Use-wear Analysis of Aboriginal Flaked Stone, Glass and Porcelain from Calperum Station, South Australia

By

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Declaration

I certify that this thesis: 1. does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any university; and 2. to the best of my knowledge and belief, does not contain any material previously published or written by another person except where due reference is made in the text.

Simon Munt, January 2022

Dedication

I dedicate this work to my late father, David.

Acknowledgements

My foremost thanks go to my adored family. I thank my supervisors, Amy Roberts and Heather Burke and, in particular, Richard Fullagar, for his expert, voluntary use-wear tutelage and use of his metallographic microscope. It has been a privilege to work with the River Murray and Mallee Aboriginal Corporation, most notably on-site over several field trips, and it is my sincere wish that its members derive value from reading this research. John Byrne kindly assisted with sourcing the experimental silcrete from a non-archaeological context, Craig Westell assisted with the creation of site maps, and Adelaide Microscopy and Benjamin Wade provided access to and assistance with a laser scanning confocal microscope. A stipend and fieldwork equipment were supplied by Flinders University as a co-investment from the ARC Linkage project (LP17010047a) led by Professor Amy Roberts, Associate Professor Mick Morrison, Professor Heather Burke and Dr Ian Moffatt.

Please note that at no stage of this thesis was an editor used for any purpose.

Abstract

For around 65,000 years Aboriginal Australians adjusted their stone technological practices according to changing socio-cultural and environmental conditions. Innovations assisted them to thrive in unfamiliar territories and during periods of climatic fluctuations. Technological adaptations did not cease following permanent European colonisation over 200 years ago, with Aboriginal groups across the country selectively incorporating introduced materials. In the Riverland of South Australia (SA), intense, often violent, complex cross-cultural encounters began in the mid-late 1830s yet until recently few archaeological investigations had been undertaken for this vast region. Consequently, it has been relatively unknown how Aboriginal peoples in the Riverland may have adapted their technological practices to include uses for new European materials.

My thesis addresses this gap in knowledge, with the application of two key methods: (1) microscopic use-wear analysis of tools made from stone and introduced glass and porcelain from two sites at Calperum Station in the Riverland; and (2) documentation of oral histories and current practices of the Aboriginal Traditional Owners (TOs). *A main objective is to understand how and why Aboriginal people around Calperum Station incorporated introduced glass and porcelain into their culture/lifeways following permanent European colonisation.* This thesis represents the first use-wear study in Australia concerning Aboriginal uses of porcelain and the first in SA that considers all aspects of use-wear on bottle glass used by Aboriginal peoples.

Traditional knowledge forms a key component of this thesis. Use-wear analyses have not always incorporated such knowledge, and living cultural memories and inferences from TOs around Calperum Station, based on knowledge passed on to them from previous generations, add insights into past uses for introduced materials that were beyond detection under microscopic investigations. This includes manufacturing and using glass tools to process wood and meat, and glass (and chert) tools for spear tips.

Use-wear experiments that approximate archaeological conditions at Calperum Station are another key aspect of this thesis. The primary goals of use-wear analysis are to determine the motion(s) with which a tool was used and the material(s) that were processed. To aid the interpretation of the archaeological assemblage, 106 tool-use experiments were conducted and the use-wear analysed. Tool raw materials closely matched the chert, silcrete, bottle glass and porcelain from the archaeological assemblage, and a range of tool motions was implemented, informed partly by TO knowledge of their antecedents' tool-use techniques. Materials were processed that, according to both the literature and TO knowledge, were historically available in the region: wood (*Eucalyptus camaldulensis*), bone (kangaroo), meat (lamb), fresh hide (cow) and plant material (*Typha domingensis*).

The archaeological specimens analysed (n = 62) included 29 stone (16 chert and 13 silcrete), 25 glass and eight porcelain flakes and fragments. Of these, eight were tools with diagnostic traces of use, seven had probable traces of use, and 18 had possible traces of use. No formal tool types were identified. Of the eight tools with diagnostic traces of use, four were manufactured from glass, one from porcelain and three from chert. Evidence was compelling that the four glass tools had been used to scrape bone. For the porcelain and chert tools, evidence for the material(s) worked was inconclusive. A key finding of this thesis, supported by Aboriginal oral histories and current practices, is that production and use of glass tools replaced stone for some tasks and has been maintained from initial or early contact up to the present day.

The introduced materials appear to have been incorporated into pre-existing technological frameworks. Although motives for past behaviour may not always be discernable, the locations of both sites suggests that Aboriginal peoples may have chosen to use the new materials in a space removed from the colonial gaze. Regardless, the Riverland can now be understood as a region where, at these two sites and possibly others, Aboriginal peoples, by adapting their technological practices, mirrored the cultural dynamism that has characterised Aboriginal cultures in Australia for many millennia.

Chapter One: Introduction

1.1 Research Description

Aboriginal Australians used stone artefacts from their arrival in the continent around 65,000 years ago (Allen 2017; Clarkson et al. 2017:309; Clarkson et al. 2020:5; Norman et al. 2018:229–230, 237; Tobler et al. 2017:182–183; Veth et al. 2017:20, 23–26; Veth et al. 2019:118–119). Within several millennia they manufactured new stone technologies better suited to environmental conditions to which they had not previously been accustomed, and subsequent generations repeatedly adapted their stone technological practices in response to changing climatic conditions and socio-economic influences (Brumm 2011; Brumm and Moore 2005:162, 165–166, 169; Florin et al. 2021:300; Ford and Hiscock 2021:9, 16–20; Hamm et al. 2016:281; Hiscock 1994, 2002; Hiscock et al. 2016:2, 4, 8–10; Maloney et al. 2018:205, 216, 224–226; McNiven 1994:77–80). As was the case with many other Indigenous groups, such as Andaman Islanders (Gorman 1995:90; Man 1883:380), American Chinookans (Simmons 2014:106–120), Patagonians and Tierra del Fuegans (Charlin et al. 2016:320–321; De Angelis 2014; Delaunay et al. 2017:1333–1340), this adaptability did not cease after the permanent colonisation of Europeans over 200 years ago. Rather, there was a widespread adoption of introduced materials, such as bottle glass, metal and ceramic (Akerman 1978:489; Akerman et al. 2002:22; Barker et al. 2020; Harrison 2002a, 2006; Head and Fullagar 1997:422–424; Jones 2008:126; May et al. 2017:703; Perston et al. 2021; Smith 2001:26–28; Veth and O'Connor 2005:5; Wallis et al. 2018; Walshe and Loy 2004).

However, few microscopic use-wear analyses have been conducted on glass in Australia, and none on porcelain flakes ('use-wear' refers to wear resulting from human use). Consequently, the issue of whether these new materials were put to new uses or incorporated into pre-existing traditional practices, perhaps as an assertion by Aboriginal peoples of their cultural methods in the face of colonisers' efforts to enforce European ways upon them, has remained less than fully resolved. Most investigations involving glass have informed about issues not centred on artefact uses. For example, Cotterell (1968), Cotterell and Kamminga (1987) and Cotterell et al. (1985:215–216, 218–219) conducted a vast number of experiments investigating glass as a proxy for the mechanics of stone flaking, while Akerman (1978, 2007), Akerman et al. (2002) and Harrison (2002a, 2003, 2006, 2007) examined technological and social behaviours related to the well-known glass Kimberley point. The majority of studies involving Aboriginal people and glass in Australia have been based on macroscopic analyses, which, while useful for addressing a range of research questions, are limited in their ability to understand uses of glass artefacts (Allen and Jones 1980; Barker et al. 2020; Birmingham 1976; Carver 2005; Cooper and Bowdler 1998; Gibbs and Harrison 2008; Goward 2011:44–47, 49–65; McCarthy and Davidson 1943; Paterson 1999; Perston et al. 2021; Rhodes and Stocks 1985; Runnels 1976; Tindale 1941; Wallis et al. 2018). Other projects have examined Aboriginal uses for different introduced materials, such as metal (Harrison 2003:323–324; Jones 2008:116–129; Khan 2003).

No complete microscopic use-wear study has previously been undertaken for Aboriginal flaked glass or porcelain in SA. Walshe et al. (2019:203–204) microscopically examined ten glass pieces from an historical site in an outer suburb of Adelaide, but despite claiming 'strong evidence' of past use, their examination was limited to edge scarring, with no analysis of the other major forms of use-wear: polish, abrasive smoothing, striations or edge rounding. Walshe et al. (2019:204) suggested that one artefact may have been used as a knife, one as an awl and another as a point, but evidence was insufficient for them to infer worked materials or specific tool motions. Knowledge about past Aboriginal uses for porcelain has hitherto been limited to ethnographic records and observations from early European settlers, who reported that it was sourced from telegraph insulators and used as spear barbs (Anon. 1887:4; Jones 2008:126; Moyal 1984:54; Noone 1949:112; Veth and O'Connor 2005:5). Walshe and Loy (2004) interpreted a single flaked porcelain artefact on Kangaroo Island as an adze used to work wood, but this was based only on macroscopic observations.

Use-wear studies of tools made from other forms of ceramic are also relatively scarce across the world and virtually non-existent for Australia. Whenever the use of ceramic has been considered it has been from the perspective of how other materials were used to work the ceramic, rather than how the ceramic may have been used to work other materials (Akerman et al. 2002; Bray 1982; Forte et al. 2018; Kintanar 2014; López Varela et al. 2002; Shamanaev 2002; van Gijn and Hofman 2008; van Gijn and Lammers-Keijsers 2010; Vieugué 2008). In contrast, this research, while assessing the possibility of the porcelain being worked by other materials, focusses on how porcelain tools were used to work other materials.

Glass artefacts have commonly been regarded as proxies for post-European contact in Australia (Gibbs and Harrison 2008:61; Goward 2011:12; Harrison 2005:16, 19), yet most of our knowledge has derived from glass pieces classified as artefacts based on macroscopic observation. This method can be problematic. Macroscopic identification is sufficient when the morphology is irrefutably consistent with well-accepted technological types, such as Kimberley points (Akerman et al. 2002; Harrison 2002a:353, 356–359; Harrison 2003:326; Harrison 2006:63–64, 72–79), and when clear attributes demonstrating intentional knapping are present. However, macroscopic observations are often insufficient because, unlike most stone, the accidental breaking of glass can result in characteristics resembling those produced by deliberate human manufacture and modification, such as a bulb of percussion, retouch, prepared platforms and negative scarring (Allen and Jones 1980:231; Beaumont 1961; Carver 2005:82–86; Conte and Romero 2008:251–252; Cooper and Bowdler 1998:74; Harrison 2000, 2005:19; Knudson 1979; Martindale and Jurakic 2006:417; Martindale and Jurakic 2015:35–38; Ulm et al. 1999:42; Ulm et al. 2009; Wolski and Loy 1999:65). Even among the range of macroscopic observations of glass across the world, no consensus has been reached for diagnostic attributes (Allen and Jones 1980; Barker et al.

2020; Beaumont 1961:161; Birmingham 1976; Carver 2005; Cooper and Bowdler 1998; Gibbs and Harrison 2008; Flexner and Morgan 2013; Goward 2011:44–47, 49–65; Man 1883:380; Man 1932:160–161; McCarthy and Davidson 1943; Paterson 1999; Perston et al. 2021; Rhodes and Stocks 1985; Runnels 1976; Simmons 2014:73–81; Tindale 1941; Wallis et al. 2018; Wilke 1996).

Microscopic use-wear analysis can not only overcome these diagnostic issues, but can provide substantial evidence for the uses of glass (and for uses of artefacts made from other materials) (Conte and Romero 2008; Gorman 2000; Kononenko 2011; Martindale and Jurakic 2006, 2015; Ulm et al. 2009; Walton 2019). There have only been two published microscopic use-wear and/or residue analyses for bottle glass for Australia. Analysing a Victorian assemblage, Wolski et al. (1999) dispelled the misconception that body shards were rarely used due to a common preference for artefact manufacture from bottle bases, while Ulm et al. (2009) demonstrated, from their analysis of a Queensland assemblage, that glass was used for tasks such as wood-working and plant-processing. Several unpublished reports have reached the same conclusions for other regions, including around western Sydney (e.g., Kononenko and White 2019; Munt 2020, 2021).

Overseas use-wear/residue analyses of glass tools, including natural glasses such as obsidian, have indicated a variety of uses. These include the processing of various plants, wood, shell, skin, clay and meat (Church and Rigney 1994; Fullagar 1992; Hurcombe 1992; Kamminga 1982; Kononenko 2011:49–67; Kononenko et al. 2015; Vaughan 1985; Walton 2019), shaving, body modification or tattooing (Gorman 2000; Kononenko 2012; Kononenko et al. 2016; Torrence et al. 2018), blood-letting (Stemp 2016a; Stemp et al. 2019:7–9), projectile weaponry in the form of points (Charlin et al. 2016:320–321; Delaunay et al. 2017:1333–1340) and crescents (Boulanger et al. 2021:7), and potentially the shearing of camelids (Nesbitt et al. 2019). Use-wear analysis on a glass assemblage from Argentina also demonstrated how the application of this technique can help to correct previous misinterpretations based on macroscopic observations only (Conte and Romero 2008:258–260).

Potential glass and porcelain (as well as stone) artefacts were observed at Calperum Station ('the Station') in SA's Riverland during field surveys in 2014–2018, raising the possibility that past Aboriginal peoples in the region used these materials following permanent European colonisation in the late 1830s. Few archaeological studies had previously focused on this vast area, despite historical records indicating frequent cross-cultural encounters and extreme violence between Aboriginal peoples and Europeans (Burke et al. 2016). A gap in knowledge is thus addressed in this thesis with the application of microscopic use-wear analysis to investigate how post-contact Aboriginal peoples from this Riverland region used introduced materials. In doing so, this study forms an independent part of a collaborative archaeological project between Flinders University and the River Murray and Mallee Aboriginal Corporation (RMMAC) that investigates the broad nature of Aboriginal-European relations around the Station before, during and since contact. My involvement in the project began in 2018 when site directors desired a use-wear analysis.

Experimental archaeology constitutes a significant part of this thesis. The nature of the use-wear on tools can differ according to several factors, including a tool's raw material, the material that it was used to work ('worked material') and the motion with which it was used ('tool motion') (Clemente-Conte et al. 2015; Gibaja and Gasson 2015; González-Urquijo and Ibáñez-Estévez 2003; Kamminga 1982:29, 83; Keeley 1980:36–61; Kononenko et al. 2015; Lemorini et al. 2014). Therefore, whilst published images of microscopic use-wear traces serve as useful guides, any use-wear analysis for a given assemblage is more robust when based upon an experimental reference collection that best approximates local resources and conditions (Hayes et al. 2018:97, 100; Keeley 1980; Kirgesner et al. 2019; Kononenko 2011; Pedergnana and Ollé 2017; Rutkoski et al. 2020:38, 46; Skakun and Terekhina 2017; Walton 2019). To best represent the conditions under which tools were used at Calperum Station, experiments were conducted on a sandy substrate, using chert and silcrete that closely approximated the fine-grained nature of the two major stone raw materials present at the site, along with bottle glass and porcelain. Wood (river red gum or *Eucalyptus camaldulensis*), bone (kangaroo), meat (lamb), fresh hide (cow) and plant material (*Typha domingensis*) were worked because these materials were known to be available historically and Aboriginal Traditional Owners (TOs) indicated that they were exploited in the past.

To complement the experimental and archaeological analyses, living cultural memories, knowledge and interpretations from TOs were recorded. These oral histories, along with observations made during a community demonstration of ongoing practices for the use of glass tools, provide additional perspectives on past and present Indigenous technological behaviour that may otherwise be unattainable. The knowledge is particularly valuable because the practices were informed by previous generations (Timothy Johnson and Philip Johnson, pers. comm. 2019). In this way, the living memories, knowledge and skills also serve to highlight some continuing effects of contact with Europeans.

The notion of 'contact' can be conceived of in various ways. The term may be used to refer to the first cross-cultural encounter between colonising groups and Indigenous peoples or to encompass periods during which it may be argued that effects of initial encounters are ongoing (Berrojalbiz 2018; Carroll 2011; Dietler 2010; Flexner 2014:48–76; Lydon 2002, 2005; Mulvaney 2018:249, 258–261; Silliman 2005, 2010). Such continuing interactions are often framed as 'cultural entanglements,' essentially meaning that people and practices of different cultures become entwined (Flexner 2014:53; Silliman 2010:29–31). Power imbalances and other connotations of the concept of contact are discussed further below in the context of European colonisation, but in this thesis the term 'contact' is used to denote the approximate time during which Europeans and Indigenous peoples around Calperum Station were first encountering each other (mid-late 1830s). The 'contact period' does not involve a precise time limit, but is used to include the first several years after initial contact. 'Post-contact' refers particularly to the several decades following the contact period and, in some contexts, encompasses the time period right up to the present.

1.2 Research Question

The primary research question for this thesis is:

How did Aboriginal people at (two sites within) Calperum Station, South Australia, incorporate introduced glass and porcelain into their pre-existing stone technology and toolkits following permanent European colonisation?

1.3 Research Aims

This thesis has the following data-specific aims:

1. To survey, identify and collect surface stone, glass and porcelain artefacts from key sites at Calperum Station;

2. To undertake experiments approximating archaeological conditions at the Station, using stone, glass and porcelain tools and to then analyse resulting use-wear in order to inform the archaeological analysis;

3. To conduct a use-wear analysis of the archaeological stone, glass and porcelain artefacts and determine tool functions;

4. To investigate the potential for laser scanning confocal microscopy to quantify aspects of use-wear, particularly on glass and porcelain artefacts;

5. To record oral histories and contemporary understandings and observations, relating to flaked artefacts, from current TOs who were taught tool-use techniques by their ancestors; and

6. To consider how the methods used in this thesis, particularly concerning the involvement of TOs, may assist future functional analyses.

1.4 Traditional Owner Engagement, Collaboration and Ethics

On 18 November 2011 Justice Mansfield, at a Federal Court sitting at Lake Bonney, SA (*Turner vs State of South Australia 2011; FCA 1313*), handed down a consent determination that recognised the Aboriginal River Murray and Mallee people's non-exclusive rights:

> to access, hunt, fish, camp, gather and use natural resources, undertake cultural activities, conduct ceremonies and meetings, and protect places of cultural and religious significance.
>
> www.nativetitle.org.au/find/pbc/7494. Accessed 11 March 2019

This determination applied to parts of a claim area originally submitted in April 1998 as the First Peoples of the River Murray and Mallee Native Title Claim, which encompassed several separate Aboriginal language groups (*Turner vs State of South Australia 2011; FCA 1313*). The 'Erawirung'/'Jirau'/'Yirau'/'Erawiruck' people were recorded by Berndt et al. (1993:304) and Tindale (1974:211) as the Aboriginal group relevant to the sites under study in this thesis, although several other descriptions exist for cultural boundaries and group names (Clarke 2009:144–147; Hope and Hercus 2009:201–203; Radcliffe-Brown 1918; Shaw 1879). The consent determination area is managed by RMMAC, the prescribed body corporate for the River Murray and Mallee Aboriginal community (National Native Title Tribunal 2011). The present study region falls within the RMMAC area.

RMMAC has supported and been actively involved in the research for this thesis. In July 2018, following a presentation to, and meeting with, several community members, RMMAC provided its support for this discrete project, and on 18 March 2019 issued its formal agreement to jointly participate in related research. The collaborative project is partly supported by an Australian Research Council grant (Project No. LP170100479) and was approved by the Flinders University Social and Behavioural Research Ethics Committee (Project No. 6618). Permits for collecting, storing, analysing and returning the artefacts under Sections 21, 23 and 29 (1) (b) of the *Aboriginal Heritage Act 1988* were received from the Premier of SA on 10 September 2019. Continued community engagement was maintained by regular provision of written research updates to RMMAC Directors' Meetings (examples provided in the Appendix), informal discussions with community members and the active involvement of TOs at all times during fieldwork, according to cultural protocols. TOs were involved in the design of the tool-use experiments, through their knowledge about materials exploited by their antecedents. In particular, TOs Timothy Johnson and Phillip Johnson demonstrated their engagement in this thesis by providing a demonstration, at Calperum Station, of their current use of glass tools, and by communicating their living cultural memories during oral history interviews (Figure 1; Chapter Six; Appendix).

Figure 1 Philip Johnson and Timothy Johnson discussing their memories and cultural knowledge with the author, along with Flinders University/RMMAC project leader Amy Roberts (obscured), at Calperum Station, 7 May 2019. Photo: Catherine Morton.

1.5 Study Area (Calperum Station) and its History

This thesis involves two sites within Calperum Station. The main site, 'West Woolpoolool,' is approximately 17,000 square metres and was selected because of the concentrated presence of flaked stone and glass. The other site, the 'Telegraph Insulator Site,' is 15 square metres and was selected upon the observation of several potentially flaked porcelain shards and a near complete insulator. Stone artefacts were also often present at other locations surveyed within the 242,800 hectares of the Station but other glass fragments observed across several field visits were mostly isolated and/or clearly modern and non-artefactual. To provide a broad contextual description for the sites, the ‘study area’ refers to all of Calperum Station, while each site is described below under ‘Site Descriptions.’

Calperum Station is located around 10 km north of Renmark on the western margins of the River Murray floodplain (Figure 2) and currently managed by the Australian Landscape Trust (Australian Landscape Trust 2019). The floodplain is a classic riverine environment seasonally rich in resources such as the plant root *Typha* (*T. domingensis*), which is and has been present for at least recent periods (Gott 1999:36), as well as other plants, shellfish, fish and reptiles (Angus 1847; Brown and Stephenson 1991:192; Eyre 1845 2:244–295; Gill 1973:11; Pardoe 1995:699–701; Pate 2006:237–238; Pate 2017:127, 131–132, 134; Taplin 1879:18–19, 29). According to British explorer Charles Sturt (1833 2:135), the region could support seasonally intensive gatherings of 300 individuals, while fellow British explorer Edward Eyre (Eyre 1845 2:252, 372) considered that it could accommodate 600. The River Murray is the major river in SA and its tributaries include rivers in the Murray-Darling river system.

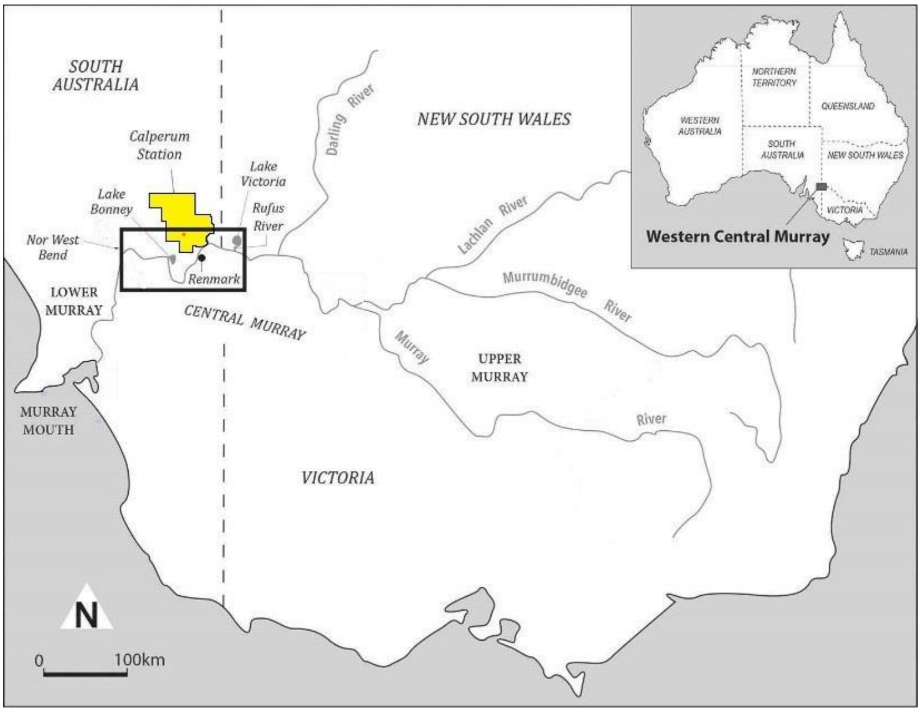

Figure 2 Calperum Station, part of the western-central River Murray/Riverland region; the small red square indicates the approximate locations of West Woolpoolool and the Telegraph Insulator sites. Adapted from Burke et al. (2016:149).

Raw materials suitable for the manufacture of stone artefacts are not specifically known within the study area. However, thick seams of knappable chert and silcrete are present in the Karoonda Surface, which outcrops along the nearby Murray Valley cliff lines (Bowler et al. 2006:171–172; Gill 1973:32–33; Thredgold 2017:62–63). Chert may also have been available from the Springcart Gully region (Pilling 1958:101), approximately 15–20 km from Calperum Station.

For the majority of the time since European settlement, Calperum Station has been used primarily for pastoral activities (Linn 1995:123) and been part of several different leases taken up by various leaseholders (Land Titles Office n.d.). Some Aboriginal peoples in earlier post-contact periods lived and worked on the Station, primarily as labourers (Roberts et al. in prep. 2021). In 1846, Albermarle Bertie Cator obtained the first pastoral lease of a broad area inclusive of Calperum Station, which was then referred to as either Ral Ral or Bookmark (Land Titles Office, n.d.:2). Subsequent leaseholders included William Finke, John Chambers and Richard Holland, who, in the mid-1860s, divided the property into two stations which he named Chowilla and Bookmark[1] (Department of Environment and Natural Resources 1995:8–9). Upon retirement in 1896, Holland transferred the lease to his step-sons John, William and Robert Robertson, whereupon John Robertson changed the name of Bookmark Station to Calperum Station (Department of Environment and Natural Resources 1995:8–9). In later times the area was occasionally referred to as 'Calperum outstation' (*Murray Pioneer* 16 November 1944:1) and in 1993 Calperum Station was leased by the Chicago Zoological Society and the Australian Government (Department of the Environment and Energy 2019). Currently the property is a working ecological station dedicated to the conservation and preservation of Aboriginal sites and a range of rare and threatened wildlife species (Australian Landscape Trust 2019).

[1] 'Chowilla' is an anglicised version of the Erawirung word 'Tjauwala,' meaning 'place of ghosts and spirits' (Tindale c. 1934–c. 1991). 'Bookmark' derives from the Aboriginal word *pukumako*, translating to 'flint-stone axe' or 'sandstone grit hole' (Manning 2006:62).

Bottle glass for the manufacture and use of artefacts may have been sourced in several ways by Aboriginal peoples. From the mid-late nineteenth century the former Ral Ral Hotel, no longer standing and nowadays the site of the offices and accommodation at Calperum Station (*Murray Pioneer* 16 November 1944:1), operated as a welcome relief for locals and workers on the mail exchange during their regular route from Adelaide to Wentworth (*Murray Pioneer and Australian River Record [Renmark 1913–1942]*:13 July 1928). The abundant glass available from the surrounds of the Ral Ral Hotel would almost certainly have been the most accessible source of European bottle glass for Aboriginal peoples in the early post-contact period. Bottles discarded by overlanders[2] before overlanding in the region ceased by around 1850 (Roberts et al. in prep. 2021), may have been another early source, as may refuse from Calperum Station and the adjacent Chowilla Station over various periods. Some of the glass retrieved for this analysis was of the kind commonly referred to as black, but which was in fact dark green and manufactured from the seventeenth century until 1880 (Burke et al. 2017:449; Jones 1986:11–15; Jones and Sullivan 1989:14). Other glass retrieved was amber, manufactured from c. 1875–1900 and since 1914 (Hutchinson 1981:154; Lockhart 2006:50). These periods of manufacture do not provide precise time frames for any dark green Calperum Station glass artefacts because such pieces could have been used before or after 1880. However, the amber pieces can only have been used following their initial manufacture in c. 1875, which is around four decades after permanent European colonisation of the region.

The probable source of the flaked porcelain was insulator material on the overland telegraph line, first established in 1872 (Moyal 1984:53) then extended across the Riverland region by 1882 (Woolmer 1986:45–46). The site at which the porcelain was observed was along the telegraph line, which was within three kilometres of the main site for this study (West Woolpoolool).

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[2] 'Overlanders' refers to Europeans who drove stock across land, typically for selling at the destination point. In the context of this research it refers primarily to those travelling on the Overland Stock Route from Sydney to Adelaide.

Further, several reports exist of Aboriginal peoples in other parts of Australia targeting porcelain insulators (Balfour 1903; Moyal 1984:54; Noone 1949:112; Veth and O'Connor 2005:5).

The geomorphology of the study area has been examined by Westell et al. (2020) and is currently being investigated in a doctoral project by Craig Westell. At present, it is known that, like other parts of the broader River Murray region, such as the Chowilla floodplain in nearby north-western Victoria (Murray-Darling Basin Authority 2012:2, 13), the Calperum floodplain has been and continues to be subject to a range of fluvial, aeolian and lacustrine processes. These processes have resulted in a complex geomorphology consisting primarily of floodplains, levees, lakes, lunettes, dunes, creeks, sand sheets and anabranches (Prendergast et al. 2009). Flooding cycles, caused by the simultaneous transport of water from monsoonal rains down the Darling and Murray Rivers (Pate 2017:130), have had particularly significant impacts on mobility patterns, with past Aboriginal inhabitants of the Calperum Station region occupying higher ground during yearly floods and lower floodplain settings at other times (Jones et al. 2017:51, 56). The same response was evident in the Katarapko-Eckert Creek region, around 25 km southwest (Wood et al. 2005). According to Westell et al. (2020:4), there have been several distinct hydrological phases over the last c. 50,000 years: (i) relative humidity from c. 50,000–35,000 BP; (ii) increasing cooling and aridity beginning at around the Last Glacial Maximum and continuing until c. 12,000 BP; (iii) a 'wetter' period from the early Holocene to the mid-Holocene; and (iv) greater variability and aridity through the late Holocene.

1.6 Site Descriptions

All stone and glass artefacts analysed in this thesis were retrieved from West Woolpoolool, while all of the porcelain artefacts were recovered from the Telegraph Insulator Site, approximately three kilometres away (Figure 3). In accordance with the wishes of RMMAC and the requirements of the *Aboriginal*

Heritage Act (South Australia) 1988, coordinates are not revealed here, but site descriptions are permitted.

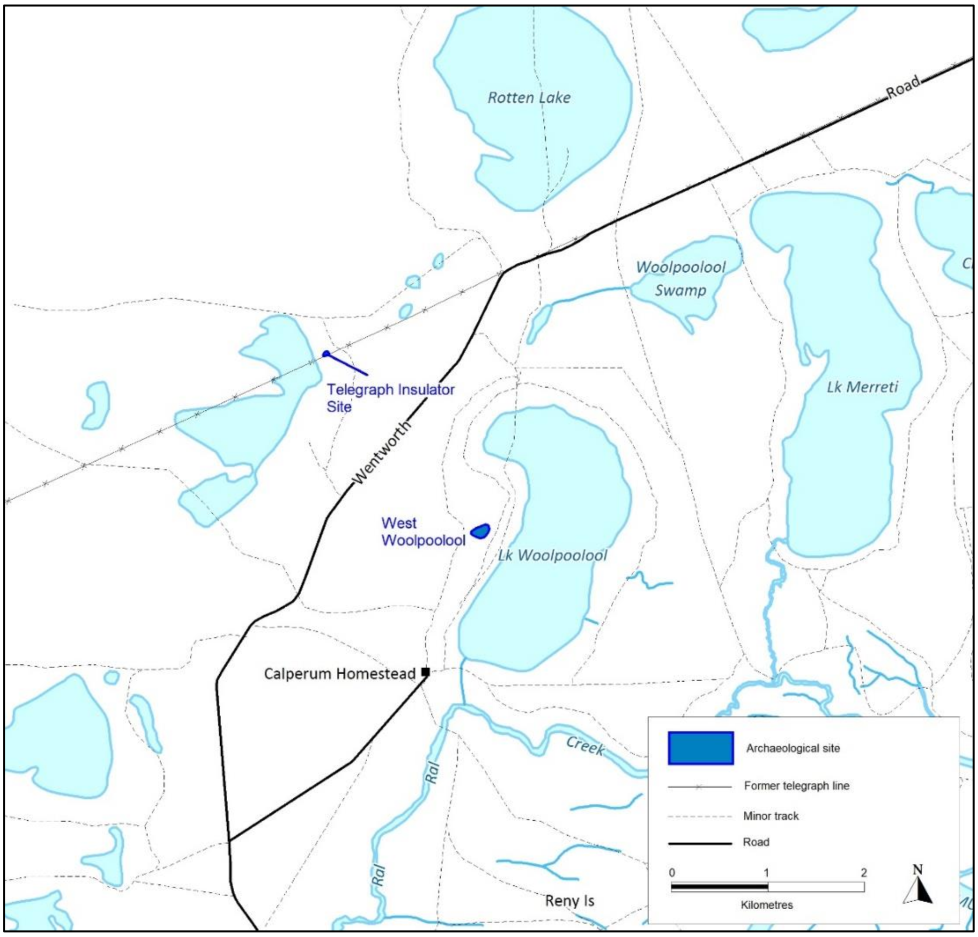


Figure 3 The locations of the two sites involved in this thesis: West Woolpoolool and the Telegraph Insulator site. Adapted from a map created by Craig Westell.

1.6.1 West Woolpoolool Site

West Woolpoolool is an open-air, surface site around two kilometres from the former major thoroughfare for European pastoralists and overlanders (now the Calperum Station offices—marked as 'Calperum Homestead' in Figure 3). The site (Figure 4) is a sandy substrate with an extensive scatter of stone and glass artefacts, some middens and a solitary (non-diagnostic) clay pipe stem. Burials are present less than 20 metres beyond the site boundary. Of the 62 artefacts analysed in this thesis, 54 were retrieved from this site, which is located on a high terrace west of Lake Woolpoolool, a seasonally flooding brackish lake salinised in the 1950s (Steggles et al. 2003). Westell et al.

(2020:6, 12) obtained three radiocarbon estimates on densely packed shell (*Velesunio ambiguus*) from the surface of West Woolpoolool and a fourth from a sample located 115 m south. The dates range from 897–722 cal. BP (OZX283) to 9,460–9,144 cal. BP (OZX284) (Westell et al. 2020:7), and provide a broad but not complete time frame for potential human occupation because the bottle glass artefacts (and the clay pipe stem) are post-contact materials. However, the dates suggest that most of the stone artefacts are probably from the pre-contact period.

a

b **c**

Figure 4 West Woolpoolool in 2019. ***A****: the site, facing west (author visible); photo: Catherine Morton.* ***B****: three chert flakes.* ***C****: a ‘black’ (dark green) bottle glass artefact.*

Erosion has probably been accelerated by European activities, with cattle and burrowing animals (introduced and endemic) potentially disturbing the ground. There was no evidence of aggradation, which is supported by further radiocarbon dates obtained by Craig Westell (yet to be published), that demonstrate the exposure on the surface of approximately mid-Holocene middens (Craig Westell, pers. comm. 2021). Flooding has probably had relatively little effect on the movement of surface artefacts, given that suspended silt and clay sediment loads indicate that modern flows are low energy (Thredgold et al. 2017:105). Because the oldest stone artefacts are probably pre-contact they would have been subject to the greatest duration of weathering (since surface exposure). The bottle glass artefacts, being post-contact and potentially never buried, have been subject to a maximum of around 180 years of exposure to sun, rain and wind. Similarly, given the construction of the telegraph line commenced in the region in 1882 (Woolmer 1986:45–46), the porcelain shards at the Telegraph Insulator site can only have been exposed on the surface for a maximum of around 145 years.

The Aboriginal meaning of 'Woolpoolool' has been recorded as 'place of milk-like mud' (Manning 2006:469). West Woolpoolool is located, like many others in contact and post-contact Australia, on the margins of a European settlement: around 2 km from the location of Ral Ral Hotel (now Calperum Station homestead, as mentioned above). Lake Woolpoolool is part of the linear dune system of the Woorinen Formation, one of several dune systems of the Western Murray Basin (Lomax et al. 2011:724–725; Pell et al. 2001:151). The Western Murray Basin formed in distinct phases, beginning around 380,000 BP and extending to the Holocene (Lomax et al. 2011:724–725, 731).

1.6.2 Telegraph Insulator Site

Around five kilometres from the former European thoroughfares and three kilometres north-west from West Woolpoolool is the Telegraph Insulator site: a 5 x 3 m surface scatter of porcelain telegraph insulator material, from which seven shards and a near complete insulator were recovered (Figure 5). While several further fragments and another entire insulator lay some 30 metres away (not part of the site), they were in direct association with wooden pylons that may have been an unused stockpile of former telegraph poles (Figure 5). Because of the added potential of these further fragments to have been damaged naturally, possibly as the pylons fell, only the material from the 5 x 3 m area was selected for analysis. No other archaeological material was present at the Telegraph Insulator site and the nearest reliable water source, Lake Woolpoolool, was around two kilometres away (the lake alongside, visible to the west in Figure 3, is salty).

a

b

c

*Figure 5 Telegraph Insulator site (A–B). **A**: several porcelain shards. **B**: a near complete porcelain telegraph insulator. **C**: wooden pylons around 30 metres away from the site.*

1.7 Significance of Thesis

This thesis is significant for several reasons. First, relatively little archaeological research has been undertaken in the Riverland despite this being a region of early, prolonged and extensive cultural contact. Second, historical evidence derives from European perspectives only (Anon. 1841a:2; Anon. 1841b:3; Anon. 1841c:9; Buchanan 1923:63, 72–73, 75; Coutts Crawford 1839; Eyre 1845 2; O'Halloran 1841:82, 84–89; O'Halloran 1904:74, 79, 84–91; Sturt 1849:86–87), and the inclusion of TO knowledge in this thesis assists in redressing this imbalance. Third, this research adds to understandings about behaviour concerning cross-cultural interaction, which recent studies elsewhere indicates is highly complex (Berrojalbiz 2018; Birmingham and Wilson 2010:19–27; Carroll 2011; Challis 2012:266, 268, 270; Croucher 2011; Curthoys and Martens 2013; Dietler 2010:39–40, 50–53; Flexner 2014; Gosden 2004; Jordan 2009; King 2017a; Lawrence and Davies 2009; Lawrence and Shepherd 2006:59; Mulvaney 2018:248–249, 255, 258–261; Ouzman 2005; Panich 2013; Panich and Schneider 2015; Paterson 2011, 2014; Reynolds 2006; Ryan 2013; Schneider 2015; Silliman 2005; Spielmann et al. 2006; Sundstrom 2012:335–336; Turner 2018; Van Buren 2010; Wang and Marwick 2020). Fourth, the primary research question for this thesis concerns technological and other behavioural adaptability, which has been a central focus in the discipline of prehistoric archaeology over many decades (Balme 2000:4; Brumm 2011; Hamm et al. 2016:280–282; Hiscock 1994, 2002; Hiscock and Wallis 2005; Hiscock et al. 2016:2, 5; Langley et al. 2016:200, 208, 210–211; Marwick 2002:25–29; Morse 1993:877–878; Munt et al. 2018:75–77, 81; Slack et al. 2009:33–34; Smith 2006; Smith et al. 2017; Thorley et al. 2011:47–49; Veth 1989, 1993). Finally, experimental data from this thesis can be used in other studies to assist functional interpretations of chert, silcrete, glass and porcelain artefacts.

The recording of oral histories and the field demonstrations of glass tool-use by TOs enabled important cultural experiences and knowledge to be preserved for future generations and the scientific information to be supplemented. Although steel and other items are now readily available, glass tools are still used by some RMMAC members, whose knowledge derives from that shared by previous generations (Philip Johnson, pers. comm. 2019; Timothy Johnson, pers. comm. 2019). Living memories, therefore, provide new narratives about the nuances of past stone and glass technological behaviour that are unattainable through solely archaeological means, adding information about the origins of a cultural practice whose legacy is ongoing in the form of contemporary implementation. These memories enabled holistic inferences to be made about the nature of change/continuity in the Aboriginal use of stone, glass and porcelain technology in the Riverland region.

Although not a major focus of this thesis, the use of laser scanning confocal microscopy (LSCM), in supplementing observations made under conventional optical microscopes, represents the first attempt to quantify the microtopographic depths at which polish and abrasive smoothing are present on Aboriginal flaked glass and porcelain artefacts. LSCM has previously been used effectively for such quantifications for chert and other stone materials (e.g., Álvarez-Fernández et al. 2020; Evans and Donahue 2008; Evans and MacDonald 2011; Farber 2013:28–30; Ibáñez et al. 2014; Macdonald and Evans 2014; Pedergnana et al. 2020; Stemp and Chung 2011; Stemp et al. 2013:31–32; Stevens et al. 2010), but nonetheless is currently in its infancy as an application to archaeological projects. Due to a lack of application of LSCM to post-contact materials, it was not known whether this method would be viable, let alone effective, for glass and porcelain.

1.8 Thesis Outline

The remainder of this thesis consists of nine chapters. Chapter Two begins with a discussion of previous studies at Calperum Station and the broader region before briefly reviewing existing knowledge concerning the nature of frontier contact between Europeans and Aboriginal peoples in the western-central River Murray/Riverland area. Consideration is then given to the concepts of colonialism, resistance and adaptation and the appropriateness of their application to this study. Examples of the Aboriginal adoption of introduced materials elsewhere in Australia are then outlined, with an emphasis on the use of glass and porcelain. The chapter concludes with a discussion concerning the manner in which aspects of middle-range theory apply to this thesis.

Chapter Three focusses on previous studies of Aboriginal glass artefacts, initially considering known past uses. Limitations in the ability of macroscopic observations to diagnose pieces of glass as artefacts are then addressed. Finally, descriptions are provided of methods that may, in certain circumstances, be used to obtain broad dates for the manufacture of particular glass bottles. Using such methods has the potential to indicate the approximate oldest dates at which any shards deriving from the bottles at Calperum Station were used.

Detailed discussions of the literature concerning the nature of use-wear, the manner in which it can be analysed and the information it may provide, are the focus of Chapter Four. Following descriptions of the artefact raw materials relevant to this research, consideration is given to the microscopic identification of wear resulting from taphonomic influences. Discussion then concentrates on the behavioural information obtainable from the analysis of each main form of use-wear: polish and smoothing, striations, edge scarring and edge rounding. Previous research is addressed as it relates to the use-wear on chert, silcrete, glass and porcelain tools. Initially, use-wear resulting from the working of wood is discussed separately because this material is not only known to have been regularly used by past groups across a range of settings but because tools were used to work wood with a particularly wide range of motions. Thereafter, summaries are given of the typical use-wear on tools of each raw material after the working of hide, bone, meat and plant (*Typha)*, as these materials were commonly available historically in the study area. Because some tools from many given assemblages may have been hafted, wear resulting from hafting is then briefly described. Finally, residue analysis is briefly discussed. Residue analysis was not conducted in this research because although ‘ancient’ residues can survive in certain circumstances in open, sandy substrates (Birgitta Stephenson, pers. comm. 2018; Cooper and Nugent 2009:210–211, 215–222; Langejans 2010:980; Owen et al. 2019:186), survival is relatively rare (Langejans 2010:980, 982; Langejans and Lombard 2015:201; Lombard and Wadley 2007:164; Owen et al. 2019:185; Rots et al. 2004:1297–1298), and initial inspection of the artefacts, followed by low-magnification screening, suggested that there were no such residues present. Regardless, given its close relationship with use-wear analysis and its potential for future research at the Station, emanating from this thesis, a brief consideration is warranted.

All methods used in this thesis are described in Chapter Five. The nature of decisions made during fieldwork are initially discussed, particularly in terms of the rationale for artefact sampling, followed by details concerning artefact storage. After an initial outline of procedures undertaken for trampling experiments and the on-site TO wood-working demonstration, the suite of practices implemented for the tool-use experiments is described. Principles guiding the experiments are then outlined, after which the chapter concentrates in detail on the methods used for the use-wear analysis—which applied to both the experimental and archaeological assemblages. This discussion also concerns decisions made during the screening of the archaeological artefacts in the laboratory (which followed initial screening in the field), and artefact cleaning and preparation procedures.

In Chapter Six, results are presented from the analysis of the experimental assemblage. This includes the 40 flakes from the trampling experiment, two from the demonstration by TOs and 106 from the tool-use experiments. Excerpts from the cultural memories of the TOs are included when related to the given tool and worked materials. For the tool-use experiments, the results are categorised according to the tool raw material (chert, silcrete, glass and porcelain) and worked material (wood, bone, hide, plant and meat).

Chapter Seven provides the discussion about the experimental results. The use-wear is considered, in conjunction with understandings from previous experiments and analyses, in terms of how it can inform interpretations of the archaeological assemblage.

Results from the analysis of the archaeological assemblage are outlined in Chapter Eight. Observations are categorised according to artefact raw material and detailed for each individual artefact.

The archaeological assemblage is discussed in Chapter Nine. Initially, several issues arising from previous discussion are considered. Thereafter, interpretations are made for tool uses across each tool raw material, based on comparisons with the experimental assemblage and previous studies. Answers are provided for the research question, with inferences made concerning technological adaptations made by past Aboriginal peoples at Calperum Station as well as reasons for the changes. Concluding this chapter is a discussion of the limitations of this thesis and future research directions that could be pursued based on knowledge gained.

Conclusions are made in Chapter Ten, concerning how the use-wear evidence provides original knowledge about the manner in which Aboriginal peoples at these sites in the Riverland incorporated introduced materials. Inferences are provided for the nature of continuity or change in pre-existing tool-working techniques, and for consequent implications concerning Aboriginal technological autonomy. Reflections are offered about the extents of visitation to each site and the value of the trampling and tool-use experiments. Finally, comments are made about the significance of incorporating TO knowledge in use-wear investigations.

Chapter Two: Background and Theoretical Context

This chapter provides the contextual background for the thesis. Initially, an overview of previous studies related to the Calperum Station region is presented, followed by brief outlines of past archaeological projects concerning the broader River Murray region. Discussion then focusses on the nature of contact between European and Aboriginal peoples around the western-central River Murray/Riverland region, of which Calperum Station is a part. The argument is made that it is more pertinent and informative for this research to address the question of how Aboriginal peoples' use of introduced glass and porcelain represented adaptation to the colonial presence in the landscape, rather than to attempt to infer motives that were direct responses to specific colonialist practices. Finally, I discuss how aspects of middle-range theory are used in this thesis.

2.1 Previous Studies in the Study Area

A range of projects in recent decades have examined the archaeology of broader South Australian and interstate regions along the River Murray and Murray-Darling Basin (Balme and Beck 1996; Berryman and Frankel 1984; Bonhomme 1990:51, 74; Buchan 1980:43; Coutts et al. 1979:61, 78, 80, 82; Garvey 2013; Johnston 2004:50; Klaver 1998:219–220; Lane 1980:113; Martin 2006:127, 144; Simmons 1980; Sullivan 2014; Tutty 2020; Westell and Wood 2014:45). Archaeological studies focusing on Calperum Station began in 2014, with several projects having been completed (Dardengo 2019; Dardengo et al. 2019; Jones 2016; Jones et al. 2017; Roberts et al. 2020a, 2020b; Ross 2018; Ross et al. 2019) and others in progress.

