9
Wood	**3**	**8**	**11**
Flint	1	1	2
Silcrete	2	7	9
Total no. of flakes	**17**	**15**	**32**

Table 1. Number of experimental flakes by processed material, flake raw material, and the use motion

Microscopic use–wear analysis was undertaken with both a high–powered (200x–500x) and a low–powered (50x–100x) microscope. The analysis occurred at arbitrary times: after 0, 15, 30 and 60 minutes of continuous use. The flakes were washed lightly under running water to remove any loose material still present on the surface and were air–dried overnight prior to analysis.

Four main types of use–wear features were documented on the edges of the flakes: scarring, striations, edge–rounding and polish. Scarring use–wear appears as small negative flake scars or fractures along the used edge from that edge being placed under force during use, similar to the mechanics of flake manufacture (Hayden and Kamminga 1979:6–7; Kamminga 1982; Semenov 1964:13). Striations are caused by loose abrasive particles, which create an indentation in the surface of the tool that follows the direction of use (Fullagar 2009:222; Kamminga 1982:10–14). These abrasive particles can be foreign additions or particles derived from the tool or worked material (Kamminga 1982:11). Edge rounding is related to the development of polish and abrasive smoothing through extended use. It is identified where the edge of the tool has been blunted through use (Fullagar 2009:225; Kamminga 1982:17). Lastly, use–related polish, or abrasive smoothing, is surface levelling along a working edge or surface through abrasion or an 'additive' process caused by a chemical reaction between the worked material and a tool's surface (Fullagar 1991; 2009:225; Kamminga 1982; 1979).

Damage can occur on the surfaces and/or edges of an artefact at every stage of its life (see Hurcombe 1992:151 and Robertson 2005:28). Non–use related damage can occur during initial manufacture and use, storage, discard, burial, and excavation and handling (Hurcombe 1992; Keeley 1974; Robertson 2005). As non–use related damage can appear similar to use–wear, but in a randomised and inconsistent manor, a positive diagnosis of archaeological use–wear relies on the identification of two or more use–wear features, as well as the consistency and confinement of use–wear features to a particular area or edge.

Results

The use–wear features presented here were identified microscopically, under low– and high–powered magnification, and were often found in small localities randomly positioned along the used edge. Use–scarring formed quickly on the experimental flakes and was observed on all flakes during each stage of microscopic analysis (**Figure 1**). Edge–rounding, use–striations and use–polish took longer to form and were not evident on all flakes after 60 minutes of use. The contact material influenced the formation rate of individual use–features, the harder wood and tubers caused more scarring and polish formation where the softer meat encouraged the development of edge–rounding (**Table 2**). However,

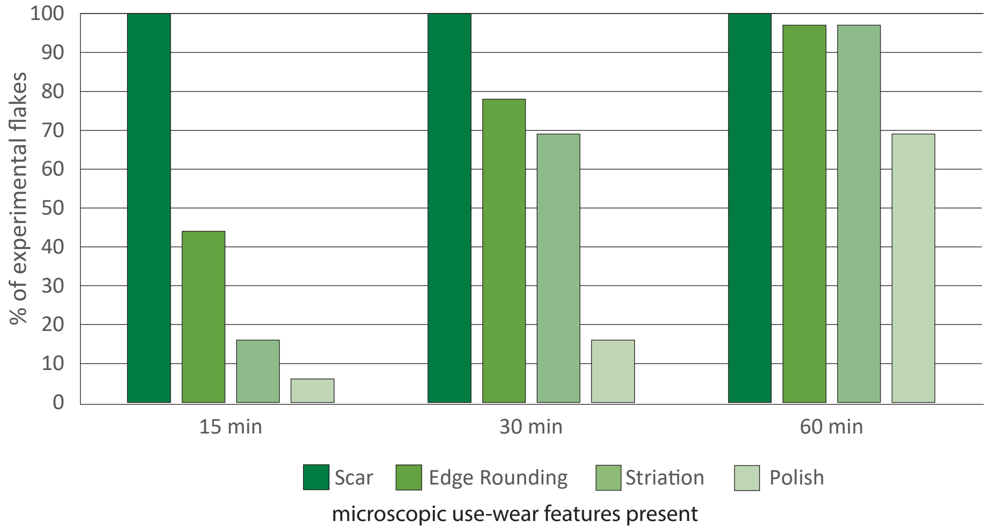


Figure 1. Percentage of the experimental flakes showing microscopic use–wear features during analysis after 15, 30 and 60 minutes of use. Note: the use–wear feature amounts presented in the graph were recorded as present whilst being inconsistently distributed along the used edge and may not be accurately identified as use–related damage during analysis of archaeological materials