Thredgold (2017:64–78) and Thredgold et al. (2017:110) conducted a technological analysis of stone artefacts on and within a radius of 10 m from 13 different earth mounds at Calperum Station. There were no glass or porcelain artefacts and the mounds were not at West Woolpoolool or the

Telegraph Insulator site. Rather, the mounds were identified, in conjunction with Jones (2016), at other sites within Calperum Station: Reny Island, Hunchee Island, Hunchee Creek and Ral Ral Creek. Like West Woolpoolool and the Telegraph Insulator site, almost all of these mound sites were several kilometres away from the main European thoroughfare. Thredgold (2017) and Thredgold et al. (2017) did not address use-wear or issues related to new technological material in the contact or post-contact periods (because only stone artefacts were present at sites that they investigated). Rather, they focused on the nature of stone artefact manufacture, finding that lithics associated with mounds were low in density, dominated by small (typically <20 mm), unmodified chert and silcrete flakes, and that such characteristics supported previous arguments by Coutts et al. (1979:57), Johnston (2004:56) and Westell and Wood (2014:31, 50, 56–57), that River Murray mounds were typically used for cooking events and shorter visits rather than as regular camping places. Chert flakes were small probably because local seams of chert are often narrow in the environment (e.g., Grist 1995: 36, 44), while bands of silcrete tend to be somewhat larger (e.g., Grist 1995:35–36, 44), leading to larger silcrete lithics (Thredgold et al. 2017:113).

For Thredgold (2017) and Thredgold et al. (2017), the Calperum Station lithics shared similar characteristics to those from other River Murray mounds. The overall small nature of the lithics appears to be consistent even with those at sites distant from the Calperum region, such as Barmah Forest, Victoria (Bonhomme 1990:73–74), Nyah Forest, north-west Victoria (Coutts et al. 1979:55–57, 61–62), Lake Boort, north-west Victoria (Johnston 2004:52), Caramut and Mt William in south-western Victoria (Williams 1988:115–116, 201–202), the Murrumbidgee riverine plain in south-central NSW (Klaver 1998:203, 206–207, 209, 213, 217) and the Hay Plain, also in south-central NSW (Martin 2006:127, 144, 218–223). Bipolar flaking was another common characteristic across Calperum Station (Thredgold 2017:126) and a range of other River Murray mounds (Bonhomme 1990:73; Johnstone 2004:53–56; Klaver 1998:209, 211–213, 217; Martin 2006:127–128, 130–131, 144; Williams 1988:110, 197).

Thredgold (2017:140) and Thredgold et al. (2017:110) inferred that the Calperum Station lithics in association with earth mounds were used for food-processing activities. They inferred this primarily because the assemblage was dominated by small, unretouched flakes and because previous experiments by Walker (1978:713) had demonstrated that unretouched flakes were more effective than retouched flakes for animal butchery. Zupancich et al. (2018:266) also found that unretouched tools were preferred for animal butchery, albeit from earlier hominins during the Acheulean period. In contrast, butchery experiments by Schoville et al. (2016:17) and Kamminga (1982:32–34, 117–119) demonstrated that the edges of some unretouched flakes became blunt relatively quickly (e.g., tool #20, silcrete; Kamminga 1982:118). However, in circumstances where raw material is readily available, it may have been easier to replace unretouched flakes as necessary rather than expend considerable effort in manufacturing retouched flakes. This thesis does not focus on lithics around earth mounds but food processing is one of several potential activities for which artefacts at the study sites may have been used.

Taphonomic processes around earth mounds were identified as a significant issue by Thredgold (2017) and Thredgold et al. (2017:105–107). The primary difficulty was human and animal trampling that probably occurred when Calperum Station was used for pastoral activities from 1846–1993 (Sinclair 2001:90; Thredgold et al. 2017:105). For Thredgold (2017:105) and Thredgold et al. (2017:102, 103, 106, 115), the low lithic numbers near mounds were more likely due to trampling and other taphonomic processes, as well as a local lack of stone suitable for flaking and the potential use of shell and other items instead of stone for cutting and similar purposes.

Trampling can indeed cause artefacts to move downwards in the stratigraphy (Cahen and Moeyersons 1977; Eren et al. 2010; Gifford-Gonzales et al. 1985; McBrearty et al. 1998; Nielsen 1991; Richardson 1992; Shea and Klenck 1993:191–192). However, there is no reason why trampling and the use of items other than stone would minimise the visibility of lithics in association with earth mounds more so than for other landforms. In any case, numerous pedestrian surveys undertaken for this and concurrent projects at Calperum Station demonstrated that even if trampling limited the surface visibility of the lithics in some areas, stone artefacts on other landforms were still ubiquitous. Experiments were also undertaken in this thesis to further understand the potential impacts of trampling on stone, glass, and porcelain artefacts.

The lack of suitable lithic raw material does not appear to be a convincing reason for the low lithic numbers near earth mounds, but the use of shell (as an alternative to stone) may be part of the explanation. Observations during field surveys for this thesis attest to an abundance of chert and silcrete artefacts across a range of landforms at Calperum Station, including near earth mounds. No reason was evident for an inability of people to carry these raw materials over short distances to earth mounds. Recently, Roberts et al. (in press 2021a) excavated two freshwater mussel shell artefacts at Calperum Station (reported as probably *V. ambiguus*): a perforated fragment dating to 770–738 cal. BP and a serrated piece dating to 624–517 cal. BP. Although there was no evidence that either artefact had been used, Roberts et al. (in press 2021a) inferred that use may have been intended but ultimately prevented by the delamination of the perforated shell during manufacture and by errors during the production of the serrated shell. Regardless, the recovery of the shell artefacts suggests that others may be present under the surface in the study area and have been used at times as an alternative to stone.

The manufacture and use, at Calperum Station, of tools from materials other than stone would be consistent with similar evidence from adjacent River Murray regions. Roberts et al. (in press 2021a) also excavated a perforated freshwater mussel shell near Murray Bridge, some 200 km south-west, and early Europeans observed Aboriginal peoples from various Lower River Murray regions using shell to cut a range of materials (Angus 1847:55, 66–67, 92, 96; Beveridge 1883:43–44). Further archaeological evidence for the use of shell tools also exists from sites further east of the study area, along the River Murray (Bonhomme 1990; Klaver 1998:196). Lower River Murray peoples also used avian materials, such as bones, for tools, ornaments, oil, toys, ceremonies and rituals (Hale and Tindale 1930; Hutchinson 2012; Wilson et al. 2021). For example, emu bone was used as an awl to make nets (Berndt et al. 1993:271; Clarke 2018a:29–42; Eyre 1845 2:166–167; Harvey 1939).

Thredgold (2017) and Thredgold et al. (2017) made several further inferences concerning the Calperum Station lithics. Flaking strategies were largely basic, evidenced primarily by the absence of formal tool types aside from one chert adze, and by a lack of platform preparation (Thredgold et al. 2017:114). Only one knapping floor was observed, but Thredgold (2017:124) speculated that more on-site knapping probably occurred, despite the absence of debitage, based on the presence of heavily reduced cores and 18 cone-split flakes. Cone-split flakes have previously been identified as knapping debitage (Doelman 2005a:56), and are unlikely to be caused by taphonomic processes (Hiscock 1988:365–366; also argued by Thredgold 2017:123). Thredgold (2017:125) cast doubt on the extent to which lithics associated with the earth mounds were used for wood-working, based on her observation of a dearth of adzes—a tool commonly associated with this activity (Akerman 2006:339; Harrison 2003:318; Hiscock 1994:270; Maloney 2021:7, 13–14; Maloney and Dilkes-Hall 2020; McCarthy 1976:31–34; Veth et al. 2011b:7, 9). While this was a reasonable inference within the context of a technological analysis, the possibility of wood-working and other uses is directly testable in the present thesis via use-wear analysis across a broad range of artefact raw materials.

Incerti (2018) analysed lithics, using technological approaches, from a wider spectrum of landforms at Calperum Station, producing similar results and interpretations to Thredgold (2017) and Thredgold et al. (2017). Four of her sites were adjacent to the earth mounds investigated by Thredgold (2017) and Thredgold et al. (2017), while three were in different locations (Figure 6). She concurred that the considerable proportion of breakage in the lithics was attributable to taphonomic processes rather than artefact manufacture, and that flaking strategies reflected efforts to conserve and maximise the use of raw materials given their short supply (Incerti 2018:108–111, 113, 116–118). Silcrete was the dominant raw material, followed by chert, the vast majority of flakes were unretouched, and the average length and width of all flakes was less than 20 mm (Incerti 2018:62, 69, 91, 111). Flaking strategies were generally basic, albeit with some core rotation, and lithic frequency was significantly greater on landforms other than earth mounds, possibly because of a combination of underlying geomorphological processes and an occurrence of more intensive knapping in lacustrine environments (Incerti 2018:115–116). Like Thredgold (2017:120, 122, 133, 139–140), Incerti (2018:111) suggested that the lithics were used for food-processing activities. Table 1 displays the main results from the analyses of Thredgold (2017), Thredgold et al. (2017) and Incerti (2018).

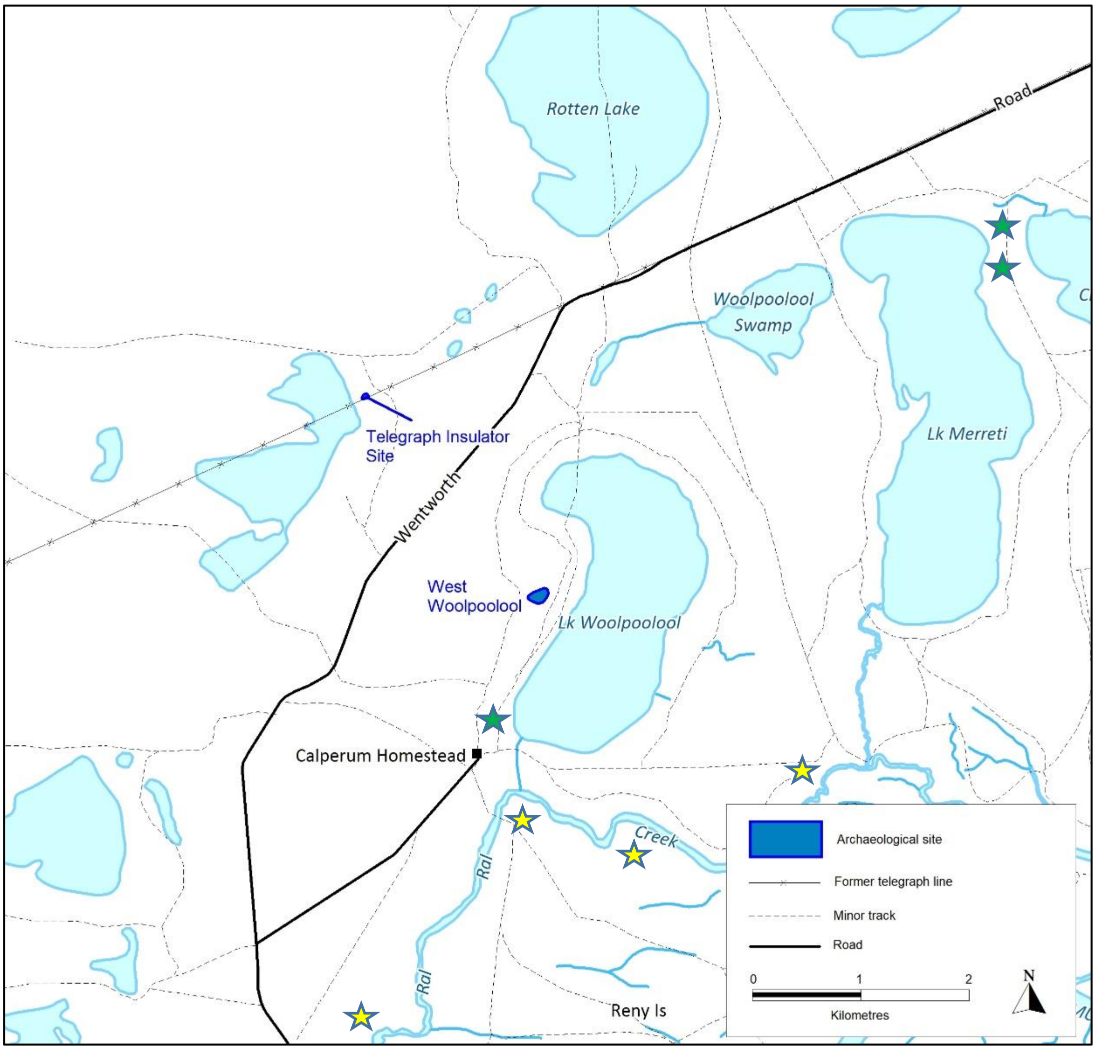


Figure 6 Locations of stone artefact sites from previous projects, along with the sites investigated in this thesis. Yellow stars = Thredgold (2017), Thredgold et al. (2017) and Incerti (2018). Green stars = Incerti (2018). Adapted from Figure 3.

Table 1 Comparison of results from technological analyses of stone artefacts from other Calperum Station sites, by Thredgold (2017), Thredgold et al. (2017) and Incerti (2018).

Lithic Classification	**Thredgold (2017)/ Thredgold et al. (2017)**	**Incerti (2018)**
Total number of artefacts *	195	157
Flakes: total number **	111	93
Flakes: complete/broken **	32 complete (29%) 79 broken (71%)	52 complete (56%) 41 broken (44%)
Flakes: unretouched/retouched **	101 unretouched (89%) 10 retouched (11%)	88 unretouched (95%) 5 retouched (5%)
Flakes: average length, width, thickness (mm) **	17 length (width and thickness unspecified but appear to be < 20 and ~ 5 respectively; Thredgold 2017:89–90, 93–94)	19 x 17 x 5
Flakes: raw material frequency **	Silcrete: 66 Chert: 62 Quartz: 2	Silcrete: 60 Chert: 31 Quartz: 2
Flakes: raw material total weight (g) **	Silcrete: 378 Chert: 111 Quartz: 1	Silcrete: 455 Chert: 108 Quartz: 8
Flakes: platform preparation (rare/moderate/frequent) **	Rare	Rare
Cores: total number	12	8
Cores: raw material frequency	Silcrete: 5 Chert: 7	Silcrete: 3 Chert: 4 Quartz: 1
Cores: raw material total weight (g)	Silcrete: 316 (excl. 1 x 1000 g outlier) Chert: 66	Silcrete: 92 Chert: 31 Quartz: 1
Cores: directionality/reduction	8 = bipolar/multidirectional 4 = bipolar/unidirectional	6 = bipolar/multidirectional 2 = bipolar/unidirectional
Flakes and cores combined: raw material frequency **	Silcrete: 79 Chert: 69 Quartz: 2	Silcrete: 65 Chert: 35 Quartz: 3
Flakes and cores combined: raw material total weight (g) **	Silcrete: 694 (excl. 1 x 1000 g outlier) Chert: 177 Quartz: 1	Silcrete: 547 Chert: 139 Quartz: 9
Flakes and cores combined: cortex (rare/moderate/frequent) **	Rare	Rare
Flakes and cores combined: flaking strategy 'basic'/'complex')	Mostly basic	Mostly basic

* However, some were designated as 'heat shatter' and potentially non-artefactual, and others were classified as 'non-diagnostic shatter'

** Excluding 'heat shatter' and 'non-diagnostic shatter'

Jones (2016) and Jones et al. (2017) analysed late Holocene earth mounds at Calperum Station, seeking to understand the nature of past Aboriginal use of the environment. Of the 32 mounds they observed, Jones et al. (2017:39, 53) interpreted 27 as oven mounds, formed each time by the repeated use of a discrete area for cooking and other food-processing activities, as evidenced by the consistent presence of clay heat retainers and food remains such as shell. All mounds were located on natural levees near active river channels and billabongs, and shell middens, lithic scatters, isolated lithics and mussel shell were typically present in association, albeit not always in abundance (Jones et al. 2017:33, 48). Ultimately, Jones (2016:110) and Jones et al. (2017:56–57) argued that the earth mounds at Calperum Station represented shorter-term food-processing locations rather than occupation sites.

For Jones et al. (2017:51, 56), the location and nature of the Calperum Station earth mounds reflected the seasonal exploitation of aquatic resources according to cyclic flooding events, similar to evidence from earth mound studies from various locations in Victoria and NSW. Jones et al. (2017:51) concurred with ethnographic observations (Beveridge 1889:32–34; Kenyon 1912:102; Mitchell 1839 2:53, 60, 80–81, 134) that the seasonal availability of *Typha* was a critical factor at Calperum Station because this plant root was cooked for consumption and also used for other fibre-processing activities. Aboriginal people in the Calperum Station region may thus have lived in a semi-sedentary manner, moving to and from the floodplain and elevated grounds according to the timing of floods (Jones et al. 2017:51, 56). However, debates are ongoing about archaeological evidence that may be indicative of sedentism, as this is not a straightforward issue, with some concluding that semi-sedentism/sedentism was increasingly common in the broader River Murray region (and across much of the country) from the mid-late Holocene onwards (Pardoe 1988; Pate 2006:229; Pate and Owen 2014:91), while others argue that the extent of sedentism has been exaggerated (Hill et al. 2020:231–232; Littleton and Allen 2007).

After examining the potential of geophysical techniques for analysing earth mounds, Ross (2018:138–143) and Ross et al. (2019) concurred that the mounds were probably used repeatedly for food-processing activities and not as camp sites. Ross's (2018:93, 127) use of geophysical techniques enabled him to identify probable sub-surface heating elements, and, based on the presence of fire-altered material in association with these and surface heating elements on and within all mounds from his survey, he inferred multiple earth oven 'rake outs' and therefore repeated site use (Ross 2018:139).

Dardengo (2019) and Dardengo et al. (2019) analysed the attributes and spatial distribution of culturally modified trees ('scarred trees') at Calperum Station so as to examine the nature of Aboriginal peoples' use of bark from before and after European contact. Bark had been used extensively by Aboriginal peoples across Australia prior to European colonisation (Basedow 1914; Curr 1883:90–91; Klaver 1998:223; Roth 1908:161), and Dardengo (2019:98–99, 109–110) and Dardengo et al. (2019:61) concluded that both continuities and changes were evident in bark use. Aboriginal peoples around Calperum Station continued to manufacture bark items based on traditional methods, but also adapted their technology to incorporate steel axes, which were also used to remove bark.

Dardengo's (2019:109) observations led her to conclude that most pre-contact axe marks were on black box trees (*Eucalyptus largiflorens*) whereas after European contact, most were on river red gum trees (*E. camaldulensis*). Dardengo et al. (2019:61) suggested that the change may have been due to two potential factors: (i) an imposition, by European settlers, of restrictions upon Aboriginal peoples around Calperum Station to the floodplain areas where the red gum trees were more readily available; and/or (ii) a reduction in the availability of red gum trees as a result of European riverboat and woodcutting industries. However, despite the general change in resource procurement, Dardengo et al. (2019:61) identified, based on the sizes of scars in the trees, that red gum trees continued to be targeted post-contact for the production of canoes. The continuities and adaptations in bark use demonstrates that Aboriginal peoples around the Station incorporated new steel axes but also maintained many pre-existing production methods.

During field surveys for this thesis in September 2018, a solitary flaked tektite was located in association with lithics and middens some 0.5 km to the north of the sites studied here. Tektites, also known as 'australites,' are highly siliceous natural glass (Rapp 2009:53, 197) used by Aboriginal peoples in traditional healing practices, as message stones, for the production of formal tool types, for their aesthetic and ornamental value and for what were considered to be magical properties (Akerman 1975:117–118; Baker 1957:1, 17; Clarke 2018b; Harrison 2003:312; McNamara and Bevan 2001:27–28; Rowland 2014:4). The process for obtaining legislative permission to retrieve the Calperum Station tektite (for potential purposes such as laboratory use-wear analysis) had not at the time been completed so the recording of technological attributes was performed in the field. On the following field trip, by which time all legislative requirements had been met, the tektite was no longer present, so it was not able to be subjected to use-wear analysis. Nonetheless, the initial field observations confirmed the presence on the 20 x 16 x 0.4 mm tektite of a pronounced bulb of percussion, flaked platform, pitting on the dorsal surface and a minor amount of retouch (Roberts et al. 2020a:77). The find not only extended the known distribution of tektite artefacts in Australia (Roberts et al. 2020a:77), but demonstrated that Aboriginal peoples within the vicinity of the study area used a form of glass prior to European colonisation. In this context, any post-contact bottle glass use by Aboriginal peoples in the study area represents continuity, with some adaptation, in the use of glass technology.

2.2 Contact in the Western-Central River Murray/Riverland, South Australia

The above descriptions and discussions concerning the study area and previous related projects provide contextual background for the present study, but for completeness, the broad nature of contact must also be understood.

Much violence occurred from the 1830s up to at least 1842 in the western-central River Murray/Riverland region, primarily along the Overland Stock Route from Sydney to Adelaide (Anon. 1841a:2; Anon. 1841b:3; Anon. 1841c:9; Buchanan 1923:63, 72–73, 75; Burke et al. 2016; Coutts Crawford 1839; Foster et al. 2001; Hemming 1984:13–15; Nettelbeck 1999; Nettelbeck and Foster 2010:53.1–53.2; O'Halloran 1841:82, 84–89; O'Halloran 1904:74, 79, 84–91; Roberts et al. 2020b:236–237, 244–246, 249; Sturt 1849:86–87; Sullivan 2014). However, it appears that overt physical violence declined considerably following the well-documented Rufus River massacre of 1842 because of a range of measures, such as the governmental supply of rations (Tutty 2020:16, 19, 40, 45–47, 50–64, 107, 109–113, 115).

There were also non-violent interactions. Burke et al. (2016:166–167) described gift-giving of nets, fish and women by Aboriginal peoples to Europeans as conciliatory gestures, and how in return Aboriginal peoples placed great value on many gifted European material items (and potentially 'thieved' European items—although Aboriginal peoples often did not consider their actions as theft, based on their common cultural practice of communally sharing resources; see also Langhorne to O'Halloran 22 June 1841). The South Australian colonial government at times provided Aboriginal peoples with fishhooks, blankets and flour—although, as with similar items provided by some pastoralists, government motives may have been more concerned with placating, rewarding or bribing than gift-giving (Anon. 1847; Anon. 1850; Foster 1989; Tutty 2020:15, 54–55). Another Aboriginal response, which indeed forms a major focus of this thesis, was the incorporation of these new materials, particularly glass and porcelain, into existing technological practices. The historical evidence for multi-faceted, nuanced interactions is discussed in further detail in the next section and demonstrates that colonialist influences and Aboriginal responses to them ranged from overt to subtle and were, in totality, complex.

2.3 European Colonialism

As Europeans and others expanded their empires over the last several centuries, the forces of colonialism affected not only Aboriginal Australians but also a number of cultures across the world in a wide variety of ways (Berrojalbiz 2018; Birmingham 1976:311–316; Birmingham and Wilson 2010:19–27; Carroll 2011; Challis 2012:266, 268, 270; Connor 2010; Croucher 2011; Curthoys and Martens 2013; Delaunay et al. 2017; Dietler 2010:39–40, 50–53; Dowson 1994:332; Flexner 2014; Hauser 2011; Jordan 2009; King 2017a; Lawrence and Davies 2009; Lawrence and Shepherd 2006:59; Llosas 2012:359; Mulvaney 2018:248–249, 255, 258–261; Ouzman 2005; Panich 2013; Panich and Schneider 2015; Paterson 2011; Reynolds 2006; Rowlands 1998:327; Ryan 2013; Schneider 2015; Semelin 2001; Silliman 2005; Spielmann et al. 2006; Sundstrom 2012:335–336; Turner 2018; Van Buren 2010; Wang and Marwick 2020). 'Colonialism' can be conceived of in many guises (Broome 2005; Croucher and Weiss 2011:3–6; Dietler 2010:18–19; Gosden 2004:1–6, 25–26; Jacobs 2009; Paterson 2014:1559; Reinhard 2001:2240; Silliman 2005:56–57), but can essentially be interpreted as one culture attempting to dominate another by means of physical force and/or coercion. Colonialism can involve any combination of social, religious, political and economic practices and, usually, a range of forms of resistance, accommodation and avoidance of such subversion from Indigenous peoples whom colonialists sought to subjugate.

Colonialism can thus manifest in complex ways. In Australia, Europeans exercised legal and systemic efforts to enforce their will on Aboriginal peoples. From the outset, Europeans declared Australia *terra nullius,* so as to enable them to claim Australia for the Crown (Dickey and Howell 1986:43; Gosden 2004:26–30; Kramer 2016:192). Aboriginal peoples were declared British subjects and therefore subjected to British legal and political systems, despite their not being involved in the decision, let alone providing consent (House of Commons 1837:77). A major colonialist goal of the Europeans was to 'civilise and Christianise' Aboriginal peoples (Birmingham and Wilson 2010:18–19;

Foster et al. 2001:3; Grey 1840; Lydon 2002:62–63, 72; Lydon 2005:216–223, 229; Middleton 2010:180–181; Nettelbeck and Ryan 2017:1–2, 4, 6–7, 16; Singley 2012:31). This process typically involved the forced relocation of Aboriginal peoples onto missions, which often separated family members, and their education in European values. The European goal involved subjecting Aboriginal peoples to institutionalised oppression through government laws, policies and systems that, for example, suppressed their use of their own language, deprived them of the right to vote and required verification of their court testimonies by Europeans (Broome 2005; Burke et al. 2016; Foster 2009; Foster and Nettelbeck 2009:221; Giuliani 2011; House of Commons 1837; Jacobs 2009; Rogers and Bain 2016).

It is not always possible to precisely identify whether and when colonialism began and ended, as debates are ongoing as to the material evidence, behaviours, practices, institutions, power relations and beliefs that are attributable to colonialist influences over time (Croucher and Weiss 2011:7; Deringil 2013; Gosden 2004:3–4, 31–32; Litster and Wallis 2011:113–114; Paterson 2011; Schmiechen 2018; Wesley and Roberts 2018:8; Wiltshire et al. 2018). Nonetheless, some forms of archaeological evidence, such as missions and their contents, are widely accepted as useful for inferences about colonialism. For example, the analysis of remains of structures within the Weipa mission in Queensland attested to initially minimal attempts by missionaries to physically control movement by Aboriginal peoples to, from and within the mission, followed by increasing restrictions over time (Morrison et al. 2015). The archaeological evidence indicated that Aboriginal peoples exerted considerable autonomy as to whether and when they engaged with the mission and that power relations fluctuated, discounting presumptions that colonial missionaries possessed all control (Morrison et al. 2015).

Other forms of archaeological evidence can also inform about colonialist practices. For example, the physical locations of some Native Police camps in places associated with Aboriginal ceremonial gatherings suggests that

European colonisers exerted control with either a disregard for or indifference to practices considered important in Aboriginal culture (Barker et al. 2020:34). Further, items from Christianity recovered in contextual association with Aboriginal activity support the existence of the European aim to convert Aboriginal peoples to Christianity, while the occasional practice of ‘payment’ of Aboriginal workers with clothing (Nettelbeck and Ryan 2017:8, 14) represented an exercise in the assertion of European cultural values. Clothing was also a common instrument used by European missionaries to assist in the colonisation of Indigenous peoples elsewhere, such as in Samoa, Tahiti (Thomas 2002) and South Africa (Comaroff and Comaroff 1997:218).

Colonialism did not always occur as a straightforward dichotomous process between colonisers and the colonised (Silliman 2010:30–32). Rather, myriad complexities and entanglements existed in cultural exchanges, confounding oversimplifications inferred by binary models of dominance and resistance. Indigenous peoples exerted agency within colonialist spaces, incorporating and resisting aspects of introduced practices to differing extents and adapting their group identities accordingly (e.g., Panich 2013:108–110, 114–116; Van Buren 2010:152). For example, in central California, Indigenous groups under Spanish missionary colonialism from the 1770s to 1850s were still able to exercise some autonomy and maintain many cultural practices by asserting some control over their spatial living arrangements within missions, continuing ceremonies and, when absconding or otherwise leaving the mission, maintaining trade with other Indigenous groups (Panich and Schneider 2015:52–53). Covert resistance occurred in seventeenth century New Mexico, when Indigenous Pueblo ceramic manufacturers made dramatic changes in their decorations as a response to religious persecution by Spanish missionaries, encoding religious messages designed to maintain and teach their pre-existing religion to future generations (Spielmann et al. 2006:624, 631–633, 639–643).

Indigenous peoples also used the landscape to maintain some degree of autonomy. Indigenous Californians selectively adopted aspects of Spanish culture at intersections in the landscape between Indigenous and colonialist spaces, while at further removed locations they engaged with colonialist systems as they pleased (Panich and Schneider 2015:54; Schneider 2015:697, 699–700, 705–706). Similarly, eighteenth and nineteenth century South African Bushmen took refuge from British colonialists in the Maloti-Drakensberg mountains, where they maintained trade links and autonomously continued most aspects of their pre-colonial lives (King 2017a:540–545). Indigenous Bedu people in regions of the Transjordan in the second half of the nineteenth century used the landscape in a clandestine manner to defy Ottoman colonialism and maintain their own cultural practices (Carroll 2011). Upon their initial occupation of this region the Ottomans forced the Bedu to change their land use from largely subsistence-based pasturing to large-scale agricultural operations controlled by, and for the benefit of, the state (Carroll 2011:113–114). However, the Bedu circumvented state control to a considerable degree by exercising a high level of mobility, maintaining their own modes of agricultural production which they then hid in caves (including, for example, hiding taxable livestock), and underrepresenting the extent of their production to reduce or avoid taxation (Carroll 2011:107, 115; LaBianca 2000:209, 211–212; Oestgaard et al. 2003:460). Bedu people also actively resisted Ottoman rule by establishing links with the upper merchant class so as to expand their distribution of produce to an increasingly global market (Carroll 2011:108–109, 116; Kasaba 2009:93–94).

Resistance to colonialist forces can thus be reflected in forms such as material items, uses of landscapes and, as can be seen in Australia, by acts of physical violence. Aboriginal peoples actively retaliated against European violence, such as is described above for the western-central River Murray/Riverland region. Debates are ongoing as to whether they were the instigators of various conflicts, such as the Maria massacre, or whether the killing of colonists by Aboriginal peoples was a response to provocation and/or other colonialist power practices (Burke et al. 2016:154–156; Foster et al. 2001:13–28).

Roberts et al. (in press 2021b), for example, argue that the killing of a European overlander at what subsequently became known as 'Dead Man's Flat,' in the Riverland, may have been a reprisal for trespass or previous violence by Europeans, rather than an unprovoked, random attack. There is no archaeological evidence at the site but for Roberts et al. (in press 2021b), disparities and potential concealments in the historical records of the event hint at inaccurate accounts of not only the motivations for the killing of the overlander but of possible subsequent reprisals undertaken by Europeans.

Aboriginal peoples also used powerful, non-violent tools to resist colonialism. For example, many groups continued to practise traditional Aboriginal customs and beliefs in the face of efforts by colonial powers to repress such behaviour, and they targeted European livestock (Armand 2003; Cole 2004:174–180; Connor 2002:48; Elder 2003:27–41; Foster et al. 2001:13–28; Gould et al. 1971:165; McNiven and Russell 2002:28, 30, 34, 37; Pearson 1984; Ryan 2008; Smith 2007:13–14; Williamson 2002:78–79). Aboriginal peoples never ceded sovereignty or considered that they had been conquered (McNiven and Russell 2002:28; Reynolds 2006:71), and refused to submit to the European control of resources (Connor 2010:10–11,15–18, 21, 26–27; Foster 2009; Litster and Wallis 2011:108; Ngarrindjeri Nation 2006:8–13; Reynolds 2006:72–75; Rogers and Bain 2016:83–84; Ryan 2013). They continued their pre-contact rock-art styles and techniques, created different artistic conventions, incorporated introduced materials and iconography and strategically placed the art in colonialist locations within the landscape as expressions of Aboriginal identity and assertions of historically ongoing spatial rights (Chaloupka 1993:196–200; Cole 2010:24–25; David and Wilson 2002:43, 57; David et al. 1990:82; David et al. 1994:249; Macdonald 2008; McNiven and Russell 2002:28, 30, 34, 36–37; Morwood 2002:172–173; O'Connor et al. 2013; Taçon et al. 2012). At the Point Pearce/Burgiyana mission in SA, Aboriginal peoples, according to Fowler (2015:310–313), defied colonisers' attempts to dominate the maritime industry by continuing to practise boat construction.

Resistance was not the only response by Aboriginal Australians to colonialism. Introduced materials, such as metal, glass and cloth, were selectively adopted (Barker et al. 2020; Cole et al. 2020:14; Cooper 1979; Harrison 2002a, 2003:323–324; Harrison 2006; Head and Fullagar 1997:422–424; Jack 1922:502; Jones 2008:116–129; Khan 2003:52–53; Moseley 1879:350–363; O'Connor 1877; Perston et al. 2021; Smith 2001:26–28; Wallis et al. 2018; White 1981), often resulting in the creation of new cultural meanings. For example, after Governor Macquarie bestowed a breast plate upon an Aboriginal person for the first time in 1815, 'king's plates' became highly valued by many groups across the country (Harrison 2003:323–324; Troy 1993:1–43). King's plates were military items and a central part of officers' uniforms and, understanding this, some Aboriginal peoples attached similar status-laden value to them (Harrison 2003:324)—although it cannot be presumed that all Aboriginal peoples viewed the king's plates favourably, given that these items were synonymous with colonial power.

The ascription of new meanings to introduced items resulted in both positive and deleterious effects for Aboriginal groups. Metal axes and tomahawks, for example, quickly became prized trade items among some Aboriginal societies because of their cutting efficiency compared to stone axes and because they removed the previous time-consuming process of manufacturing stone axes (Jones 2008:112–117, 123–126). However, in some Aboriginal groups, the distribution of stone axes had previously been strictly controlled by senior Aboriginal men (Brumm 2011:89–91; Jones 2008:119), and the provision of metal axes and tomahawks by Europeans, along with the regular opportunities for Aboriginal peoples to procure metal through stealth, threatened existing social hierarchies (Jones 2008:119–120). Inter-group trade of stone axes had occurred for hundreds and potentially around one thousand years (Brumm 2011:86–88; Davidson et al. 2005:125; Ford and Hiscock 2021:16–20), particularly from northern Queensland production centres to southern regions such as Lake Eyre and from Victoria north into New South Wales (NSW) (Dickson 1981:17; McBryde 1987:252–273; McCarthy 1977:253; Roth 1897;

Tibbett 2002:27), but the introduction of metal interfered with this kind of trade (Jones 2008:119–120).

Aboriginal Australians, including at Calperum Station, not only incorporated settler materials but also selectively engaged with their economies and practices, although typically not without the exertion of powerful influence by colonists. Aboriginal peoples around Calperum Station worked in a variety of capacities, such as labouring and providing transport, predominantly in the 1840s and occasionally in the following decades (Anon. 2 August 1829:4; Roberts et al. in prep. 2021). Aboriginal peoples in other parts of Australia also worked, possibly due to a combination of choice and necessity, in a range of colonialist spaces, particularly on pastoral stations, and in industries as varied as domestic service, fishing, sealing, pearling and whaling, but were often grossly underpaid and otherwise exploited (Kartinyeri and Anderson 2008:21–22; Paterson 2011:248–249, 251–256, 260; Pope 1988; Smith 2000:77, 80–81; 2007:14; Wiltshire et al. 2018:96). Archaeological evidence alone can be insufficient for understanding the extent of Aboriginal involvement in European industries and how related 'European' items and practices sometimes became entwined in Aboriginal peoples' intangible heritage. For example, only through oral histories and engagements with Aboriginal descendent communities along the River Murray in SA did it become known that Aboriginal peoples worked in the riverboat industry and developed multiple layers of cultural attachments to barges (Roberts et al. 2017:143–144).

It is clear that many kinds of post-contact artefacts and practices, despite their origins, were not exclusively 'Aboriginal' or 'European.' In cross-cultural encounters, materials may be introduced by one group but become imbued with cultural significance by the other (Loren 2000:87, 90; Silliman 2009:213–217; 2010:29–30). For example, in the Kimberley region of Western Australia (WA), cultural memories communicated to Harrison (2002b:72) by people who had worked at fringe camps at Old Lamboo attested to Aboriginal people emphatically identifying metal match tins as Aboriginal objects that represented cultural continuity. Similarly, Silliman (2009:217–227) demonstrated that in colonial North America, Eastern Pequot peoples attributed cultural ownership and significance to items they used that were initially introduced by colonisers, such as bottle glass, ceramic vessels and metal buttons. Colonising groups sometimes adopted practices and items from Indigenous cultures. In Australia, European colonisers incorporated Aboriginal architectural techniques for the creation of bark humpies and water troughs (McIntyre-Tamwoy 2002:176), and Kimberley points and other items deemed to be collectible for their aesthetic values became culturally valued by Europeans. Stone Kimberley points had been manufactured by north-western WA Aboriginal groups prior to contact, but subsequently this artefact type was also manufactured from glass (Akerman 1975, 2006:331–333; Harrison 2002a, 2003). Colonisers, valuing the aesthetic appeal of the glass Kimberley points, traded for them with Aboriginal groups, who then purposely increased their manufacture for exchange (Akerman 1978:489; Akerman et al. 2002:22; Harrison 2002a).

Glass artefacts can reflect a range of responses by Indigenous groups to colonialism. For example, Aboriginal troopers in Queensland's Native Mounted Police regularly procured and flaked introduced glass from European rubbish dumps, among other sources (Perston et al. 2021). These troopers had often been forcibly brought to Queensland from elsewhere in Australia to subjugate local Aboriginal peoples, and their glass flaking may have represented an assertion of their own cultural ways while negotiating the new colonial world (Perston et al. 2021). Further, Williamson (2002) identified a number of glass artefacts from Burghley in north-western Tasmania with morphologies of formal stone tool types, and Dickson (1971:60) observed a glass Bondi point in an assemblage from Botany Bay, NSW. At a post-contact western NSW site, Harrison (2003:318) retrieved glass tula adzes and numerous heavily used glass shards. In each of these assemblages there was no evidence for use of the formal glass tools, and the glass Bondi point was particularly unusual given that stone Bondi points are not known to have been produced in the region for approximately 1,000 years (Attenbrow 2010:156). One of the more plausible explanations for the glass Bondi point and other unused glass formal tools is skeuomorphism: whereby new materials are used in a manner that invokes memories of previous familiar practices (even if the past practices were undertaken by ancestors and known via oral communications passed own over generations). For Harrison (2003:327), Aboriginal peoples manufactured formal glass tools with pre-existing methods but using introduced materials to symbolise their 'world turning upside-down' after European colonisation. Assertions of Aboriginality may also have prompted the manufacture of other formal glass tools. The labour-intensive production of glass Kimberley points not intended for use may represent efforts, by more contemporary groups, to remember past behaviours deemed central to masculinity and Aboriginality, thus affirming Aboriginal culture amid permanent European colonisation (Harrison 2003:324–326).

However, the ability to make inferences concerning any symbolism or motives for responses to colonialism is limited among glass assemblages where no formal tools are present, such as at Calperum Station, and other evidence for colonialism is often non-archaeological. For example, it was primarily cultural memories and knowledge that demonstrated that, although oppressive practices occurred at the Weipa mission, relations between missionaries and Aboriginal peoples were more complex than the simple dynamic of oppressor and oppressed (Morrison et al. 2015:97–102). Similarly, much of the evidence for the past behaviour of Indigenous Bedu peoples (discussed above) was historical and ethnographic (Oestgaard et al. 2003:460), rather than archaeological. Historical evidence has often been the primary basis for inferences concerning colonialism, including, for example, records of indentured or otherwise forced labour (Harkin 2020:155; Kartinyeri and Anderson 2008:21–22; Paterson 2011:248–249, 251–256, 260; Smith 2007:14; Wiltshire et al. 2018:96), and the aforementioned laws and systems that denied Aboriginal peoples equal status.

For this thesis, a far more productive approach to examining technological continuity and change is to consider how Aboriginal peoples around Calperum Station continued to demonstrate the desire to adapt that was repeatedly displayed by their antecedents. Any adaptability can, in particular, be investigated in terms of how introduced materials were incorporated within pre-existing, traditional technological traditions and whether new uses were invoked in a reworking of these traditions and lifeways brought about by the cultural entanglements that led to a new social and material world. Observations can still also be made concerning the uses of landscapes, in regard to the spatial locations of the sites in relation to colonialist spaces, and possibilities concerning the exercising of autonomy that this may imply.

Determining the extent of agency in decision-making is complex and not always possible because many intangible factors may contribute to behavioural processes. The use of introduced materials might suggest Aboriginal agency in engaging with European material culture, but unlike the intent of colonialists to 'civilise and Christianise' Aboriginal Australians, there is no evidence to indicate whether any use of glass and porcelain was in response to attempts by colonisers to force or prevent such use. Aboriginal agency around Calperum Station is partially implied in the finding by Dardengo (2019) that there was a shift in the use of previously preferred tree types for the manufacture of wooden items to another variety of tree after contact. However, the restricted access to the preferred tree types following contact (Dardengo 2019), due to the European occupation of relevant areas in the landscape (rather than specific colonialist practices), probably prompted the change in procurement. Agency within colonial society in the broad region of the study area may also be reflected by Aboriginal peoples' provision of their labour, but the extent of any autonomy is uncertain. Europeans typically controlled the conditions of labour but Aboriginal peoples were not forced to work and at times chose to use their knowledge of the landscape that Europeans lacked in order to obtain favourable payment (Tutty 2020:59–60).

Investigating technological adaptability among past Aboriginal people at Calperum Station expands the application of a common theme in archaeology. Evidence for such adaptations can be seen from relatively early in the Aboriginal occupation of Australia, with the manufacture of the first edge-ground stone axes in the world, which were advantageous for their new type of environment (Hiscock et al. 2016:2, 5; Veth et al. 2019:118–119). As arid inland regions, coasts and a variety of environments were occupied relatively rapidly, other early innovations were made, such as the production of backed artefacts and bone points (Clarkson et al. 2017; Hamm et al. 2016:280–282; Langley et al. 2016:200, 208, 210–211; Maloney et al. 2018:216, 218–220, 224–225; Tobler et al. 2017:182–183; Veth et al. 2017:26–27). Symbolic behaviours, already present at initial colonisation, were repeatedly evident (Balme and Morse 2006:803–809; Balme et al. 2009:65; Brumm 2011; Brumm and Moore 2005; Ford and Hiscock 2021:2; Mulvaney 2013:99; O'Connor and Fankhauser 2001; Veth et al. 2011a:204, 207–220), and during periods of environmental change such as the Last Glacial Maximum—the most dramatic climatic change during the history of Aboriginal occupation of Australia (Hesse et al. 2005:66; Smith 2013:110)—adjustments were made in occupation patterns, uses of the landscape and across technological practices (Balme 2000:4; Hamm et al. 2016:281; Hiscock et al. 2016; Maloney et al. 2018:205, 216, 224–226; Marwick 2002:25–29; Morse 1993:877–878; Munt et al. 2018:75–77, 81; Slack et al. 2009:33–34; Smith 2006; Thorley et al. 2011:47–49; Veth 1989, 1993).

Adaptations continued over the course of the ongoing Aboriginal occupation of Australia. Foraging ranges were adjusted according to local changes in resource availability, a strategy also used by North American, Hungarian, European Palaeolithic and other foragers (Biró 2009:49–52; McBryde 1987; McCarthy 1977; Meignen et al. 2009:1821; Randolph 2001; Roth 1897; Smith 2013:269–274; Tibbett 2006:29–30; Veth 1989, 1993). When El Niño-induced heightened aridity took effect in mid-Holocene Australia, Aboriginal peoples, particularly in south-eastern regions, minimised risks by adapting their stone technology. According to Hiscock (1994, 2002, 2008:156–160), they increased their reliance on backed stone artefacts and points due to the portability, multi-functionality and ease of maintenance of these lithics (at some sites in this region the timing of technological adjustments varies, e.g., Theden-Ringl 2017:94).

Flaking of porcelain is known to have been undertaken by some Aboriginal groups, including in another part of SA. Walshe and Loy (2004) interpreted a flaked telegraph insulator in the form of an adze on Kangaroo Island ('KI'), SA, as a wood-working instrument—unsurprising given the weight of existing understandings for stone adzes as wood-working tools (Akerman 2006:339; Cane 1992:22–24; Gould et al. 1971:152–154; Harrison 2003:318; Hiscock and Veth 1991:335; Maloney 2021:7, 13–14; Maloney and Dilkes-Hall 2020; Veth et al. 2011b:7, 9). KI had been abandoned since perhaps c. 4,300 BP or at the latest by c. 2,500 BP and was not occupied at the time of European contact (Lampert 1981:170; Walshe 2014:131). However, following contact, Aboriginal women were often forcefully and violently taken to the island by European sealers (Taylor 2000:73–74)—and the overland telegraph line was established in Adelaide in 1872 (Moyal 1984:53). The porcelain adze must therefore have been manufactured after this time and probably after 1876 when the overland telegraph line reached KI (Walshe and Loy 2004:38–39).

Porcelain from telegraph insulators was used by Aboriginal peoples for a variety of purposes in different parts of the country, probably because of its conchoidal fracturing properties (Khreisheh et al. 2013:37–39; Speer 2018:73):

> dislodged with a well-aimed stone…(it) provided a light, sharp and consistent material for spearheads. The porcelain was easy to work and as effective as another new substance brought by Europeans—glass.
>
> Jones 2008:126

In Queensland, following the construction of the first overland telegraph line in 1861 (Queensland Government 2020), Aboriginal peoples not only flaked the insulators for use as spear barbs, but also used associated telegraph wiring for attaching the barbs to spears (Anon. 7 April 1887:4; Anon. 16 May 1888:2). In WA, Aboriginal peoples manufactured Kimberley points and other artefacts from telegraph insulator ceramic (Allen and Akerman 2015:89; Balfour 1903; Noone 1949:112; Veth and O'Connor 2005:5). On a pastoral labour camp in NSW, Harrison (2004:182) interpreted 14 out of 16 pieces of ceramic insulator as knapped or otherwise modified. He suggested that ceramic had been used for cutting or scraping, although he did not describe how he reached this conclusion (Harrison 2004:182).

Having considered colonialism and related behaviours, the following section addresses how a major theoretical approach to understanding past human behaviour is used in this thesis: middle-range theory. This framework has been used across the world in different fields over several decades, as a theoretical basis for interpretations of empirical data.

2.4 Middle-range Theory

Middle-range theory emerged in the discipline of sociology around the late 1940s, essentially as a heuristic principle that initially aimed to explain entire social systems by integrating theory and empirical research (e.g., Parsons 1948, 1950, 1951). However, the theory was criticised for involving extremely abstract conceptualising and theorising that led to its inability to be applied to test narrower, discrete sociological research questions (Merton 1968:52). For example, Freese (1980) and Raab and Goodyear (1984:258, 265) argued that middle-range theory, based on grand theorising, ignores the fact that societal systems change over time and therefore does not facilitate fuller understandings of human behaviour. Grand theorising is predicated on the notion that carefully constructed, highly abstract theorising has the potential to lead to understandings of universals that exist in the social world (e.g., see critique in Mills 1959:33–44). However, the criticism from Freese (1980), Raab and Goodyear (1984:265) and others (e.g., Mills 1959) was that social dynamism across cultures contradicted the argument for the existence of universals and therefore other theoretical approaches are necessary for more comprehensive understandings. Exchange theory, for example, can be used to understand social interactions over time, such as how trade and exchange systems between individuals and communities create expectations of forms and levels of reciprocity in terms that influence kinship relations, power relationships and even entire social systems (Croucher 2011:166–169; Levi-Strauss 1969:466–476).

However, the use of middle-range theory for examining aspects of human social behaviour, rather than entire systems, gained traction after advocacy by Merton in 1968. For Merton (1968), middle-range theory was effective for bridging the divide between ‘lower level’ theory that relied solely on empirical data and ‘higher level’ theory based on remote, abstract concepts that could never be practically tested by empirical data. Primarily, Merton (1968:38) argued that abstract concepts were valuable only if they were able to be tested by empirical data—which effectively encompassed both inductive and deductive research.

Middle-range theory was originally employed in archaeology by Binford in the 1970s (Binford 1977:67). Mirroring Merton, Binford (1981:21–30; 1982) conceived of middle-range theory as a conduit between lower level archaeological generalisations and higher level theory-building, based on the use of empirical data derived from present-day observations of static artefacts in order to make inferences about dynamic past behaviour. Effectively, this was the same principle as that advocated by Merton (1968), but at the time was a significant shift from the more common culture-historical approach used by archaeologists (Yu et al. 2015:3). Binford’s (1977, 1981) view of middle-range theory also required the explicit declaration of assumptions about the past upon which resultant inferences were based, given that all archaeologists making these inferences derive their understandings of the world from modern circumstances (e.g., Cowgill 1993:554–555). For example, conclusions drawn about social status on the basis of grave goods may be based on modern assumptions about the importance of economic values of the goods (and modern concepts of economic value), yet past values ascribed to grave goods and other items of material culture may have been based on non-economic criteria, such as symbolic value and political or religious views (Araho et al. 2002; Brumm 2011:89–91; Ford and Hiscock 2021:2; Hodder 1982:119–122; Torrence et al. 2013a and b).

The declaration by archaeologists of assumptions underlying their interpretations may assist the transparency of their applications of middle-range theory, but contemporary political and societal values can nonetheless have significant, perhaps undue effect on such interpretations (Trigger 2006:39). These influences can even lead to archaeological interpretations that are deemed acceptable within one societal context but outmoded and racially offensive in another. For example, amid nineteenth and twentieth century colonial social-Darwinist notions of ‘cultural progression’ (Mason 1895; Morgan 1876:66–82; Spencer and Gillen 1899; Uhle 1907; Williamson 2004:232–233), Tylor (1869, 1871) and Lubbock (1865, 1870) interpreted British material culture as evidence of human progress from barbarism and savagery toward civilisation. Similarly, Tindale (1957; 1975:207; also see critique in Bland et al. 2012:48–50) typologically classified lithics from Ngaut Ngaut (Devon Downs) in SA according to a sequence of increasing ‘sophistication’ across separate waves of progressively advanced peoples. For Tindale (1957; 1975:207), this ‘cultural succession’ of ‘Kartan,’ ‘Tartangan,’ ‘Pre-pirrian,’ ‘Pirrian,’ ‘Mudukian’ and ‘Murundian’ peoples was evidenced largely by increasingly ‘complex’ stone artefact forms. However, it has since been repeatedly demonstrated that the primary influence underlying variations in artefact form are the principles of fracture mechanics (Clarkson 2007:27–38; Cotterell and Kamminga 1987; Macgregor 2005; Pelcin 1997:1109–1112). Contextual factors also exerted considerable influence on artefact morphology, further confounding notions of cultural progression. Different artefacts were favourable in particular environmental and social conditions, and quickly manufactured artefacts that could achieve the same outcomes as more ‘complex’ forms were energetically advantageous (Holdaway and Douglass 2011).

Interpretations of middle-range theory have not always been consistent. Binford’s (1977, 1981) approach emphasised the importance of understanding how a site formed, so as to reconstruct the conditions in which past peoples lived, which would help to reduce aspects of the aforementioned assumptions. Schiffer (1976, 1996) also emphasised the importance of understanding site formation processes and, although he and Binford (1977, 1981) differed on the extents of different influences on site formation—primarily between human behaviour and taphonomic factors—their aims were essentially the same (see also Kelly 2011:286, 290). Yet Willey and Sabloff (1980:249–251) considered the issue of how sites formed to be the domain solely of lower order constructions, involving, in practice, issues such as how the morphological attributes of artefacts affected their distributions within a site. For Willey and Sabloff (1980:249–251), middle-range theory concerned the development of explanations for why, in addition to how, past cultural systems led to the particular nature of site formation. However, because site formation is influenced by more than cultural systems, the effects of environmental and any other factors must be identified so as to delineate where human behaviour was directly involved.

The application of middle-range theory can involve aspects of other theoretical and methodological devices, such as 'contextual archaeology.' While Binford's (1982:128) middle-range theory emphasised the importance of objectivity, Hodder's (1986:121–125; 1992:29–30) contextual archaeology, essentially based on hermeneutics, involved the deliberate making of assumptions about the intentions of past people, and their cultural contexts, prior to assigning meaning to artefacts. For Hodder (1986:4, 13–14, 17, 107, 180), middle-range theory alone is linear, not independent from higher-level theories, and too insensitive to the presence and significance of past peoples' ideas and intentions—the factors motivating their production of artefacts. Assumptions under contextual archaeology are revisable as research progresses, and ultimately testable by assessing the (i) coherence and consistency of resultant theories or arguments and (ii) ability of the evidence, from the specific site being studied, to support the theory or argument (see also Kosso 1991:626). However, despite this conceptual difference between Binford (1982) and Hodder (1986, 1992), both schools of thought involve the same basic set of methods: observing and creating empirical data based on artefacts and making inferences about past behaviour within the context of a theoretical structure (Arnold 2003:63; Cunningham 2003:36; Kosso 1991:625).

‘Behavioural archaeology’ can also complement middle-range analysis in that it involves efforts to identify patterns in relationships between past humans and their artefacts across time and space (Skibo and Schiffer 2008:6). Binford (1978), for example, argued that if the traits of a certain kind or kinds of artefact could be ethnographically verified as reflecting a particular behaviour or set of behaviours, it was reasonable to infer that such behaviours also operated in earlier times. However, this approach ignores the dangers inherent in extrapolating about the nature of past behaviour based on modern or near modern material remains, in that an abundance of evidence exists demonstrating cultural dynamism over many millennia (Beaton 1983; Hamm et al. 2016; Hiscock 1994, 2002; Hiscock et al. 2016; Langley et al. 2018; Lourandos 1983; Maloney et al. 2018; McNiven 1994; Smith et al. 2017). For example, the analysis of lithic manufacturing techniques and/or functions may identify technological behaviours that are either particular to a time, cultural group and region or indeed that are common across these domains.

Nevertheless, middle-range theory can draw on the behavioural archaeological aim of identifying behavioural patterns, by conducting experimental use-wear lithic analyses—regardless of potential debates about whether, and if so at what points, the process may be deemed to constitute middle-range theory (e.g., Binford 1977, 1987; Johnson 2019:54–70). Comparisons are able to be made between the use-wear on experimental and archaeological artefacts because the flaking mechanics operate in the same manner across all time periods (Arnold 2003:65; Clarkson 2007:31; Cotterell and Kamminga 1987; Flenniken and White 1985; Fullagar 2014; Hiscock 2007:202–203; Macgregor 2005; Semenov 1964:16–21). Taphonomic investigations are another typical example of methods involving middle-range theory (Arnold 2003:65), and experiments concerning the effects on lithics of trampling, also conducted in this thesis, can further add to our understandings about why a site formed in a certain manner (Marwick et al. 2017).

Middle-range theory also emphasises the value of ethnographic information (Binford 1977, 1978, 1987). Past peoples regularly made varied decisions about how to further modify lithics and other artefacts following the initial stages of manufacture, and ethnographic information can provide more holistic knowledge about the bases of these decisions, as well as about any potential cultural meanings of artefacts (Dawson 1831:67, 135; Man 1883:380; Man 1932:160–161; Rowland 2014:4; Stemp et al. 2015:423–424; Tolstevin 2011). Hodder (1982:155–161), for instance, drew upon ethnographic information to explain variations in the archaeological faunal record of twentieth-century Nubian settlements. In Nubian culture, women were responsible for pigs, and in one particular settlement, males held a strong belief that women were intrinsically 'polluting.' Pig debris was therefore prohibited in compounds so their remains were rare. Yet in a separate settlement, where this belief was milder, pig remains were tolerated and as such more abundant. This past behaviour may not have been fully understood if only the archaeological evidence was interpreted.

Given that middle-range theory has been defined, interpreted and applied in a range of manners and contexts across the world, and that many different views exist as to when this theoretical device is actually being invoked during research, the approach taken in this thesis may be considered as broadly employing aspects of middle-range theory. Several methods reflect this. First, empirical data are used to make inferences in relation to higher order theorising regarding potential reasons for the adoption by past Indigenous peoples of materials introduced by an incoming, foreign culture. This is a rejection of highly abstract, grand theorising which presumes the existence of universal truths operating in societal systems across time and space. Second, site formation in this study is considered from the perspective not solely of how the relevant sites formed but why they formed as they did. Aboriginal sites of various types (e.g., campsites) were frequently situated on the margins of European settlements, and this was the case for both West Woolpoolool and the Telegraph Insulator site. Inferences are then made as to the higher order theoretical possibility that these sites formed where they did because

Aboriginal peoples chose their living arrangements in an attempt to avoid or minimise their involvement in skewed colonial power relationships, reworking introduced materials in 'traditional' Aboriginal ways without European interference. Third, oral histories, tool-use experiments and a demonstration by TOs of ongoing community glass-working practices are used to further inform about why Aboriginal peoples adopted glass and what this might have meant for past lifeways and choices.

2.5 Chapter Summary

This chapter has addressed an array of topics and issues in establishing the broad contextual background for this research. From the review of previous archaeological studies concerning Calperum Station, several patterns of behaviour appear to have existed among Aboriginal peoples in the region. For Thredgold (2017), Thredgold et al. (2017) and Incerti (2018), stone flaking strategies were relatively basic and flakes were used for food-processing activities. For Jones (2016:110), Jones et al. (2017:51, 56–57), Ross (2018:138–143) and Ross et al. (2019), earth mounds reflected short-term visits for cooking activities rather than longer-term occupation, by highly mobile groups who cyclically occupied higher and lower grounds in response to seasonal flooding cycles. Following permanent European colonisation Aboriginal peoples around the Station adapted their technology to incorporate steel axes and continued and changed aspects of their procurement of resources for the production of wooden items (Dardengo 2019:98–99, 109–110; Dardengo et al. 2019:61). Aspects of these inferences from previous studies are commented upon and extended in this research.

European colonisation, colonialism and middle-range theory were also addressed in this chapter. In particular, it was argued that because of the complexity involved in ascribing motives for past behaviours, along with the context of this assemblage (e.g., no formal tool types), it would be tenuous to infer that the incorporation of introduced materials was a direct, certain type of response to particular colonialist *practices*. Rather, inferences may be made concerning potential responses to the permanent *presence* of Europeans. Further inferences may be made in relation to issues such as the willingness of Aboriginal peoples at Calperum Station to continue to adapt their technological practices as others around Australia had for many previous millennia. Discussion in this chapter concerning middle-range theory centred on the past development of this approach to examining the past, along with its relation to other theoretical frameworks and how together these apply in this research. The points at which middle-range theory is invoked in a project may not always be clearly definable but in this case, its main manifestation is in the use of and value ascribed to experimental archaeology, ethnographic information and the use of empirical data to support inferences about past human technological behaviour.

Chapter Three: Aboriginal Australian Glass Artefacts

Cultural memories, historical observations and several previous archaeological studies attest to the use of introduced glass by Aboriginal Australian groups in the historic period. However, difficulties have often arisen in attempts to macroscopically identify glass pieces as artefacts, complicating the ability to reliably infer related technological behaviours. This chapter begins by addressing the known Aboriginal uses for glass, based on observations from early European settlers. Discussion then concentrates on the difficulties encountered in attempts to diagnose pieces of glass as artefacts based on macroscopic observations or insufficiently detailed microscopic investigations. Such discussion establishes the basis for the following chapter, in which methods for overcoming such difficulties are examined. The final part of this chapter focusses on the ways in which glass bottles, from which flakes may have been manufactured and used, may be identified and broad dates obtained.

3.1 Past Use of Flaked Glass by Aboriginal Australians

> One of the most commonly reported items of material culture that was adopted by Aboriginal people at contact with Europeans/settlers was glass.
>
> Veth and O'Connor 2005:7

Various forms of natural glass material have been used by Aboriginal Australians before and since European colonisation. For example, tektites (discussed previously) and Darwin glass (an impactite utilised in Tasmania) were used to manufacture tools before European arrival, although these materials were rare and are categorised by analysts as a class of stone material (Akerman 1975:117–118; Baker 1957:1, 17; Cotterell and Kamminga 1987:677; McNamara and Bevan 2001:27–28; McNiven 1994:77; Rowland 2014:4). For the purposes of this thesis, 'glass artefact' refers to anthropogenically modified glass derived from introduced European glass. Glass (in a variety of forms such as window panes, containers and insulators) is a favourable raw material because it is highly siliceous and brittle, it fractures predictably and thus is easy to flake, and sharp edges are readily produced (Cotterell and Kamminga 1987:677; Harrison 2004:175).

Ethnographic evidence and observations from settlers in several parts of Australia attest to Indigenous peoples' use of introduced European bottle glass. For example, bottle glass, rather than stone, was preferred for scraping wooden spears in the Hunter Valley, NSW, regions of far north Queensland, parts of the Nullarbor Plain in SA, the lower River Murray region in SA and the Adelaide Plains (Angus 1847:93; Bolam 1925:82; Cawthorne 1925–1926:50–51; Dawson 1831:67, 135). Aboriginal groups on the Adelaide Plains also used glass for animal butchery (Stephens 1889:477), and around Lake Bonney, in the Riverland, Eyre (1845:221) observed glass being used for self-inflicted wounds. Glass was also used as a trading item. Aboriginal peoples around the Hunter River and Port Stephens regions of NSW traded glass for goods such as possum skin and yarn (Dawson 1831:135), and in Victoria and WA glass was obtained through exchange for use as barbs on wooden spears (Moore 1884:119). Like in other parts of the world (Wang and Marwick 2020), glass beads were commonly used by Australian Aboriginal peoples after European arrival as necklaces, ornaments and for trade, in a range of regions including northern Australia and along the central River Murray (Allen et al. 2018:48–61, 76; Clarke and Hope 1985:71–72, 75; Litster 2019; Wesley and Litster 2015). In many cases, glass and other artefacts are found on the margins of European settlements where Aboriginal peoples often lived in the post-contact period (Allen 2008; Beck and Somerville 2005; Bell 2014:116–117; Birmingham and Wilson 2010; Di Fazio and Roberts 2001:48; Gibbs and Harrison 2008; oral histories in Bell 2014:116–119; Paterson 2006:104, 106–107; Paterson 2011:254; Veth and O'Connor 2005:10; Walshe et al. 2019:205–207).

There is little recorded or published evidence for recent use of glass by Aboriginal peoples. However, oral histories attest to Muruwari men and women in NSW using this material until the 1970s (Harrison 2004:176–177; Harrison 2005:20) for purposes such as scaling fish and cutting emu, porcupine, goanna and kangaroo meat (Harrison 2004:177). Harrison's (2004:176) oral history interview with missionary Ray Gunter, who had worked with the Muruwari people from the 1960s into the 1970s, revealed that wood-working was also a key use for flaked glass. Scraping with glass was often undertaken in the manner of a 'finishing tool,' with light pressure typically applied for smoothing pre-carved wooden items. Gunter recalled that Aboriginal man Robin Campbell:

> would sit cross-legged out the front there with a very blunt tomahawk, and he would chip away there at a piece of wood until he got it resembling a boomerang, and then he had these pieces of glass…and he would actually shave off the small shavings of wood down the side of the boomerang until he could smooth it right off. And he could actually smooth it right down until you would think it was done by sandpaper.
>
> Harrison 2004:176

Flaked bottle glass was also used for wood-working in other locations, again as a finishing tool. For example, in 1997 Tony Perkins, an Indigenous member of the Yarrawarra Aboriginal Corporation in Corindi Beach, NSW, outlined how his grandfather:

> used to get a piece of glass and break it, then 'e'd, anything 'e wanted to make, wooden thing, he'd get the glass and shave everything down with a piece of glass. Just a piece of broken glass, used to break it, crack it, like until it had the proper edging. Then he used to just shave down anything that he wanted to make...wooden handles or anythin' like that or, he used to carve a lot of sticks too. A lot of sticks, they used to all walk with a stick, and they used to all put different carvings on these sticks.
>
> Tony Perkins 30 December 1997, recorded in Beck and Somerville 2005:477.

Given the above evidence for the past use of glass by Aboriginal Australians, the archaeological analysis of stone and glass artefacts—in combination with oral histories also undertaken in this thesis—has the potential to provide us with a more holistic understanding of the complexities of Aboriginal responses to European colonisation.

3.2 Difficulties Involved in the Macroscopic Diagnosis of Glass Artefacts

While the value of stone artefact analysis has been well understood in Australian and world archaeology for many decades, analyses of glass artefacts have been less common. Such relative rarity is probably because of the difficulty in unambiguously identifying intentionally flaked glass based on macroscopic observations. The major issue (as described earlier) is that accidental/taphonomic breakage can result in identical or near identical macroscopically visible physical characteristics to those which are the product of intentional human modification (Allen and Jones 1980:231; Beaumont 1961; Carver 2005:82–86; Conte and Romero 2008:251–252; Cooper and Bowdler 1998:74; Harrison 2000, 2005:19; Knudson 1979; Martindale and Jurakic 2006:417; Martindale and Jurakic 2015:35–38; Perston et al. 2021; Ulm et al. 1999:42; Ulm et al. 2009; Wolski and Loy 1999:65). For Allen and Jones (1980:231), 'it (does) not seem possible ... to produce a set of criteria which would precisely identify any single artefact from a fortuitously flaked and shaped non-artefact.'

Difficulty with the macroscopic identification of intentionally flaked glass has beset previous studies. For example, Allen and Jones (1980) considered that 'some' of the 20 pieces of glass they analysed from Oyster Cove in Tasmania were artefactual, based on the presence of (i) negative flake scars on several pieces, (ii) one artefact (a possible core) possibly demonstrative of bipolar flaking, (iii) bottles at the site, and (iv) the recovery of glass 'artefacts' from other sites in the country. However, as they acknowledged (Allen and Jones 1980:231), the Oyster Cove glass was recovered from a cleared roadway and 'no struck flakes' were present. Further, Tindale (1941) analysed a specimen from Tasmania with minimal contextual description, while McCarthy and Davidson (1943:226–227) probably observed several distinctive glass flakes from Singleton in NSW, based on their descriptions of 'heavy chipping' for some specimens. However, like other macroscopic studies (e.g., Birmingham

1976:313–314; Rhodes and Stocks 1985:10), McCarthy and Davidson (1943) could not provide unambiguous diagnostic criteria.

Foghlú et al. (2016) described a single glass ‘artefact’ from Weipa in northern Queensland and although their descriptions of a combination of macroscopic attributes suggest that the piece could have been artefactual, several doubts exist. Foghlú et al. (2016) oscillated in describing the artefact as a core and a utilised flaked piece and their primary macroscopically observable criteria for its artefactual status were the presence of unidirectional negative flake scars and radial scars. For Foghlú et al. (2016:14), non-use damage caused by trampling could be precluded because of the absence of multidirectional flake scars on the artefact’s edges. However, such a criterion is insufficient because humans at times intentionally struck flakes from cores in different directions (Clarkson and O’Connor 2007:31, 33–35, 37; Perston et al. 2021).

Microscopic criteria employed by Foghlú et al. (2016:14) are also unconvincing. Their threshold for artefactual status was the presence of edge scarring on four edges, identified under x200 magnification (Foghlú et al. 2016:14). Edge scarring can indeed contribute to evidence for use, and therefore of artefactual status, but on its own is the least reliable microscopic indicator (Lombard 2005:285) (common microscopic analytical methods are described in Chapter Four, and those used in this thesis are described in Chapter Five). The key difficulties are that some aspects of edge scarring can be the same or similar after working different materials using tools made from the same raw material (Collins 2007; Fullagar 2011:119), and taphonomic processes, such as trampling, can create edge scars that appear similar to use-related scars (Blume 2010; Martindale and Jurakic 2006). The presence of multiple forms of use-wear in association typically constitutes more robust evidence for the material(s) worked and motion(s) used with a tool (Fullagar and Jones 2004; Harrison 2005:19, 21–22; Hayes et al. 2017; Kamminga 1982; Keeley 1980; Kimball et al. 2017; Kononenko 2011; Lombard 2011; Rots 2003, 2004, 2005; Solheim et al. 2018; Walton 2019). However, Foghlú et al. (2016) did not mention any analysis of polish, striations or edge rounding, suggesting that these essential components of any comprehensive use-wear analysis were not investigated. An allusion to 'unidirectional deep scratches on the sides of the artefact' (Foghlú et al. 2016:14) hints at potential striations but this is unclear and in any case not described further.

Similarly, microscopic analysis employed by Walshe et al. (2019:203–204) on ten glass pieces from an historical site in McLaren Vale, SA, could have been more robust. Their macroscopic observations, that some pieces displayed edges converging to form points while others were notched and one piece exhibited pronounced serration (Walshe et al. 2019:204), appear to be reasonable evidence for intentional human modification. However, such combinations of attributes were not present on all ten pieces and of significant concern is that, like Foghlú et al. (2016), their microscopic use-wear analysis involved only the examination of edge scarring.

Although no consensus for criteria for the macroscopic identification of flaked glass currently exists among archaeologists, several characteristics have been suggested. One regularly cited feature has been the use of 'cores,' derived from the base of bottles. These cores typically exhibit multiple, regular negative flake scars and negative bulbs of percussion and can, on occasion, constitute morphologically compelling evidence of artefact status (Figure 7). Several analysts have used this 'bottle-base core' trait, such as Freeman (1993:91) for glass from Onkaparinga, SA, Tindale (1937) for Kangaroo Island, SA, Foghlú et al. (2016) for Weipa in far north Queensland, Allen (1969:240) for Port Essington, NT, Cooper and Bowdler (1998:80-80) for Monkey Mia, WA, and Birmingham (1992:121) for Wybalenna on Flinders Island off the coast of Tasmania. Bottle bases were also the preferred part of the bottle for flaking in Native Mounted Police camps in Queensland (Barker et al. 2020:38; Perston et al. 2021; Wallis et al. 2019:8). The bottle-base criterion has support from ethnographic and archaeological evidence for other parts of the world, such as the Andaman Islands (Gorman 2000:271–272; Man 1883:380; Man 1932:160–161; Radcliffe-Brown 1964:445), Antigua (Gorman 2000:315–316, 318) and South Africa (Beaumont 1961:161).

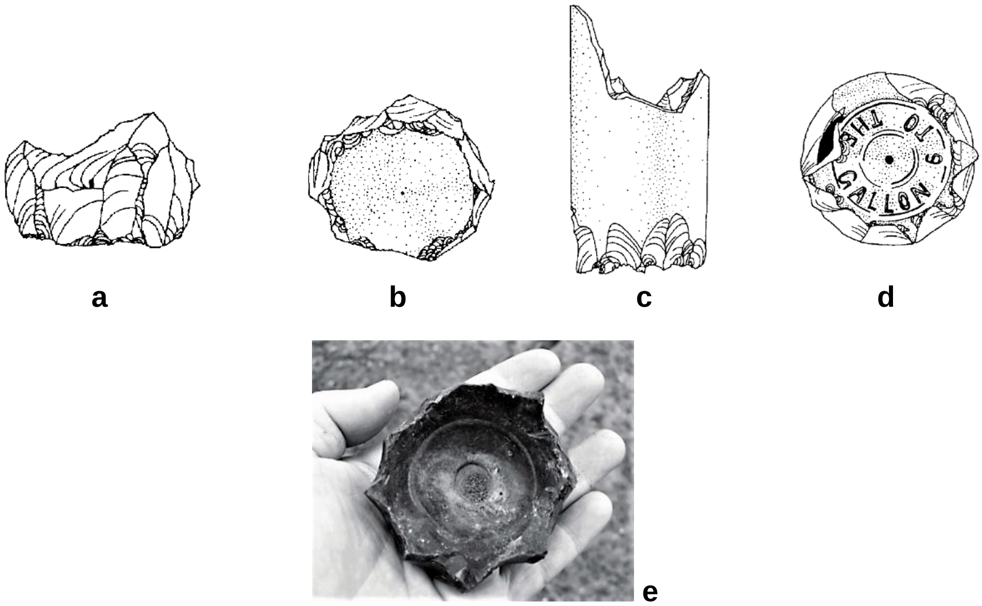


*Figure 7 Bottle glass used to produce flakes at Monkey Mia, WA (a and b), and Cape Lesueur, WA (c and d). **A**: side view of flake scars. **B**: base; **C**: bottle being used as a core. **D**: base view of (c). Adapted from Cooper and Bowdler (1998:80–81). **E**: a heavily worked core derived from the base of a black glass bottle in WA. Adapted from Gibbs and Harrison (2008:65).*

Allen and Jones (1980:231) offered additional macroscopic identification criteria. Whilst acknowledging limits, their criteria included: the flaking of glass from the thicker parts of bottles; the presence of bulbs of percussion on the majority of flakes in an assemblage; some amount of wall still attached to the bottle base; bifacial flaking present on the lower, thicker part of the bottle wall when this wall was still attached to the base; and continual damage on artefact edges. Allen and Jones (1980:231), like Barker et al. (2020:38), Harrison (2000:44), Veth and O'Connor (2005), Paterson (1999:81), Walshe et al. (2019:203) and Perston et al. (2021), also emphasised the importance of the contexts in which potential glass artefacts were found. Paterson (1999:81), when analysing glass from SA's Lake Eyre Basin, adopted some macroscopic criteria similar to that used by Allen and Jones (1980:231), but also included ambiguous, insufficiently described considerations, such as 'qualitative differences between tools and other unmodified glass fragments.' Veth and O'Connor (2005:8) also offered macroscopic criteria that, in combination, would constitute robust evidence for the intentional anthropogenic modification of glass, such as the presence on flakes of an identifiable ventral surface, a point of force application, negative flake scars, retouch, step fractures and crushing.

Whilst useful, Allen and Jones (1980) and others (e.g., Cooper and Bowdler 1998) may have under-emphasised the importance of glass body shards that were unretouched or otherwise unmodified by a manufacturing process. Such under-emphasis may be due to the difficulties involved in distinguishing morphologically between utilised and unutilised body glass shards, particularly for expedient industries (Knoblock and Vanderpot 1998; Martindale and Jurakic 2015:6, 35–36; Wolski and Loy 1999:72). Use-wear/residue analyses, however, have been central to demonstrating the utilitarian value of body glass shards to Indigenous Australians. For example, Ulm et al. (2009:115) found that 34 of 36 glass artefacts from Tom's Creek in Bustard Bay, Queensland, were body rather than bottle-base shards. Similarly, Wolski and Loy (1999:69, 71) demonstrated through residue analysis that glass body shards were commonly used by Indigenous people from western Victorian contact sites to cut and scrape fresh and dry wood as well as tubers and plant stems. The edge angles of such glass artefacts varied considerably, indicating that the formation of use-wear is not always dependent upon particular edge angles. Wolski and Loy (1999:71) also identified residues on the edges of glass shards that displayed no macroscopic damage. Glass shards appear to have been commonly used expediently in Australia, with the primary considerations being ease of handling and usefulness of edges (Gould et al. 1971:165; Harrison 2003:318–319; Hayden and Nelson 1981:89; Moore 1884:119). Expedient use of broken, rather than flaked, glass shards is also known overseas, such as in Alaska, where Binford (1978:62–63) directly observed Nunamiut people cutting frozen caribou tissue.

In addition to these microscopic analyses, several studies based on macroscopic observations indicate that body shards were important. At two Native Mounted Police sites in Queensland, Perston et al. (2021) identified six reduction strategies, including two where the basal side of a heel was used as a platform to strike flakes into the body of a glass bottle, as well as two other techniques where the body was struck directly. Niemoeller and Guse (1999) identified that at least 35 of 45 glass points at Bradshaw Station in northern Australia were made from bottle walls, although the figure was lower for another northern Australian site ('Union Reefs'). Similarly, McNiven et al. (2017:185–186) found that the vast majority of what they interpreted as glass artefacts in association with a mid-nineteenth century stone house in south-western Victoria were manufactured from bottle walls or shoulders. As well as macroscopic observations, McNiven et al. (2017:185–186) referred to the presence of 'nibbling' as a form of use-wear. While this trait probably refers to particularly small-sized edge scars, it is not explained in any detail (McNiven et al. 2017:185–186). Regardless, in light of the totality of the above evidence—primarily from the use-wear analyses—it is essential for any attempt to identify glass artefacts that shards with no macroscopic signs of modification are also fully examined.

Regional variations in Aboriginal glass manufacturing techniques also appear to exist, adding further complexity to the ability to apply a single set of macro-observation diagnostic criteria. For example, at Shark Bay in WA, 90% of glass artefacts identified by use-wear and residue analysis were produced from the bases of bottles, but several hundred kilometres south, along the Swan River near Perth, the figure was only 18%, with most manufactured from the flat or rounded sides of the bodies of bottles (Harrison 2000:39–42). Among Native Mounted Police camps in Queensland, glass bottle bases were most commonly knapped (Barker et al. 2020:38; Perston et al. 2021: Wallis et al. 2018:19), while at Onkaparinga in SA, there was a preference for manufacture from the curved and corner parts of bottles (Freeman 1993), and in the north-west of WA, Kimberley points were predominantly made from larger side panels of bottles (Harrison 2000:36).

Relatively recently it has emerged that glass artefacts were at times also manufactured in the form of formal stone tool types. The existence of recurring stone artefact 'types' is widely recognised by Australian archaeologists (Attenbrow et al. 2009; Hiscock 1994, 2002; McBryde 1985; McCarthy 1976;

Smith 2013:185–192), and indeed some pieces of glass were at times modified in such a manner that macroscopic observation is sufficient for the irrefutable designation of artefactual status. The Kimberley point is one such artefact (Figure 8). Widely known for its continuous retouch around both lateral edges and often the distal margin, this artefact type was manufactured from stone prior to European arrival in Australia (Akerman 1978, 2007; Akerman et al. 2002:13; Etheridge 1890, 1891; Harrison 2002a:357; Harrison 2006:63–64; Harrison 2007) and typically from glass in the post-contact era, for aesthetic, ritual, trading and competitive display purposes (Akerman et al. 2002:13; Clendon 1999:317; Harrison 2002a; Tindale 1965:156). For some time the Kimberley point was thought to be the only macroscopically distinctive formal tool type (Cooper and Bowdler 1998:75). However, Veth and O'Connor (2005:9–10, 12–13) considered that in parts of the Western Australian arid zone, tula adzes, burren adzes, geometric microliths, engravers and thumbnail, notched and nosed scrapers were also manufactured from glass. A future use-wear/residue analysis could explore this hypothesis in more detail.

a **b**

Figure 8 Kimberley points (no scales provided in original images). ***A****: bifacial stone Kimberley point from Mt Behn in the Kimberley, WA. Adapted from Maloney et al. (2017:44).* ***B****: a glass Kimberley point. Adapted from Australian Museum: https://australianmuseum.net.au/learn/cultures/atsi-collection/cultural-objects/kimberley-spear-points/*

Analysts' observations and formal morphologies may often be strong indicators of artefact status but not always definitive. Veth and O'Connor (2005:5) also observed, in proximity to government wells in WA, glass pieces that they considered to have been 'unquestionably' modified by Aboriginal peoples, while Cole et al. (2020:24) identified flaked glass pieces near Laura, Queensland. Such interpretations from experienced analysts are probably reliable, and obvious anthropogenic modification does not require resemblance to a formal tool type. One distinctive modification is also known to have been practised by Chinese people in post-contact Australia. Across three historical sites in Melbourne and Sydney, glass bottle bases were distinctively modified by Chinese Australians for opium-smoking, with the pontil mark chipped away to create a small hole for a pipe (Bowen 2013:90–91; Galloway 2005:112–113). However, in the many cases in Australia, Europe, South Africa, America and elsewhere where individual stone or glass artefact morphologies do not as clearly reflect known types such as the Kimberley point, analysts' interpretations have varied considerably (Allen and Jones 1980; Bordes 1973, 1978; Cooper and Bowdler 1998; Dibble 1995; Goward 2011; Harrison 2000; Howchin 1934; Kuman and Field 2009:157–168; Leakey 1970, 1971; McBryde 1977; McCarthy 1976; McCarthy and Davidson 1943; Mulvaney 1977, 1985; Prasciunas 2011; Runnels 1976; Simmons 2014; Tindale 1937; Tixier 1995; Toth 1985; Tuffreau 1988).

Various other macroscopically observable attributes of glass pieces may also contribute evidence for artefactual status without being conclusive. For example, bifacial flaking, the presence of flake scars, and the orientation of flake removal, can be useful guides, but can sometimes result from accidental breakage (Martindale and Jurakic 2015:33), and trampling can sometimes cause bifacial flaking on glass (Chazan et al. 2013). Similarly, a general trend may exist in some parts for use of the thicker parts of bottles, but this alone would be diagnostically insufficient. Contextual considerations can assist interpretations, particularly in regard to locations in which glass artefacts are found—often, as mentioned, on the margins of European settlements (Paterson 2006:104, 106–107; Veth and O'Connor 2005:10).

Given the difficulties involved in macroscopic diagnoses, a conservative approach, such as that adopted by Perston et al. (2021), appears to be the most prudent. Perston et al. (2021) used three categories reflecting varied levels of diagnostic confidence for glass shards from two Native Mounted Police camps in Queensland: (i) deliberately knapped, where features were clear and unambiguous; (ii) possibly modified pieces; and (iii) glass that showed no signs of knapping. They acknowledged that pieces in the second and third categories had potentially been used but that in the absence of a microscopic use-wear and/or residue analysis this could not be confirmed (Perston et al. 2021). Consequently, they only subjected shards in the first category to their macroscopic analysis.

3.3 Glass Bottle Identification

The identification of the type of bottle from which glass fragments may have been struck can facilitate more nuanced contextual understandings. For example, shattered fragments of Coca-Cola bottles found alongside modern beer and wine bottles and other contemporary paraphernalia at houseboat moorings by the River Murray, are less likely to constitute Indigenous flaked artefacts. However, glass fragments with identifiable manufacturer markings demonstrating origins closer to the decades following European colonisation of a region (e.g., Burke et al. 2017:428–451; Goward 2011:52–54, 96–97; Walshe et al. 2019:202, 205), accompanied by stone artefacts and an absence of other modern materials, would have more contextual potential for artefactual status. Notwithstanding these considerations, it is possible that any piece of glass may have been used by Aboriginal peoples because of their ongoing use of glass and continued accessing of 'Country' along the River Murray until the present.

Glass fragments can often be dated to a maximum age when they preserve evidence of the bottle manufacturer. Production techniques were typically particular to a certain period, and manufacturers' symbols were stamped, embossed, imprinted or otherwise added to the bottles themselves, generally on or around the base (Burke et al. 2017:428–451; Shueard and Tuckwell 1993). However, many glass shards in archaeological contexts are non-diagnostic because they are not from the base or finish of a bottle. Nonetheless, in such situations, the probability of artefact status can be strengthened if shards are found alongside diagnostic bases or finishes of the same colour, because this suggests temporal association—a presumption that may be supported by other contextual factors, such as evidence of little or no taphonomic disturbance and an absence of contemporary debris. Microscopic analysis would then further inform interpretations of artefactual status.

For the study region of this project, several local glass manufacturers existed across different time periods. Aerated water bottles were manufactured in Renmark by 'Thomas J. Adams' from 1892 to 1897, 'H.G. Cattermole' from 1897 to the 1920s, 'A.E. Emslie and L. Emslie' from 1910 to 1911, 'L. Emslies Renmark' from c. 1910–1911 (Figure 9), 'F. Hale' from 1913 to 1935 and 'John Hisgrove' in 1897 (Figure 9) (Shueard and Tuckwell 1993:325–327). In Waikerie, around 79 km west, 'W.M. Francis' manufactured aerated water bottles in 1916 (Shueard and Tuckwell 1993:336). For the broader South Australian region, many manufacturers operated for considerable periods of time in Adelaide and regional districts. For example, in Adelaide, the 'South Australian Glass Works' operated from 1875–1913 under a variety of names, such as 'South Australian Glass Bottle Factory Ltd' and 'South Australian Glass Bottle Company' (Arnold 1997:13–14). From 1890 to 1913, '00' was embossed on the bases of all bottles from the South Australian Glass Works in its various iterations (Arnold 1997:14; Figure 9). Glass artefacts in the study area may have derived from local and/or non-local manufacturers, and Table 2 displays a range of dateable colour features from glass bottles.

a b c

*Figure 9 Aerated water bottles (no scales provided in original images). **A**: manufactured by 'L. Emslies Renmark,' c. 1910–1911. Adapted from Shueard and Tuckwell (1993:326). **B**: manufactured by ‘John Hisgrove,’ Renmark. Adapted from Shueard and Tuckwell (1993:327). **C**: an example of diagnostic embossing, with the ‘00’ on the base of ‘South Australian Glass Works’ bottles from 1890 to 1913. Adapted from Shueard and Tuckwell (1993:326).*

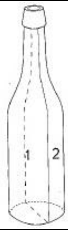
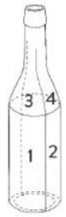
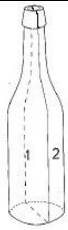
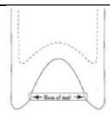
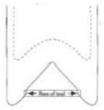
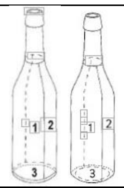
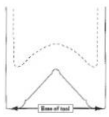
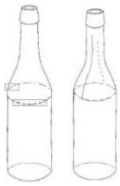
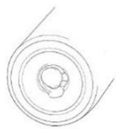
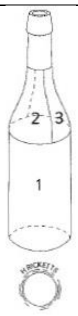
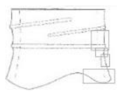
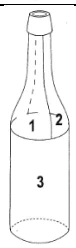
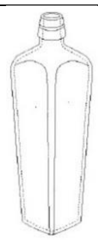
Table 2 Dateable features of glass bottle colouration. Adapted from Burke et al. (2017:428–451) and others where indicated.

Dateable Feature	Description	Date	Reference
Colourless	No tint or hint of colour	Post 1870	Burke et al. 2017:448
Purple/amethyst	Initially colourless, but tint is caused after prolonged exposure to UV light activates manganese present in the glass	1885–c. 1920s	Burke et al. 2017:448; Goward 2011:Appendix C; Myhrer et al. 1990:3
Black/extremely dark green	Technically a dark green but often appears black even in reflected light	Pre-1880	Burke et al. 2017:449
White	Often confused with ceramic	c. 1890s–1920	Burke et al. 2017:449; Goward 2011:Appendix C

Bronze/pale rusty colour/ honey colour	Initially colourless, but tint is caused by the addition of selenium as a bleaching agent	1910–1950s	Lockhart 2006:53; Sharp 1933:763
Amber/brown	n/a	1914–present; most beer bottles = 1875–1900	Hutchinson 1981:154; Lockhart 2006:50

Manufacturing techniques are the most common means by which glass bottles can be dated because methods changed over time periods. Bottles were manufactured entirely or mostly by hand before the advent of relevant machinery in the early 1900s (Burke et al. 2017:430; Jones and Sullivan 1985:171), and hand manufacture can be recognised by features such as pontil marks or an applied finish whereby a bottle was reheated and extra glass added to the neck (Burke et al. 2017:434, 442). Machine manufacture is evidenced by characteristics such as a continuous, full length two-piece mould, suction scar or valve mark (Burke et al. 2017:430, 437–438). Many other features, too exhaustive to list here, can assist in the identification of bottles (Arnold 1985, 1997; Shueard and Tuckwell 1993; Vader and Murray 1975). For example, embossed lettering or symbols on the external bottle surface range from 1821 to the 1920s, paper labels were common from c. 1850 onwards, stamped seals typically pre-date 1840 and stippling on bottle bases began after around 1940 and is ongoing (Burke et al. 2017:429). Other common dateable features include the nature of the collar, seal, lip or mould type used and additional aspects of the base of bottles. Table 3, based on information from Burke et al. (2017:429–451), outlines select dateable features in further detail.

Table 3 Dateable features of bottle glass according to manufacturing technique. Adapted from Burke et al. (2017:429–451).

Dateable Feature/ Description	**Image**	**Date**	**Dateable Feature/ Description**	**Image**	**Date**
Mould: full body-length two-piece. Body is moulded but the finish (collar and lip) was hand-made		c. 1750 to 1900–1930; common until c. 1860–1870	*Mould*: four-piece: Has two shoulder/neck mounds and two body moulds		1870s–1910
Mould: entire bottle. Entire body, including lip and collar, is moulded		Post c. 1920	*Push-up* (‘kick-up’): Wooden cone push-up Metal-capped cone push-up		c. 1820–1870
Mould: cup-bottom base (left): circular seam above heel; *Mould*: post-bottom base (right): circular mould seam on base.		c. 1850s–1920s	*Push-up*: Metal-capped cone with metal baseplate push-up		c. 1810–1860
Mould: dip mould Tapered one-piece mould used: faint, circular mark/bulge is present on upper body/shoulders		1760 to c. 1860–1870	*Pontil mark:* This is the mark left after the bottle broke free from the pontil rod used during manufacture		Varieties from 1840 to 1875 (Burke et al. 2017:434)
Mould: Ricketts mould: Horizontal seam at intersection of the body and shoulder, with two vertical seams extending from there to the neck; base seam is on heel, embossing is on the base		1821–1920s	*External screw thread*: Raised glass ridges allowing bottle to be sealed by a screw cap		1885–present
Mould: turn-paste: No embossing or mould seams, a high level of polish; possibly faint horizontal rotational lines on body		1870–1920	*Base*: Maugham patent: Long, cylindrical bottle with rounded base for flat storage		Post 1845
Mould: three-piece: Horizontal mould seam on shoulder, two diametrically opposed vertical seams extending from there to the neck		c. 1820 to 1900–1920	*Base*: case bottles: Square based and tapering bottle body allowed for vertical storage		1600s–1930s

3.4 Chapter Summary

Discussion in this chapter focused on key issues concerning Aboriginal Australian glass artefacts. In particular, known past uses for glass and the difficulties involved in the macroscopic identification of glass pieces as artefacts were explored. Natural glasses, such as tektites, had been used prior to European contact, and observations from early European settlers attest to the use of bottle glass for purposes such as animal butchery and scraping wooden spears. Glass artefacts have typically been recovered from sites physically distant from or on the margins of main European thoroughfares and settlements, suggesting that Aboriginal peoples sought to manufacture and/or use them away from any potential interference. While some glass artefacts are clearly identifiable macroscopically, there remains no consensus as to exact macroscopic diagnostic criteria. Microscopic use-wear analysis not only largely redresses this issue but can also be used to inform about the manner in which artefacts were used. Finally, glass artefacts may be broadly dateable if marks from bottle manufacturers are present.

Chapter Four: Use-wear Analysis of Flaked Stone, Glass and Porcelain Artefacts

This chapter discusses the nature of use-wear on flaked tools and techniques for its analysis. Following a basic contextualisation of use-wear studies, descriptions are provided about the characteristics of chert, silcrete, glass and porcelain, because the tool raw material is one of several factors that influences the formation of use-wear. Consideration is then given to the potential taphonomic influences that can result in artefact attributes that mimic use-wear and to the traits that can assist in distinguishing between wear resulting from natural and anthropogenic agents. Discussion then focusses on the nature of, and analytical techniques for, the individual forms of use-wear: polish and abrasive smoothing, striations, edge scarring and edge rounding. Having addressed these forms of use-wear, an overview is provided, from the literature, of the particular forms in which they can be present on chert, silcrete, glass and porcelain tools used to work materials commonly found in the past around Calperum Station: wood, bone, meat, hide and plant material. Although not undertaken in this analysis due to the lack of preserved residue, the chapter concludes with a brief outline of residue analysis so as to contextualise the value of use-wear analysis for inferring tool functions, and to highlight the value of residue analysis for any materials that may be excavated during potential future research (discussed in more detail in 'Limitations and Future Research Directions' in Chapter Nine).

Understanding tool functions can contribute to our knowledge of past technological, subsistence and related practices and to the consideration of a wider range of archaeological theories and issues (Álvarez-Fernández et al. 2020; Attenbrow et al. 2009; Clarkson et al. 2017; Evans et al. 2014:1; Fullagar 2014:234, 254; Fullagar and Jones 2004; Fullagar et al. 2006; Gorman 2000; Hayes et al. 2018:97; Keeley 1974:323; Kirgesner et al. 2019; Kononenko 2011; Kononenko et al. 2015, 2016; Luong et al. 2019; Piperno et al. 2009; Rots 2004; Rots et al. 2016; Rutkoski et al. 2020; Spry et al. 2020; Summerhayes et al. 2010; Veth et al. 2017; Walton 2019; Xhauflair et al.

2017:80; Xhauflair et al. 2020). Not only can use-wear/residue analyses assist in overcoming the difficulties in the macroscopic identification of artefactual glass, but they are robust means by which to investigate the functions of flaked glass, stone and porcelain, as well as other artefacts. Such analyses typically involve specialised methods that examine multiple lines of evidence (Dickinson 2021; Fullagar and Jones 2004; Fullagar et al. 2021; Gorman 2000; Harrison 2005:19, 21–22; Hayes et al. 2017; Kamminga 1982; Keeley 1980; Kimball et al. 2017; Kononenko 2011; Kononenko et al. 2015, 2016; Lombard 2011; Luong et al. 2019; Robertson 2009; Robertson et al. 2009; Robertson et al. 2019; Rots 2003, 2004, 2005; Semenov 1964; Solheim et al. 2018; Spry et al. 2020; Stemp 2004; Ulm et al. 2009; Walton 2019).