		15 minutes of use			**30 minutes of use**			**60 minutes of use**		
Use feature	**Presence/ absence**	**wood (11)**	**tuber (11)**	**meat (10)**	**wood (11)**	**tuber (11)**	**meat (10)**	**wood (11)**	**tuber (11)**	**meat (10)**
Scarring	Absent	0	0	0	0	0	0	0	0	0
	Present	11	11	10	11	11	10	11	11	10
Striations	Absent	8	10	9	4	3	2	0	0	0
	Present	3	1	1	7	8	8	11	11	10
Polish	Absent	11	10	10	8	8	10	4	2	4
	Present	0	1	0	3	3	0	7	9	6
Edge rounding	Absent	8	4	6	5	2	0	1	0	0
	Present	3	7	4	6	9	10	10	11	10

Table 2: The presence/absence of individual use–features by the processed contact material

these differences are subtle and further research is needed to determine the extent of the impact of the contact material.

Only ~5% of all flakes displayed some form of macroscopically visible use–wear after 60 minutes of use. This use–wear comprised inconsistent, undiagnostic use–scarring. It is likely that such low levels of macroscopic use–wear would be overlooked, or misdiagnosed, during lithic analysis as non–use related damage.

Use–scarring

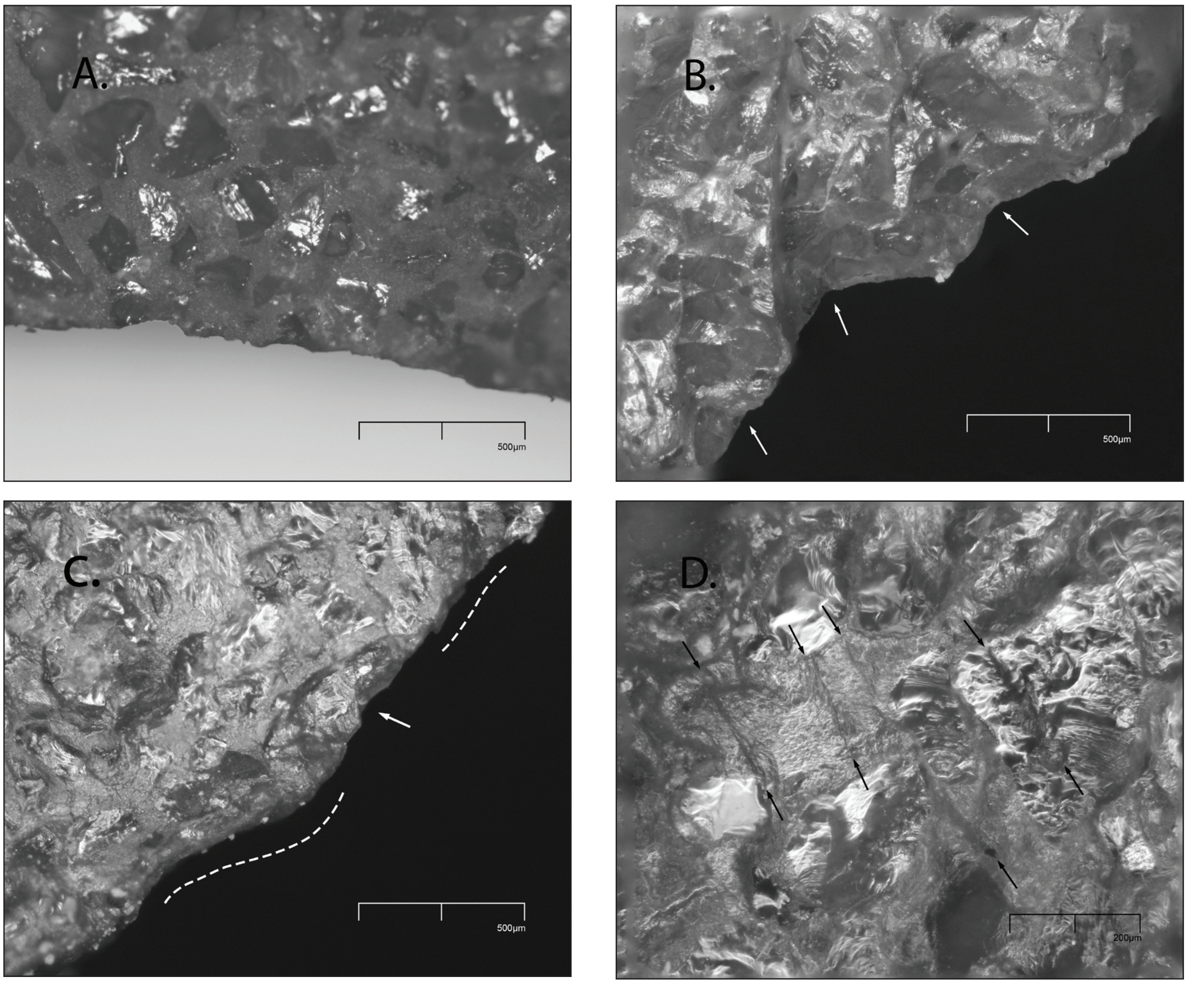
Use–scarring developed relatively quickly on the experimental flakes (**Figure 2**). All flakes displayed some form of use–scarring after 15 minutes of use. During each stage of microscopic analysis, this use–wear appeared light, small and erratically distributed along the edge—especially during the earlier stages of use. After 60 minutes of use, the use–scarring became more pronounced, and was identifiable under low–powered magnification. However, this scarring was still erratically distributed along the used edge.