Since Semenov's (1964) pioneering research, many studies, both in Australia and other parts of the world, have demonstrated the value of microscopic use-wear analysis to determine stone and, to a lesser extent glass, artefact functions (Akerman et al. 2002; Attenbrow et al. 2009; Balme et al. 2001; Barton 2009; Blume 2010; Burroni et al. 2012; Conte and Romero 2008; Clemente-Conte et al. 2015; Clarkson et al. 2017; Dickinson 2021; Dinnis et al. 2009; Fullagar 1991; Fullagar and Jones 2004; González-Urquijo and Ibáñez-Estévez 2003; Gorman 2000; Groman-Yaroslavski et al. 2016; Hayden 1979; Hayes 2015; Hayes et al. 2017; Kamminga 1982; Kashyap et al. 2009; Keeley 1980; Kimball et al. 1995; Kimball et al. 2017; King 2017b; Kononenko 2012; Langejans 2010; Lemorini et al. 2014; Lemorini et al. 2016; Liu et al. 2017; Lombard 2005, 2011; Loy 1983, 1998; Luong et al. 2019; Lynch and Miotti 2017; Martindale and Jurakic 2006; McDonald et al. 2018; Rots 2003, 2004, 2005; Rots et al. 2006; Rots et al. 2016; Rutkoski et al. 2020; Smallwood 2015; Solheim et al. 2018; Sorensen et al. 2018; Spry et al. 2020; Ulm et al. 2009; Walton 2019). For example, Gorman (2000) compared the microwear on glass from archaeological contexts in the Andaman Islands with that of known glass razors from the ethnographic period, identifying 61 artefactual glass pieces and their uses as body modification tools. Ulm et al. (2009) determined that glass artefacts in the late eighteenth/early nineteenth centuries at Bustard Bay in Queensland were used primarily for wood-working and plant-processing. Extensive use-wear experiments by Kononenko (2011) and Walton (2019) are among other several key projects that have provided valuable understandings about the nature of use-wear on natural glass (obsidian).

Use-wear analyses have also informed us that overseas Indigenous groups incorporated glass introduced by incoming peoples. For example, the predominantly female tool-makers of the Andaman Islands increasingly adopted glass after contact, often in preference to chert because the glass was sharper (Gorman 1995:90; Man 1883:380). Chinookans in post-contact America chose to use glass instead of stone for some practices, while still applying traditional methods to work this new material (Simmons 2014:106–120), and glass use has been known in Ethiopia (Gallagher 1977:408). Similarly, Indigenous coastal groups in Patagonia and on the nearby South American offshore island of Tierra del Fuego, largely replaced lithics with introduced glass obtained from shipwrecks or through exchange or commerce, and used it to manufacture traditional tool forms, such as scrapers, for tasks including hide-processing and as points for projectile weaponry (Charlin et al. 2016:320–321; De Angelis 2014; Delaunay et al. 2017:1333–1340). The Tierra del Fuegans also used glass expediently (Musters 1871:172, 179).

4.1 Use-Wear

In order to best infer function, it is necessary to determine the location of use-wear on a tool, the tool motion and the worked material (Attenbrow et al. 2009:2766–2767; Luong et al. 2019; Robertson and Attenbrow 2008:32–33; Rots and Williamson 2004:1297). Use-wear analysis is particularly effective for making these determinations but cannot normally assist in identifications of the worked material to a taxonomic level (Gorman 2000:190–193; Kamminga 1982:4, 11–14; Keeley 1980:20–24, 36; Kimball 2017:67, 70; Lemorini et al. 2014:15, 17, 19, 21; Lombard 2005:285; Šmit et al. 1998:213; Solheim et al. 2018; Spry et al. 2020). Use-wear analysis also does not enable functional diagnosis on every occasion, mostly because of taphonomic influences (discussed below) and/or because of the occasional overlap of some use-wear attributes after the working of different materials (Collins 2007; Hayes et al. 2017:250). One of the more effective ways to minimise these difficulties is to conduct experiments that approximate the conditions of the relevant archaeological site(s), as is undertaken in this thesis (and discussed further in the Methods—Chapter Five). Such experiments are important because different environmental conditions can affect the occurrence of use-wear. For example, use-wear such as edge rounding may be more common at sites where there is an abundance of abrasive agents, such as sand and grit (Fullagar 2014:249; Kamminga 1982:17; Lombard 2005:285).

Use-wear analysis is highly effective for determining tool motion(s) (Kamminga 1982:4, 11–14; Keeley 1980:20–24, 36; Kimball 2017:67, 70; Lombard 2005:285; Luong et al. 2019:2; Spry et al. 2020; Stevens et al. 2010; Ulm et al. 2009). Stone tools were used with a variety of motions, such as cutting, slicing, scraping, sawing, chopping, adzing and drilling (Attenbrow et al. 2009:2768; Fullagar and Jones 2004:89–90; Kamminga 1982:29–79; Keeley 1980:18; Lemorini et al. 2014:15, 17, 19, 21; Lombard 2005, 2011; Solheim et al. 2018:564), and glass tools were used with similar motions, such as scraping and cutting (Dawson 1831:67, 135; Timothy Johnson and Philip Johnson, pers. comm. 2019; Ulm et al. 2009; Wolski and Loy 1999:69, 71). Use-wear differs according to these worked materials and motions and across different tool raw materials (Clemente-Conte et al. 2015; Fuentes et al. 2021; Gibaja and Gasson 2015; Groman-Yaroslavski 2021a; Groman-Yaroslavski 2021b; Kamminga 1982:29, 83; Keeley 1980:36–61; Kononenko 2011; Kononenko et al. 2015, 2016; Lemorini et al. 2014; Lerner 2007; Lerner et al. 2007; Walton 2019). Much of our existing knowledge of use-wear derives from analyses involving chert tools (e.g., Álvarez-Fernández et al. 2020; Faulks et al. 2011; Ibáñez et al. 2019; Kamminga 1982; Keeley 1980; Kimball et al. 2017; Kirgesner et al. 2019), as well as tools made from obsidian (Aoyama 1995; Fullagar 1992; Hurcombe 1992; Kononenko 2011; Kononenko et al. 2015, 2016; Stemp 2016a, 2016b; Walton 2019). This thesis therefore adds to the relatively few previous microscopic use-wear analyses of bottle glass while also providing the first such analysis of porcelain shards.

4.1.1 Use-Wear: Tool Raw Material

The varied properties of different tool raw materials influence the extent and nature of use-wear (Fernández-Marchena et al. 2020; Kamminga 1982; Kononenko 2011; Lerner 2007; Pedergnana and Ollé 2017; Stemp et al. 2013; Walton 2019). It is therefore necessary to consider the nature of tool raw materials in any use-wear study. The majority of the stone artefacts at Calperum Station were manufactured from chert and silcrete, both of which are relatively hard (Kamminga 1982:27–28; Lerner et al. 2007:716 [re chert]), and somewhat more resistant to abrasion, fracture, penetration and impact than glass and porcelain.

Chert (Figure 10) tools were used in many parts of Australia and the world. This raw material is a homogeneous (Bachellerie and Schmidt 2020:240), fine-grained, highly siliceous, chemically precipitated, microcrystalline sedimentary quartz (Perry Jr and Lefticariu 2005:99–100) that occurs in a variety of colours, including white, brown, yellow-grey, red, black, blue, pink and green (Rapp 2009:76). Chert shares properties with flint, and some geologists and archaeologists consider one to be a variety of the other, while others argue that there is no compositional or practical difference between the two (see discussion in Luedtke 1992; Ward et al. 2019:171–174; Whittaker 1994:70). For this thesis, including when referring to previous research, the term 'chert' is preferred, primarily because of its more regular use in contemporary Australian archaeology.

a b

*Figure 10 Examples of macroscopic images of chert (no scales provided in original images). **A**: adapted from Attenbrow et al. (2009:2767). **B**: from Munt et al. (2018:76).*

Silcrete (Figure 11), like chert, is highly siliceous (85–95%; Summerfield 1983; Webb and Domanski 2008:557), brittle and isotropic, so it fractures conchoidally (Hawkins and Mosig Way 2020:197; Webb and Domanski 2008:557). Like other materials, silcrete was often heat-treated by hunter-gatherers to improve flaking quality, even as long ago as between 130,000 and 200,000–400,000 BP, during the Middle Stone Age in South Africa (Schmidt et al. 2020a:8). A strongly indurated or hardened material, silcrete is formed as a result of the low temperature surface or near surface silicification of porosities in pre-existing sediments (Nash and Ullyott 2007; Taylor and Eggleton 2017:987; Thiry and Milnes 2016:13; Webb and Domanski 2008:557; Webb et al. 2013:130–131), often in duricrusts in semi-arid environments (Gill 1973; Rapp 2009:57; Taylor and Eggleton 2017:987; Thiry and Milnes 2016:2). Silcrete can often be distinguished from many other microcrystalline rocks by the fact that it fractures smoothly through the grains and by the presence of cream-coloured streaks of anatase (Webb et al. 2013:131). A vitreous lustre is also common (Eggleton 2001; Webb et al. 2013:131).

Silcrete is predominantly comprised of quartz, variation in the grains of which contributes to different levels of suitability for flaking (Sullivan et al. 2014:43–44; Webb and Domanski 2013:131). Leaving aside the many other factors involved in flake formation, such as pre-existing impurities and amounts and angles of applied force, silcrete typically fractures more easily when grains are finer (Webb and Domanski 2008:557). The degree of fineness/coarseness is commonly described as 'microcrystalline,' 'fine-grained,' 'medium-grained' or 'coarse-grained.' Microcrystalline silcrete contains extremely fine grains scattered with silt-sized quartz clasts, while fine-grained silcretes are comprised of clasts that are slightly larger but less than 0.25 mm (Webb and Domanski 2008:557). Quartz clasts in medium-grained silcretes are 0.25–0.5 mm and easily visible macroscopically, while coarse-grained silcretes are characterised by clasts greater in size than 0.5 mm and sometimes pebbly (Webb and Domanski 2008:557). The edges of coarse-grained silcretes have a lower fracture toughness than those of fine-grained versions, so are less effective for use as flakes (Webb and Domanski 2008; Webb et al. 2013:138). Silcretes were (and are) widely available in Australia, outcropping primarily in central arid and eastern regions, and regularly flaked and used by Aboriginal Australians, particularly for adzing and scraping wood (Gould 1978:827–829; Hiscock and Attenbrow 2005; Kamminga 1985:17; McLaren et al. 2018; McNiven 1993; Veth et al. 2011b:9; Webb and Domanski 2008:557–558). Tulas, in particular, were commonly manufactured from silcrete (Doelman 2008:133; Smith 2006:393–395).

However, silcrete is not always easily identified. This raw material appears in a wide variety of forms, and interpretations by archaeologists and geologists often vary in terms of types of silcrete or whether a material is even silcrete at all, rather than a similar material such as quartzite or silicified sandstone (Eggleton and Taylor 2017; Hughes et al. 1973:220, 224; Taylor and Eggleton 2017:988; Thiry and Milnes 2016:4, 8; Webb et al. 2013:131). Definitions of silcrete also vary. For Lamplugh (1903), silcrete is a kind of conglomerate comprising sand and gravel cemented by silica, while Eggleton (2001) considered silcrete to be a strongly silicified, indurated regolith. Thiry and

Milnes (2016:1) adopted Eggleton's definition and, similarly, Sullivan et al. (2014:43) and Hughes et al. (2014:113) defined silcrete as an indurated rock comprising predominantly silicified quartz clasts. For Taylor and Eggleton (2017:988), silcrete is a 'silicified regolith,' while Hawkins and Mosig Way (2020:201) distinguished silcrete and chert by classifying material as silcrete if grains were macroscopically visible and chert if they were not. Some classify silcretes as either pedogenic or resulting from groundwater, based on interpretations of the origin of the fabrics within the silcrete (Doelman 2005b:16; Nash and Ullyott 2007; Nash et al. 2013:682; Thiry and Milnes 2016:4, 6; Webb et al. 2013:130). Others discount the value of such classifications because of their observations of the presence of fabrics of the same origin in each classification (Taylor and Eggleton 2017:1010–1011).

Figure 11 Examples of the macroscopic appearance of silcrete artefacts. Adapted from McLaren et al. (2018:213–214).

Glass examined in this study is soda-lime bottle glass, a synthetic form of glass whose dominant constituent is silica, at around 70–75% of the chemical composition (Terro 2006:635). Soda (Na^2CO^3; sodium oxide) and lime (CaO; calcium oxide) constitute the majority of the remaining chemicals (Terro 2006:635). Synthetic glass is non-crystalline, isotropic and extremely brittle due to its molecular structure (Gorman 1995:88; Tait 1991:8). Differences exist in aspects of the chemical compositions of synthetic and natural glass, such as obsidian (Le Bourhis 2014:28), such that these materials do not fracture identically. However, because synthetic glass is brittle and also fractures conchoidally, technological analyses can be conducted using the same methods as those used for obsidian and stone (Barker et al. 2020:38; Cotterell and Kamminga 1987; De Angelis 2014; Dogandžić et al. 2020; Wallis et al. 2018). Given that obsidian is a natural glass, along with the fact that there is a relative paucity of previous use-wear analyses on bottle glass, use-wear on obsidian tools may provide some value for comparisons with the use-wear on bottle glass tools used for the same tasks (Aoyama 1995; Hurcombe 1992; Kononenko 2011; Kononenko et al. 2015, 2016; Martindale and Jurakic 2006; Stemp 2016a; Walton 2019).

Porcelain can also be analysed with the same methods as those used for stone artefacts. This material is brittle, elastic, homogeneous and isotropic, so it too fractures conchoidally (Khreisheh et al. 2013:37–39; Speer 2018:73). Porcelain is typically made from a mixture of white china, clay, feldspar and quartz or alumina (Carty and Senapati 1998:5, 8; Khreisheh et al. 2013:39) and is highly vitreous (Rapp 2009:193). Experimental reduction of porcelain by Khreisheh et al. (2013) demonstrated that this material fractures similarly to chert and that some signs of wear, particularly wear arising from use as projectiles, could be easily discerned macroscopically. However, as Khreisheh et al. (2013:43) suggested, more detailed understandings about wear on porcelain could be ascertained through future microscopic use-wear analysis. This thesis addresses this gap, with comparisons of the wear on porcelain tools with that on other tools used for the same tasks.

4.1.2 Use-Wear: Taphonomy

Taphonomy, particularly trampling and sediment movement, is another factor that can contribute to the presence, nature and extent of non-use-related wear. Abrasion of artefacts can occur because of sediment movement, resulting in rounding of an artefact’s surface and, for materials containing quartzite, a widespread brightness from the quartzite cement matrix (Lemorini et al. 2014:14). However, there is little agreement about the exact nature of various potential macroscopic indicators of human or animal trampling, such as horizontal and vertical displacement (Eren et al. 2010; Evans 2014; Gifford-

Gonzales et al. 1985; Gorman 2000:212; Lemorini et al. 2014:14; Marwick et al. 2017; Nielsen 1991; Shea and Klenck 1993:191–192; Simmons 2014:73–74; Villa and Courtin 1983).

Despite this lack of agreement, previous experiments and analyses of archaeological assemblages have repeatedly demonstrated that trampling has the potential to cause not only artefact displacement but also damage that resembles use-related wear (e.g., Flenniken and Haggarty 1979; McBrearty et al. 1998; Vallin et al. 2001:428; Zupancich et al. 2018). Zupancich et al. (2018:259) found that diagnostic use-wear could only be distinguished from taphonomic wear on eight of 91 Acheulian chert artefacts, and McBrearty et al. (1998:124) observed that trampling can even affect artefact morphology to the extent that artefacts resemble formal tool types. Downward artefact movement caused by trampling or otherwise-induced subsurface sediment movement, such as at Gombe Point in the Kalahari (Cahen and Moeyersons 1977:813–814) and Kenniff Cave in Queensland (Richardson 1992:417), can also cause striations, resulting from abrasion with soil particles, that appear similar to use-related striations (Gorman 2000:210; Hayes et al. 2018:100).

However, some previous experiments also indicate that trampling does not always damage artefacts. Eren et al. (2010:3019) observed minimal edge scarring during their experiments in India involving the trampling of limestone artefacts by water buffalo and goats. In dry conditions the inclination of the artefact on the surface changed little (mean = ~ < 10º) but the difference was substantial in watered substrates (up to ~ 70º). Horizontal and vertical artefact movement was minimal in dry substrates but a mean of approximately 6 cm of vertical movement occurred in watered substrates (Eren et al. 2010:3016–3019). In all settings, the horizontal and vertical movement was not influenced by the sizes of the artefacts (Eren et al. 2010:3015, 3018). Similar results were evident in experiments by Gifford-Gonzales et al. (1985), Nielsen (1991) and Villa and Courtin (1983). Marwick et al. (2017) found that artefact size was not a reliable predictor of horizontal movement but that the flatness of an artefact can contribute to downward movement, albeit also dependent on other taphonomic factors. Other experiments have demonstrated that trampling does not always have such profound effects on vertical movement (e.g., Driscoll et al. 2015), in which case striations caused by sediment movement are minimised.

A number of indicators on artefacts of the effects of trampling and other taphonomic influences appear to be plausible, particularly if present in association with each other. Use-wear traces typically occur in localised regions along an artefact's edge and different types of use-wear attributes (discussed below) commonly occur in combination, whereas non-use wear is distributed randomly (with no consistent pattern in directionality or location in relation to the edge) and often on raised parts of an artefact (Asryan et al. 2014:20, 23; Lemorini et al. 2014:14; Nielsen 1991:500; Rots and Williamson 2004:1288; Shea and Klenck 1993:178; Tringham et al. 1974:113). Exposure to heat following artefact use does not appear to impact the presence or nature of polish on an artefact's surface. For example, Rutkoski et al. (2020:40–41) placed 50 experimental chert artefacts around a fire for one hour and 17 minutes and, from their before and after comparisons of polish micrographs, found that thermal alteration did not affect the polish.

The context in which artefacts are present is particularly significant. Kaňáková (2020) demonstrated that rounding on archers' projectile tips from the Early Bronze Age Nitra culture of east Moravia and southwest Slovakia was caused by the transport of the projectiles over hundreds of kilometres rather than by use. Physical contexts can influence the formation of wear. For example, artefacts from a ploughed field or otherwise frequently trampled location would be more likely to exhibit non-anthropogenic signs of wear (Allen and Jones 1980:231; Gorman 2000:212; Goward 2011:21, 23; Harrison 1996:104; Knudson 1979:280; van Gijn 2010:42). Trampling of artefacts in harder substrates is more likely to lead to non-anthropogenic edge-damage (Gifford-Gonzales et al. 1985:813; Nielsen 1991:500), and a high percentage of artefact breakage in an assemblage is a potential indicator of trampling (Douglass and Wandsnider 2012:353, 356, 359; Eren et al. 2010; McBrearty et al. 1998:114). The presence of small flake scars resembling negative flake scars caused by retouch may also reflect trampling—these small flake scars occur, unlike retouch scars, in a discontinuous form on the artefact edge and may be present on the dorsal ridges of artefacts (Douglass and Wandsnider 2012:359). In all cases, evidence for artefact use is more robust when multiple lines of evidence are present (Kamminga 1982:11; Lombard 2011:1920).

4.1.3 Use-Wear: Microscopy and Forms of Use-wear

Early use-wear methodological discussion focused primarily on the relative virtues of low power (using low magnification stereozoom microscopes with oblique light sources) versus high power (using high magnification metallographic microscopes with vertical incident light) (Bamforth et al. 1990; Brink 1978; Kamminga 1982:113; Keeley 1980:2, 12–14; Keeley and Newcomer 1977; Lewenstein 1987; Odell 1996; Schultz 1992; Semenov 1964:22–23; Stafford 1977; Tringham et al. 1974; and see Yerkes 2019:1, 3). However, the most effective method is to use both low and high magnifications, supplementing conventional microscopes with other techniques (e.g., scanning electron microscope [‘SEM’], Raman, LSCM). For example, low magnification enables the efficient screening of artefact edges, while high magnification facilitates the detection of finer use-wear features (Berehowyj 2013:15; Fullagar 2014:235–239; Gibaja and Gassin 2015:42; Keeley 1980:12–14; Kimball et al. 2017:74; Lemorini et al. 2019:4734–4735; Luong et al. 2019:10; Stemp and Harrison-Buck 2019:192; van Gijn 2014:167). Contemporary conventional microscopy for low magnification use-wear analysis still consists primarily of a stereomicroscope with oblique external light, and for high magnification, a metallographic microscope with vertical incident lighting and brightfield and/or darkfield illumination (Bordes et al. 2020:3; Buc et al. 2021:371; Caricola et al. 2018:7; Field et al. 2020:1366; Fuentes et al. 2021:3; Fullagar 2015:223; Fullagar et al. 2021:2; Groman-Yaroslavski et al. 2021a; Groman-Yaroslavski et al. 2021b; Hayes et al. 2014:77, 81; Hayes et al. 2017:248; Hayes et al. 2018:102–103; Hilbert and Clemente-Conte 2021:132; Holen et al. 2017:Supplementary Information;

Kirgesner et al. 2019:4; Kononenko et al. 2021:5; Lemorini et al. 2019:4736; Luong et al. 2019:10; Robertson et al. 2019:77; Rutkoski et al. 2020:40; Sorensen et al. 2018:13; Stemp and Harrison-Buck 2019:192; Stemp et al. 2019:5; Stemp et al. 2021:7; Walton 2019:912–914; Wright et al. 2016:731; Yamaoka et al. 2021:96).

Several forms of use-wear are widely recognised. The primary forms are polish and smoothing, striations, edge rounding and edge scarring (Clemente-Conte et al. 2015:59; Fullagar 2014:245; Gibaja and Gassin 2015:42; Hayden and Kamminga 1979:6; Kamminga 1982:4; Keeley 1980:9; Lombard 2005:285; Robertson and Attenbrow 2008:33; Rots et al. 2017:16–17; Semenov 1964:13–15). Polish and smoothing can help to indicate the nature of the worked material and possibly tool motion(s) (Christensen 1998:870, 874; Keeley 1980:23, 35; Lombard 2005:290–291; Semenov 1964:14–15; Solheim 2018), and striations can inform about tool motion(s) (Fernández-Marchena et al. 2020; Hayes et al. 2018:107; Kamminga 1982:11–14; Keeley 1980:36; Kimball 2017:67, 70; Lombard 2005:285). Edge rounding and edge scarring may inform about the materials that were worked (Akoshima 1987; Fernández-Marchena et al. 2020; Grace 1989; Kimball 2017:64, 66–67, 70; Kononenko 2011; Lombard 2005:285; Stevens et al. 2010:2675; Walton 2019) and edge scarring can also help to understand the motion(s) with which a tool was used (Fernández-Marchena et al. 2020; Kamminga 1982:4; Keeley 1980:20–24; Stemp and Awe 2014:235).

4.1.4 Form of Use-Wear: Polish

Intentional human use of stone and glass can be indicated by the presence and nature of polish on a tool's surface (Christensen 1998; Fullagar 2014:239; González-Urquijo and Ibáñez-Estévez 2003; Kamminga 1982:4, 14–17; Keeley 1980:22–23; Kimball et al. 2017; Kononenko 2011:8; Lombard 2005:285; Luong et al. 2019:10; Rodriguez et al. 2021; Rots et al. 2004:1297–1298; Rutkoski et al. 2020; Semenov 1964:14–15; Skakun et al. 2020; Sorensen et al. 2018:7, 10–11; Stemp and Harrison-Buck 2019:192; Walton

2019; Figure 12). Polish on a flaked artefact can be conceived of as an altered zone that normally appears shinier than the surrounding surface and is also associated with the process of abrasive smoothing, where abrasion can cause some levelling of the artefact's surface (Fullagar 2014:249; Kononenko 2011:8). However, not all polish is use-related because it can also be caused by contact with gravel or soil and by other post-depositional factors (Donahue and Evans 2012; Kononenko 2011:10; Pedergnana 2019:19). Non-use-related polish is typically distinguishable by its irregular distribution and lack of alignment with the working edge (Kononenko 2011:10). Association with other forms of use-wear further aids the identification of use-related polish (e.g., Lombard 2011:1920).

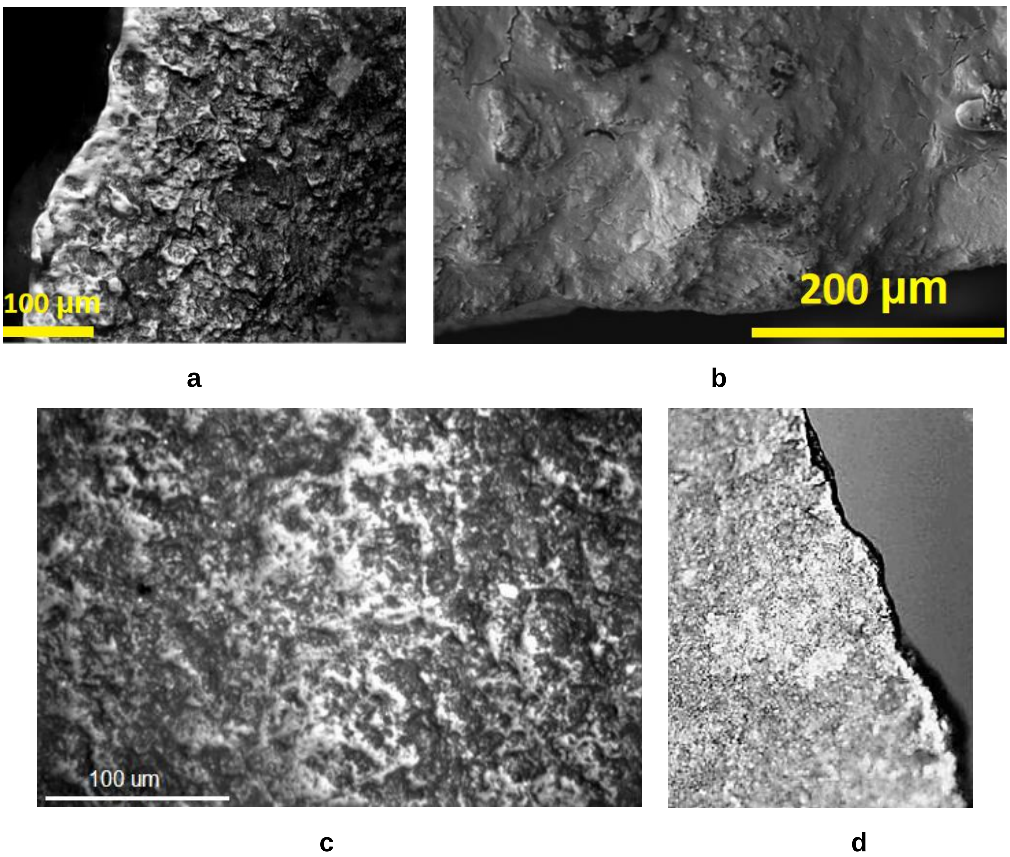


Figure 12 Polish and smoothing. ***A****: smooth-textured polish with a distinct boundary between the polished and unworked part of the artefact surface. Adapted from Luong et al. (2019:11).* ***B****: smooth, domed polish. Adapted from Lemorini et al. (2019:4743).* ***C****: polish on predominantly the microtopographic high points ('peaks'). Adapted from Solheim et al. (2018:567).* ***D****: polish distributed as a band on the edge (plant exudate is also visible in the centre). Adapted from Lombard (2005:291); no scale was provided in the original image but it was taken at x50 magnification.*

Earlier debates concerned whether polish is formed on stone as a result of an additive or abrasive process (polish formation on glass is discussed below). A key argument for an additive process was that polish on stone is a form of silica gel deposit on the tool surface formed as a result of the friction created between the tool and material being worked (Anderson 1980; Andersen and Whitlow 1983:472). Several experimental results suggested that residues of the worked material can occasionally become embedded within a polished layer and contribute to the development of a distinctive polish despite there being no loss of material from the tool surface (Christensen et al. 1998:870–874; Keeley 1980:43; Loy 1993:58). For example, Christensen et al. (1998:870–874) claimed that polish formed in the same regions on the surfaces of chert tools where they had intentionally embedded copper ions before working bone for 30 minutes and there was no loss of material. However, the veracity of this experiment was questioned by Schmidt et al. (2020b), who contended that Christensen et al. (1998) had not investigated the precise locations in which they embedded the copper ions relative to the regions in which polish formed, or the diffusion of the copper ions into the chert.

It appears that more recently, the 'abrasion model' for the formation of polish has become widely accepted (Ollé and Vergés 2008:41; Rodriguez et al. 2021; Schmidt et al. 2020b). For proponents of abrasion, polish is formed when parts of a tool's surface microtopography become smoothened by abrasive, hard contact with a material being worked (Del Bene 1979; Fullagar 1991; Ollé and Vergés 2008:41; Schmidt et al. 2020b). For example, after experimenting with flint tools to scrape dry hide and cut wet graminoid (*Brachypodium phoenicoides*), then examining micrographs from an SEM, Ollé and Vergés (2008:41) found that only a loss of material occurred. Fullagar (1991:3) also found that polish developed through abrasion rather than from residues from the material being worked. He experimentally used chert tools to work purified and distilled ice for 30 minutes. Water is composed solely of hydrogen and oxygen so there was no residue, yet some polish formed. Schmidt et al. (2020b) added considerable weight to the abrasion model when experimenting with chert tools to work antler, ivory, bone and wood. Using reflection infrared spectrometry they observed that in no case did silica form on the surface of a tool, yet polish nonetheless formed.

However, not all is yet fully understood about polish formation. In particular, eliciting the relative influences of factors such as the tool raw material, tool motions, properties of the worked material and the force applied, requires further experimentation (e.g., Stemp et al. 2016:13) (such experimentation would require a comprehensive programme, which is not the focus of this research). Most recently, Rodriguez et al. (2021) experimentally tested the influence, on polish development, of the hardness of the worked material. Using a tribometer to compare polish on flint tools used to process harder materials (bone, antler and ivory) and softer materials (beech wood and spruce wood), they observed that polish was more abundant (and smoother) on the softer materials—a counterintuitive result given that harder materials typically abrade more (Rodriguez et al. 2021). For Rodriguez et al. (2021:17), the most likely explanations were that more hard grit had become embedded within the softer worked materials and/or that particles of the stone tool had broken off at the interface between tool and worked material.

Notwithstanding the possibilities as to the exact nature of its formation, many previous studies have demonstrated that a range of polish characteristics can inform inferences for the worked material (González-Urquijo and Ibáñez-Estévez 2003:483–484, 488; Fullagar et al. 2021; Hayes 2015:76; Ibáñez et al. 2019; Kamminga 1982; Keeley 1980:35, 62; Key 2013:42; Kimball et al. 2017; Kirgesner et al. 2019:4–6; Kononenko 2011:8; Luong et al. 2019:10–11; Šmit et al. 1998:213; Solheim et al. 2018; Walton 2019). For example, experiments, predominantly on chert, have found that wood-working and plant-processing generally produce a domed microtopography (Figure 12b) (González-Urquijo and Ibáñez-Estévez 2003:483–484, 488; Keeley 1980:35, 62; Linton et al. 2016:1041; Rutkoski et al. 2020:40; Schmidt et al. 2020b), while the processing of highly siliceous plants typically results in a particularly bright polish (Fullagar et al. 2021:4; Luong et al. 2019:10; Skakun and Terekhina 2017:15).

Polish traits include brightness, texture, distribution, microtopography and ‘invasiveness’ (Conte and Romero 2008; Faulks et al. 2011; Fullagar 1991; González-Urquijo and Ibáñez-Estévez 2003; Keeley 1980:22–23; Kimball et al. 2017:67–68; King 2017a; Kirgesner et al. 2019:5; Kononenko 2011; Linton et al. 2016; Luong et al. 2019; Šmit et al. 1998:213; Stemp and Stemp 2001:85; Stemp and Stemp 2003:287–292; Stevens et al. 2010:2672; van Gijn 2010:81; Walton 2019). Polish brightness refers to the extent of polish reflectivity compared to the surrounding non-polished regions, texture concerns the smoothness of the polish, and distribution refers to where the polish is present on a tool. Microtopography involves descriptions of the surface of the tool on which the polish is present, such as on high points (‘peaks’), low points (‘valleys’) or both (González-Urquijo and Ibáñez-Estévez 2003:484–485; Keeley 1980:22–23; Kimball et al. 2017; King 2017b:4; Kirgesner et al. 2019:4–5; Lemorini et al. 2014:16–19; Linton et al. 2016; Lombard 2005:285; Luong et al. 2019:10). Polish invasiveness concerns the extent to which polish extends inward from the artefact edge in comparison to any edge scarring in physical association.

For some worked materials, polish characteristics have varied in past experiments. For example, mixed results have been obtained for the working of fresh meat. From his experiments with chert tools, Kamminga (1982:34–36) found that polish was absent. However, he did not use a metallographic microscope and other researchers who did so have recognised a distinct, often weakly developed polish. For example, Kirgesner et al. (2019:4–5) observed a dull polish with a greasy lustre on all ten of their experimental chert tools. Kirgesner et al. (2019) also experimented with chert to work frozen meat, in the only such experiment since Keeley and Newcomer (1977) worked a solitary tool for the same purpose. For both fresh and frozen meat, no discernible difference existed in polish brightness or texture, no striations were present and any edge scarring occurred in the form of scars with bending initiations (Kirgesner et al. 2019:4–5). However, key differences were also evident. After working fresh meat, polish typically extended 1 mm or more inwards from the tool edge, whereas on tools used to process frozen meat polish only ever extended as far in as 0.5 mm. This difference is unsurprising given the added resistance to penetration of frozen meat (Kirgesner et al. 2019:5). Use-related edge scarring was also more frequent after the working of frozen meat (Kirgesner et al. 2019:5).

Polish is one of the more robust indicators that an artefact was used, but on its own may not always definitively indicate the worked material. This is because of working multiple materials and the occasional overlap of polish characteristics that can occur after working different materials (Fullagar 1986a:164–165; Ibáñez et al. 2019:1183, 1185, 1188–1189; Rodriguez et al. 2021; van Gijn 2010:31; van Gijn 2014:168). In particular, overlap is common after working materials that are different but nonetheless similar, such as bone, antler and ivory (Pedergnana et al. 2020:5; Rodriguez et al. 2021). However, previous research has shown consistencies in polish characteristics that, when viewed in context with other aspects of use-wear, can indicate at a minimum the broad class of worked material(s) (Anderson 1980:181; Bamforth 1988:11; Bamforth et al. 1990:414; Donahue et al. 2004; Evans and Donahue 2008:2229; Fullagar 1986a:83, 160–165; González-Urquijo and Ibáñez-Estévez 2003:483–484, 488; Hayes 2015:76; Ibáñez et al. 2019; Kamminga 1982; Keeley 1980:35, 62; Kimball et al. 2017; Kononenko 2011; Mansur-Franchomme 1983:223; Solheim et al. 2018).

Polish brightness can particularly assist in the identification of the worked material (González-Urquijo and Ibáñez-Estévez 2003; Keeley 1980:62; Kimball et al. 2017:65–73). For example, at a broad level, brighter polish tends to be associated with plant material (Fullagar et al. 1996:743; Groman-Yaroslavski et al. 2016:1, 5 [Figure a], 6; Lombard 2005:290; Luong et al. 2019:10), including wood (Fullagar 1986a:179; Kimball 2017:63; Walton 2019:917). For Luong et al. (2019:10), the presence of a sharp boundary between the polished and unpolished parts of a tool indicates the working of a relatively hard plant material, and Keeley (1980:35–36) found, from his experimental working of a vast range of hardwoods and softwoods, that a very bright polish formed that was consistent across all wood types and distinctive from other types of materials.

Polish brightness can be categorised as dull, dull-moderate, moderate, moderate-bright or bright (or simply as dull, moderate or bright, e.g., Kononenko 2011:19), and is linked with polish texture. Typically, a smooth texture lends itself to a continuous band of bright polish, whereas a rough and flat texture is associated with a matte polish (Gorman 2000:263). In some cases, the texture can be quite specifically linked to the worked material. For example, Keeley (1980:43) found that the scraping of bone typically produced tiny pits (< 1 μm) within a bright polished surface, while Fullagar's (1986a:188) experiments produced the same results and a regular distribution of polish in small patches with highly distinct boundaries between these and the unpolished parts of the tool surfaces. Polish brightness is also affected by the presence of any natural or applied lubricant, such as amorphous silica (Fullagar 1991), whereby, as the volume of lubricant increases, so too does the polish brightness (Keeley 1980:49). These and other polish characteristics vary across tool raw materials (Clemente-Conte et al. 2015; Fullagar 1986a:160–162; Gorman 2000:183; Kamminga 1982:22, 82–83; Kononenko 2011; Rots et al. 2004:1297–1298)—necessitating the manufacture of an experimental reference library using the same tool raw materials as those encountered archaeologically.

Polish and smoothing form differently on glass (and quartz) in comparison to microcrystalline stone such as chert. Glass is typically more brittle, so edge fractures can often occur more easily and before sufficient tool-working time has elapsed for polish to have developed (Gorman 2000:193). Unlike stone, the surface of glass is normally smooth prior to working, but upon use, abrasion between the glass and the worked material causes some of the surface of the glass to be removed, resulting in a rougher, matte surface (Fullagar 1991:1; Gorman 2000:191)—this is the first stage of polish development and very light edge rounding occurs (Fullagar 1991:6; Vaughan 1985:28; Walton 2019:899). The second stage of polish development on glass is represented by the formation of polish and smoothing on high points of the microtopography, with pits in the valleys in between, and the third stage is that which is potentially diagnostic of the worked material: a silica gloss is formed on an extensive stable polished surface (Fullagar 1991:6). However, because the dominant constituent of most glass is amorphous silica (Kononenko 2011:10), the glass creates its own polishing agent as the edge fractures (Fullagar 1991; Richard Fullagar, pers. comm. 2020). While this process is additive in a manner described above, the added material derives from the tool itself rather than the worked material. Consequently, this adds complexity to efforts to distinguish between polish caused by the glass itself and that resulting from the working of a material.

In such circumstances, the presence and nature of other forms of use-wear become particularly valuable for inferences about the worked material. For example, sawing motions introduce more abrasives that work to inhibit the development of polish (Fullagar 1986a:151), and because some materials (such as hide) are less conducive to sawing than others, it may be less probable that such materials were worked, depending on other evidence. Comparisons between polish on experimental glass and glass within an archaeological assemblage may help to aid inferences for the worked material.

Understanding the microtopographic depths at which polish is present on a surface of a tool made of any raw material is particularly helpful for making inferences about the worked material. To achieve this goal, some qualitative observation under conventional microscopy is required. For example, an analyst must still use his or her observations and interpretations to identify polished regions on a tool. Individualistic descriptions of polish microtopographies, such as ‘flat,’ ‘not distinctive,’ ‘honeycomb,’ ‘crumpled foil’ and ‘grainy’ (Gorman 2000:263, 276, 297–299) can then still convey information effectively.

However, there has been an increasing shift in emphasis toward quantification of microtopographic depths and the development of methods to limit analyst subjectivity. Optical methods of interferometry create height and depth profiles by using reflected light from a solitary light source (typically the microscope lamp) ‘that is reflected from the artefact surface and split by several reference mirrors to establish the interference fringes of the artefact surface’ (Hayes 2015:102–103; see also Anderson et al. 2006; Dumont 1982; Stemp et al. 2013:31–32). Laser profilometry generates profiles (line scans) of the artefact surface to display the microtopography (Stemp 2014; Stemp and Stemp 2001, 2003; Stemp et al. 2008, 2009, 2010), and ‘focus variation microscopy’ can be used to obtain profile and areal measurements and determine the mean height of the surface area of an artefact (Macdonald 2014). A rugosimeter can be used to produce height and depth profiles in 3-D imagery by measuring microtopographic lateral movement and vertical variation (Bofill 2012:72; Hayes 2015:103), while an atomic force microscope, with a scanning tip, can inform about the nature of the artefact surface by measuring the atomic forces between the surface and the scanning tip itself (Hayes 2015:103; Kimball et al. 1995:10–11).

Whenever an artefact does not physically fit in the machinery required for these methods, or cannot be removed from an archaeological site, moulds of the artefact’s surface can be created and analysed (e.g., Fullagar et al. 2021; Spry et al. 2020:8). Artefact attributes on such moulds are visible in the negative. For example, higher points of the surface microtopography appear as lower points on the moulds, and vice-versa. However, some caution is necessary because Macdonald et al. (2018) demonstrated that moulds are not always entirely replicative of the artefact’s surface, particularly when cleaning procedures fail to remove sediment that obscured parts of the surface microtopography.

Although the above qualitative methods have been highly effective, another means of quantifying polish microtopography has emerged in the last decade or so, in the form of laser scanning confocal microscopy (LSCM). Once polish has been identified under a metallographic or other microscope, its microtopographic depths can be measured and displayed in microns based on 3-D point data obtained through the LSCM (Álvarez-Fernández et al. 2020; Evans and Donahue 2008; Evans and MacDonald 2011; Farber 2013:28–30; Ibáñez et al. 2014; Macdonald and Evans 2014; Stemp and Chung 2011; Stemp et al. 2013:31–32; Stevens et al. 2010). LSCM uses laser light, reflecting and forming images from a discrete focal plane, and after scanning the z-axis of an artefact from the lowest to the highest points takes and stacks multiple images to create three-dimensional images with a high depth of field (Álvarez-Fernández et al. 2020; Evans and Donahue 2008:2225–2226; Pedergnana et al. 2020:3; Figure 13).

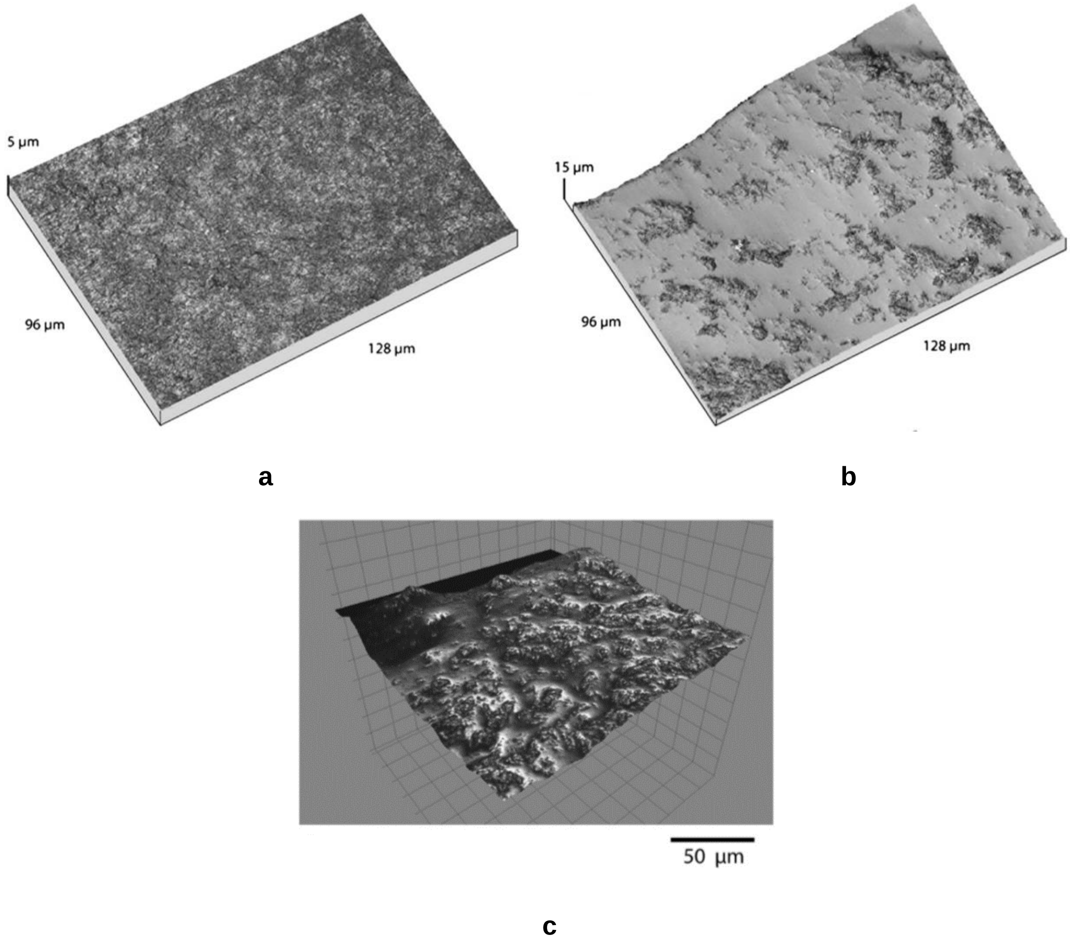


Figure 13 Examples of output (three-dimensional micrographs/projections) from the use of LSCM to quantify microtopographies of use-wear on experimental chert artefacts. ***A****: the surface of unused chert. Adapted from Evans and Donahue (2008:2227).* ***B****: the surface of a chert tool used to work wood for 40 minutes—note the smooth polish. Adapted from Evans and Donahue (2008:2227).* ***C****: projection of a tool used to cut soft plants. Adapted from Stevens et al. (2010:2672)—note the polish on peaks and in valleys.*

The use of LSCM for quantifying polish microtopography is in its relative infancy, still requires further reference data, and is time consuming, so is best used to complement, rather than replace, conventional microscopic analysis (e.g., Álvarez-Fernández et al. 2020). Most LSCM analyses hitherto undertaken have involved tools manufactured from chert (Álvarez-Fernández et al. 2020; Evans and Donahue 2008; Macdonald and Evans 2014:23–24; Macdonald et al. 2018:841; Stemp 2004; Stemp et al. 2013:28; Stevens et al. 2010:2673), although analyses have also been conducted on chalcedony (Stemp 2004), obsidian (Farber 2013:13; Stemp and Chung 2011) and quartzite (Masojć et al. 2021; Pedergnana et al. 2020). No previous studies have been located that use the technique on Aboriginal flaked bottle glass and porcelain. Information derived from the LSCM cannot constitute a complete use-wear analysis because it must be considered in conjunction with the analysis of other aspects of polish as well as striations, edge scarring and edge rounding, typically more effectively observed using conventional microscopy. Similarly, inferences about material(s) worked must not be based exclusively on polish data obtained from the LSCM. As previously noted, overlap can occasionally occur in polish characteristics from different worked materials (Pedergnana et al. 2020:5; Rodriguez et al. 2021; Stevens et al. 2010:2673), so other use-wear, such as edge scarring, must be considered. For example, edge scars with a preponderance of step fractures typically indicate the working of a hard material (Stevens et al. 2010:2675).

Various other forms of equipment and methods can help to inform about aspects of polish other than microtopography. For example, proton-induced x-ray emissions can determine the elemental composition of the polish (Hayes 2015:105). During this process, the polished surface of an artefact is exposed to an ion beam and the nature of the resultant radiation wavelengths corresponds to the known related characteristics of particular elements (Hayes 2015:105). The potential worked material may then be inferred because certain elements are more closely associated than others with polish that results from the working of specific materials (Hayes 2015:105). Digital image analysis has previously been somewhat effective in determining the nature of the polish texture, pattern and degree of development. Such analysis involves the use of a computer program that divides a micrograph into 512 x 512 pixel squares, with each pixel displaying a certain intensity of light, measurable in grayscale from 0 (black) to 255 (white). For example, González-Urquijo and Ibáñez-Estévez (2003:483) used only raw, unfiltered images of experimental chert artefacts and, based on a 'control' of ten images from five unused pieces of stone, established a grayscale luminosity threshold for the presence of polish of 160+. Polish patterns and degree of development of polish were identifiable by colour from the computer program's delineation between polished and unpolished regions on the surfaces of artefacts.

Digital image analysis can also assist with other aspects of use-wear. Lerner (2007) employed similar techniques to those used by González-Urquijo and Ibáñez-Estévez (2003) to demonstrate that the amount of accrued use-wear is sometimes less influenced by the time for which a tool was used than by different tool raw materials. Tool raw material hardness (also Lerner et al. 2007) was a significant influence, as was the amount of any lubricant used during the working of a material. Lerner (2007) showed that edge scarring, edge rounding and invasiveness of wear could be effectively measured through digital image analysis, and Knuttson (1988), using far less advanced computer technology than what is now available, correctly identified 24 of 36 (75%) stone tools that had been used experimentally to work plants, antler, bone, hide and wood.

However, digital image analysis is somewhat limited. Lighting in previous experiments (e.g., González-Urquijo and Ibáñez-Estévez 2003) has not always been able to be kept consistent and varied tool surface angles during the capturing of images can produce inconsistent results (Evans and MacDonald 2011:295). Digital image operators/analysts can unwittingly saturate images with excessive lighting, thereby distorting the grayscale values upon which this form of analysis relies, and reflectivity of the material cannot always be controlled (Evans and Donahue 2008:2224; Jane Sibbons, pers. comm. 2019).

4.1.5 Form of Use-Wear: Striations

As with polish, striations can contribute robust evidence for artefact use, primarily concerning tool motion (Clemente-Conte et al. 2015:66; Fullagar and Matheson 2014:7063; Fuentes et al. 2021:3, 6–7; Hurcombe 1992:16, 19, 26–27, 50–51; Kamminga 1982:10–14; Keeley 1980:23; Kimball et al. 2017:67; Kononenko 2011:7; Lombard 2010:1920; Semenov 1964:16–21). During the use of a tool, the presence of abrasive agents on the tool and/or worked material, such as sand and dust, can create striations on the tool's edge or surface (Kamminga 1982:11; Lombard 2011:1920; Ulm et al. 2009:116). Striations may be even more common on glass than other materials because glass is more brittle and its surface contains fewer flaws that may inhibit the path of the striation (Gorman 2000:195).

Several types of striations are widely recognised (Figure 14). 'Sleeks' are smooth, extremely fine plastic deformations with regular margins, while 'rough-bottomed' striations, also known as 'furrows,' are characterised by irregular, torn or discontinuous margins and an irregular, rough bottom (Fernández-Marchena et al. 2020:10; Gorman 2000:194; Hurcombe 1992:37, 57; Kamminga 1982:12; Kononenko 2011:7). 'Intermittent' striations are a series of small, rounded and distinct points of damage arranged in a line on the surface (Gorman 2000:194; Hurcombe 1992:37; Kononenko 2011:7–8). Finally, 'flaked' striations are associated with a line of fracture damage on the edge of a tool (Gorman 2000:194; Hurcombe 1992:37; Kononenko 2011:8).

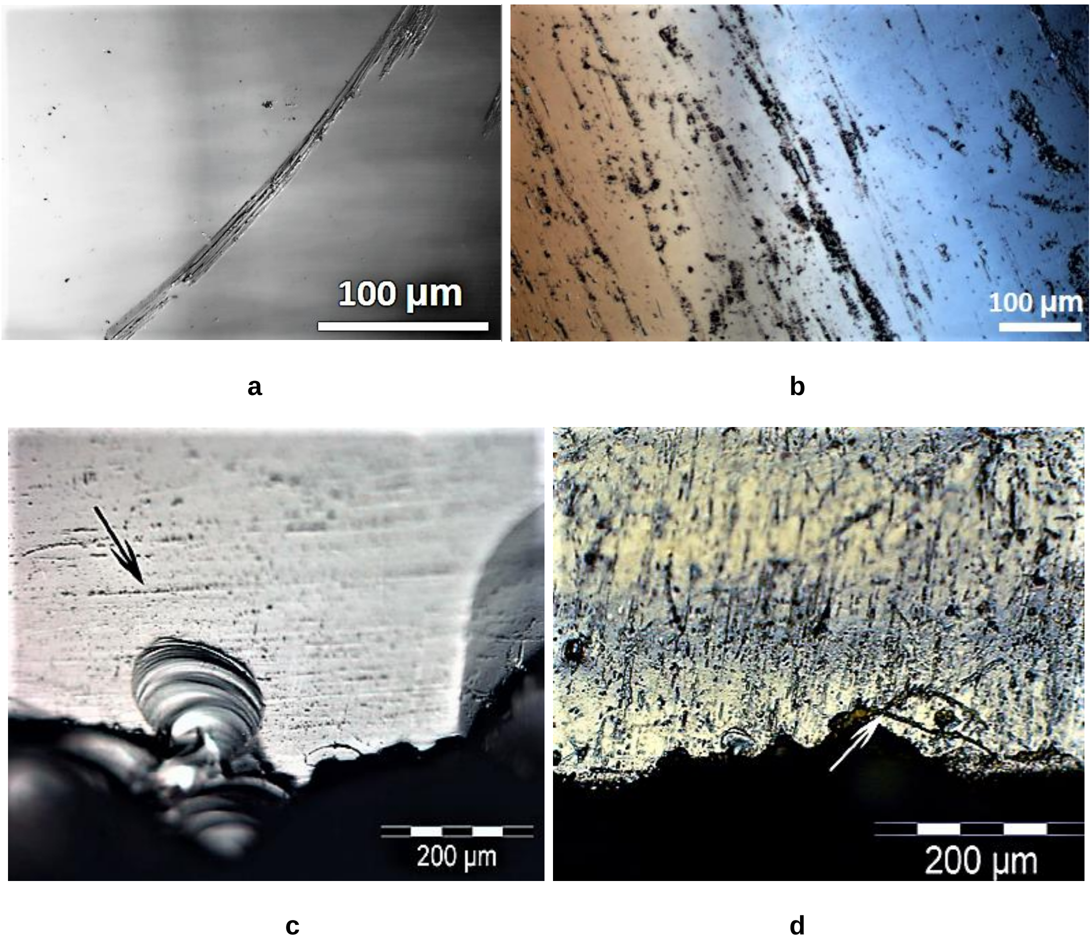
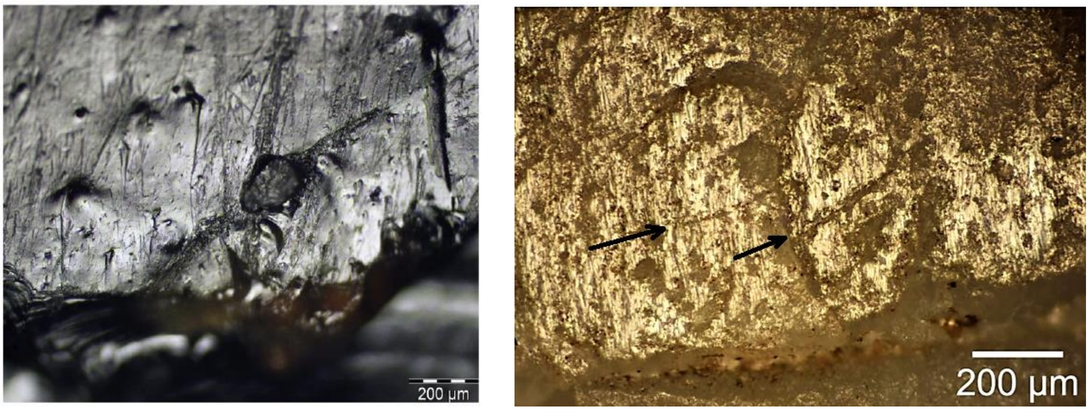


Figure 14 Four different kinds of striation. ***A****: sleek. Adapted from Fernández-Marchena et al. (2020:8).* ***B****: furrow. Adapted from Fernández-Marchena et al. (2020:8).* ***C****: intermittent (indicated by white arrow). Adapted from Kononenko (2011:161).* ***D****: flaked (indicated by white arrow). Adapted from Kononenko (2011:207).*

The orientation of striations in relation to the working edge provides information about tool motion (Fernández-Marchena et al. 2020; Fuentes et al. 2021:3, 6–7; Kamminga 1982:10–11; Kononenko 2011:7; Lombard 2005:285). Their presence parallel to the edge indicates a cutting motion (Figure 15), or a sawing motion if the striations are in greater density along the edge (Keeley 1980:38; Kimball et al. 2017:67; Kononenko 2012:18; Lombard 2005:285). A cutting/sawing motion also normally produces scarring on the upper and lower parts of a tool's edge because both parts come under pressure from the worked material (Keeley 1980:36; Lombard 2005:285; Semenov 1964:83). Scraping, shaving and planing, however, typically only leave striations on the surface that was closest to the worked material

(Lombard 2005:285). Striations perpendicular to a tool’s edge indicate a transverse tool motion, such as scraping (Keeley 1980:38; Kononenko et al. 2010:17; Figure 15).



a **b**

Figure 15 Striations indicating tool-use motion. ***A****: striations perpendicular and oblique to the working edge of a tool. Adapted from Kononenko et al. (2015:261).* ***B****: striations parallel to the tool working edge. Adapted from Sorensen et al. (2018:10).*

The nature of striations, in conjunction with other lines of evidence, can also sometimes help to indicate the materials that were worked. For example, Kononenko (2011:25, 31) found that after working hard woods and tubers with obsidian tools, intermittent striations were common and there were occasional rough-bottomed striations and sleeks. Keeley (1980:23) did not consider striation length a useful indicator of the worked material, because length can be influenced by a vast number of factors. However, during his experiments using chert tools, a particularly broad (~15 µm), shallow type of striation only resulted from wood-working (Keeley 1980:35). After cutting and scraping bone, striations were more common and typically deep and narrow (Keeley 1980:43). Those observable after butchering meat (cutting through tendons, joints and ligaments but not bone) were extremely narrow: < 1.5 µm wide, deep relative to their width, and normally < 20 µm long (Keeley 1980:54). Keeley’s (1980:61) only descriptions of striations resulting from plant (sickle) processing were that they were generally parallel and at a low angle (30º) to the working edge. However, while striation widths can be measured in microns, recording their depths as precisely is not always feasible. It is logical that the working of harder materials results in deeper striations because more force is required (e.g., Mansur 1982:220), but the deepest points of striations are not always observable. Keeley (1980) partially overcame the issue by using broad classifications of ‘shallow’ and ‘deep.’ Nonetheless, even these alternatives are not always decipherable under microscopic observation.

Not all striations are use-related, so tool manufacturing techniques must be understood. For example, striations (and other forms of use-wear) can often be present within the negative scars produced by retouch (Rots et al. 2017:48), and platform preparation can also cause various forms of wear (Keeley 1980:4). Striations can occur because of non-use mechanisms such as soil movement, and for Keeley (1980:34), such striations are typically broad (≤ 60 μm) and deep (≤ 50 μm), with a U-shaped cross-section. Evidence for artefact use and the nature of such use based on striations is, therefore, strengthened when combined with other lines of evidence, such as a regular distribution of wear along an artefact’s working edge (González-Urquijo and Ibáñez-Estévez 2003:488; Lombard 2011:1920).

4.1.6 Form of Use-Wear: Edge Scarring

Edge scarring can occur on a tool as scars of different sizes, terminations and orientations (Fernández-Marchena et al. 2020; Kamminga 1982:5; Keeley 1980:24–25; Martindale and Jurakic 2006:418–422). During tool use, small flake scars are sometimes detached from the edge due to the application of force. At the point where force is exerted, various types of fracture initiation or occasionally crushing can be microscopically visible and when the force exits the region, thereby detaching a scar, a feather, hinge, step, axial or plunge (‘outrepasse’) termination is created (Cotterell and Kamminga 1987:699–701; Figure 16; Rots 2010). Many factors contribute to the type of fracture termination, including the tool edge angle, the angle at which the tool was held in relation to the worked material, the fracture toughness of the tool raw material and the hardness of the worked material. For example, axial terminations typically occur on tools with acute edge angles (Cotterell and

Kamminga 1987:700), step terminations after the working of hard materials (e.g., bone, antler and wood) and feather terminations after the processing of softer materials (Akoshima 1987; Grace 1989; Martindale and Jurakic 2006:421). As such, edge scarring can sometimes contribute to inferences about the broad nature of the worked material. Certain traits can occasionally be particularly distinctive. For example, after sawing bone with fine-grained silicates, Kamminga (1982:48–49) commonly observed scars with distinctive bending initiations containing micro-fracturing, along with axial terminations.

Edge scarring can also contribute to inferences about tool motion. Typically, smaller scars result from the use of tools with broader edge angles, whereas tools with thinner edges and acute edge angles (15–35º; Kamminga 1982:64–65) produce scars with bending initiations, particularly when the tools have thinner edges (Hurcombe 1992:7; Kamminga 1982:65). Such acute angles are normally used in motions such as planing. Similarly, an approximately even distribution of edge scars on both faces of a tool would normally be expected from a sawing or cutting motion because the edge angle is parallel, resulting in both tool-faces contacting the worked material relatively equally.

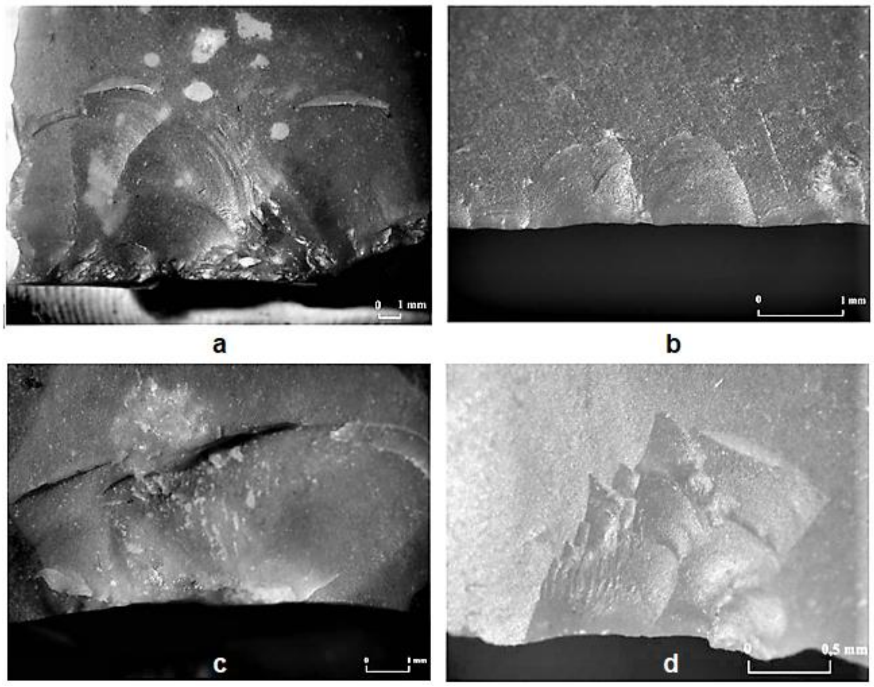


*Figure 16 Edge scarring. **A**: crushing (Rots 2010:240). **B**: feather termination (Rots 2010:244). **C**: hinge termination (Rots 2010:243). **D**: step terminations (Rots 2010:240).*

However, several difficulties can be encountered when attempting to interpret edge scarring. Collins (2007) demonstrated, through replicative experiments, that overlap occasionally exists in the nature of edge scars, including on tools made from the same raw material, after working different materials. This overlap precludes the ability to diagnose the exact worked material using only edge scarring characteristics. Edge scarring can also easily be caused by many non-use related actions, such as techniques used in tool manufacture—particularly the retouching of tool edges (Cooper and Nugent 2009:220–221; Kamminga 1982:9). Further, distinguishing between edge scarring resulting from use rather than retouch is not always straightforward. Although use-related scars are often smaller (Martindale and Jurakic 2006:421), other factors, such as the tool edge angle and the angle at which it was held in relation to the worked material (as mentioned above), and the processing of relatively soft worked materials, can contribute to the formation of smaller scars (Martindale and Jurakic 2006:421; Stevens et al. 2010:2675). Non-use-related edge scarring in a range of sizes can also be produced during handling and transportation before and during analysis (Kamminga 1982:10; Lombard 2005:285), and other taphonomic processes, such as trampling, can have similarly significant effects (Clarkson and O'Connor 2014:175; Shea and Klenk 1993; Tringham et al. 1974; Zupancich et al. 2018). Shea and Klenk (1993:176, 192), for example, demonstrated that human trampling, even by a solitary person for 15–30 minutes, can cause edge scarring.

Nonetheless, the nature of edge scarring caused by trampling has varied across previous experiments. For Martindale and Jurakic (2006:418), the key characteristic of bottle glass edge scarring after experimental human trampling was irregularity in distribution. The edge scarring from experiments conducted by Nielsen (1991) and McBrearty et al. (1998:120) was present on both faces of flakes and exhibited no consistent morphology, whereas Tringham et al. (1974) found only unifacial edge scarring. Tringham et al. (1974) also observed scars that were primarily randomly orientated, yet flakes trampled by Gifford-Gonzales et al. (1985) and McBrearty et al. (1998:124) exhibited only perpendicularly orientated scars. Edge scars from experiments by Shea and Klenck (1993) were typically broad rather than elongated, yet Tringham et al. (1974) consistently observed elongated scars. No single cause has been identified for these differences, but factors such as the type of substrate and raw material may have some influence (McBrearty et al. 1998:120). Particularly notable for this thesis, given the sandy study area, is that the frequency of scarring on lithics trampled by McBrearty et al. (1998:118–119, 123) in a sandy substrate was considerably less than that for loamy substrates (primarily because of the lesser resistance of sand to penetration), yet the scars on flakes trampled in sand were regularly elongated. Nonetheless, over 80% of trampled flakes in McBrearty et al.'s (1998) experiments displayed some form of edge scarring.

Given the many potential causes of edge scarring and contradictory observations from previous studies, there is no unequivocal criteria, applicable to all cases, for distinguishing use-related scarring. Kamminga (1982:4–5) emphasised, among other factors, the importance of tool raw material, and Keeley (1980:24–25) developed a system for the classification of edge scarring. Some researchers (Gorman 2000:266; Martindale and Jurakic 2015:38; Shea and Klenck 1993; Tringham et al. 1974) consider that non-use related edge scarring is typically present in isolation, randomly distributed, varied in size, often present away from the working edge, visible macroscopically and characterised by step terminations. However, ultimately it appears that, because of the range of variables involved, edge scarring is best viewed as a contributing indicator of artefact status and use when present in distinct distributional patterns and in physical association with other forms of use-wear/residue (Lombard 2005:285).

4.1.7 Form of Use-Wear: Edge Rounding

Depending on the context of the artefact, edge rounding can contribute to the identification of the worked material (Fullagar 2014:249; Groman-Yaroslavski et al. 2021b:8; Hurcombe 1992:43–44, 46; Keeley 1980:50; Kimball et al. 2017:64, 66–67, 70; Kononenko 2011:22, 24–25, 31, 39; Lemorini et al.

2019:4740, 4745; Lombard 2005:285; Torrence et al. 2018:67; van Gijn 2010:81, 194; Walton 2019:920, 934). Edge rounding is an attrition process caused by abrasion, which is facilitated by the presence of grit between the tool surface and worked material (Fullagar 2014:249; Kamminga 1982:17; Lombard 2005:285). The extent and nature of edge rounding depends on the hardness and density of the worked material, the force applied, the amount of lubrication and abrasive agent and the sizes of grains (Fullagar 2014:249; Lerner 2007; Lombard 2005:285). Some activities, such as the scraping of animal hide, skin and other softer materials, are typically associated with pronounced edge rounding (Kamminga 1977:210; Kimball et al. 2017:64, 66–67, 70; Lemorini et al. 2019:4740, 4745; Rots 2010:257; Stevens et al. 2010:2675; Figure 17). Taphonomic factors can also cause edge rounding (Fullagar 2014:254; Hayden and Kamminga 1979:9; Kamminga 1982:17), so understanding the physical context of the artefact, its raw material and the extent of rounding and/or other use-wear on its other edges, can strengthen the basis for the identification of use-related edge rounding (Cooper and Nugent 2009:217; Fullagar 2014:249; Hayden and Kamminga 1979:9; Kamminga 1982:17; Lombard 2005:285; Robertson et al. 2019:77).

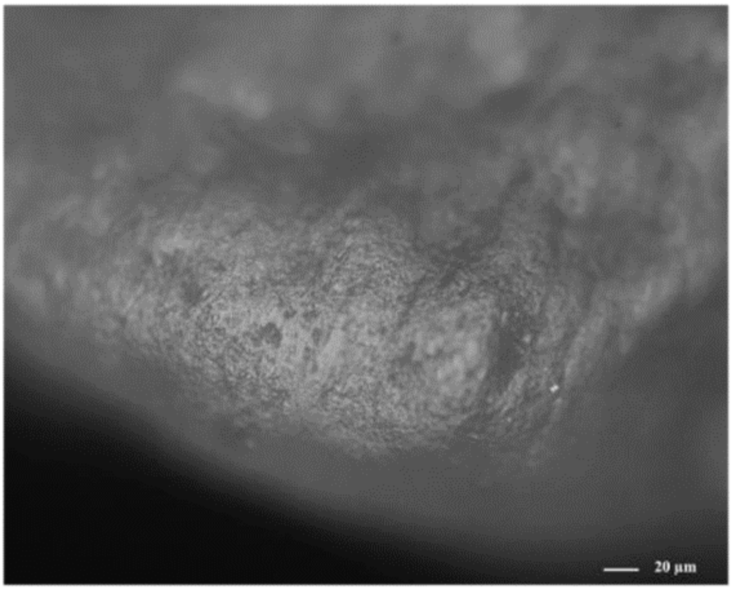


Figure 17 Significant edge rounding (polish is also visible) on a chert tool used for scraping hide; x200 magnification (Rots 2010:257).

4.1.8 Use-Wear Resulting from the Working of Wood

> The overwhelming majority of flaked stone tools were used to manufacture and repair wooden artefacts.
>
> Kamminga 1982:56

Particular focus is afforded in this section to use-wear traces on chert and glass tools used to work wood. This is because a considerable amount of research has focused on the topic, and wood was a commonly worked material in the past and one of several readily available materials around Calperum Station.

4.1.8.1 Use-Wear on Chert Wood-working Tools

As for all worked materials, use-wear traces on tools used for working wood are affected by various factors. Fullagar (1986a:149–150), for example, found that scraping wood consistently produced more polish than sawing because sawing introduced abrasives that inhibited polish development. Numerous other past experiments across a range of tool raw materials have found that use-wear typically increases the longer a tool is worked (Kamminga 1982; Keeley 1980; Kimball et al. 2017; Kononenko 2011; Pfleging et al. 2019; Walton 2019). The hardness/density and/or freshness of wood is sometimes, but not always, an important factor in use-wear formation. Working fresher, moister wood can allow the tool to penetrate more deeply, therefore increasing the surface area over which use-wear can develop, while the opposite can be the case for dried/seasoned wood (Kamminga 1982:58; Keeley 1980:36). However, given the interplay between tool raw material, tool motion and water and silica content, factors such as the density or freshness of wood are not always particularly influential (Fullagar 1986a:148; Keeley 1980:35).

Previous experiments on chert tools indicate that wood-working results in several distinctive kinds of use-wear. Keeley (1980:35) found that the working edges on 54 of 59 tools exhibited distinctive, bright, smooth-textured polish and had a consistent appearance regardless of the wood's hardness. The polished surface was generally flat-planed, aside from high points of the microtopography which became increasingly domed as the tool was worked (Keeley 1980:35). Similarly, De Stefanis and Beyries (2021:60) observed domed polish on archaeological chert tools used to scrape wood, and for Cassidy et al. (2019:452, 457–458), polish on archaeological wood-working tools from a Californian assemblage was smooth-textured. The presence of polish predominantly on high microtopographic points was also identified by Hilbert and Clemente-Conte (2021:135), Kimball et al. (2017:67), Hayes et al. (2014:85) and Rutkoski et al. (2020:40). Álvarez-Fernández et al. (2020) observed, after analysing LSCM depth quantifications on five experimental chert tools used to whittle and scrape wood, that the roughness of the natural chert surface was modified such that the difference between peaks and valleys became more pronounced. Keeley (1980:35) found that striations formed less frequently after wood-working in comparison to working other materials, occurring on only 29 of 59 tools, and that when present they were distinctively broad compared to the narrower striations resulting from the working of hide, bone and meat. The edge angle did not affect whether polish or striations formed (Keeley 1980:42). Edge scarring was present on 50 of 59 of Keeley's (1980:35–36) wood-working tools but was not distinctive in nature from the edge scarring that resulted from working other materials.

Variations in use-wear have been noted in past wood-working experiments as the result of the use of varied tool motions (Kamminga 1982:63–64, 82; Keeley 1980; Kimball et al. 2017:65). Figure 18 depicts common tool motions and Table 4 describes use-wear characteristics resulting from the working of wood with experimental chert tools using a range of motions. The motions of boring and graving were not considered in this thesis because they almost always involve a pointed end of a stone tool, and no such points were present in the Calperum Station assemblage.

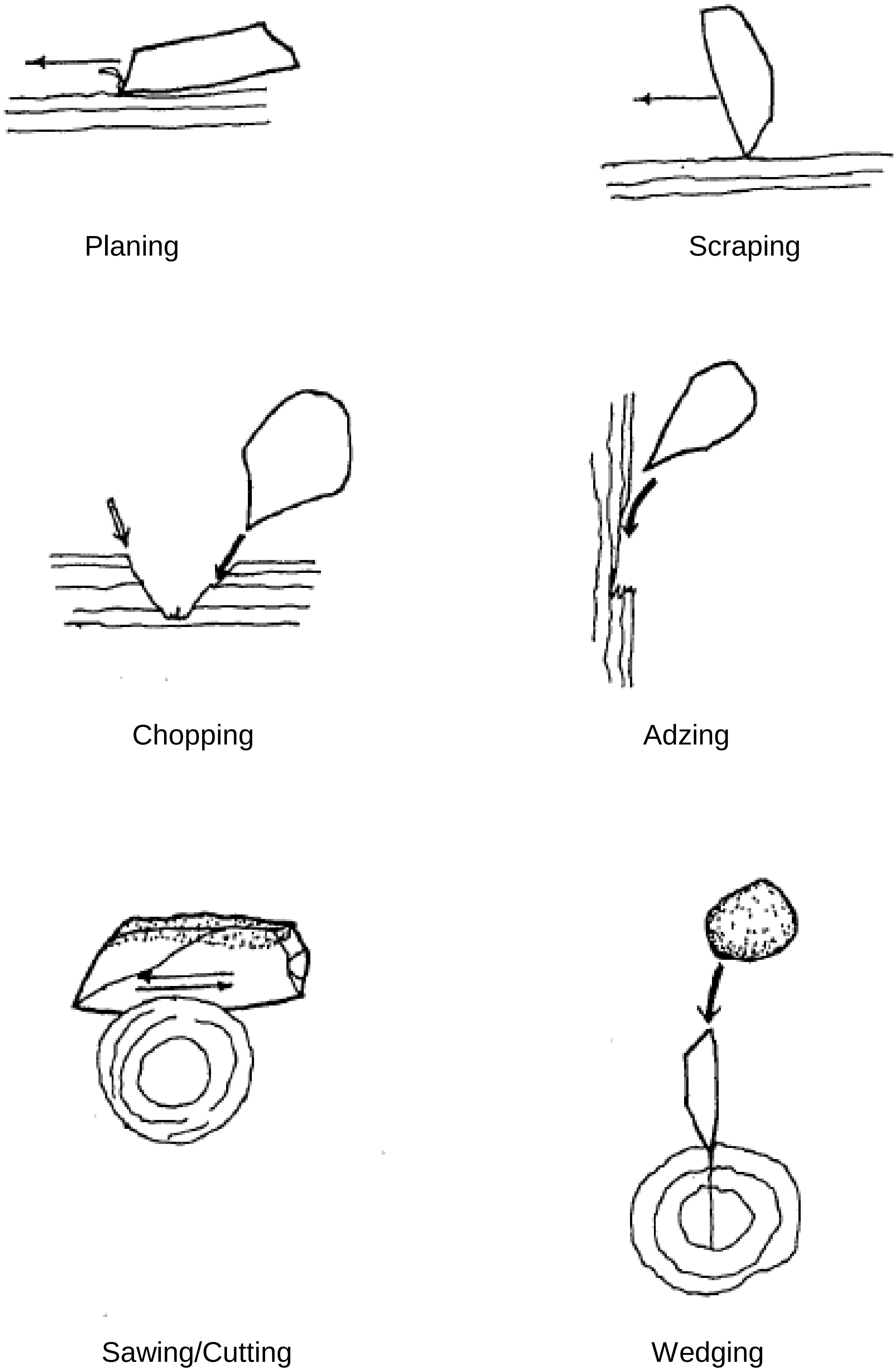


Figure 18 Tool motions commonly used when working wood. Adapted from Keeley (1980:18).

Table 4 Use-wear on chert tools from wood-working using different tool motions (Keeley [1980] unless otherwise specified).

Tool Motion	Description of Tool Motion (adapted from Keeley 1980:17–19, 42)	Use-Wear
Planing	Shaving off material with the artefact working edge held at an approximate right-angle to the direction of use	● Polish occurs more on the side contacting the worked material (Solheim et al. 2018:565); some polish may occur on the opposite side if prolonged tool use results in edge rounding whereby this opposite side then contacts the worked material; however, planing rarely results in edge rounding (Lerner 2007:61) ● Higher points of the microtopography can be worn, becoming flat, whereas valleys remain unaffected—experiment conducted by Kimball et al. (2017:65) ● Striations occur at 45–90º to the working edge ● Edge scarring on upper surface (from downwards pressure) and on lower surface (from end-on pressure)
Sawing/ Cutting	Working edge is parallel to the direction of use and moved forwards and backwards, cutting into an object	● Polish, striations and edge scarring occur on both sides of working edge; striations are parallel to edge ● Sawing may produce less polish than scraping (Fullagar 1986a:149) ● Bending initiations are common on edge fracture scars for thin and low-angled working edges ● No use-wear differences between sawing fresh, dried, light or dense woods (Kamminga 1982:82)
Scraping	Working edge is held at high angle to the surface of the worked material, the leading aspect of the edge is pulled rather than pushed	● Polish is normally on both sides of working edge ● Edge scarring normally occurs on only one side of working edge (if working edge is thin, small, deep scalar scars [0.5–2 mm wide] will occur on the working edge opposite the worked material); step terminations are frequent (Poplin 1986:227–228) ● Striations occur, perpendicular to working edge ● Kamminga (1982:68) observed regular edge ‘blunting’ and moderate to significant edge rounding

Chopping	Heavy, repeated blows into another object	● Faint polish occurs on both sides of working edge ● Striations occur, perpendicular to working edge; and at a distance from the edge ● Bending initiations common on edge fracture scars for thinner working edges ● Edge scars typically > 1–2 mm, and minor edge rounding, were common on dense woods during Kamminga's (1982:63–64) experiments involving a range of lithic raw materials
Adzing	Similar to chopping but blows are lighter and quicker	● As above for chopping except that polish normally occurs mostly on downward side of working edge
Wedging	Essentially the same as chiselling: one end of the artefact contacts the surface of the worked material while the other end is hit with a hard hammerstone	● If the struck end i.e. platform of the tool was flat, edge scars are present on both sides and many incipient cones will be present on the struck surface; if the struck area was an edge, edge scars are larger and more invasive—and higher areas, e.g., dorsal ridges, sustain the least damage ● On the working edge of the tool, polish occurs on both faces; striations occur at right (or high) angles to the working edge; edge scars occur in various sizes originating on the working edge
Note: when edge scarring results after the working of harder woods, step fractures typically predominate (Stevens et al. 2010:2675)		

4.1.8.2 Use-Wear on Glass Wood-working Tools

Previous experiments have also demonstrated the nature of use-wear on glass/obsidian tools used to work wood. Conte and Romero (2008) found that after experimentally scraping wood with bottle glass tools, polish formed directly on the working edges, edge rounding was pronounced, striations were prominent on the tool-face that contacted the wood and edge scarring mostly occurred on the opposite face. Fullagar (1986a:162–164) found the quantity of polishing agent to be the most influential factor in determining whether polish developed to his diagnostic 'stage 3.' Silica was particularly influential because this polishing agent exists within the glass itself and can also be present in the material being worked. However, silica is not always necessary:

Fullagar's (1991) later experiments with obsidian tools and ice demonstrated that water alone was a sufficient agent for the development of polish. Because of the variations in silica content between wood and other plants, Fullagar (1986a:163–164, 168) found that overlap often existed in polish characteristics on obsidian tools after working these different materials. On such occasions, other kinds of use-wear become critical to any ability to distinguish between wood and other plants.

However, several use-wear characteristics were common after working different forms of wood. Fullagar (1986a:177, 179–180), like Keeley (1980) and Kamminga (1982) for chert, found that polish on the obsidian tools after working different forms of wood was typically bright, smooth and often dome-shaped (yet note that these characteristics can also result from the working of other materials). The polish was also always continuous and close to the edge, while striations were wide, edge scarring was common and lighter, denser wood produced more edge rounding than did other wood types. Kononenko (2011:22, 24–25) also used obsidian to experimentally work wood (among other materials). On her tools, polish typically appeared on peaks only, was lightly to well-developed after sawing and well-developed after scraping, while striations were common, edge scarring generally prolific and edge rounding prominent (Kononenko 2011; further details are outlined below).

4.2 Use-Wear on Chert Tools

To more comprehensively contextualise the microscopic use-wear resulting from wood-working, use-wear resulting from the working of other materials must be considered. The nature of use-wear after working other materials also varies according to the tool motion and condition of the worked material. For example, extremely dry hide is very resistant (Beyries and Rots 2008:22), requiring more force, which may increase the extent of edge rounding and other use-wear (Table 5). Much analysis has previously been undertaken for chert tools, so for brevity, Table 5 summarises typical use-wear characteristics on chert that are consistent across a range of tool motions following the working of common materials other than wood. In the case of hide, scraping is isolated because this was the most prevalent tool motion used in the past to process this material (Beyries and Rots 2008; Keeley 1980:51; Lerner 2007). Use-wear characteristics on tools made from a range of raw materials and used to process plant material can vary according to the kind of plant (Xhauflair et al. 2016), so the features described in the following tables are broadly typical but cannot be used to identify individual plant taxa.

Meat-cutting typically produces relatively little use-wear (Álvarez-Fernández et al. 2020; Pawlick and Thissen 2017:106–107; van Gijn 2010:63). On their six experimental chert butchering tools, Álvarez-Fernández et al. (2020) observed some polish, albeit very lightly developed, and noted that the natural microtopography was barely modified. Consequently, it was particularly difficult to distinguish between worked and unworked parts of the surface (Álvarez-Fernández et al. 2020). Kirgesner et al. (2019:4) found that polish was common on chert butchering tools and Keeley (1980:53) observed some polish and occasionally striations and edge scarring after his experiments. However, Kamminga (1982:35) found that no polish developed on experimental tools (ten made of volcanic tuff, one obsidian and one flint) when cutting fresh meat, even with tools which were in constant contact with sand and grit. For Kamminga (Johan Kamminga, pers. comm. 2018), it is the residues that may remain from meat-working that are often misinterpreted as polishes. Kamminga (1982:34) also argued that any edge scarring that may develop would not be sufficiently distinctive for it to be differentiated from accidental fracture damage.

Archaeological and ethnographic evidence exists in Australia, albeit limited, for the use of stone tools to work bone. Roth (1989:87) observed Aboriginal peoples in Queensland using chert tools to drill bone, while use-wear analysis by Attenbrow et al. (2009:2768) found that backed stone artefacts at Mussel Shelter in NSW were used with a range of motions to work bone for a variety of purposes, including domestic. Further use-wear analyses, by Fullagar et al. (2009) and McDonald et al. (2007), demonstrated that backed stone artefacts from Narrabeen, NSW, were hafted as composite parts of armatures (and used to penetrate into the bone of the victim; discussed further below), while Langley (2016:202) interpreted 'numerous sub-parallel striations' as evidence of the use of a stone tool at Carpenter's Gap in WA to shape a bone tool. Experiments by Kamminga (1982:48–49) demonstrated that sawing bone using a chert tool produces a distinctive form of use-wear (as described earlier): edge scarring with thin bending-initiated fractures, containing micro-scarring inside (the same features developed on silcrete tools although less prominently and were difficult to detect due to the coarse nature of silcrete). Additional use-wear resulting from the use of chert tools to process bone, along with hide, meat and plant material, is outlined in Table 5.

Table 5 Use-wear on chert tools after working hide, bone, meat and plant material.

Material Worked	**Polish**	**Striations**	**Edge Scarring**	**Edge Rounding**
Hide (scraping)	Wet, fresh hide: ● Relatively bright, slow-forming, greasy (Keeley 1980:49) ● Rough, (Keeley 1980:49; Rots 2005:65; van Gijn 2010:81) ● Less wear than dry hide Dry hide: ● Dull, pitted, with a matte texture (Keeley 1980:49; King 2017b:7) ● Occasional small, circular pits (diameter ≤ 5 μm) (Keeley 1980:50) Occasional overlap of traits can occur between dry and fresh hide polish (Ibáñez et al. 2019:1183, 1189)	Rare but if present, either: ● Narrow and deep (Faulks et al. 2011:310); often sharp, well-defined; varied sizes (Keeley 1980:50); or ● Relatively broad and shallow; ill-defined; hard to detect; common on rounded edges rather than faces (Keeley 1980:50)	● Typically only minute (e.g., Mansur 1982:216). Edge scars are either deep or shallow and abruptly terminated—but in either case are < 0.5 mm wide (Keeley 1980:24–25, 50) ● Sometimes difficult to distinguish from retouch scars on retouched artefacts (Keeley 1980:51) ● Tool edge angle does not affect the nature of the edge scarring (Keeley 1980:53)	High extent (Fullagar 2014:249; Groman-Yaroslavski et al. 2021b:8; Keeley 1980:50; Kimball et al. 2017:64, 66–67, 70; Lemorini et al. 2019:4740, 4745; Masclans et al. 2021:12; Stevens et al. 2010:2675; Sussman 1985; van Gijn 2010:81)

Bone	● Bright, typically smooth (Faulks et al. 2011:311) ● 'Innumerable' tiny pits (≤ 1 μm) present in polish surface (Keeley 1980:43) ● Develops much more slowly than wood yet is almost always present (Keeley 1980:42–43) ● Predominantly or exclusively on high points of the microtopography (Faulks et al. 2011:311; Keeley 1980:43)	● Quite common; generally deep and narrow (Keeley 1980:43)	Intense damage; large scars (Kamminga 1982:48; Keeley 1980:44); step fractures common (Stevens et al. 2010:2675) and often seen macroscopically (Mansur 1982:216); sawing produces bending fractures with micro-fractures within (Kamminga 1982:48–49)	Some edge rounding may occur (Kamminga 1982:51; Kimball et al. 2017:68)
Meat (cutting)	Mixed results: **1.** Absent (Kamminga 1982:34–36) ● Dull; sometimes greasy lustre (Keeley 1980:53; Kirgesner et al. 2019:5) ● On peaks and in valleys (Faulks et al. 2011:310–311; Kimball et al. 2017:67–68) **2.** Present but very lightly developed (Álvarez-Fernández et al. 2020) **3.** Common (Kirgesner et al. 2019:4–6) ● Fresh meat: extends > 0.5 mm inwards from edge; frozen meat: ≤ 0.5 mm	● Rare (van Gijn 2010:63) but when present, striations are minute: - Width < 1.5 μm, length < 20 μm; deep relative to width (Keeley 1980:54) ● Absent for Kirgesner et al. (2019:5)	● Rare (van Gijn 2010:63) ● For Keeley (1980:24–25, 55): sometimes present, in the form of scars < 0.5 mm and either deep and wide or shallow and abruptly terminated ● For Kirgesner et al. (2019:5), any damage occurs as bending fractures	Almost never present (Fullagar 1986a:187; Kamminga 1982:34)

Plant	● Bright (De Stefanis and Beyries 2021:60, 64; Luong et al. 2019:10; Skakun and Terekhina 2017:15), well-connected, undulating (Fuentes et al. 2019:8; Luong et al. 2019:10); many micro-pits; can be domed, smooth, spotted (Fuentes et al. 2021:7; Linton et al. 2016:1041)	● Range of orientations in relation to working edge (Keeley 1980:61), but primarily transverse (Fuentes et al. 2019:6; van Gijn 2010:65)	● Minimal if any (Stevens et al. 2010:2675)	● Occurs to a range of extents (Fuentes et al. 2019:6; van Gijn 2010:194)

4.3 Use-Wear on Glass Tools

Because use-wear can develop differently across tool raw materials, the known characteristics of wear resulting from the working of a range of materials with glass tools must be considered separately. These traits are summarised in Table 6. The above description about the use-wear on glass after wood-working is also expanded in Table 6, with a summary of traits resulting from the working of soft and hard woods as established through previous experiments. In particular, it is apparent that wood-working typically produces more intense use-wear on glass than does the working of many other materials.

Key analyses investigating the use-wear on glass include those for obsidian, a natural glass that fractures in essentially the same manner as bottle glass (Aoyama 1995; Hurcombe 1992; Kononenko 2011; Martindale and Jurakic 2006; Stemp 2016a; Walton 2019, 2021). Kononenko (2011), Walton (2019) and Hurcombe (1992) experimented using obsidian to work a wide range of materials, while Martindale and Jurakic (2006:422) scraped hide with bottle glass. Stemp (2016a) used obsidian to cut animal skin and flesh as proxies for human skin and meat, to investigate potential use-wear from Mayan auto-sacrificial blood-letting practices, observing that no polish or edge rounding developed, striations almost never formed and very small edge scarring was common. Similar results for meat-processing are seen in Table 6. In contrast, Walton (2021:281) found, from a comprehensive range of experiments and an analysis of archaeological assemblages in Mexico, that bloodletting with obsidian tools produced distinctive use-wear (plus residue): (i) 'very light edge rounding in the form of bending, feathered, and mild hinge-terminating microflake scars'; (ii) 'microscopically visible crushing on the distal tip'; (iii) 'very infrequent, if any, fine shallow striations, often diagonal, isolated near the tool's used edge'; and (iv) 'the absence of moderate to intensive surface abrasion or polish formation beyond stage 1 (Fullagar 1991).' Berehowyj (2013:14) found that tuber-processing using glass tools resulted in use-wear characteristics that overlapped with those resulting from the working of other materials, while Aoyama (1995:133) and Walton (2019:927; Table 6) observed that scraping and sawing bone produced polish, within which were small pits, as was the case on stone tools used for the same tasks. In a recent pilot study of use-wear on pitchstone, a volcanic glass similar to obsidian but which fractures less predictably and has a typically 5–10% greater water content and duller lustre, no diagnostic use-wear traits were able to be distinguished from potential post-depositional causation after the working of wood, hide, reed, meat and bone (Gurova and Bonsall 2020).

Table 6 Use-wear on glass tools after working a range of materials.

Material Worked	Polish	Striations	Edge Scarring	Edge Rounding
Hide (scraping)	Characterised by small, circular pits only a few µm in diameter (Moss 1983:83); often present mostly on rounded parts of working edge (Conte and Romero 2008:256–257)	Uncommon; but rough-bottomed and sleek striations after fresh hide; flaked striations after dry hide (Hurcombe 1992:45); long after dry hide (Conte and Romero 2008:256–257)	Minimal (Mansur 1982:216); small (Martindale and Jurakic 2006:422)	Medium to high extent (Conte and Romero 2008:256–257; De Angelis 2014:30); for Hurcombe (1992:46), the extent was greater on fresh hide

Soft wood	Sawing: Smooth, developed to well-developed, on peaks only, is a continuous band on edge after only 5 minutes of use, then band extends further after 15–30 minutes (Kononenko 2011:22) Scraping: Well-developed, on some points of working edge (Kononenko 2011:24)	Sawing: Common; often rough-bottoms and sleeks (sometimes intermittent), parallel or slightly oblique (Kononenko 2011:22); narrow (Walton 2019:935) Scraping: Oblique and perpendicular, mostly unifacial; rough-bottoms and sleeks; rarely intermittent (Kononenko 2011:24); narrow (Walton 2019:935)	Sawing: Intense, closely clustered and commonly bending, step and feather scars (Kononenko 2011:22) Scraping: Scars with mixed termination types (though step, bending and feather scars are common) on one tool-face (Kononenko 2011:24)	Sawing: Medium to high extent (Kononenko 2011:22) Scraping: Medium (Kononenko 2011:24)
Hard wood	Sawing: For Kononenko (2011:25): light to developed and on peaks only Scraping: Well-developed (Kononenko 2011:25); right on the working edge (Conte and Romero 2008:256); for Walton (2019:917): well-developed, bright, smooth and unifacial after scraping, but bifacial after sawing	Sawing: Parallel; commonly sleeks and rough-bottomed; rarely intermittent (Kononenko 2011:25; Walton 2019:917); narrow (Walton 2019:935) Scraping: Isolated, unifacial, perpendicular and oblique (Kononenko 2011:25); narrow (Walton 2019:935); possibly thicker after sawing (Walton 2019:917)	Sawing: Intense, closely clustered, with mixed terminations (Kononenko 2011:25) Scraping: Intense, closely clustered; often overlapping bending, step and feather scars (Kononenko 2011:25); scars are mostly on face opposite that which contacted the wood (Conte and Romero 2008:256)	Sawing: Low extent (Kononenko 2011:25) Scraping: High extent (Conte and Romero 2008:256; Kononenko 2011:25)

Bone	Small pits within; bright; rough; developed to stage 2 after 5 mins and stage 3 after 15 mins (Aoyama 1995:133; Walton 2019:927)	Common (Walton 2019:927)	Common and on the edge (Walton 2019:927)	Low extent (Walton 2019:934)
Meat (cutting)	Rare (Aoyama 2009:13; Hurcombe 1992:43–44; Stemp and Awe 2014:235); developing moderately (Fullagar 1986a:186) after ~ 40 mins (Torrence et al. 2018:67; Walton 2019:933)	Rare (Aoyama 2009:13; Hurcombe 1992:43–44; Walton 2019:920)	Rare (Aoyama 2009:13), Hurcombe (1992:43–44; Stemp and Awe (2014:235)	Very rare (Aoyama 2009:13; Hurcombe 1992:43–44); low extent (Torrence et al. 2018:67; Walton 2019:920)
Relatively harder plant process-sing (tubers)	<u>Sawing:</u> Light to developed (Kononenko 2011:31) <u>Scraping:</u> Well-developed (Kononenko 2011:31)	Moderate number of isolated rough-bottoms and sleeks (rarely intermittent), slightly oblique and sometimes intersecting (Kononenko 2011:31)	Discontinuous, non-distinctive bending and feather scar patterns after a few minutes, then increasing in number (Kononenko 2011:31)	Medium extent after sawing, high extent after scraping (Kononenko 2011:31)
Relatively softer plant process-sing (greens, leaves and stems)	Light to moderately developed (Kononenko 2011:39; Walton 2019:914)	Few to moderate no. of sleeks; rarely rough-bottomed or intermittent (Kononenko 2011:39); narrow, near edge (Walton 2019:914)	Very small scars, less intensive than after wood-working (Kononenko 2011:39); rare for Walton (2019:914)	Low to medium extent (Kononenko 2011:39)

4.4 Use-Wear on Silcrete Tools

Comprehensive descriptions of the nature of microscopically observed use-wear on silcrete cannot currently be provided because of a paucity of previous analyses. This may be attributable to several factors. Complications may have been caused by the previously discussed wide variations in the definitions of silcrete, wherein material is interpreted by some as silcrete but by others as a similar but different material, such as quartzite. Silcrete was also rarely sourced by past hunter-gatherers across the world other than in South Africa and Australia, in comparison to materials such as chert (Nami 2015:142; Will and Mackay 2017:631). Analysts may be reluctant to microscopically analyse the use-wear on silcrete because the surface microtopography of this material is, like quartzite, often particularly irregular and difficult to interpret (Hayes et al. 2014:88; Masojć et al. 2021:7; Pedergnana 2019:3, 5, 29; Pedergnana and Ollé 2017:36, 42–43; Pedergnana et al. 2020). Surfaces of coarse-grained materials can even be difficult to interpret macroscopically, as was evident with attempts by Spry et al. (2021:49) to diagnose quartz flakes. Given these issues, the use-wear analysis on silcrete tools in this thesis makes a significant contribution to this area of study.