Whilst use–scarring was present on the experimental flakes after 15 minutes of use regardless of the contact material, it was found that the contact material influenced the size and appearance of use–scarring. The softer, more elastic material (meat) created smaller use–scars in localised areas where the worked edge was very acute. In comparison, the harder, more ridged materials (tubers, wood) created larger use–scars in addition to small use–scars along the worked edge. Due to the small sample size, there was no clear difference in formation rates of use–scarring between materials.

Edge–rounding

Edge–rounding also formed relatively quickly on the used edges of flakes, with nearly half of the flakes displaying edge–rounding after 15 minutes of use (**Figure 2**). By the end of the experiments, more than 95% of the flakes displayed some form of edge–rounding. This use–wear occurred more clearly and consistently along the used edge compared to the other use–wear features. After 60 minutes of continuous use edge–rounding was able to be identified under low–powered magnification (50x–100x). Edge–rounding often overlaid use–scarring, muting the latter after 60 minutes of use. However, in some instances, newer use–scarring overlaid edge–rounding.

The contact material appeared to have some influence on the formation rates of use–related edge–rounding. Flakes that came into contact with softer materials (meat, tuber) exhibited greater amounts of edge–rounding than



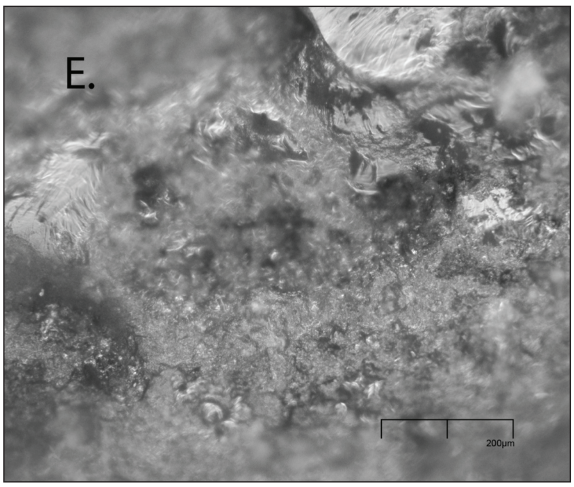


Figure 2. A. A fresh flake blank prior to use. B. Scarring after 60 minutes of use. Scars are indicated by white arrows. C. Edge-rounding and a new use-scar after 30 minutes. Rounding is indicated by the dotted line and the scar by the white arrow. D. Striations after 60 minutes of use. Striations are indicated by the black arrows. E. Polish after 30 minutes of use, visible by the rough and sugary surface texture. (All images were taken and edited by Grace Stephenson-Gordon)

harder materials (wood). The edge rounding caused by harder materials was often overlaid with newer use–scars. In contrast, for the softer materials it appeared to be less likely for the formation of new use–scars to overlay the edge rounding.