The most comprehensive use-wear investigation involving silcrete tools was undertaken by Kamminga (1982). He provided useful information about edge scarring and edge rounding on silcrete tools (as well as on tools of volcanic tuff, flint, Olary chalcedony, basalt, quartzite and quartz) used experimentally to process a wide range of materials with an array of varied tool motions (Table 7). However, his analysis was limited because in not using a metallographic microscope he was unable to examine fine details of any polish and striations that may have been present. Further, the edge scarring and edge rounding on silcrete tools was not often diagnostic of specific tasks because of the lack of distinct characteristics (Kamminga 1982:52, 66). The tool motion of drilling appears to be an exception, as this regularly resulted in edge scarring, particularly on parts of the edge that were close to the tip of the tool, as well as considerable tip-fracturing and subsequent tip-rounding (Kamminga

1982:139, 141, 143–144, 157)—but the use-wear did not help to distinguish the material that was drilled (Kamminga 1982:66).

Table 7 Use-wear on experimental silcrete tools used by Kamminga (1982) to process various materials using a range of tool motions.

Task	Use-wear	Page
Light-duty kangaroo butchering (1 tool)	Few, scattered edge scars	118
Heavy-duty kangaroo butchering (1 tool)	Moderate edge rounding along entire working edge	120
Skinning kangaroo (2 tools)	No identifiable use-wear on one tool; edge rounding between bending fractures on other tool	123
Engraving kangaroo skin (1 tool)	Poorly defined bending fractures and moderate edge rounding	128
Awling kangaroo skin (1 tool)	No identifiable use-wear (after punching 500 holes)	134
Sawing kangaroo bone (2 tools)	Bending fractures, occasionally with feather terminations; moderate edge rounding; minute fracturing between a cleft on one of the edges	136–137
Drilling kangaroo bone (1 tool)	Scarring and abrasive smoothing on edges leading up to the tip of the tool; abrasive smoothing, rounding and blunting of the tip; rounding of projections on tool edges	139
Drilling turtle shell (ten holes) (1 tool)	Scarring on edges leading up to the tip; tip fracturing and rounding; some edge rounding	141
Drilling baler shell (1 tool)	Tip initially became extensively fractured, then rounded and smoothed; step- and feather-terminated scars on edges close to tip	143–144
Chopping dense wood (3 tools)	Mainly large, step-terminated edge scars; some feather-terminated and hinge-terminated scars	148
Sawing dense wood (1 tool)	Bending fractures along most of the working edge; moderate rounding of some prominences	154
Drilling dense wood (1 tool)	Tip fractured then became rounded; step-terminated scars on edges close to tip	157
Scraping dense wood (3 tools)	Some macroscopically observable, but no microscopically observable edge scars; occasional rounding of prominences between fractures on edges; occasional, small areas of abrasive smoothing	161–162

Scraping dense wood (2 tools, hafted)	Continuous bending-initiated, feather-terminated scars on the upper face of the working edge; one step-terminated scar; edge blunting or rounding	168
Adzing medium-light wood (1 tool, hafted)	Large edge scarring (not described in further detail)	172
Adzing dense wood (2 tools, hafted)	Large edge scarring (not described in further detail)	174
Note: all tools were hand-held other than those specified as hafted; where a form of use-wear is not mentioned this indicates that it was not present		

Experiments conducted by Berehowyj (2013) also offer some insights into use-wear on silcrete tools but none that can be used for conclusive diagnoses. Berehowyj (2013:13–14) experimentally used coarse-grained silcrete (and other materials) to peel and slice tubers, finding that use-wear other than polish mostly formed on the individual quartz grains and that there were no striations within the polished regions. Although she did not claim that the use-wear was diagnostic of tuber-processing, because of potential overlap of characteristics with those resulting from the processing of other soft, fleshy plants, Berehowyj (2013) observed:

(i) Discontinuous scarring with feather terminations and particularly isolated bending scars;

(ii) Shallow striations that were not particularly close to each other;

(iii) A low to medium extent of edge rounding in patches; and

(iv) Patches of smooth, lightly-moderately developed polish on peaks of the microtopography but not on valleys, because the polish had not developed beyond Fullagar's (1991:6) 'stage two.'

Several other use-wear investigations have been conducted involving silcrete tools, although without mentioning any characteristics particular to this raw material. Subsequent to McDonald et al. (2007), Fullagar et al. (2009) analysed the use-wear on 'red' and 'pink' silcrete (and other) backed artefacts lodged within the skeleton of a relatively young mid-Holocene Aboriginal man from what is now Sydney. They observed use-wear typical of impact fracture damage: various combinations of tip-crushing, impact edge/tip scarring and some step and feather-terminated, bending-initiated scarring (Fullagar et al. 2009:266–268). Linear striations, linear polish and edge rounding were rare, although longitudinal striations were present near the tip of one of the red silcrete tools (Fullagar et al. 2009:261). Fullagar et al. (2009:266–268) interpreted this use-wear as evidence of the use, on this occasion, of silcrete backed artefacts as hafted spear tips, spear barbs or armatures and/or knives, employed in the slaying of the Aboriginal man. Kamminga (1985:11) analysed fine-grained silcrete 'pirri gravers,' which were used to grave wooden items, finding that the use-wear was the same or similar to that on chert tools used to scrape wood, particularly regarding the nature of polish and smoothing. Long striations were also common (Kamminga 1985:17). Hayes et al. (2014) investigated use-wear on silcrete and other flakes from Madjedbebe in the NT, but their results were not separated according to tool raw materials. Clarkson et al. (2017) examined the use-wear primarily of silcrete grindstones from Madjedbebe, as did Hayes (2015) (whose analysis also included grindstones from Lake Mungo), but grindstones and flaked tools were used so differently in the past that the use-wear on surfaces and edges may not be comparable—although characteristics of polish formation are likely to be similar. Smith (2006:398) referred to use-polish, transverse striations and edge rounding on silcrete flakes from Puritjarra, but did not describe these characteristics or his use-wear analytical methods in detail.

The use-wear on quartzite and quartz experimental tools is likely to be relevant for understanding use-wear on silcrete, because each material largely comprises quartz grains (Fullagar 1986b; Pedergnana and Ollé 2017:36; Webb and Domanski 2013:131). Quartzite is tougher than chert in the sense that it can absorb more energy, tensile and compressive strength elastically (i.e. without fracturing; Pedergnana and Ollé 2017:36, 55, 57). As a result, several use-wear characteristics are generally apparent. Edge scarring tends to occur less frequently and, like on other quartzose materials, striations are less abundant and often shorter and narrower (Pedergnana and Ollé 2017:42). Polish, when present, appears as 'extremely worn out spots' and tends to form in smaller areas (Pedergnana and Ollé 2017:45). These use-wear traits are probably largely due to the irregular surface microtopography of these raw materials. However, surface microtopography is not the only influence. As is the case for tools made from other raw materials, polish development on quartzite and quartz is particularly dependent upon the amount of amorphous silica in the material(s) being worked. This was demonstrated, for example, when a distinctive polish developed after Fullagar (1986b:193) used quartz tools to scrape bamboo.

More specific use-wear patterns on quartzite tools have been demonstrated through a relatively recent experiment. Of the tasks similar to those undertaken experimentally in this thesis, Pedergnana and Ollé (2017) used quartzite to butcher meat, scrape hide, and scrape and saw wood and bone. Butchering involved some hard contact with bone, which was probably responsible for the minor extent of edge scarring and rare (furrow) striations, but there was no other use-wear (Pedergnana and Ollé 2017:49, 55). Hide-scraping resulted in use-wear along the entire working edge, with rough, pitted polish, a minimal amount of edge scarring, rare, short (< 5 μm) striations and 'characteristic' edge rounding (Pedergnana and Ollé 2017:49–50). The description of edge rounding as characteristic infers similarities with the high extent of edge rounding commonly observed on tools of other raw materials used for the same task (Conte and Romero 2008:256–257; De Angelis 2014:30; Hurcombe 1992:45–46; Keeley 1980:50; Kimball et al. 2017:64, 66–67, 70; Lemorini et al. 2019:4740, 4745; van Gijn 2010:81). After scraping bone, Pedergnana and Ollé (2017:51, 55) observed less extensive use-wear, consisting of smooth, abundant polish on only the high points of the microtopography, minor edge scarring and rarely striations. Sawing bone resulted in the same polish characteristics aside from slightly less development, but edge scarring was extensive and striations somewhat more frequent. A notable difference was that there was no mention of any distinctive bending fractures and micro-fractures as observed by Kamminga (1982:48–49) after sawing bone.

4.5 Use-Wear on Porcelain Tools

To my knowledge, prior to this research, no use-wear analyses have been undertaken for porcelain tools. In one ‘preliminary’ study (Kintanar 2014) undertaken on porcelain, the shards constituted the material worked by other tools (primarily cutlery), rather than the tools themselves. Following a similar analysis of historical ceramic shards by Griffiths (1978), Kintanar (2014) examined 23 mostly Chinese blue and white porcelain shards from a historical site in San Juan, Papua New Guinea, seeking to determine how variations in ‘scratches’ and abrasion marks might enable the identification of a distinction between knife and spoon/fork use. She only had brief access to a USB microscope, which she used at x50–60 magnification, but identified that knife cut marks were deeper, with openings or clefts and distinct tears along the edges of the cuts, whereas spoon and fork use resulted in lighter scratches (Kintanar 2014:65–66, 71). Non-use-related abrasion was identifiable by its location only on the outside of foot rims and sometimes other parts of vessels, which, for Kintanar (2014:74, 77–78), indicated possible contact between vessels during their storage.

Other forms of ceramic tools have been subjected to use-wear analysis overseas. Vieugué (2015) undertook a comprehensive, systematic experimental study involving potsherds, drawing on the results to interpret the use-wear on Neolithic recycled potsherds from Bulgaria. After experimentally processing hide, wood, clay, bone and marble, he observed that tool motions could be determined by assessing use-wear directionality in the same manner as that applicable to stone and other materials. Vieugué (2015:94) also identified that taphonomic processes were reflected by the presence of wear in a ubiquitous, rather than localised region of an artefact. Similarly, Skibo (2015:194) observed that isolated striations on ceramics were typical of non-use-related processes. Both sets of observations are consistent with the identifications, by many others, of non-use-related wear on artefacts made from stone and other raw materials (discussed earlier).

The materials worked using the ceramic tools during Vieugué's (2015) experiments were identifiable based on six criteria. Several of these are the same or similar to criteria used for stone and other tools: (i) the regularity of abraded edges; (ii) the outline of the use-wear; (iii) the polish; (iv) the bluntness of mineral inclusions; (v) the frequency of chipping at the junction of abraded edges/unworn surfaces; and (vi) the presence or absence of large and deep scratches (Table 8). For Vieugué (2015:94), these criteria are typically also applicable to forms of ceramic tools other than potsherds, based on similarities he noted with a range of ceramic tools from other assemblages.

Table 8 Diagnostic use-wear for the working of a range of materials using ceramic tools, according to Vieugué (2015:94).

Worked Material	**Diagnostic Criteria**					
	Regular Abrasions	**Outlines of Use-wear**	**Polish**	**Abrasion of Mineral Inclusions**	**Frequency of Chipping**	**Presence of Large, Deep Scratches**
Hide	no	very diffuse	bright	unworn?*	absent	absent
Wood	no	slightly diffuse	dull	unworn?*	absent	absent
Bone	no	slightly diffuse	none	unworn?*	absent	absent
Clay	yes	clear	none	blunt/ chipped	absent	absent
Marble	yes	very clear	none	levelled	frequent	absent
Note: * = question mark was included in original table by Vieugué (2015)						

Use-wear analyses of recycled potsherds have also been undertaken elsewhere. For example, Shamanaev (2002) experimentally used potsherds to process hide and wood before analysing the use-wear on archaeological potsherds from a Roman Iron Age site, Uppåkra. The main use-wear characteristics after hide-scraping were what he described as a 'gloss' on the surface and a rounded or slightly flat working edge, while perpendicular striations that were narrower than those resulting from the working of wood were also present and mostly observable macroscopically (Shamanaev

2002:145). The gloss after hide-scraping may be akin to the bright polish observed by Vieugué (2015:94). After working wood, edge scarring was common and striations were perpendicular but more frequent and wide (Shamanaev 2002:145–146). Shamanaev (2002:146–147) interpreted the handful of potsherds from Uppåkra as probable hide scrapers.

Further insights into use-wear on ceramic tools can be gained from the study by van Gijn and Hofman (2008), who analysed experimental tools followed by archaeological specimens from the Caribbean, dating to c. 400 BCE–1400 CE. After experimentally processing hide for 150 minutes, van Gijn and Hofman (2008:28) found that ceramic tools were not well suited to this task due to the constant build-up of grease on the tools' edges and that the edges had barely deteriorated and use-wear was 'virtually undetectable.' However, after processing relatively softer plant material (fresh reed) for just five minutes, clear abrasion tracks and a bright polish with transverse directionality were observable microscopically. Their description of the experimental ceramic tools as fired at high temperatures (van Gijn and Hofman 2008:28) suggests that the use-wear on these and on the porcelain tools analysed in this thesis are highly comparable, albeit that hide and plant material were the only common materials processed across both studies. Similar experiments were subsequently undertaken and results observed by van Gijn and Lammers-Keijsers (2010).

Ceramic shards appear to be have been commonly used to assist in the manufacture of pottery vessels. This was the task inferred by van Gijn and Hofman (2008:29) for the Caribbean archaeological ceramic tools. The diagnostic use-wear for this activity, also identified by van Gijn and Lammers-Keijsers (2010:758, 760), was rounding and faceting of the working edge, smooth, bright polish distributed as patches on high and low points of the microtopography and a considerable amount of abrasion. López Varela et al. (2002) identified similar use-wear characteristics following their experiments using ceramic tools with scraping, evening, smoothing, polishing, incising and boring motions to produce pottery vessels.

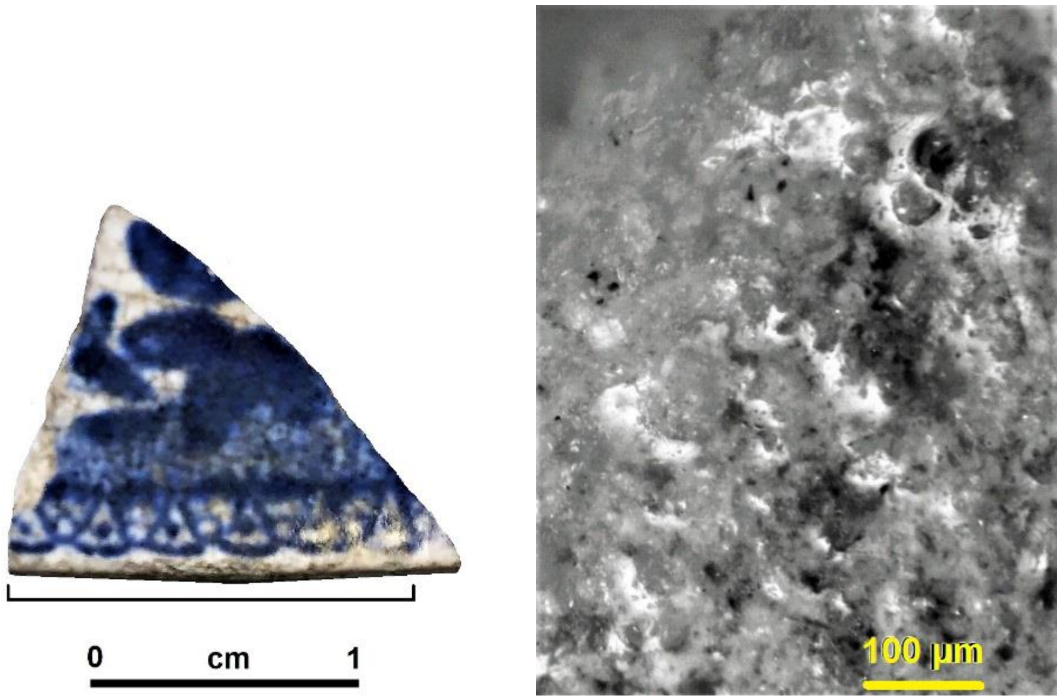
Forte (2018) analysed use-wear after experimentally using entire pottery vessels to work other materials. He examined striations, depressions, 'scratches' and grooves, finding that after working harder materials, striations were linear in shape, coarse in texture and had a 'closed frequency,' 'mixed incidence,' 'mixed cross-section' and 'irregular sharp-edge morphology' (Forte 2018:127). Depressions were coarse, with a U-shaped cross-section and also had an irregular sharp-edged morphology (Forte 2018:127). These categories may be somewhat undefined but possibly his most significant observation was that use-related abrasive wear was characterised by recurring, patterned distributions, rather than random ones (Forte 2018:127). Forte (2018) applied his observations to what he described as 'modern' Roman domestic whole vessels, interpreting them as cooking pots. It is highly improbable that such characteristics, or those identified by van Gijn and Hofman (2008), van Gijn and Lammers-Keijsers (2010) and López Varela et al. (2002), would be present on ceramics from Calperum Station, because Aboriginal Australians are not known to have undertaken pottery manufacture using ceramic shards.

After analysing 124 complete Mimbres ceramic bowls from a museum collection in Arizona, Bray (1982:136) interpreted the use-wear as demonstrative of domestic activities. Use-wear was present in the interior of the vessels in the form of striations and abrasion of the paste and on the exterior, primarily the rims and bases, as abrasion and pitting of the paste (Bray 1982:137). Bray (1982:137) inferred that much of the use-wear probably resulted from contact between a utensil, such as a ladle, and the surfaces of the vessels. Several other use-wear studies have also been undertaken on the use of ceramic domestic items, such as bowls and jars (Hally 1983; Jones 1989). However, although no possibility is precluded in this thesis, such use-wear would be unexpected among the Calperum Station ceramics, because having derived from telegraph insulators, these were not associated with domestic activity.

No detailed, comprehensive use-wear analysis has been published for the Aboriginal use of ceramics in Australia. Akerman et al. (2002) examined use-wear and residue on glass, stone and ceramic points from the Kimberley region and others from a collection from the Australian Museum, but details are scarce for their ceramics. Use-wear indicative of use as projectile tips was present on glass and stone points and it was inferred that the same applied to the ceramic points, but in their tabular summaries ceramic tools are not included (Akerman et al. 2002:38–39). Regardless, no evidence existed nor were inferences made that ceramics were used as tools for working other materials rather than as finished products themselves (such as spear tips).

Although there have been no previous, detailed use-wear analyses published concerning the Aboriginal use of ceramics in Australia, the first is due around the time of the completion of this thesis (Munt and Owen in press 2021). This derives from a separate study, unrelated to this thesis, which I conducted as a consultant (Munt 2021). The ceramic was stoneware and earthenware from a post-contact assemblage in western Sydney and when compared to the porcelain in the experimental and archaeological assemblages in this thesis, the use-wear formed and presented in the same manner despite the subtle differences in the types of ceramic material. Use-wear was present on four of the 133 ceramic shards from western Sydney and the tools were interpreted as used for whittling or planing wood and processing relatively hard plant material using a range of motions, including cutting and scraping (Munt 2021; Munt and Owen in press 2021).

The use-wear was not only consistent across the types of ceramic from the western Sydney and Calperum Station assemblages, but with that on stone tools used for the same inferred tasks. On this basis, comparisons may at times be possible across tool materials for the Calperum Station assemblage, although it is necessary to proceed with caution due to variations that nonetheless exist in the surface microtopographies between the different materials. On the solitary tool from the western Sydney assemblage that was used to work wood, the few striations were wide and oblique (~ 45–70º) to the working edge and there was some edge scarring but no edge rounding (Munt 2021:30, 102). A bright, smooth, occasionally pitted polish and abrasive smoothing were identified on peaks and other high points of the microtopography. On the three western Sydney ceramic tools used to process plant material, striations were relatively few but when present were wide and perpendicular to the working edge, while a bright, domed and not particularly well-connected polish was also present, with some pitting visible within the polish (Figure 19). There was no edge scarring, and edge rounding could not be distinguished because the working edges of the shards were the outer edges of the original ceramic vessels (probably plates) rounded during manufacture.



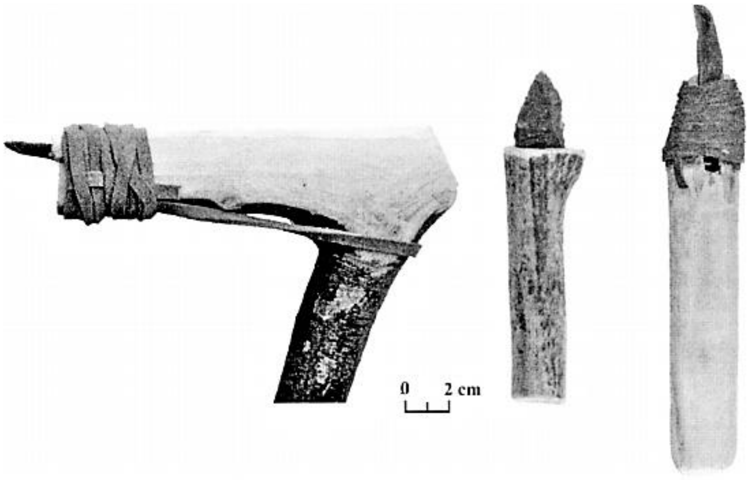
a **b**

*Figure 19 A ceramic tool from western Sydney that was used to process relatively hard, non-wood plant material (Munt 2021:103; Munt and Owen in press 2021). **A**: macroscopic image; brackets indicate the working edge. **B**: relatively bright patches of polish; x200 magnification.*

4.6 Potential Evidence for Hafting

Any robust examination of the uses of artefacts requires consideration of the possibility that they were hafted. Addressing this issue may provide more dynamic information about the past use of technology at a given site, because hafting can indicate additional behavioural patterns. For example, it may reflect more detailed planning concerning raw material acquisition and knapping procedures, as well as, potentially, efforts to extend the use-life and/or effectiveness of a tool (Clemente-Conte et al. 2017:209; Rots 2003:805–808). Microscopic evidence for hafting can be complex, particularly due to the potential influences of post-depositional factors, so contextual considerations are paramount (Pyżewicz 2017:122; Rots 2003). The presence of an adhesive, such as resin, is one of the most robust indicators, but hafting can also cause wear on a tool.

Hafting wear is directly influenced by several factors (and indirectly by others). First, the locations of any hafting wear can differ according to the type of hafting arrangement used (Groman-Yaroslavski et al. 2021a:11; Rots 2003:811–813; Rots 2005:61; Rots 2010:139–156; Figure 20). In a male hafting arrangement, where the tool is inserted into a hole in the handle, the wear on the tool is the same over the entire hafted area and only this arrangement results in intensive edge scarring (Rots 2003:811). With a juxtaposed arrangement, wear patterns differ between the ventral and dorsal faces of the tool, and in a male split hafting arrangement, where the tool is inserted into a cleft in the handle, wear patterns differ between the centre of the tool and its edges (Rots 2003:811). Another factor influencing hafting wear is the kind of hafting material used (Chen et al. 2017:188; Groman-Yaroslavski et al. 2021a:11, 13; Rots 2010:123–133; Rots and Plisson 2013:159). For example, the use of bindings can create a distinct type of edge scar (Rots 2003:811; Figure 21)—although supportive contextual evidence is necessary because drilling and perforating can also create this kind of scar (Rots 2003:811–812; Rots 2010:153–154). Finally, hafting wear differs according to the material worked with a tool (Rots 2010:106–118): harder, more resistant materials typically result in better developed hafting traces (Rots 2003:812).



a b c

*Figure 20 Different hafting arrangements. **A**: juxtaposed. **B**: male. **C**: male split. Adapted from Rots (2005:62).*

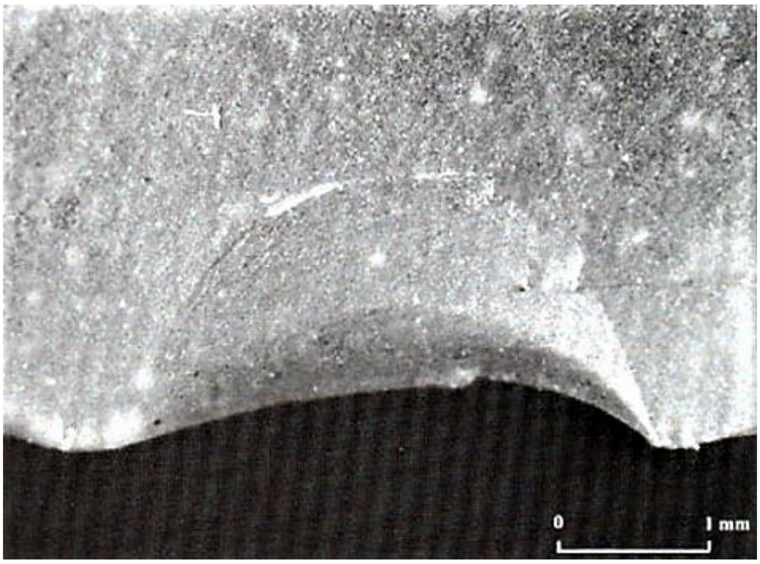


Figure 21 A distinct scar caused by the use of bindings for hafting. The scar has been sliced into. Adapted from Rots (2003:811).

Given these considerations, it appears that hafting wear, as distinct from post-depositional influences, can be microscopically identified by the presence on a tool of several key traits (rather than a solitary characteristic; Rots 2012:281). ‘Bright spots’ (Figure 22) can be caused by post-depositional agents (Levi-Sala 1996) and other factors, such as the use of a tool for grinding (Pyźewicz 2017:122). However, on the basis of previous experiments, bright spots are identifiable as hafting wear when present in association with edge scarring in an organised, rather than random distribution (Chen et al. 2017:185; Robertson et al. 2019:76; Rots 2003:809–810, 813). Hafting wear typically occurs at the opposite edge to the working edge (because that is the edge that was in contact with the haft) and is also concentrated most intensely at the limits of the haft (Rots 2003:810; Rots and Plisson 2013:159). The limits of the haft are indicated microscopically by a sudden halt in the presence/prevalence and/or nature of the wear, which may be any combination of bright spots, a light hafting polish, scarring and occasional striations (Rots 2003:810; Rots 2005:68). Any hafting polish that may be present also typically lacks directionality (Rots 2003:810).

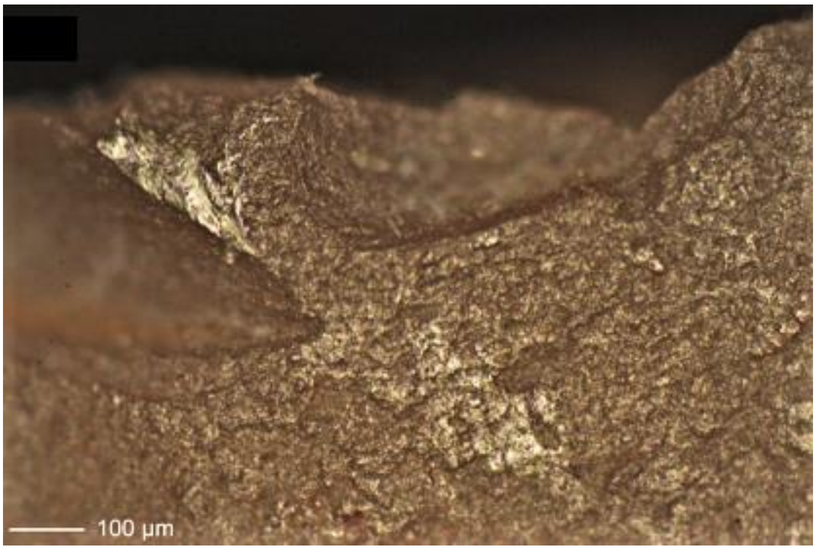


Figure 22 Hafting wear: bright spots associated with edge scarring. Adapted from Rots et al. (2011:652).

4.7 A Note Concerning Residue Analysis

Although not undertaken in this thesis due to the lack of preserved residues among the assemblage, residue analysis warrants brief discussion given its valuable role in functional analyses and potential for future research that may emanate from the findings and interpretations in this thesis (discussed in Chapter Nine under ‘Limitations and Future Research Directions’). The survival of organic residues on flaked tools from open, sandy, surface substrates (such as Calperum Station) is often highly problematic (Langejans 2010:980, 982; Langejans and Lombard 2015:201; Lombard and Wadley 2007:164; Owen et al. 2019:185; Rots et al. 2004:1297–1298). However, there can be exceptions, and in these circumstances residue analysis can complement use-wear analysis in informing about tool use (Cattáneo et al. 2017:285; Fullagar et al. 1996:741; Langejans 2010:971–972, 983; Langejans and Lombard 2015:199; Lombard 2005:286; Lombard and Wadley 2007:162; Luong et al. 2019; Rots et al. 2016). First, it is necessary to consider difficulties that can arise.

4.7.1 Difficulties Involved in Residue Analysis

It is insufficient to only use residue analysis to accurately infer the uses of tools from archaeological contexts (Hayes et al. 2017:257–259; Huntley et al. 2021:55, 57, 70; Lombard 2005:280). Because taphonomic processes can remove residues after a tool was used, residue analysis alone cannot determine the number of artefacts in an assemblage that were used (Fullagar and Matheson 2014:7062; Langejans 2010:983; Rots et al. 2004:1298). Use-related residue may represent only the tool's final use, whereas use-wear traces can sometimes reflect a tool's entire life cycle of use (Rots et al. 2004:1297–1298). Misinterpretations are also easily made because of ambiguity regarding, and poor understandings about, non-use related mechanisms by which residues can adhere to artefact surfaces, such as incidental handling by analysts (Figure 23) and other taphonomic factors (Bordes et al. 2020; Briuer 1976:482; Hayes et al. 2017:259; Huntley et al. 2021:55; Langejans and Lombard 2015:201; Lombard and Wadley 2007:158; Monnier et al. 2012; Pedergnana 2016:1, 5–9, 12, 17; Rots and Williamson 2004:1298; Rots et al. 2004:1298; Rots et al. 2016:2, 11–17, 23–24). Sample contamination is one of the most frequent and sometimes insurmountable difficulties (Bordes et al. 2020; Hayes et al. 2017:259; Pedergnana 2016). In contrast, use-wear traces are typically more definitive: their impact on the tool's edge is clear and they are normally clustered in particular regions on a tool (Rots et al. 2004:1298).

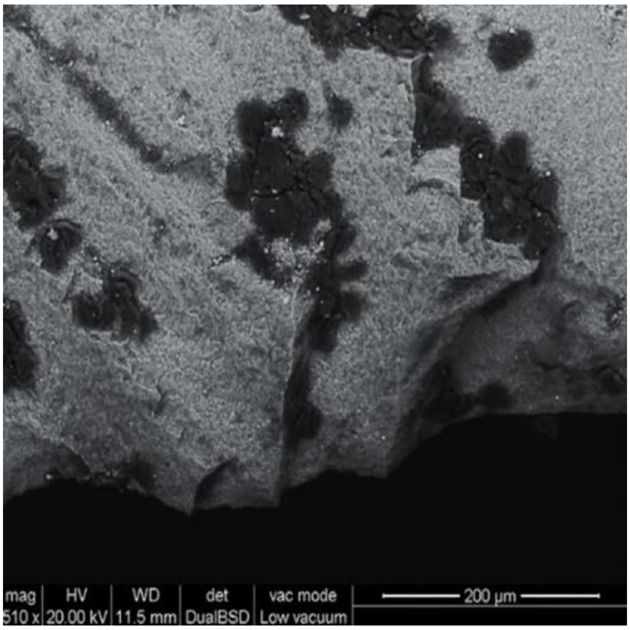


Figure 23 SEM image of contaminant in the form of skin flakes from an analyst's hand. Adapted from Pedergnana et al. (2016:14).

Early residue analysis, beginning with the study conducted by Briuer (1976), had mixed success in conclusively identifying particular residues and inferring tool function. Briuer (1976) was able to broadly distinguish between plant and animal tissue but not to a taxonomic level. In most cases Anderson (1983) identified plant material on experimentally worked and some archaeological tools, based largely on the 'durability' of various plant materials. Loy (1983) claimed to have been able to identify blood residues on lithics by using crystallisation techniques and Nelson et al. (1986) attempted to identify blood through the detection of iron from haemoglobin. Loy's (1983) and Nelson et al.'s (1986) studies were regarded as promising but not widely accepted due to an inability to preclude the presence of other, non-blood related residues (Fullagar et al. 1996:742; Gurfinkel and Franklin 1988; Smith and Wilson 1990; see also debate in Eisele et al. 1995).

A conducive preservation environment must exist for any blood to be preserved and this is often difficult in archaeological settings. Smith and Wilson (1990) contended and Cattáneo et al. (1993) subsequently demonstrated that human immunoglobin can, in some circumstances, survive for less than a year due to microbial action that destroys protein (which is necessary for the confirmation of the presence of blood) (see also Tuross et al. 1996:295). Dry to desiccated or frozen environments are optimal because they can minimise microbial activity (Cattáneo et al. 1993:40; Smith and Wilson 2001). However, blood is less resistant to microbial activity than other proteins, including particularly hard tissue with different organisational structures, such as tooth, bone, antler and shell (Gernaey et al. 2001:323). All proteins can degrade on artefacts (Gernaey et al. 2001) and most archaeological settings, particularly open-air sites (Langejans 2010:973), provide less than optimal preservation environments for blood (Lombard and Wadley 2007:155–156).

Notwithstanding these issues, the ability to identify blood residues whenever they do indeed adhere to artefacts has improved as testing methods have advanced. Earlier presumptive tests for blood received some criticism on the basis that some non-haemoglobin residues, such as manganese oxide (Custer et al. 1988:344) and non-immunoglobulins that were transferred through handling by artefact analysts (Manning 1994:160), reacted to the tests. However, Matheson and Veall (2014:237) have since resolved this issue, demonstrating that the use of a chelating agent, which in their study was EDTA (ethylenediaminetetraacetic acid), in conjunction with the commonly used presumptive test Hemastix®, significantly minimised the reaction of non-haemoglobin. Consequently, blood residues were more effectively isolated. Following a successful presumptive test, further procedures, such as microscopic analysis and absorbance spectroscopy, can be conducted to contribute to a confirmation of the presence of blood (Matheson and Veall 2014:240).

4.7.2 The Potential of Residue Analysis

Despite the possible difficulties involved, residue analysis can, on the occasions when artefacts derive from conducive contexts, provide indications about tool uses when complementing use-wear analysis and holistic, contextual considerations (Bordes et al. 2017:1213; Cattáneo et al. 2017:285; Fullagar et al. 1996:741; Hardy and Garufi 1998:182–183; Huntley et al. 2021:55, 57, 70; Langejans 2010:971–972, 983; Langejans and Lombard 2015:199; Lombard 2005:286; Lombard 2011:1920, 1925; Lombard and Wadley 2007:162; Luong et al. 2019; Rots et al. 2004; Wright et al. 2016:734, 736). For example, use can be indicated by the presence of an abundance of residue of the same or similar variety within a concentrated region of a tool (Attenbrow et al. 2009:2766; Bordes et al. 2017:1213; Cooper and Nugent 2009:218, 220; Hayes et al. 2017:245, 254, 259; Figure 24), particularly when such a region has been initially associated with use via use-wear investigations (Hardy and Garufi 1998:179; Lombard 2011:1920; Lombard and Wadley 2007:158–159; Rots et al. 2016). Preservation issues are not always prohibitive. Residues can preserve under favourable conditions, including at open-air sites, such as when extreme pH levels help to minimise microbial activity (Birgitta Stephenson, pers. comm. 2018; Cooper and Nugent 2009:210–211, 215–222; Langejans 2010:980; Owen et al. 2019:186). The preservation integrity of sub-surface sites must also not always be privileged in our interpretations, because virtually all sub-surface archaeological assemblages were open-air sites for varying lengths of time prior to burial (Cooper and Nugent 2009:223; Dunnell and Dancey 1983).

Figure 24 Woody residue from an experimentally used tool (Rots 2016:28).

The most reliable circumstance for residue identification is when combinations of residues exist on a tool. For example, the presence of several faunal residues together (hair, fat, bone, collagen and others), helps to distinguish a sample from plant residues. Cooper and Nugent (2009:210–211, 215–222), for instance, found that a broad range of residues (and use-wear) had indeed survived their open-air context, and from their examination of 23 surface stone artefacts from Camooweal in Queensland, they inferred functions only when combinations of residues existed. The presence of woody plant tissue, cells, cellulose, bordered pits and exudate, for example, led to their interpretation that wood had been worked (Cooper and Nugent 2009). Sediment analysis from a site must also be undertaken in order to assist in the distinction between plant and animal residue (Bordes et al. 2017:1212–1213; Lombard 2011:1920; Lombard and Wadley 2007:159). Isolated residue must be interpreted cautiously and the origin of any residue must be investigated in order to preclude modern contamination.

When the above factors are considered, some understandings and criteria for use-related residue identification, established by previous studies, can be applied. The primary consideration is the context of the residue in terms of its locations on the tool surface, abundance on a tool and presence in relation to the remainder of a given assemblage (Hayes et al. 2017:245, 254, 259; Pedergnana et al. 2016:5; Rots et al. 2004:1294; Wallis et al. 2020:113–114). Other particularly important general principles are that non-use related residues are typically isolated and use-related residues usually have a more macerated or smeared appearance (Rots et al. 2004:1293). Further, some plant and animal micro-residues are birefringent (the double refraction of incident light; Lombard and Wadley 2007:156), and the use of cross-polarisation on samples under reflected light microscopy can result in birefringent residues becoming brighter to different extents. Measuring the intensity of this brightness can help to distinguish different residues (Langejans and Lombard 2015:203), and the shape, colour, size and texture of the residue can help in its broad identification (Langejans and Lombard 2015:204). However, complexity is added to the ability to make such identifications, let alone to a taxonomic level, by the fact that colour and morphology can easily be altered by decay and post-depositional processes (Pedergnana et al. 2016:1).

It is not always straightforward to visually distinguish animal and plant structures microscopically (Lombard and Wadley 2007:161–162, 164), at least not without further quantitative evaluation (e.g., refractive index) and biochemical indicators. Identification to taxonomic level requires extensive numbers of specimens and experimental reference libraries (Luong et al. 2019:1). (Occasionally, across a range of archaeological settings, DNA may also be obtainable and assist identifications; Hartnup et al. 2009; Speirs et al. 2009). For animal material, such reference collections would require extensive residue samples from a broad range of species, and for plants, a vast array of samples of different types of starch grains, raphides, phytoliths, cellulosic matter, pollen, resin, gums and other exudates (Hayes 2015:86; Luong et al. 2019:1–2). However, the fundamental difference between plant and animal material is that plants contain cellulose (carbohydrates) and have typically thick cell walls (Evert and Eichhorn 2006:65–66), whereas animal material contains collagen, muscle tissue, potentially blood, occasionally visible nuclei and does not exhibit a visible cell structure (Hardy and Garufi 1998:177; Lombard 2005:287). Residues may also derive from neither animal nor plant sources, but rather inorganic material, such as ochre or haematite (Lombard and Wadley 2007).

One of the most effective means of microscopically distinguishing residue type is the chemical staining of samples—particularly for woody residues (Rots et al. 2016:25). Commercially available stains such as 'Picro-sirius Red,' 'Orange G,' 'Methylene Blue,' 'IKI' and 'Congo Red' only adhere to certain residues, such as proteins or collagen, thereby enabling the distinction between animal and plant material. Tables 9 and 10 provide further important criteria for aiding the distinction between plant and animal residues, with some examples seen in Figure 25.

Table 9 Some criteria for the identification of plant residues.

Residue type	Identification Criteria	References
General	• 'Plant cells have double walls, large vacuoles, and chloroplast organelles' and appear 'stiff and angular'	Langejans and Lombard 2015:204
	• 'Plant or cellulose fibres usually consist of long, slender cells that commonly occur in ribbon-like strands or fibrous bundles. The cellulose strands often appear as broken twisted fibres, with shattered ends'	Langejans and Lombard 2015:204; Lombard 2005:286
	• Archaeological plant residue normally exhibits only a silica skeleton; degraded plant tissue is often dark brown	Langejans and Lombard 2015:205
Starch	• Charcoal or burnt plant normally ranges in colour from dark brown to black	Langejans and Lombard 2015:204
	• Starch is ubiquitous, so on its own is insufficient to infer artefact use	Lombard 2008; Lombard and Wadley 2007:158; Rots and Williamson 2004
	• Forms as grains that are usually oval or spherical, and they are birefringent	Odell 2003:159
	• Size = 1–175 μm	Langejans and Lombard 2015:205
	• Often, particularly under cross-polarised light, exhibit a characteristic extinction cross (Figure 25)	Evert 2006:52–53; Liu et al. 2017:447; Lombard 2005:285–286
Resin	• Resin is a range of plant secretions e.g., pitch, waxy oils, gums, latex	Langejans and Lombard 2015:205
	• Characterised by concentric growth rings or lamella; under cross-polarisation, two discrete dark bands cross in the middle of the starch granule	Langejans and Lombard 2015:206
	• Glassy, transparent, brown to yellow in colour, may be birefringent; present in small, smooth droplets or straight-edged, clear cracks; degraded mixes generally are not glossy and transparent and they appear globular	Lombard and Wadley 2007:159
Wood	• 'The presence of vessels, bundles of vessels, and cell structure consisting of tracheids (elongated conducting and supporting cells) and parenchyma (living thin-walled cells)…(and) sometimes fibres'	Lombard 2005:187
	• Systematically arranged, double-walled cells	Langejans 2010:972
	• Woody residue is also characterised by a 'blocky' structure (e.g., Figure 25)	Elspbeth Hayes, pers. comm. 2018; Lombard and Wadley 2007:157

Table 10 Some criteria for the identification of animal residues.

Residue type	Identification Criteria	References
General	• Made from proteins • Less rigid than plant cells • Contain only small vacuoles • Nuclei sometimes visible • Blood, hair, bone and cartilage are the residues that most often preserve after animal butchery	Langejans and Lombard 2015:207 Fullagar et al. 1996:741
Supportive/ connective tissue	= Bone, sinew and cartilage	Langejans and Lombard 2015:207
	• Collagen is present and formed in parallel bundles 2–10 mm in diameter, and comprised of fibrils whose ends may appear unravelled • Collagen is mostly fibrous	Lombard 2011 (e.g., Figure 25) Lombard 2005:287
	• Cartilage: flowing and fibrous; can be birefringent, but bone and fatty cartilage often appear as amorphous, opaque and grey	Langejans and Lombard 2015:207
Muscle tissue	• Composed of long, contractible cell walls • Generally less translucent than plant tissue • Darker bands birefringent under cross-polarisation • Ends of fibres can appear unravelled or twisted • Pale to yellow, orange and brown in colour	Langejans and Lombard 2015:207; Lombard 2005:287
Fat and marrow	• Distinctively globular or ovoid • Opaque and sometimes bluish under cross-polarisation	Lombard 2005:287
Hair	• Cylindrical, with three layers: cuticula (outer layer), cortex and medulla (which consists of tightly packed, dry cells	Lombard and Wadley 2007: Figs 4c,d; Langejans and Lombard 2015:209
Bone	• Often amorphous, greasy and opaque, therefore difficult to distinguish; fatty deposits, collagen particles and white opaque bone flakes may be present	Jahren et al. 1997:247; Lombard 2005:287; Loy 1993
Blood	May be problematic in archaeological samples due to the degradation of protein and other elements, but some common characteristics: • Red blood cells: have a biconcave disc shape with average. diameter of 7.2 µm • Mud-cracking of thick films	Lombard and Wadley 2007:155–156 Lombard 2005:287–288

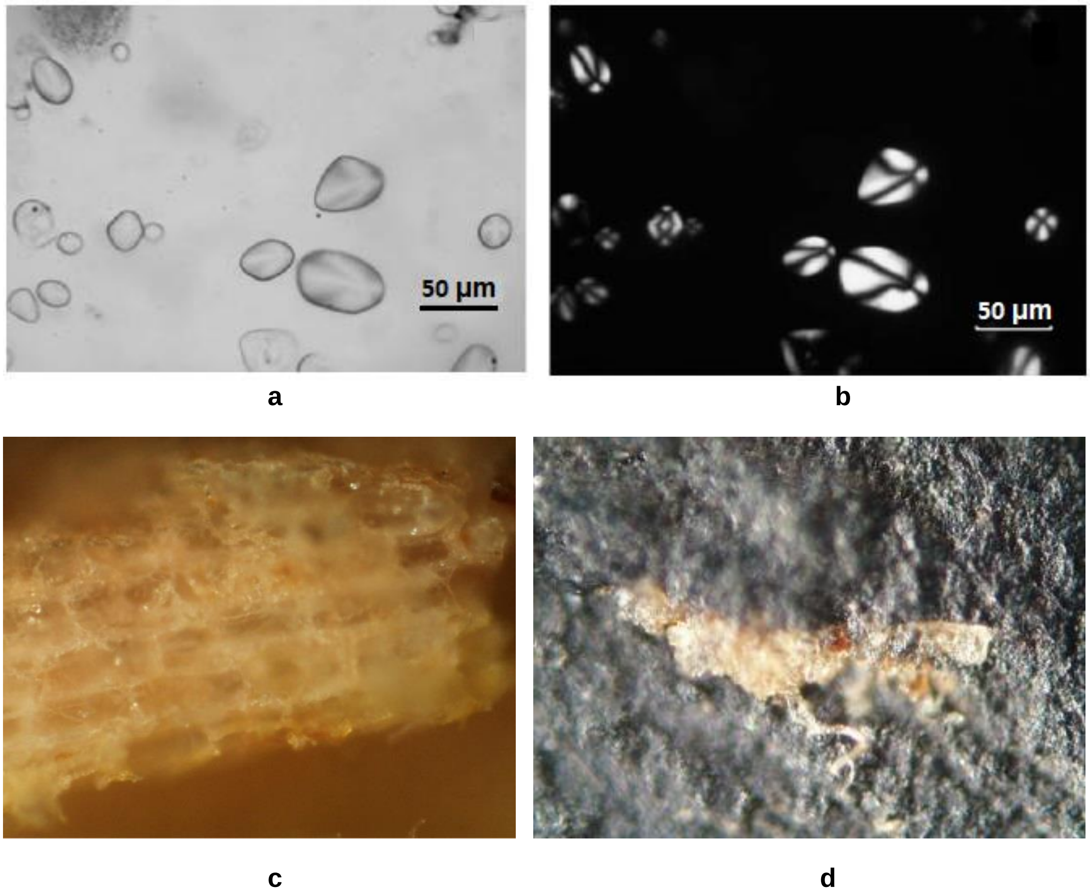


Figure 25 ***A****: starch grains in plane-polarised light. Adapted from Hayes (2015:90).* ***B****: starch grains in cross-polarised light. Adapted from Hayes (2015:90).* ***C****: characteristic 'blocky' cellular structure of wood. Adapted from Lombard and Wadley (2007:157); no scale was provided in the original image but it was taken at x200 magnification.* ***D****: collagen residue, from hide-scraping; x100 magnification. Rots and Williamson (2004:1293); no scale was provided in the original image but it was taken at x100 magnification.*

4.8 Chapter Summary

This chapter has discussed how each form of use-wear can contribute, individually and in combinations, to interpretations of tool functions. Influences on variations of the nature of wear have been considered, particularly the tool raw material and taphonomic processes. From the many previous studies discussed, it appears that the main distinctions between non-use-related and use-related wear is that the former is characterised by random distributions and orientations of, in particular, striations and edge scarring. Use-related wear is typically more localised on a tool's surface and more clearly orientated in relation to the working edge(s). Discussion in the following chapters of the trampling experiments undertaken in this thesis will contribute further to this issue. Particular use-wear traits across each tool raw material were discussed in this chapter that result from the working of materials readily available around Calperum Station in the past: wood, bone, meat, plant material and hide. A number of broad differences typically exist which aids efforts to distinguish the working of these materials. Understandings gained from the review of the past literature can be implemented in the organisation of the methods used in this thesis for fieldwork, artefact screening, tool-use experiments and ultimately the use-wear analysis.

Chapter Five: Methods

The methods used for all components of this analysis are described in this chapter. Explanations are provided for decisions made regarding survey locations and artefact screening, and descriptions are given of all processes involved in the trampling experiments. The manner in which TOs demonstrated their ongoing use of glass tools is described, followed by an outline of procedures undertaken for the tool-use experiments. These experiments were designed to approximate archaeological conditions at Calperum Station as closely as possible, and drew on TO knowledge about materials available locally (e.g., kangaroo, *Typha* and river red gum wood). Use-wear analysis was conducted in the same manner for the experimental tool-use assemblage and the archaeological assemblage, and all methods of use-wear analysis are described. The chapter concludes with methods used for ascribing different confidence levels to interpretations of artefact use for the archaeological assemblage.

5.1 Fieldwork

All fieldwork for this project adhered to the legislative requirements discussed earlier and to cultural protocols requested by RMMAC and required under the Flinders University Social and Behavioural Research Ethics Committee. Such protocols involved, for example, cultural smoking ceremonies prior to and following each day of fieldwork, the presence of cultural monitors appointed by RMMAC during all fieldwork and their regular involvement in discussions, consultations and decisions about fieldwork issues (Figure 26). Preliminary fieldwork conducted prior to the beginning of this research, by members of the Flinders University/RMMAC collaborative project, resulted in the identification of several sites containing stone artefacts and post-contact artefacts, such as glass and other materials (Amy Roberts, pers. comm. 2018).

Figure 26 Surveying at West Woolpoolool with TO, Julie Cook, 2019. Photo: Catherine Morton.

5.1.1 Surveys

Survey areas were based on several factors. First, site directors had observed, prior to the commencement of this thesis, glass, stone and porcelain in the regions of the West Woolpoolool and Telegraph Insulator sites. Second, the two sites were selected after surveys conducted for this thesis indicated that the concentration of artefacts present provided the best potential to address the research questions. Third, upon viewing these sites during surveys, TOs communicated their agreement with the site selections. Finally, site directors had also sought to investigate new parts of Calperum Station, following areas covered by Jones (2016), Dardengo (2019), Ross (2018), Thredgold (2017), Incerti (2018) and those currently being examined for other doctoral projects. Pedestrian surveys for this thesis were conducted over eight days across field trips in September 2018 and May 2019. Given that this thesis was part of the Flinders University/RMMAC combined research, Flinders University project directors, RMMAC members, authors of concomitant projects and volunteers all participated in field surveys. Surveys for this thesis were typically conducted with three to five individuals, on each occasion walking transects 5–10 metres apart.

Site locations were initially recorded using a hand-held GPS (*Garmin Extrex 10*), and coordinates, site descriptions and maps were subsequently provided to RMMAC and the South Australian Aboriginal Affairs and Reconciliation Department (AARD) as part of the process of obtaining a permit. Maps were generated by Craig Westell using *ArcGIS*. West Woolpoolool was earmarked on the bases that (i) there were several hundred artefacts and (ii) the presence, in association, of stone, glass, a (non-diagnostic) clay pipe stem, shell and faunal bone suggested it was probably a pre- and post-contact Aboriginal camp site. The Telegraph Insulator site was chosen because of the presence of several shards of potentially flaked porcelain telegraph insulator, originally observed by Craig Westell, and the significant potential of these artefacts to contribute to the consideration of Aboriginal peoples' incorporation of European material items into their technological practices.

5.1.2 Artefact Sampling Strategy, Collection and Storage

Following approval from AARD for collecting and relocating the artefacts, a third field trip was undertaken in September 2019. Site and artefact locations were then recorded to a greater level of precision using a total station (*Leica Flexline TS09 plus 3*).

As previously discussed, use-wear and/or residue analysis has rarely been applied to a representative number of archaeological specimens from any one site or archaeological level. For example, Hayes et al. (2018:75) analysed 40 tools, Hayes et al. (2017:257) 15, Lemorini et al. (2014:14) 62 and Gorman (2000:272) 61. Further, Haslam (2009:49–50) found, from his synthesis of world-wide tool residue analyses conducted between 1976 and 2006, that the overwhelming majority of studies involved fewer than 20 tools and that the mode was three. His analysis of statistical significance thresholds also demonstrated that, for any interpretation based on residue analysis to be ascribed a statistical confidence level of 95%, a (logistically) prohibitive minimum of 385 tools is required (this principle would also apply to use-wear analysis) (Haslam 2009:55–56).

Statistical significance is not essential for research questions which focus on a small, discrete area that does not require extrapolation from a small sample size for a much larger population (Haslam 2009:53–58). In the current research, tool uses are investigated for a very limited geographic region without a diverse array of landforms and this information is not intended to be extrapolated to a greater area. In essence, if, for example, a single tool exhibited use-wear consistent with the working of animal bone, further such tools are not necessary to infer that this use occurred (Flood et al. 1987).

Given these considerations, a stratified, judgement sampling strategy was adopted (Burke et al. 2017:90–93). The primary criteria for artefact selection was the quality of edge preservation and a 10x hand lens was used to assist this initial screening process in the field. Another criteria was evidence of intentional knapping because I considered that this indicated a reasonable possibility of subsequent use. Stone, glass or porcelain artefacts whose edges were extremely crushed or that had any part of their surfaces clearly patinated, weathered or otherwise damaged, were excluded. Finally, it was ensured that artefacts were selected from many areas within the 17,000 square metre West Woolpoolool site. On the above bases, a sample of 101 stone and glass pieces was collected from the estimated 200–250 artefacts at West Woolpoolool, many emanating from the densest concentration of artefacts (Figure 27). From the Telegraph Insulator site, eight of the more than 50 porcelain artefacts were retrieved.

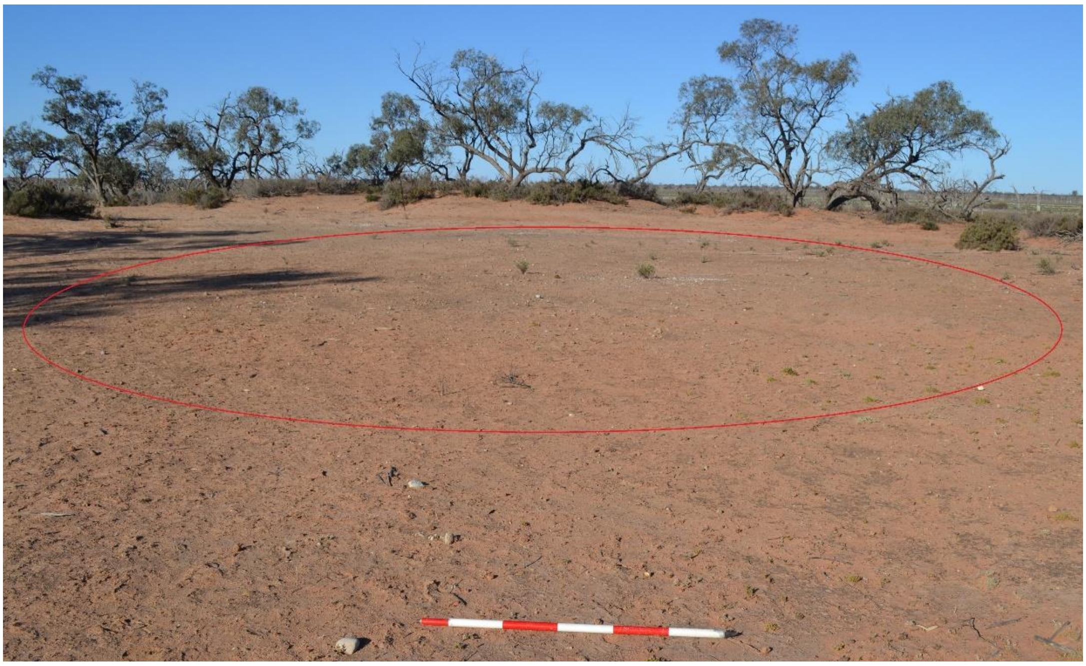


Figure 27 The densest concentration of artefacts at West Woolpoolool; September 2019, facing east.

Further screening was subsequently undertaken in a laboratory using a metallographic microscope (*Olympus BH-2®*), and Dino-Lite (*DinoCapture 2.0 Version 1.3.7.A®*) microscope with oblique lighting and magnifications of up to approximately x80. This enabled the closer examination of the quality of edge preservation and the potential presence of any form of use-wear, whose detailed nature could then be fully analysed through high-powered analysis (e.g., Luong et al. 2019:7). As a result of this screening, the 101 artefacts from West Woolpoolool were reduced to a sample of 54, while all eight porcelain artefacts were retained, primarily because their edges were well preserved. The total number of artefacts analysed in this thesis was therefore 62.

During the screening process, observations of technological features on the archaeological artefacts were essential for drawing subsequent microscopic distinctions between attributes resulting from production and use. For example, retouch, when applied, is a part of the artefact manufacturing process, yet resultant retouch scars can appear similar to use scars. Artefact attributes that are the product of conchoidal fracturing (including initiation, propagation and termination) are distinguishable under the microscope. Such characteristics may include, among others, a bulb of percussion, a ring crack and compression waves, as well as flakes detached as a result of a bending initiation that often display a pronounced 'lip' on the underside of the platform on the ventral surface (Clarkson 2007:29; Clarkson and O'Connor 2014:156–157; Cotterell and Kamminga 1987:690). Flakes detached after a wedging initiation, which is common in bipolar flaking, do not have bulbs of percussion and often display crushed platforms with cascading step scars on the platform edge (Clarkson 2007:30; Cotterell and Kamminga 1987:688–689). Artefact platforms can also display evidence of preparation prior to flake detachment, visible in forms such as abrasion or the removal of one or more small flakes via pressure flaking (Clarkson 2007:29, 31–32; Macgregor 2005; Pelcin 1997).

Great care was exercised in the collection, storage and transportation of artefacts, to prevent accidental damage. Artefacts were handled only while wearing powder-free, nitrile plastic gloves, so as to minimise the transference of skin flakes and natural oils and lipids, and were individually placed in plastic snap-locks bags. Each artefact number, site, raw material, coordinates and total station ID point were recorded using blue ball-point pen on labels that were then inserted into a second plastic snap-lock bag, with bubble wrap (Figure 28). All artefacts were then stored in boxes packed sufficiently tightly to prevent movement during transportation to the Flinders University archaeology laboratory, whereupon they remained secure, with the appropriate permissions from RMMAC and the AARD.

Figure 28 The author recording and storing artefacts at West Woolpoolool, September 2019. Photo: Catherine Morton.

5.2 Experimental Archaeology

5.2.1 Trampling Experiment

An experiment was conducted, after preliminary observations of the site but before the formal fieldwork, in order to investigate the effects of trampling on surface artefacts. The experiment was particularly important given that Calperum Station was a working station (now managed for the conservation of wildlife and heritage) with regular pedestrian and vehicular traffic in some parts, as well as being subject to a range of natural taphonomic processes resulting from past and present-day animal burrowing. The primary aim of the experiment was to examine any microscopic characteristics on the flakes following trampling, in order to help the distinction between non-use and use-related wear on the archaeological specimens.

5.2.1.1 Trampling Experiment Procedures

In preparation for the trampling and other experiments, nodules of chert and silcrete were obtained through private donors from non-archaeological contexts that closely approximated archaeological materials in grain sizes. The chert was sourced from the Port MacDonnell region of SA and the silcrete from the Cumberland Plain in NSW. The quartz clasts in the silcrete were fine-grained: larger than microcrystalline clasts but less than 0.25 mm. Bottles of thick, very dark green glass and clear glass akin to the kind used by TOs in their demonstration were sourced from private collections, and modern porcelain crockery (shards ~ 1–2 cm thick) was used to approximate the archaeological porcelain. The following procedures were then undertaken.

1. I detached ten each of chert, silcrete, glass and porcelain flakes with a combination of knapping and indirect percussion. Artefact lengths, widths and thicknesses are not always significant factors in relation to the effects of trampling (Marwick et al. 2017), but to ensure consistency, the dimensions of the 40 trampled flakes broadly approximated those of the archaeological flakes: ~ 2.5 (length) x 2 (width) x 1.5 cm (thick).

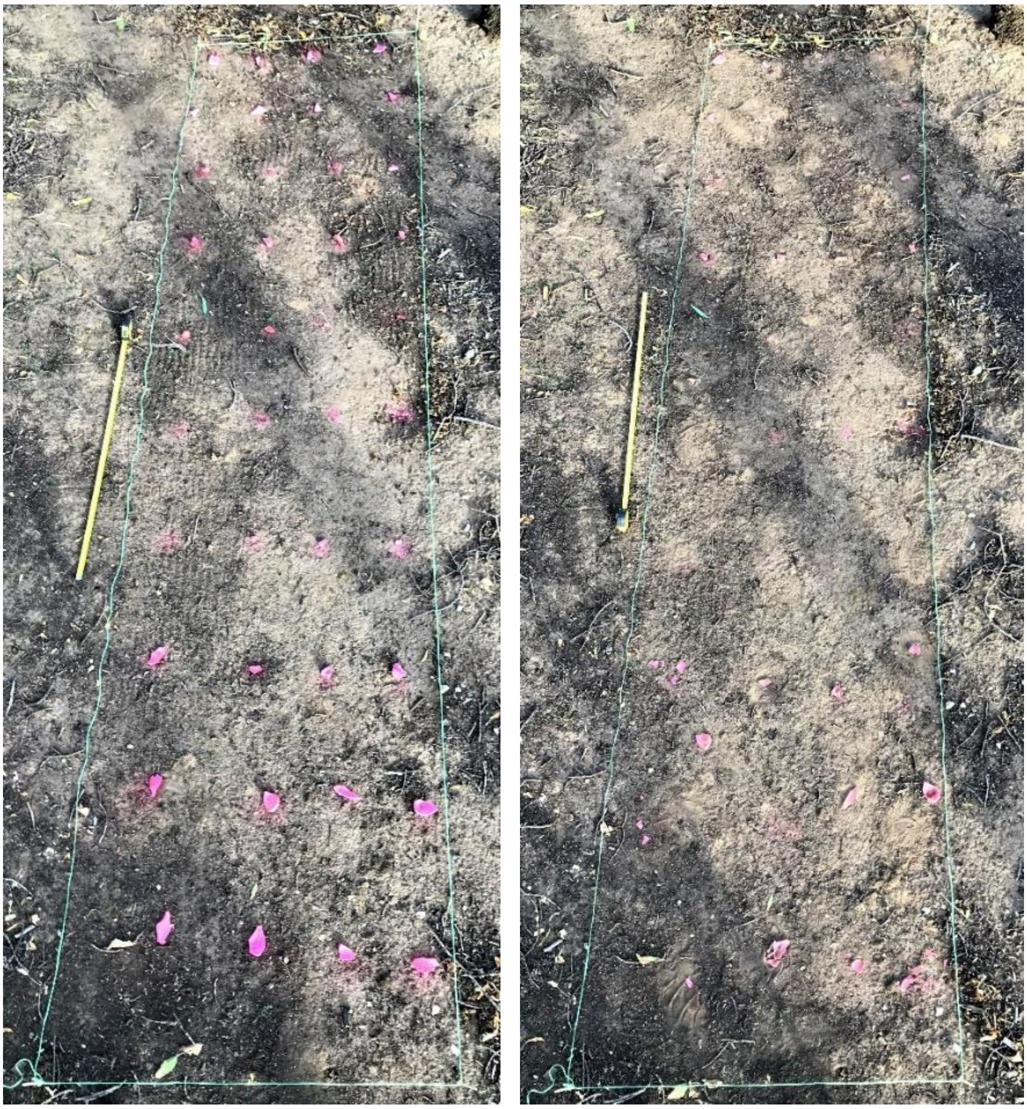
2. Every flake was spray-painted on one surface, to assist the identification and retrieval of any flakes pressed under the surface during trampling.

3. Each flake was placed flat on the surface, spray-painted surface up, in a grid 20 cm apart on the x-axis and 40 cm apart on the y-axis within a 4 m x 1 m area of flat, sandy substrate. A photograph of the gridded area was taken prior to the commencement of trampling (Figure 29).

4. Flake locations were recorded to scale on graph paper.

5. A volunteer, weighing 77 kg, and I, weighing 83 kg, walked in different directions over the flakes for 30 minutes, each of us wearing flat, rubber-soled footwear. Although others, such as Marwick et al. (2017:76), used a solitary person during trampling experiments, I considered the use of two

people with different weights more reflective of archaeological conditions. No more than two people would fit comfortably within the small trampling zone. Immediately following the trampling, a photograph was taken from the same location used prior to trampling (Figure 29).



a b

Figure 29 Trampling experiment. ***A****: before trampling.* ***B****: after trampling. Tape = 1 metre.*

6. Whole flakes and fragments were then counted to determine how many were still visible on the surface. The locations of those that were buried were carefully revealed through excavation using flat dental picks in 1 cm spits within the vicinity of their original surface locations. Sub-surface depths of these flakes were recorded to the nearest centimetre.

7. The surface positions of all flakes were then recorded to the nearest centimetre on the same graph paper used to record their original locations.

8. The vertical inclination of flakes was not measured because all flake inclinations remained unchanged.

9. The horizontal rotation of each flake was recorded as ‘none’ (0º), ‘partly’ (1–90º) or ‘largely’ (91–180º).

10. Each flake was then picked up with powder-free nitrile gloves in order to minimise any contamination, placed within a plastic snap-lock bag, a label attached to the outside of this bag with an elastic band and bubble wrap applied.

11. Flakes were cleaned using the same procedures for the other experimental assemblage and the archaeological assemblage, described below (‘Use-wear Analysis: Artefact Cleaning and Preparation’).

12. A wear analysis was then performed for each flake. Wear was recorded with the same methods used to analyse the artefacts from the tool-use experiments and the archaeological assemblage, described below (‘Use-wear Analysis: Artefact Attributes’).

5.2.2 Use-wear Experiment: Traditional Owner Demonstration

In conjunction with discussing their living cultural memories during an interview at Calperum Station woolsheds on 18 May 2019, TOs Timothy Johnson (‘TJ’) and Philip Johnson (‘PJ’) provided a demonstration of the manner in which they were taught by their antecedents to use glass for scraping wood (Figure 30). TJ and PJ brought a modern, clear spirits bottle and modern amber beer bottle respectively, both of which they shattered using a metal hammer so as to create sharp shards. After selecting shards that were both sharp and comfortable in their hands, TJ lightly scraped a pre-carved wooden walking stick for five to six minutes and PJ for two minutes, the purpose being to remove splinters and smooth the wood. Following their work their glass shards were placed in individual, small plastic snap-lock bags, labelled and wrapped in protective bubble-wrap for subsequent use-wear analysis.

a b

c d

Figure 30 On-site demonstration by TOs of their techniques for scraping wood with glass. ***A****: TJ reducing a modern, clear bottle using a metal rod.* ***B****: TJ smoothing a pre-carved wooden walking stick.* ***C****: PJ displaying the bottle base from which he obtained a glass shard suitable for scraping.* ***D****: PJ using a glass shard to scrape a long, thin piece of wood of the kind his antecedents used to manufacture spears (Philip Johnson, pers. comm. 2019).*

5.2.3 Traditional Owner Oral Histories

Informal, semi-structured interviews were used to record the oral histories of TJ and PJ. More rigid, structured methods were avoided, to afford sufficient flexibility for encouraging TJ and PJ to freely offer their knowledge and insights through their own initiation (e.g., as per Minichiello 2008:51 and Roberts et al. 2017:139). Conducting the interviews in the study area assisted the establishment of a relaxed, comfortable environment for TJ and PJ and allowed them to physically gesture and refer to relevant places within the landscape. The interview was recorded using a digital recorder (*ZOOM H4n Handy Recorder*) and a full, printed transcript subsequently provided to TJ and PJ for their own purposes and to afford them the opportunity to comment upon it and remove or amend any culturally sensitive or other information. (Ultimately TJ and PJ did not make any amendments). In producing the transcript, all spoken words were recorded other than filler words, such as 'oh' and 'um,' because such omissions did not detract from any meaning and added fluency to the written text.

5.2.4 Tool-use Experiments

Tool-use experiments were conducted over several months, to inform the subsequent use-wear analysis of archaeological material. To ensure the most robust possible outcomes, careful preparation, guiding principles and consistent procedures were instituted.

5.2.4.1 Tool-use Experiments: Preparation

Approximately 200 pieces, comprising chert, silcrete, glass and porcelain, were detached from the nodules/bottles/crockery, primarily using indirect percussion but also some direct percussion using a hammerstone. To approximate the archaeological assemblage, a combination of complete and proximal flakes and shards was manufactured and only pieces ranging in length from 2–14 square centimetres were selected. One archaeological artefact from the study area had been retouched, so several experimental pieces were retouched. Immediately following production, each experimental tool was placed in an individual plastic snap-lock bag and uniquely labelled on a paper form, beginning with ‘X01’ (Figure 31). Bubble wrap around each tool snap-lock bag prevented accidental edge scarring.

Experimental Archaeology for Study by Simon Munt (all tool working sessions = 40 mins)	
Artefact number	X…………
Participant name	
Date	
Artefact material	Chert ☐ Silcrete ☐ Glass ☐ Porcelain ☐ - base ☐ - shard ☐ Glass thickness: ………………….. (Thin/Medium/Thick)
Worked material	☐ Wood: fresh ☐ Wood: dry ☐ Meat ☐ Bone: dry ☐ Bone: fresh ☐ Hide ☐ Plant
Tool motion	☐ Planing ☐ Adzing ☐ Sawing/Cutting ☐ Wedging ☐ Scraping ☐ Chopping ☐ Range of motions
Notes/observations	

Figure 31 Individual label for each tool used in the tool-use experiments.

Materials to be worked that were as similar as possible to those available over at least the last several millennia in the study area were then chosen—an essential factor for providing robust use-wear results (Walton 2019:911). TOs were involved in the choice of materials to be worked, with their knowledge indicating that their ancestors had access to river red gum (*E. camaldulensis*), 'bulrush' (*T. domingensis*) reeds and kangaroo. Kangaroo hide was unobtainable via legal or ethical means, so a 2 x 1 m fresh cow hide was sourced because cows involved in European pastoral activities on Calperum Station may also have been exploited by Aboriginal peoples. A large array of dry kangaroo bones was collected, with the support of TOs, from deceased animals in a sandy location within a non-archaeological, natural environment. Fresh lamb was purchased from butchers. Several sizeable branches of fresh and seasoned wood were sustainably sourced from river red gum (*E. camaldulensis*) trees from the local environment, as was a substantial number of bulrush (*T. domingensis*) reeds with stems and tubers attached.

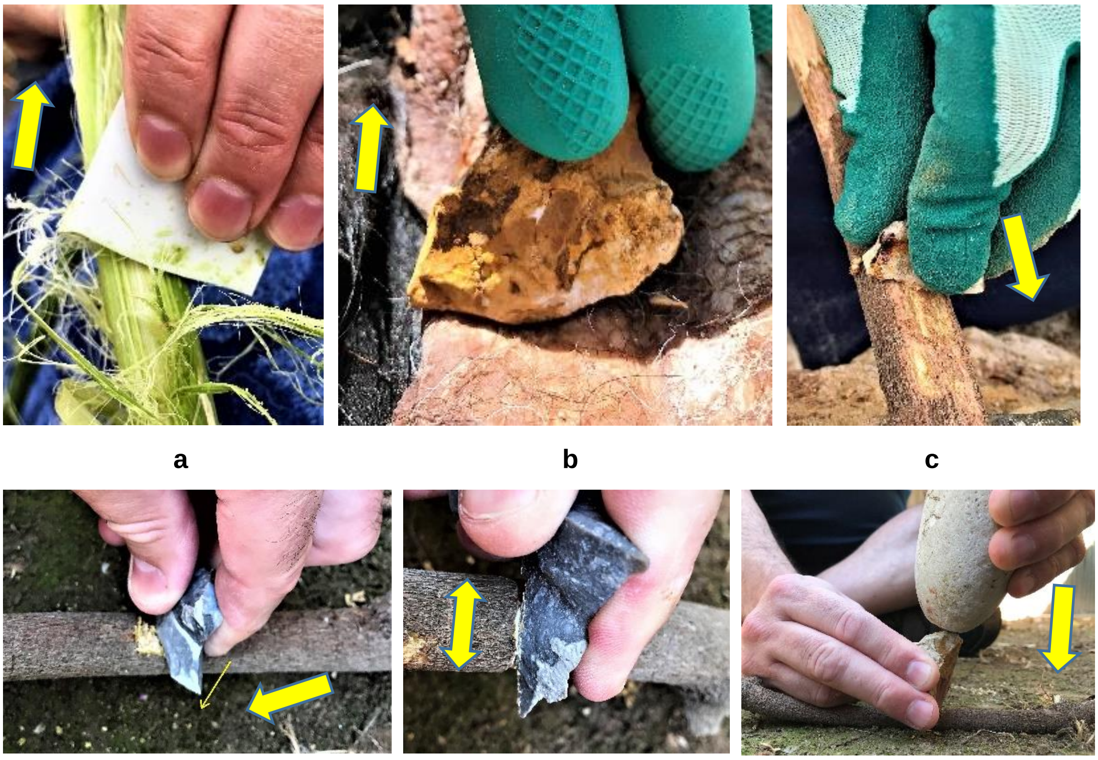
5.2.4.2 Tool-use Experiments: Guiding Principles

Experiments were guided by several principles. Tools were used by hand rather than in a haft because: (i) TOs were taught this method and indicated that their ancestors used hand-held tools (although they also later inferred that their ancestors may have used chert and/or glass spear tips/barbs; as discussed in later sections); and (ii) there was no microscopic evidence of hafting among the archaeological assemblage (were there such evidence, new experiments would have been conducted to investigate the effects of hafting). Because relatively little use-wear analysis has been undertaken for glass in Australia, and none on porcelain, three experiments were conducted using glass and porcelain tools for each different worked material, in contrast to one experiment on each occasion for the stone materials. During all preliminary attempts it became apparent that glass and porcelain tools were unsuitable for chopping, wedging, adzing and, to a lesser extent, planing. Massive edge blunting and damage formed quickly, making the tools simply ineffective for these tasks, even on thicker porcelain edges that offered more resistance to such breakage. Consequently, glass and porcelain were used only to scrape and saw. Sawing was also relatively ineffective with the rapidly blunted edges of porcelain, but nonetheless the sawing experiments were completed and use-wear documented.

Experiments were designed to approximate the conditions contemporary with Aboriginal tool-use at Calperum Station (as per Keeley 1980:6; Lerner 2007:55 and Lerner et al. 2007:715). Experiments were conducted on sandy substrates similar to the relevant archaeological layer and variations of up to several centimetres in the length of tool motions were considered acceptable. Such variations are expected for human hand motions over the course of completing tasks requiring several hundred strokes. Previous experiments, such as those by Fullagar (1986a:158–162), found that 300 strokes sufficed for reaching the final stage of polish development, and Walton (2019:914–921, 924, 927–928, 930, 933–934, 937) found that 5–15 minutes was often sufficient for distinctive use-wear to develop across his 300 or so experiments using obsidian tools. Each experiment in this project was conducted for 40 minutes, which typically resulted in well over 500 strokes (as, for example, in experiments by Rutkoski et al. [2020:40], during which 2000 strokes were completed within around 30 minutes), providing copious scope for use-wear to develop across all tool raw materials and worked materials.

No analysis of use-wear experiments could possibly control for all of the potential variables (e.g., Khreisheh et al. 2013:44–45; Marreiros et al. 2020:4), but some controls are usually applied more rigidly. For the few occasions where experiments were conducted with the assistance of a volunteer, I clearly specified, taught and monitored required tool motions for when I was not operating the tool personally. Particular emphasis was applied to the angles at which tools were held, in relation to the worked material, and according to the different modes of use (Figure 32). Scraping was conducted toward the tool-user’s body and contact with the worked material occurred only with that toward-the-body motion. Scraping tools were held at an angle of approximately 45º to the worked material, with contact limited to the leading edge of each tool. This scraping method differed from that used by Kamminga (1982:67), who also included planing and chiselling tools in his category of 'scrapers.' For Kamminga (1982:67), planing was conducted towards the body whereas for Keeley (1980:17–18) and in this research, planing involved contact with the worked material only while being pushed away from the body. There is little difference between scraping and planing because both entail very similar motions that are simply applied in different directions. However, in my experiments, planing tools were held at 20–40º to the worked material.

Edge angles at which tools were held and the amount of contact between the tool and worked material were also monitored carefully for the other tool motions (Figure 32). For sawing, tools were held at an approximate right-angle to the worked material, but with the entire longitudinal edge applied and both tool-faces constantly contacting the worked material once an initial groove had been created. Little difference existed between the tool motions of sawing and cutting. Sawing involved back and forth movements within the same groove, which was most suited to the working of wood, whereas cutting involved the creation and continued use of several grooves and the motion was predominantly towards the body after beginning at a distance away from it. It was important to distinguish between cutting and sawing because cutting was considerably more effective than sawing for tasks such as butchering. The indirect percussive process of wedging involved the tool edge being held at a range of angles between 45º and 90º to the worked material. Adzing was performed with the tool orientated approximately 60–80º to the worked material, contact occurring in short, sharp, frequent blows. For chopping, the angle was around 65–90º and the motion used was similar to that for adzing but with far heftier and fewer blows. Across all tool motions, edge angles involved a range rather than absolute precision so as to approximate tool-user hand movements.



a b c

d e f

*Figure 32 Tool motions used in the experiments (arrows indicate direction(s). **A–B**: scraping. **C**: planing. **D**: adzing. **E**: sawing. **F**: wedging.*

In addition to the angles at which edges were held, the edge angle of each tool was also recorded. This information can sometimes contribute to understandings about the resultant edge scarring. For example, after sawing with tools with acute edge angles, bending fractures are common (Kamminga 1982:47–49; or 'half-moon' breakages as referred to by Keeley 1980:25). Thin tools with acute edge angles are also more susceptible to edge fracturing, particularly on relatively brittle materials, such as glass (Gorman 2000:189). However, it appears that the influence that tool edge angle has on edge scarring should best be considered in broad terms only, because of its interplay with several other influential variables, such as the angle at which a tool was held, the nature of the worked material, force applied and tool use-duration.

Tool edge angle can be difficult to measure (Hurcombe 1992:7–8) but was recorded at points following the method established by Kamminga (1982:20) (Figure 33). For tools with flat surfaces (and not retouched), the measurement was taken at the intersection of the two parts of the working edge (Figure 33a), whereas for tools with curved surfaces, it was taken at approximately 2 mm back from the edge (Figure 33b). Each tool was placed on its side as per Figure 33, angles ruled using a pencil and ruler, as per the broken lines in Figure 33, and the measurement taken using a protractor.

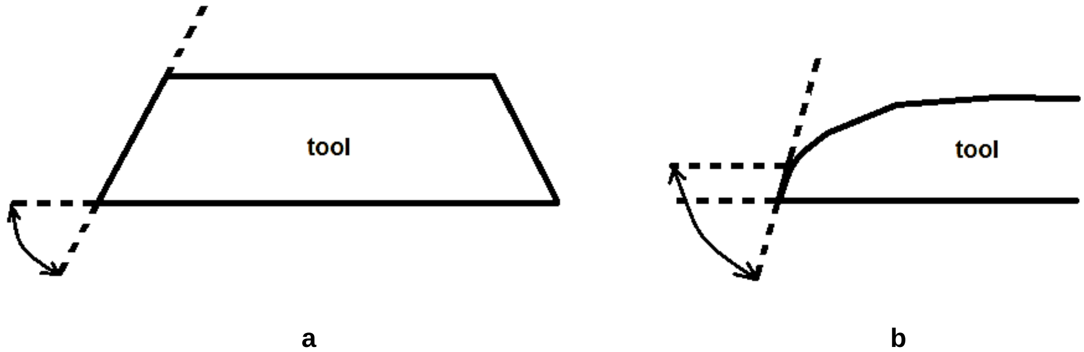


Figure 33 Measuring tool edge angle. ***A****: on a flat surface.* ***B****: on a curved surface. Adapted from Kamminga (1982:20).*

5.2.4.3 Tool-use Experiments: Procedures

In total, 106 tool-use experiments were undertaken (in addition to the two from the TO demonstration), comprising 19 on each of chert and silcrete and 34 on each of glass and porcelain. Immediately following the experiments, each tool was secured in an individual snap-lock plastic bag, with the completed recording form inserted in a separate outer plastic bag and bubble wrap applied to protect the tool edges. All experimental tools were analysed before the archaeological artefacts, using the same methods, as outlined below.

A comprehensive technological analysis was not undertaken in this thesis because, as discussed, Thredgold (2017), Thredgold et al. (2017) and Incerti (2018) recently investigated this aspect of the local stone technology, reaching consistent interpretations. Both of their assemblages were dominated by small (typically < 20 mm in length), unretouched flakes, and simple flaking strategies with some bipolar flaking predominated (Incerti 2018:115–116; Thredgold et al. 2017:114). They investigated different sites within the Station, not including the West Woolpoolool site or the Telegraph Insulator site. However, my informal observations of the technological characteristics of the artefacts from this thesis (described at the beginning of Chapter Eight) indicated that they are consistent with the technological and reduction characteristics identified by Thredgold (2017), Thredgold et al. (2017) and Incerti (2018).

5.3 Use-wear Analysis: Experimental and Archaeological Assemblages

5.3.1 Artefact Cleaning and Preparation

Although some previous researchers have argued that cleaning can damage the surface of an artefact, negatively impacting the ability to interpret use-wear and not always succeeding in removing all residues as desired (e.g., Gorman 2000:255), the overwhelming majority of use-wear practitioners advocate cleaning prior to use-wear analysis (Fuentes et al. 2021:3–4; Groman-Yaroslavski et al. 2021a:3; Groman-Yaroslavski et al. 2021b:2; Keeley 1980:10; Key 2013:36; Kimball et al. 1995:6–7, 10; Kimball et al. 2017:62; Kononenko et al. 2010:15; Lemorini et al. 2016:3; Lemorini et al. 2019:4734; Lerner et al. 2014:37; Linton et al. 2016:1039–1040; Luong et al. 2019:2; Macdonald 2018:840; Macdonald and Evans 2014:24–25; Masclans et al. 2021:5; Robertson and Attenbrow 2009:33; Rots and Williamson 2004:1288; Smallwood 2015:16; Solheim et al. 2018:561–562; Sorensen et al. 2018:13; Stemp 2004:43; Stemp and Harrison-Buck 2019:192; Stemp et al. 2013:30–31; 15; Rutkoski et al. 2020:40; Venditti et al. 2021:8–9; Walton 2019:913; Xhauflair et al. 2016:102; Zupancich et al. 2018:259).

The advantages of artefact cleaning prior to use-wear analysis outweigh any disadvantages. Cleaning removes obscuring sediments and non-use traces related to handling, such as grease, skin flakes and lipids, which are often so prevalent as to severely compromise the ability to perform accurate use-wear analysis (Keeley 1980:10; Robertson and Attenbrow 2009:33; Solheim et al. 2018:561–562; Stemp et al. 2013:30; Xhauflair et al. 2017:80). For example, Macdonald and Evans (2014:24–25) found that after cleaning an artefact with detergent, striations were visible that had not been seen following cleaning using only alcohol. If cleaning procedures use mild rather than harsh chemicals, most adhering substances can be removed without altering the roughness of the artefact's surface (MacDonald and Evans 2014), revealing its natural microtopography. Visibility is vital for assessments of polish (Macdonald 2018:846), and cleaning with weak acids, bases or solvents has minimal impact on polish (Lombard 2005:285; Walton 2019:913).

Powder-free, starch-free gloves were worn throughout artefact analysis and the cleaning measures consisted of:

1. Manual washing in warm water with a mild detergent;
2. Rinsing with tap water;
3. Immersion in weak (10%) hydrochloric acid (HCl) solution for 30 minutes;
4. Rinsing with tap water;
5. Rinsing with deionised water; and
6. Drying in a laboratory oven at 50º–60ºC

5.3.2 Microscopy

All experimental and archaeological artefacts were examined macroscopically and analysed for use-wear using an *Olympus BH-2®* metallographic microscope, with vertical incident lighting, brightfield/darkfield and long working distance objective lenses of x5, x10, x20 and x50. The long working distances of the objectives enabled a clearer view of the unevenness of an artefact's surface microtopography. The eye-piece lenses were x10 magnification so the nominal total magnification was obtained by multiplying a given objective lens magnification by 10. Low magnification (x50) observations were made using both the metallographic microscope and occasionally, particularly for stone specimens, a Dino-Lite microscope (*DinoCapture 2.0 Version 1.3.7.A®*) with external (oblique and vertical ring) illumination. Edge scarring, striations and edge rounding were clearly visible on glass specimens under the vertical incident light of the metallographic microscope. The same features were often visible under both microscopes for stone specimens, but edge scarring and furrow striations were more clearly observed when using the Dino-Lite with oblique lighting. The distinctive details of all forms of wear, including polish and smoothing, were then observed and analysed under higher magnification (mostly x200) using the metallographic microscope. Most micrographs were taken using a *DinoEye* camera attached to this microscope, and images (often up to approximately 80 per artefact) were Z-stacked using *Helicon Focus 7.6.4*® software. Some micrographs were taken with the Dino-Lite under higher magnifications (up to x250). (As specified earlier, it is stated in the caption on each occasion when micrographs were taken with the Dino-Lite; all other micrographs were taken using the metallographic microscope). The Dino-Lite and its software were also used for taking measurements of edge scar lengths and widths.

The use of LSCM is not a major focus of this thesis (due largely to expense), but once fine details of polish were observed under the metallographic microscope, polish depths on the artefact microtopography were quantified with a LSCM (*Olympus Lext 3D Measuring Laser Microscope OLS5000*®). A range of objective lenses was used, including x20, x50 and up to x100 with long working distance and a numerical aperture of 0.8. This was undertaken for six experimental tools (X09, X38, X49, X56, X80 and X86; please note that the 'X' here refers to part of the name given to each tool—not to the magnification) and nine archaeological tools (WLW01, WLW22, WLW27, WLW28, WLW29, WLW34, WLW36, WLW38 and TI07).

Relocating the polished areas under the LSCM was difficult and several methods were applied. For experimental tools, it was not necessary to avoid destructive methods, so permanent ink marks were applied at the limits of polished zones and the LSCM lenses were then easily able to be focused within these boundaries. For some of the archaeological tools, a given polished zone was large enough for the LSCM to be easily focused on a region entirely within the zone. In these cases, non-permanent ink marks were applied in the same manner as described above for the experimental tools, using a marker with a 0.4 mm nib. All non-permanent marks were subsequently removed with water and the tools re-cleaned. For tools where polished zones were too small for this method and for when comparison was sought between the polished and unpolished zones, annotated scale drawings were made after the polished zones had been identified under the metallographic microscope. These drawings included representations of the morphology of a specific polished zone, as well as measurements of its extent (width and length). When using the LSCM, an artefact 'map' was automatically created on the computer screen, indicating the exact point of the artefact on which the LSCM was focusing at any given time. Relocating the appropriate zone was undertaken with continued reference to the non-permanent ink marks, annotated drawings and known length and width of polished zones.

Surface roughness was measured on select tools using parameters common in engineering: 'Sa' (average roughness) and 'Sq' (root mean square roughness) (Suh et al. 2003:557, 561). Polished regions first identified under the metallographic microscope were marked on three-dimensional height maps using a *Microsoft Paint* drawing tool. Two-dimensional height maps were then used for selecting samples from polished and unpolished zones of the tool surface for which to obtain Sa and Sq values. Tilt corrections were applied each time, across the x and y axes. The higher the Sa and Sq values were, the rougher the surface.

Polish depths based on the LSCM were represented in the form of 3-D images based on the 3-D point data, obtained during laser scanning. Height profiles were indicated by visible peaks and valleys in the 3-D images and by a colour coding system where red represented the highest microtopographic points, followed in decreasing height order by yellow, green, blue and purple. Line profiles, displaying surface heights across selected parts of a tool's surface, were also used to provide another visual representation of polish microtopography.

5.3.3 Use-wear Analysis: Polish

The microscopic attributes recorded were chosen to provide information about tool motion, location of wear and the worked material. The following paragraphs describe the methods used in this thesis for recording polish, striations, edge scarring and edge rounding.

A broad range of polish attributes was recorded: brightness, microtopography, extension, texture, distribution (which included width), invasiveness and associations with other forms of use-wear (Table 11). Classifications within each category were defined according to systems adopted in several previous studies (Fullagar 1991:6; Gorman 2000:263–265; Hurcombe 1992:36–37; Kamminga 1982; Keeley 1980; Kirgesner et al. 2019:4–5; Kononenko 2011:19; Lemorini et al. 2014:14, 16–20; Walton 2019:901–910).

Table 11 Polish classifications used in this thesis (abbreviations in brackets).

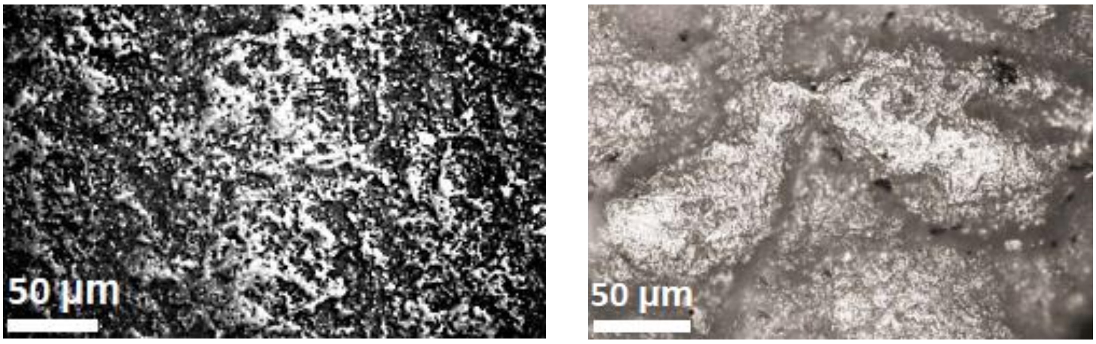
Aspect of Polish	**Classification**
Brightness	Dull (D); dull-moderate (DM); moderate (M); moderate-bright (MB); bright (B)
Texture	Smooth (S); rough (R)
Microtopography	High points only (H); low points only (L); high and low points (HL)
Extension	Unifacial (U); bifacial equal (B); more on one face than another (MO)
Distribution	Spots (Sp); thin line on edge (TLO); band on edge (BO); band away from edge (BA); streaks (St); spots and streaks (SS)
Invasiveness	Edge scars > polish; edge scars < polish; edge scars = polish; n/a (either there were no scars or the polish and scars were not in close physical association)
Association with other use-wear	None/with any combination of striations, edge scarring, edge rounding
Note: the abbreviations are used throughout tables in the Results (Chapters Six and Eight).	

Polish brightness was classified qualitatively. Comparisons were made with unpolished areas of the tool, variation of polish brightness on tools of the same raw materials among the experimental reference library created in this thesis, and with reference to a broad range of published images involving the same tool raw materials (Álvarez-Fernández et al. 2020:6–7; Conte and Romero 2008:255–259; De Stefanis and Beyries 2021:58–59, 63; Fuentes et al. 2019:8–10; Groman-Yaroslavski et al. 2021a:5–14; Hurcombe 1992:158–165, 167, 170–172, 181–187, 198–200, 212; Ibáñez et al. 2019:1189–1194, 1198, 1201–1202, 1205–1209; Kamminga 1982; Kimball et al. 2017:63–66, 68; Kirgesner et al. 2019:5–6; Kononenko 2011:158–244; Luong et al. 2019:11; Stemp and Awe 2014:239; Torrence et al. 2018:64–65; van Gijn 2010; Walton 2019; Zupancich et al. 2018:9–10).