Use–striations

Use–striations commonly appeared as furrows (torn indentations), created when fragments of the flake's edge detached and dragged across the surface of the flake during use (**Figure 2**). This type of use–wear was slower to form on flakes. After 15 minutes, approximately 15% of all flakes exhibited striations. This increased to nearly 70% after 30 minutes. More than 95% of the flakes displayed striations by the end of the experiments. Similar to use–scarring, the use–striations became more consistent and prominent in localised areas after 60 minutes of use. Whilst some striations were able to be seen at 100x magnification after 60 minutes of continuous use, analysis required high–powered magnification (200x–500x) for investigation of use–striations. For nine of the experimental flakes, an external abrasive in the form of sand was introduced during the experiments. The sand was found to not have influenced the location, appearance or consistency of striations during use–wear analysis.

There was no clear difference between the type of contact material and the formation rate of use–striations. Instead, there was a steady increase of use–striations due to the abrasive particles originating from use–scarring.

Use–polish

Use–polish developed particularly slowly on flakes in the experiments. Only ~10% of all flakes exhibited polish after 15 minutes, increasing to ~20% after 30 minutes. By the end of the experiments, nearly 70% of all flakes displayed polish. This may be due to the silica content, surface topography and time requirements necessary for polish to develop. As Fullagar (1991:18) explains, 'silica content is one important factor [in polish formation]. Other factors which affect polish development seem… to be duration of use, water, mode of use and resharpening'. The polish present on the experimental flakes after 60 minutes of use can be characterised by the first stages of polish formation (Fullagar 1991:6). The polish has a sugary texture on quartz grains and is isolated to peaks in the surface topography (**Figure 2**).

Unsurprisingly, the formation rate of polish was higher for flakes used on the plant materials (wood, tuber) with a natural silica content comparable to meat. Unlike the other use–wear features, use–polish was not identified on every flake, regardless of the processed material, after 60 minutes.

Silcrete vs flint

The experimental results suggest the formation rate of use–wear on flint flakes appear to be marginally higher than those on silcrete. The presence of all use–wear features (scarring, striations, edge rounding and polish) was slightly higher on flint flakes when analysed at 15, 30 and 60 minutes of continuous use. Only a small number of flint flakes were included in the experiments; two used on wood, two used on tubers, and two used on meat. Further research on the formation rate of use–wear on both flint and silcrete is needed to determine if there is a notable difference.

Discussion

Ethnographic evidence shows that Indigenous peoples in Australia and Oceania used unmodified flakes as tools. Yet, there is a significant lack of use–wear recorded in Australian archaeological assemblages. The mechanical properties of silcrete suggest that it is a highly durable material. Previous studies of use–wear formation and its relationship with material durability imply that use–wear will be slow to accumulate on the edges of silcrete flakes. The results of the use–wear experiments presented here suggest that a substantial amount of edge use is required for consistent use–wear to develop in amounts that are readily identifiable during microscopic analysis. It takes at least 30 minutes of continuous use for a variety of microscopically visible use–wear features to form, and at least 60 minutes for these features to be more clearly defined. However, some flakes will not exhibit any clearly defined use–wear features even after 60 minutes of use. Although there will be exceptions, the results show that fine–grained silcrete creates flakes that are very durable. They also indicate that a long period of continuous use (at least 60 minutes) is required for macroscopically visible use–wear traces to accumulate along the used edge of flakes. Together, these results suggest that most lithic analysts would not detect use–wear features in the absence of microscopic analysis.

The results support Webb and Domanski's (2008) observed correlation between the microstructure of silcrete and its resistance to compressive forces, confirming that silcrete can create highly durable flakes (depending on the microstructure of the source material). The notion that microcrystalline to fine–grained silcretes with a high matrix percentage can create highly durable flakes has implications for the analysis of lithic assemblages in Australia, whereby the raw materials present in assemblages may allude to resource management and accumulation strategies.

The mechanical properties of silcrete affect the rate of use–wear accrual. Depending on the length of time and intensity of use, macroscopically visible use–wear will not always be present for clear diagnosis. There is also potential for microscopically visible use–wear on flakes to be contested as non–use related damage. Furthermore, if a flake were used for a short period prior to discard

(60 minutes or less), then both macroscopically and microscopically visible use–wear would probably be misdiagnosed.

The use–wear experiments included flint flakes for the comparison of use–feature appearance to previous studies. This was included because of the lack of use–wear studies on silcrete and the silicious material that forms flint is similar to the silicious matrix in silcrete. Webb and Domanski (2008) suggests that silcrete has a higher compressive resistance to flint which may appear as differences in the rate of use–wear formation. The results of the experiments suggest there might be a difference in the rate of use–wear formation between silcrete and flint. However, a conclusion cannot be made due to the small sample size of flint. There may be significant differences in the rate of use–wear formation and the durability of all lithic raw materials which may influence use, tool versatility and value for lithic assemblages globally.

An important implication of the experimental results is that macroscopically visible use–wear recorded in archaeological assemblages is likely the result of prolonged or repeated use. The mechanical properties of silcrete indicate that, depending on the source material, highly durable flakes with a long use–life can be produced. A flake made on fine–grained or microcrystalline silcrete will retain a working edge for a considerable amount of time prior to requiring reshaping or resharpening (i.e. retouch). This suggests that unretouched silcrete flakes selected for use as tools would have had a high retention and transport rate prior to their discard.

The purpose and significance of retouch in Australian lithic assemblages is commonly debated (e.g. Holdaway and Douglass 2012). Backed artefacts provide clear evidence for the deliberate application of retouch to shape a flake's edges. It is commonly held that backing was used to shape and blunt an edge that was not intended to be the cutting edge (Robertson et al. 2009). Alternatively, scrapers provide examples of retouch for the purpose of resharpening, and possibly reshaping (Hiscock and Attenbrow 2003). The results of the current study can assist with investigating the latter; for example, when discussing possible conditions that prompted the application of retouch to scrapers.

The results presented here may also have implications for discussing retouch and alternate raw material types that occur in Australian assemblages. There may be suggestion of a perceived worth, or rarity, for some material types over others, which could be determined through the type and amount of retouch present, probable circumstances requiring retouch, and inferred reduction stage.

The results may also assist with analyses of resource maximisation and landscape movement. The amount of macroscopically visible use–wear and retouch on a flake may provide insights into movement across the landscape, and proximity to quarry sites. If the purpose of applying retouch was to resharpen a blunted edge, and the type of raw material creates durable flake edges, then it is reasonable to assume that the application of this type of retouch is part of a resource maximisation strategy.

The implications of the results outlined above are all avenues for further research.

Conclusion

The results of the current study provide a basis for inferring why so few flakes with use–wear is reported in Australian assemblages for which no microscopic analysis has been undertaken. The mechanical properties of silcrete, the most abundantly occurring material in the Australian archaeological record, indicate that the edges of silcrete flakes are highly durable and suitable for prolonged use. At least 60 minutes of continuous use are required to create use–wear features that are sufficient for a positive use–wear diagnosis using a microscope. For archaeological assemblages, flakes lacking clear, macroscopically visible use–wear, as inferred from a 10x–20x magnification hand lens, should not be classified as unused flaking debris—and microscopic analysis should be employed to correctly identify which items were used as tools. Additionally, silcrete artefacts that do present clear, consistent, macroscopically visible use–wear (especially when it is overlying retouch) probably represent a heavily utilised tool and indicate a high tool retention rate. This research can assist current approaches to lithic analysis in Australia and internationally, as well as broader studies of past human responses to environmental change and resource availability.

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I would like to acknowledge everyone who has assisted in the writing of both my Honours thesis and this paper. I would like to give a special thanks to my Honours supervisor, Nicola Stern, whose guidance through my thesis was invaluable. I would also like to acknowledge La Trobe University for supplying the silcrete and flint as well as the facilities used in completing the experiments outlined in this paper. Lastly I would also like to acknowledge the La Trobe University students who helped with completing the experiments, this research would not have been possible without all of you.

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