Polish texture refers to the connectedness of the polish and its smoothness. Texture is correlated with brightness and development, in that as polish develops it typically becomes both brighter (also depending on differences in the worked material) and smoother (Gorman 2000:263).

The extension of polish refers to the extent to which polish is present on one or both faces of an artefact, and this was recorded based on microscopic observation. Polish extension complements striations to contribute to indications of tool motion (Gorman 2000:264). For example, certain motions, such as whittling/planing, are known to result in the formation of polish on primarily one tool-face (Solheim et al. 2018:565), while other motions, such as cutting/sawing, more readily result in polish on both faces (Kamminga 1982:65).

Polish microtopography was recorded according to the categories outlined in Table 11, with examples of classifications from the literature seen in Figure 34.



a b

Figure 34 Polish microtopographies. ***A****: on high points. Adapted from Solheim et al. (2018:567).* ***B****: on high and low points. Adapted from Li Liu et al. (2017:444).*

Polish distribution was recorded in terms of the spatial distribution of polish on the artefact’s surface in relation to the working edge. Along with polish width and invasiveness, distribution can help to indicate the nature of the worked material and may broadly reflect the length of time (‘use-duration’) for which a tool was used. Polish distribution was classified as either ‘lines,’ defined as ≤ 10 µm wide, ‘bands,’ defined as ≥ 11 µm wide, or as ‘spots and streaks’ (Gorman 2000:264). Typically, wider bands of polish indicate longer tool use-durations (Gorman 2000:264).

Polish invasiveness was measured according to whether polish extended inward from the tool working edge to a greater, equal or lesser extent than edge scarring. It could only be measured when polish and edge scars were in physical association. When measurable, invasiveness contributes to indications of the worked material, in that tasks involving harder materials typically result in larger edge scars that extend beyond the polish boundary (‘scars > polish’), whereas for tasks performed on softer materials the polish extends beyond the scars (‘scars < polish’), which tend to be smaller. For tasks involving materials of medium density, the extent of polish is normally similar to the width of the scars (‘scars = polish’) (Gorman 2000:264–265).

5.3.4 Use-wear Analysis: Striations

Several attributes of striations were recorded (Table 12). It was essential to know the locations of striations relative to the working edge(s) and any association of striations with other forms of use-wear because close associations strengthened the probability that the striations were use-related (González-Urquijo and Ibáñez-Estévez 2003:488; Lombard 2011:1920). In contrast, isolated striations are often associated with other, non-use-related causal agents, such as soil movement (Keeley 1980:34).

Table 12 Striation classifications used in this thesis (abbreviations in brackets).

Striation Attribute	**Classification**
Presence	Present/absent
Number	1–5; 6–10; 11–15; 16–20; 21–25; 26–30; 31+
Density	Presence within a concentrated region: low (L); medium (M); high (H)
Width	In μm at point of greatest width between lateral margins ('narrow' = ≤ 2 μm; 'wide' = > 2 μm)
Orientation to working edge	Most parallel (MPa); most perpendicular (MPe); most oblique (MO); parallel and oblique even (PaO); perpendicular and oblique even (PeO); random (R—no consistent pattern in orientation)
Distance from working edge	On (O); near (N); on and near (O & N); near and far (N & F); far (F)
Presence on artefact faces	One face; both faces
Association with other use-wear	None; or with any combination of polish, edge scarring, edge rounding
Note: the abbreviations are used throughout tables in the Results (Chapters Six and Eight).	

5.3.5 Use-wear Analysis: Edge Scarring

All edge scarring characteristics recorded are detailed in Table 13. Edge scar orientation was classified according to the orientation of the percussion axis of each scar relative to the tool's edge. Termination types on edge scars were examined because they can contribute to indicators of the nature of the worked material and the tool edge morphology. For example, step scars are common after the working of denser, harder materials and axial terminations often occur on thin working edges, as well as after the scraping of bone (regardless of edge thickness) (Kamminga 1982:48–49).

Table 13 Edge scarring classifications used in this thesis (abbreviations in brackets).

Scar Characteristic	**Classification**
Mean length on artefact (mm)	< 0.5; 0.5–1; 1–1.5; 1.5–2; > 2
Mean width on artefact (mm)	< 0.5; 0.5–1; 1–1.5; 1.5–2; > 2
Orientation to working edge	Most parallel (MPa); most perpendicular (MPe); most oblique (MO); parallel and oblique even (PaO); perpendicular and oblique even (PeO); random (R—no consistent pattern in orientation)
Proximity to working edge	On (O); near (N); on and near (O & N)
Density	Mostly isolated (MI); moderately clustered (MC); closely clustered (CC)
Termination	Mostly step (MS); mostly hinge (MH); mostly feather (MF); mostly axial (MA); step and hinge equal (SH); step and feather equal (SF); step and axial equal (SA); hinge & feather equal (HF); hinge & axial equal (HA); feather and axial equal (FA)
Association with other forms of use-wear	None; or with any combination of polish, striations, edge rounding
Note: the abbreviations are used throughout tables in the Results (Chapters Six and Eight).	

5.3.6 Use-wear Analysis: Edge Rounding

Edge rounding can be difficult to distinguish from natural deterioration caused by taphonomic factors, particularly given that it can manifest in zones as small as 0.2 mm from the edge (Kamminga 1982:17). Contextual considerations were therefore paramount and the primary consideration was whether there were associations with other forms of use-wear. Polish, in particular, is typically associated with edge rounding (Kononenko 2011:18; Richard Fullagar, pers. comm. 2019; Walton 2019:901–909). Comparisons were made between used edges thought to exhibit rounding and other edges on the same artefact; and interpretations were also informed by previous studies that demonstrated that the working of relatively softer materials, such as hide, consistently resulted in more edge rounding (Kimball et al. 2017:64, 66–67, 70; Lemorini et al. 2019:4740, 4745; Stevens et al. 2010:2675). The extent of edge rounding was recorded as low (L), moderate (M) or high (H).

5.3.7 Interpretation of Tool-Use and Levels of Confidence

Upon the completion of all macroscopic and microscopic analyses, each archaeological artefact was classified according to my interpretation of the certainty that it had been used. Following Fullagar and Jones (2004:86) and Luong et al. (2019:4–5), categories were: ‘definitely used, with convincing evidence for worked material,’ ‘definitely used but worked material uncertain,’ ‘probably used but worked material uncertain,’ ‘possibly used but worked material uncertain’ and ‘no use-wear evidence for use.’ No artefact was classified as ‘unused’ because experiments in this thesis and previous research demonstrate that not all utilised tools have use-wear (e.g., Keeley 1980:35, 43; Stemp and Awe 2014; Walton 2019:920–921, 925). The presence of multiple forms of use-wear on an artefact was a major consideration in my confidence that an artefact was used.

5.4 Chapter Summary

This chapter has described key methods and the general approach of applying use-wear analysis. Specific methods were described for particular processes, steps in the analysis and items of equipment: (i) fieldwork, including surveying and artefact selection; (ii) post-fieldwork artefact selection; (iii) artefact cleaning; (iv) microscopes; (v) procedures undertaken for the trampling experiment; (vi) the on-site glass scraping demonstration by TOs; (vii) oral history interviews; (viii) principles and procedures implemented during the tool-use experiments; and (ix) use-wear analysis of the experimental and archaeological specimens. The microscopy involved several types of microscope and the examination of the main forms of use-wear: polish and abrasive smoothing, striations, edge scarring and edge rounding. Finally, in this chapter, I outlined different levels of confidence for my interpretations of archaeological tool function. The highest level of confidence is reserved for artefacts that are shown to be definitely used, with convincing evidence of the worked material. I argued that the level of confidence for tool-use increases with the number of forms of use-wear present on an artefact.

Chapter Six: Results, Experimental Assemblage

Results from the use-wear analyses of the 40 flakes from the trampling experiment, 106 from the tool-use experiments and two used by TOs during their on-site demonstration are presented in this chapter. Excerpts from the living cultural memories of TOs and inferences that were recorded on site are included throughout the chapter where appropriate (the full transcript is in the Appendix). The underlying aim of the tool-use experiments was to examine the use-wear resulting from the working of different materials (wood, bone, meat, hide and plant) using a range of tool motions (e.g., scraping, sawing and planing) across the tool raw materials (chert, silcrete, glass and porcelain). Therefore, following some broad contextual data, results from the tool-use experiments are presented under the categories of worked material and tool motion for each raw material type. Tabular précis are provided at the end of the chapter for the experimental results, designed particularly for use as a reference in this and potential future studies for interpreting use-wear on archaeological tools.

6.1 Trampling Experiment

Of the 40 trampled flakes, some form of wear was present on 17 (Table 14).[3] Thirty-five flakes were pressed into the surface and partially covered (Figure 35), but recorded as zero cm beneath the surface given that they were not entirely buried. Five had become totally buried and were recovered from 1 cm below the surface. Nine flakes had been displaced horizontally in different directions, with five moving 1 cm and one each moving 2 cm, 4 cm, 5 cm and 8 cm. Breakage was restricted to ten flakes, including seven made from glass and one each from porcelain, chert and silcrete. Only five unbroken flakes rotated, all less than 45º. Rotations were unable to be measured for the broken

[3] It is acknowledged that fonts are particularly small in this and many of the following tables. Priority was given, in presenting the large array of information for each flake, to maintaining portrait format, as it is considered that this is an easier method for reference compared to constantly changing from portrait to landscape viewing.

flakes because they had shattered. Striations were present on eight flakes, mostly isolated, in low density, always wide with random orientations and located near and/or far from, but never on the flake edges. Predominantly isolated, randomly orientated and elongated edge scarring was present on each of the broken flakes (mean 1–1.5 mm in length and mean < 0.5 mm in width; the largest remaining part of each broken flake was examined), while scars with similar lengths (mean 0.5–1 mm) and widths (mean 0.5–1 mm) were present across nine other unbroken flakes. Neither edge rounding nor polish and smoothing were observed.

Table 14 Wear on flakes from the trampling experiment.

			Flake Movement			**Striations**						**Edge Scarring**						**ER***	**Polish and Smoothing**						
Flake number	**Raw material** (C, S, G, P; see notes)	**Breakage** (N, L, M., E; see notes)	**Horizontal** (cm)	**Vertical** (cm beneath surface)	**Rotation** (0 = no rotation; 1 = 1–45º)	**Number**	**Density**	**Flake faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Wear associations**
T1	C	M	0	1	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T2	C	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T3	C	N	4	0	1	1–5	L	2	W	R	N	0.5 – 1	0.5 – 1	MP	O & N	MI	SF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES
T4	C	N	2	0	0	n/a	n/a	n/a	n/a	n/a	n/a	0.5 – 1	0.5 – 1	MP	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
T5	C	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	1– 1.5	0.5 – 1	MO	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
T6	C	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T7	C	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T8	C	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T9	C	N	5	0	1	1–5	L	2	W	R	NF	0.5 – 1	0.5 – 1	R	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES
T10	C	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T11	S	N	0	1	1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T12	S	N	8	0	1	n/a	n/a	n/a	n/a	n/a	n/a	1– 1.5	1– 1.5	R	O & N	MC	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
T13	S	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T14	S	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T15	S	L	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	0.5 – 1	0.5 – 1	R	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
T16	S	N	1	0	0	n/a	n/a	n/a	n/a	n/a	n/a	0.5 – 1	0.5 – 1	MP	O & N	MC	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
T17	S	N	1	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T18	S	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

T19	S	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T20	S	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T21	G	M	1	0	0	1–5	L	2	W	R	NF	1–1.5	0.5 – 1	MP	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES
T22	G	M	1	0	0	n/a	n/a	n/a	n/a	n/a	n/a	1–1.5	0.5 – 1	MP	O & N	MI	SF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
T23	G	M	0	1	0	6–10	M	2	W	R	NF	1–1.5	0.5 – 1	R	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES
T24	G	M	0	1	0	1–5	L	2	W	R	NF	1–1.5	0.5 – 1	R	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES
T25	G	E	0	1	0	1–5	L	2	W	R	NF	1–1.5	0.5 – 1	R	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES
T26	G	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T27	G	E	0	0	0	1–5	L	2	W	R	NF	1–1.5	0.5 – 1	R	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES
T28	G	M	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	1–1.5	0.5 – 1	MP	O & N	MC	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
T29	G	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T30	G	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T31	P	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T32	P	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T33	P	M	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	1–1.5	0.5 – 1	R	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
T34	P	N	1	0	0	n/a	n/a	n/a	n/a	n/a	n/a	0.5 – 1	0.5 – 1	MP	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
T35	P	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T36	P	N	0	0	1	1–5	L	2	W	R	N	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. only
T37	P	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T38	P	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T39	P	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
T40	P	N	0	0	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Notes

* ER = Edge rounding
For raw material: C = chert; S = silcrete; G = glass; P = porcelain
For breakage: N = none; L = little; M = medium; E = extreme
For edge scarring orientation: MP = most perpendicular; MO = most oblique; R = random (no clear pattern)
For edge scarring density: MI = most isolated; MC = most clustered
For edge scarring terminations: SF = step and feather equal; MF = most feather
For wear associations: 'str.' = striations; 'ES' = edge scarring

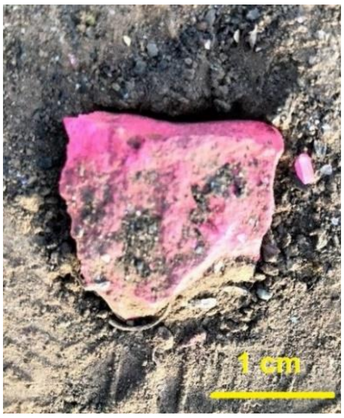


Figure 35 A chert flake in a depression caused by trampling during experimentation.

6.2 Tool-use Experiments

Use-wear on the experimental tools is summarised in Table 15. Of the 106 tools, polish was present on 90 (85%) and striations on 95 (89%). Edge scarring was observed on 90 (85%) tools and edge rounding on 61 (58%). On one tool there was edge scarring only, and on another, only edge rounding. However, the edge scarring on four tools was the result of accidental breakage prior to or during experimental working (records were made during experiments of tools unintentionally dropped). Two further tools each displayed a solitary scar and this isolation was interpreted as probably the result of accidental or other non-use-related damage not detected or recorded at the time of the experiments. Only two (approximately 2%) tools did not display any form of use-wear: one chert and one silcrete tool, each used to process meat.

Multiple (mostly three or all four) forms of use-wear were found on nearly all experimental tools. For example, three or four types of use-wear were present on 31 of 34 (91%) glass tools and 32 of 34 (94%) porcelain tools. The results also indicate that the 40 minute duration of each experiment was more than enough time for distinctive use-wear to form on chert, silcrete, glass and porcelain tools used to work any of the materials: dry and fresh wood, dry and fresh bone, fresh hide, *Typha* and meat.

Table 15 Combinations of use-wear present across experimental tool raw materials.

	Pol. only	**Str. only**	**ES only**	**ER only**	**Pol. & str.**	**Pol. & ES**	**Pol. & ER**	**Str. & ES**	**Str. & ER**	**ES & ER**	**Pol., str. & ES**	**Pol., str. & ER**	**Pol., ES & ER**	**Str., ES & ER**	**ALL forms**	**None**
Chert (n = 19)	0	0	1	0	0	1	1	3	1	0	0	1	1	1	8	1
Silcrete (n = 19)	0	0	0	0	3	0	1	0	1	0	3	2	0	0	7	1
Glass (n = 34)	0	0	0	0	1	0	0	2	0	0	16	0	1	0	14	0
Porcelain (n = 34)	0	0	0	1	1	0	0	0	0	0	10	1	0	1	20	0

Note: 'Pol.' = polish; 'Str.' = striations; 'ES' = edge scarring; 'ER' = edge rounding

Indigenous knowledge conveyed by TOs provided a holistic element to the tool-use experiments. TOs inferred, for example, that their antecedents used flaked chert as spear 'heads' (tips):

> **Simon Munt** (hereafter 'SM'): And do you know whether they (antecedents) preferred stone or glass for any particular different things?
>
> **Philip Johnson** (hereafter 'PJ'): Well it all depends, like I said, the chert stone that was the sharpest, compared to just normal stone you see laying around you know, and to me that was just like glass.
>
> **Timothy Johnson** (hereafter 'TJ'): They would have made the spear heads out of them so, yeah we run into a few of them over the border you know.
>
> **SM:** They made the spear heads out of chert?
>
> **TJ:** Out of chert.

The following paragraphs present the results from the use-wear analysis of the experimental tools according to raw material types. For ease of reference, a table is provided in the Appendix outlining tool numbers, raw materials and task details.

6.2.1 Experimental Chert Tools

6.2.1.2 Chert: Dry Wood (E. camaldulensis)

In the tool-use experiments, chert was used to scrape, saw, adze, plane, chop and wedge dry wood and the resultant use-wear is presented in Table 16. Striations were low in density in relation to the tool surface area following each tool motion, other than wedging, which resulted in medium density. In all cases the striations were wide (> 2 μm) and located on or near the working edge. The transverse tool motions of scraping, planing and adzing all produced mostly perpendicular striations, while the striations resulting from sawing were parallel. Edge scars were consistently small (< 0.5 mm) across tool motions, with orientations typically mirroring those of the striations. Like the distribution of striations, scarring occurred on or near the edge. Scars classified as 'near' the edge were always part of a cluster of other scars that were also on or near the edge, including for wedging because although scars caused by the use of this tool motion were categorised as ‘mostly isolated,’ occasional clusters were present on both the end struck with the hammerstone and the end contacting the worked material. Four of the six tool motions resulted in edge rounding (low or medium extents).

When polish was present after wood-working it was moderately bright, smooth and on the microtopographic high points of the tool surface (Figure 36). After scraping and planing, polish and smoothing were observed mainly on one tool-face, whereas after sawing they were present bifacially. Whenever polish was present it was distributed as a band on or virtually on the edge (Figure 36). After sawing, the polish was less invasive than edge scarring but after planing it was equally invasive. Invasiveness could not be recorded for the tool used to scrape because the scarring and polish did not occur in the same location. All forms of use-wear were present on tools used for scraping, sawing and planing, three forms were observed after chopping, and two forms after adzing and wedging.

Table 16 Use-wear on experimental chert tools used to work dry wood (E. camaldulensis) *with a variety of motions.*

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**							
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X21 HA: 45 TEA: 67	6–10	L	1	W	MPe	N	< 0.5	< 0.5	MPe	N	CC	MF	M	MB	S	H	MO	BO	n/a	all
Saw X18 HA: 80–90 TEA: 73	6–10	L	2	W	MPa	N	< 0.5	< 0.5	MPa	O	MC	MF	L	MB	S	H	B	BO	ES > pol.	all
Adze X22 HA: 60–80 TEA: 26	1–5	L	2	W	MPe	N	< 0.5	< 0.5	MPe	O	MI	MA	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES

Plane X16 HA: 20–40 TEA: 58	1–5	L	1	W	MO	O	< 0.5	< 0.5	MPe	O	CC	MF	M	MB	S	H	MO	BO	ES = pol	all
Chop X27 HA: 65–90 TEA: 50	1–5	L	1	W	MPe	N	< 0.5	< 0.5	MPe	O & N	CC	MS	L	n/a	n/a	n/a	n/a	n/a	n/a	str., ES, ER
Wedge X26 HA: 45–90 TEA: 78	11–15	M	2	W	MPe	O	< 0.5	< 0.5	MPe	O & N	MI	SH	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES

Notes

<u>These notes apply to this table and subsequent ones of the same format in this chapter and Chapter Eight.</u>

● Abbreviations are as follows: ‘Art. faces’ = artefact faces; ‘perp.’ = perpendicular; ‘par.’ = parallel; ‘str.’ = striation(s); ‘ER’ = edge rounding; HA = held angle (angle at which tool was held), in degrees; ‘TEA’ = tool edge angle, in degrees.

● Further abbreviations are used, as specified in the relevant tables in the Methods (Chapter Five):

- For **striation density**: L = low; M = medium; H = high
- For **striation width**: N = narrow; W = wide
- For **striation orientation** (in relation to working edge): MPa = most parallel; MPe = most perpendicular; MO = most oblique; PaO = parallel and oblique; PeO = perpendicular and oblique; R = random (no pattern of orientation)
- For **edge scarring orientation** (in relation to working edge): as above for striation orientation
- For **striation edge proximity** (i.e. in relation to working edge): O = on; O & N = on and near; N = near; N & F = near and far; F = far
- For **edge scarring proximity** (in relation to working edge): O = on; O & N = on and near; N = near
- For **edge scarring density**: MI = most isolated; MC = most clustered; CC = closely clustered
- For **edge scarring terminations**: MF = most feather; MS = most step; MH = most hinge; MA = most axial; SF = step and feather equal; SH = step and hinge equal; SA = step and axial equal; FH = feather and hinge equal; FA = feather and axial equal; HA = hinge and axial equal
- For **edge rounding extent**: L = low; M = medium; H = high
- For **polish brightness**: D = dull; DM = dull-moderate; M = moderate; MB = moderate-bright; B = bright
- For **polish texture**: S = smooth; R = rough
- For **polish microtopography**: H = high points only; L = low points only; HL = high and low points
- For **polish extension**: MO = more on one face than the other; B = bifacial equal; U = unifacial
- For **polish distribution**: Sp = spots; TLO = thin line on edge; BO = band on edge; BA = band away from edge; St = streaks; SS = spots and streaks

● Names of all tools from the tool-use experiments begin with ‘X’

● Where polish invasiveness is recorded as ‘n/a,’ this is because although polish and edge scarring may have both been present they did not occur at the same location so could not be compared

● Other ‘n/a’ classifications indicate absence of the relevant form of use-wear

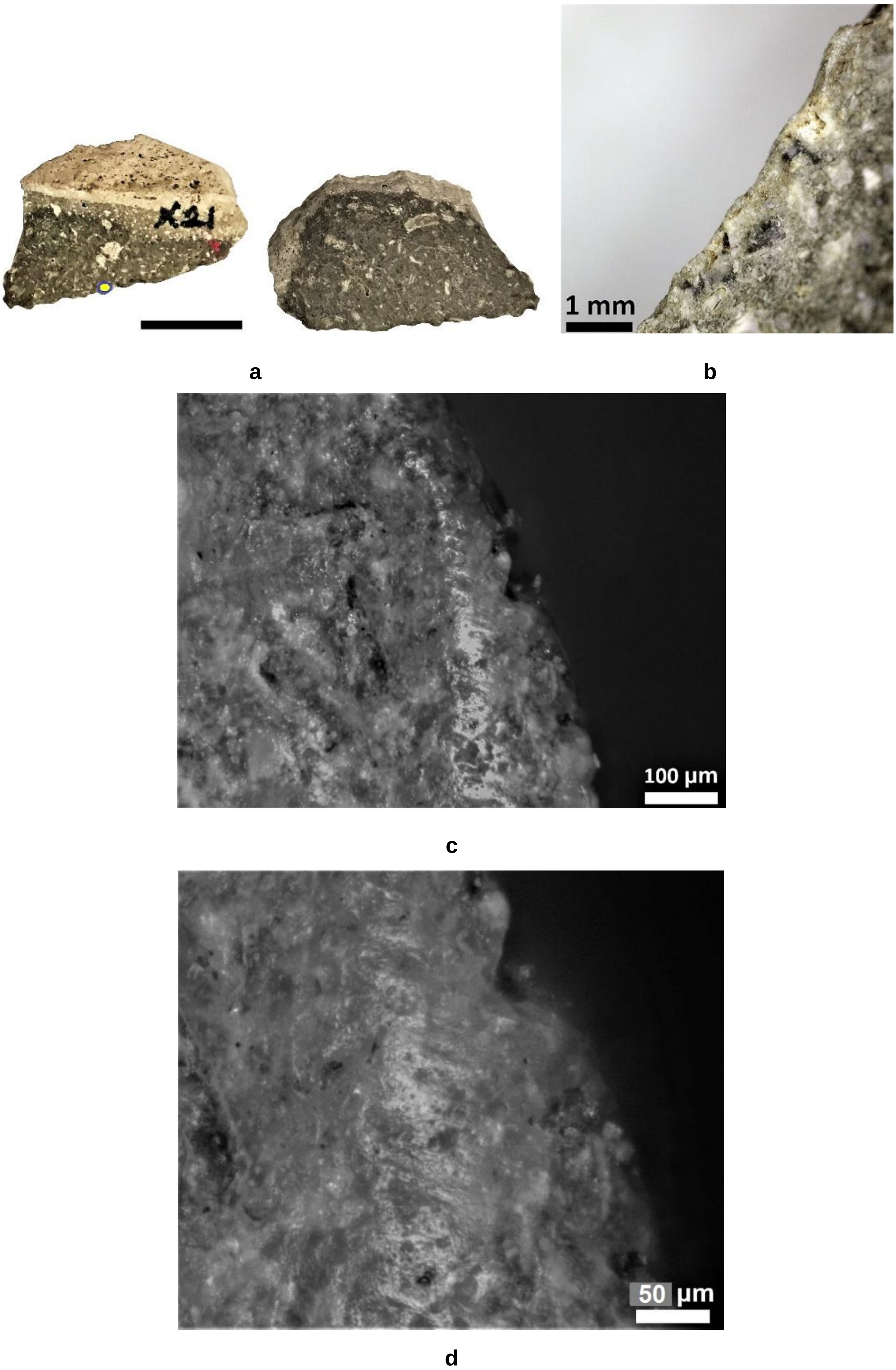


Figure 36 Experimental chert tool X21, which was used to scrape dry wood (E. camaldulensis). ***A****: macroscopic images of opposite surfaces (not 'ventral' or 'dorsal' because this was a shard rather than a knapped flake); the circle indicates the location of polish seen in 'c' and 'd.'* ***B****: a medium extent of edge rounding; Dino-Lite x50 magnification.* ***C****: polish; x100 magnification.* ***D****: the same polish; x200 magnification.*

6.2.1.3 Chert: Fresh Wood (E. camaldulensis)

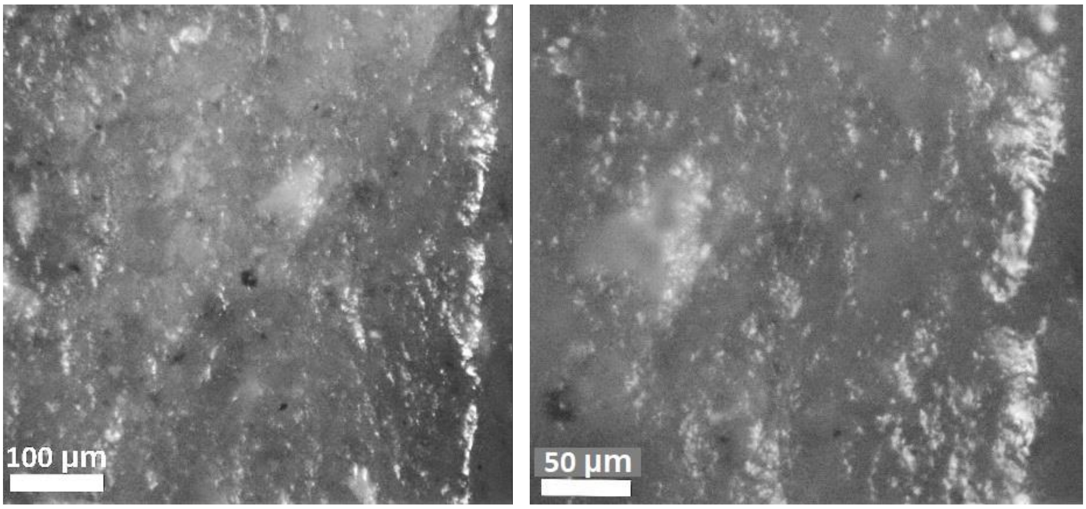
Multiple forms of wear were observed on all chert tools used to work fresh wood using the same tool motions as those applied to dry wood (Table 17). Striations were present in low densities after scraping, sawing, adzing and wedging. On each occasion they were wide, their orientations were consistent with the corresponding transverse or parallel tool motions and they were on or near the working edge. Edge scarring was present after all tool motions, small (< 0.5 mm) and also located on or near the working edge. Feather terminations predominated, with abrupt varieties also observed after sawing and wedging. Edge rounding, polish and smoothing were observed on four tools. The polish brightness was categorised as ‘moderate-bright’ except after adzing, where it was slightly duller (‘moderate’). Scraping, sawing and adzing resulted in smooth polish, whereas planing led to a rougher texture (Figure 37). Whenever polish was present it was on microtopographic high points and distributed as a band on the edge. Invasiveness could only be recorded on the tool used for planing, in which case the polish and edge scarring were equally invasive.

Table 17 Use-wear on experimental chert tools used to work fresh wood (E. camaldulensis) *with a variety of motions.*

	Striations						Edge Scarring						ER	Polish and Smoothing						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X29 HA: 45 TEA: 64	1–5	L	1	W	MPe	O	< 0.5	< 0.5	MPe	O	MC	MF	M	MB	S	H	MO	BO	n/a	all
Saw X42 HA: 80–90 TEA: 76	1–5	L	2	W	MPa	N	< 0.5	< 0.5	MPa	O & N	MC	HF	L	MB	S	H	B	BO	n/a	all
Adze X41 HA: 60–80 TEA: 35	1–5	L	2	W	MPe	N	< 0.5	< 0.5	MPe	O	MI	MF	M	M	S	H	U	BO	n/a	all

Plane X34 HA: 20–40 TEA: 77	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O & N	CC	MF	M	MB	R	H	U	B0	ES = pol	pol., ES, ER
Chop X39 HA: 65–90 TEA: 66	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O	MC	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
Wedge X33 HA: 45–90 TEA: 41	1–5	L	2	W	MPe	N	< 0.5	< 0.5	MPe	O	MC	MS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. & ES

a



b **c**

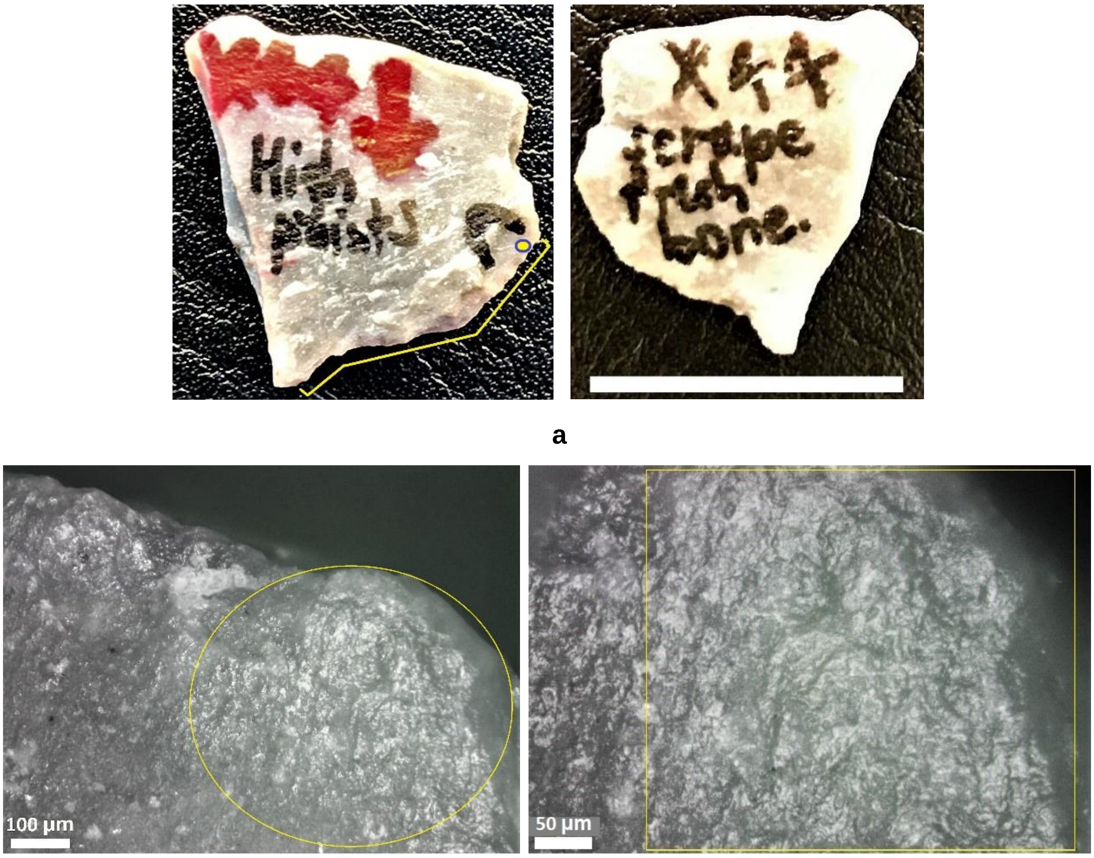
*Figure 37 Experimental chert tool X34, which was used to plane fresh wood (*E. camaldulensis*). **A**: macroscopic images; the circle indicates the location of polish seen in 'b' and 'c.' **B**: a slightly rougher polish than that on chert tools used to work wood with other motions; x100 magnification. **C**: the same polish; x200 magnification.*

6.2.1.4 Chert: Fresh Bone (Kangaroo)

All forms of wear were present on the chert tool used to scrape fresh bone and on the chert tool used to saw this material (Table 18). After both tool motions, striations were low in density in relation to the surface areas of the tools and almost all were narrow (< 2 μm) and near the working edge. Edge scarring occurred on what were thin working edges for both tools and the scars were near the edges when in clusters. Some axial-terminated scars were observed after scraping but after sawing they were slightly more frequent and the scars almost always had minute fractures within. Edge rounding, polish and smoothing were present on both tools. The polish (Figure 38) was moderate-bright and present on high microtopographic points, although its texture was rough, with regular pitting. Polish was distributed as a band on the edge (and at times virtually on it), and less invasive than edge scarring across both tool motions.

Table 18 Use-wear on experimental chert tools used to scrape and saw fresh bone (kangaroo).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X44 HA: 45 TEA: 48	1–5	L	1	N	MPe	N	0.5 – 1	0.5 – 1	MPe	O & N	MC	MS; some axial	H	MB	R	H	MO	BO	ES > pol.	all
Saw X10 HA: 80–90 TEA: 40	1–5	L	2	N	MO	N	0.5 – 1	0.5 – 1	MPe	O & N	MC	MS; some axial	M	MB	R	H	B	BO	ES > pol.	all



a

b c

*Figure 38 Experimental chert tool X44, which was used to scrape fresh bone (kangaroo). **A**: macroscopic images; brackets indicate the working edge, while the circle indicates the location of polish seen in 'b' and 'c;' scale bar = 1 cm. **B**: polish region circled; x100 magnification. **C**: the same polish, inside the rectangle; x200 magnification.*

6.2.1.5 Chert: Dry Bone (Kangaroo)

All forms of wear were present on chert after scraping and sawing dry bone (Table 19). Striations were narrow and on the sawing tool several were orientated parallel to the working edge, while others were oblique, in contrast to the almost exclusively oblique orientations on the tool used to saw fresh bone. Most edge scars after sawing displayed axial terminations and minute fractures within the scars (Figure 39). All scars, after both scraping and sawing, were relatively large (0.5–1 mm in length and width), extending further inwards from the working edge than the polish. Scraping produced use-wear primarily on one tool-face whereas sawing resulted in bifacial use-wear. The working edge again became rounded to a high extent, while polish (Figure 40) attributes matched those on the tools used for working fresh bone.

Table 19 Use-wear on experimental chert tools used to scrape and saw dry bone (kangaroo).

	Striations						Edge Scarring						ER	Polish and Smoothing						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X07 HA: 45 TEA: 31	1–5	L	1	W	MPe	N	0.5 – 1	0.5 – 1	MPe	O & N	MC	MS; some axial	H	MB	R	H	MO	BO	ES > pol.	all
Saw X04 HA: 80–90 TEA: 42	1–5	L	2	N	PaO	N	0.5 – 1	0.5 – 1	MPe	O & N	MC	MS; some axial	M	MB	R	H	B	BO	ES > pol.	all

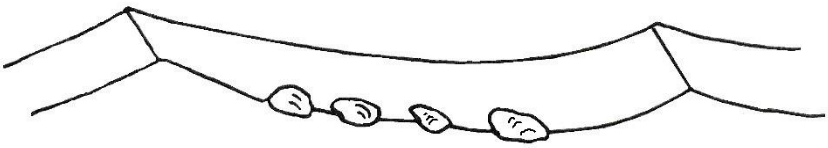
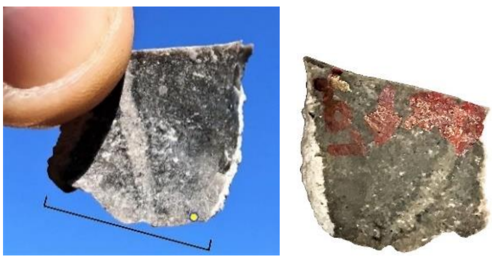


Figure 39 Illustration of minute scars within a bending-initiated scar resulting from the sawing of bone (Kamminga 1982:48; Fig.13).



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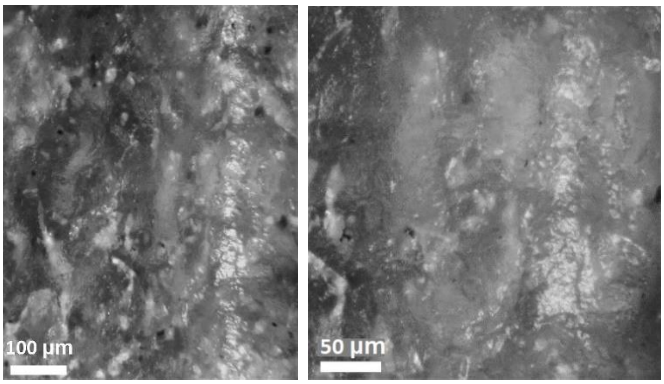


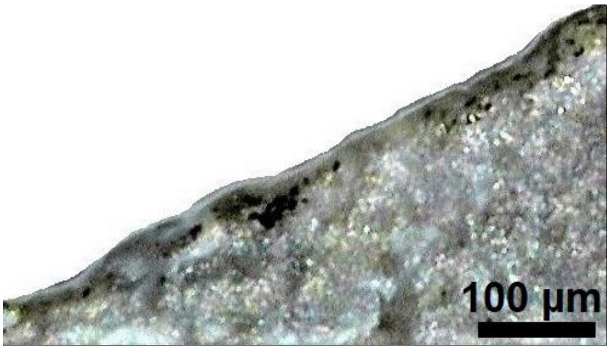
b **c**

*Figure 40 Experimental chert tool X07, which was used to scrape dry bone (kangaroo). **A**: macroscopic images; brackets indicate the working edge, while the circle denotes the location of polish seen in 'b' and 'c.' **B**: moderately bright, rough polish; x100 magnification. **C**: the same polish; x200 magnification.*

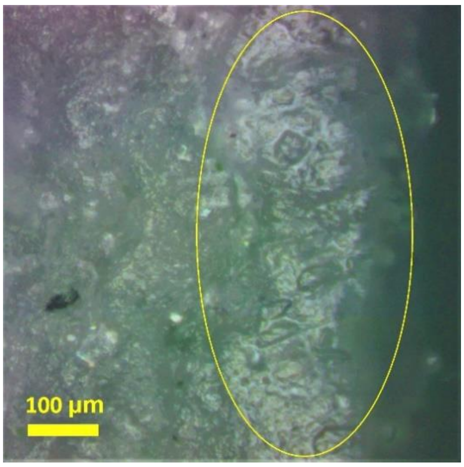
6.2.1.6 Chert: Fresh Hide (Cow)

Scraping fresh hide with chert did not result in any striations or edge scarring, but edge rounding, polish and smoothing were all present (Figure 41; Table 20). The edge became rounded to a high extent, while polish was dull-moderate in brightness, rough in texture, on high points and in valleys, unifacial and distributed as a band on the tool edge.

a



b



c

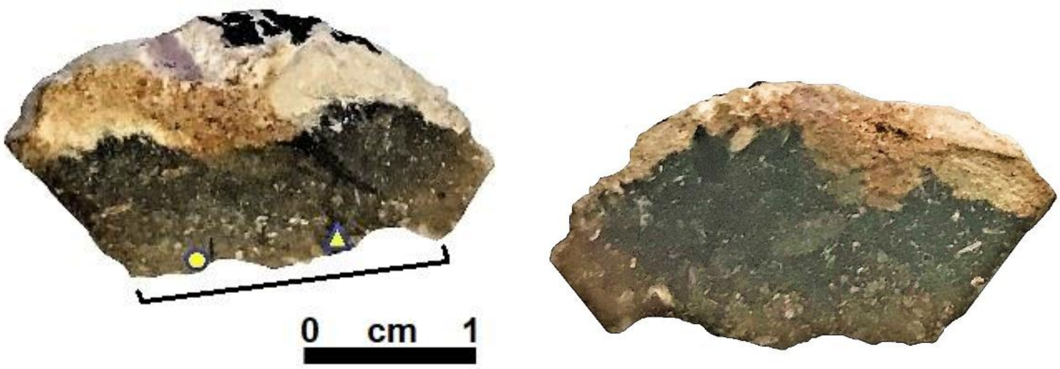
Figure 41 Experimental chert tool X89, which was used to scrape fresh hide (cow). ***A****: macroscopic images; brackets indicate the working edge, while the circle indicates the location of polish seen in 'c.'* ***B****: a high extent of edge rounding.* ***C****: polish on high and low points of the microtopography; x200 magnification.*

Table 20 Use-wear on the experimental chert tool used to scrape fresh hide (cow).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces**	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X89 HA: 45 TEA: 78	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	H	DM	R	HL	MO	BO	n/a	pol., ER

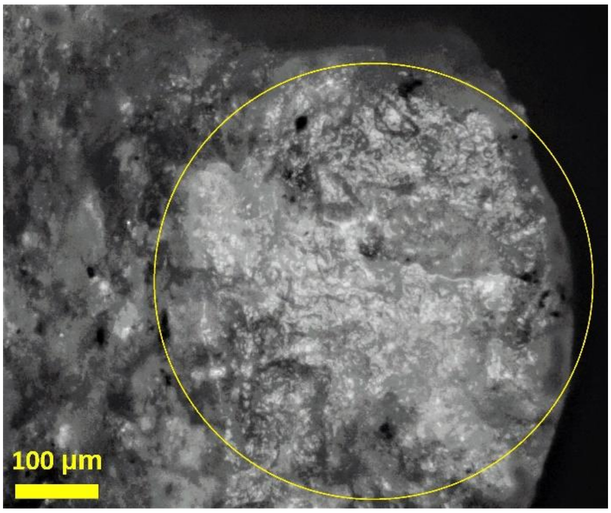
6.2.1.7 Chert: Plant (Typha)

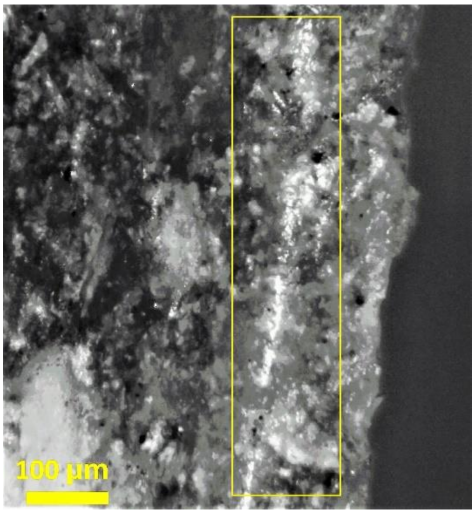
A low density of striations, along with a medium extent of edge rounding, was present after cutting and scraping *Typha* reeds with a chert tool (Table 21). The three striations (two on one tool-face and one on the other) were wide, randomly orientated and both near and far from the edge. No edge scarring was present but the polish was bright, smooth overall (although there were occasional rougher spots), on both faces, on peaks and in valleys of the microtopography and distributed as spots and streaks (Figure 42). [4]



a

[4] It is acknowledged that generally it is preferable to have all images that are parts of composite images included on the same page but priority was given during formatting here and elsewhere to maintaining sufficient image sizes and avoiding large gaps on pages.





b c

Figure 42 Experimental chert tool X45, which was used to cut and scrape plant material (Typha). ***A**: macroscopic images; brackets indicate the working edge, while the circle and triangle indicate the location of polish seen in 'b' and 'c' respectively.* ***B**: an isolated spot of bright polish; x200 magnification.* ***C**: a streak of bright polish a short distance from the tool edge; x100 magnification.*

Table 21 Use-wear on the experimental chert tool that was used to cut and scrape plant material (Typha).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces (1/2)**	**Width**	**Orientation**	**Edge proximity**	**Mean length (mm)**	**Mean width (mm)**	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Cut and Scrape X45 HA: 80–90 (cut) and 45 (scrape) TEA: 56	1–5	L	2	W	R	N & F	n/a	n/a	n/a	n/a	n/a	n/a	M	B	S	HL	B	SS	n/a	str., pol., ER

6.2.1.8 Chert: Meat (Lamb)

No use-wear of any kind was detected on the chert tool used to cut and scrape fresh meat (Table 22). The tool did not come into contact with bone or any hard substrate.

Table 22 Use-wear on the experimental chert tool that was used to cut and scrape fresh meat (lamb).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces**	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Cut and scrape X62 HA: 80–90 (cut) and 45 (scrape) TEA: 67	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

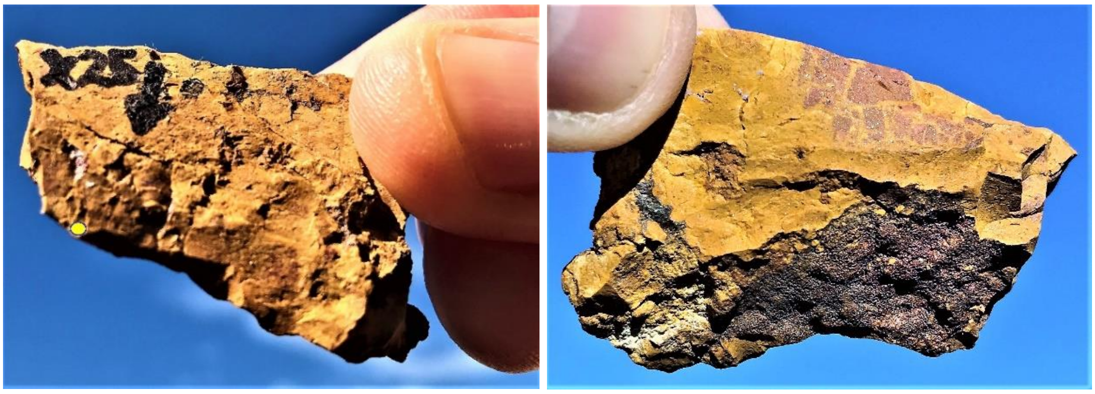
6.2.2 Experimental Silcrete Tools

6.2.2.1 Silcrete: Dry Wood (E. camaldulensis)

Three or four forms of use-wear were mostly present after using experimental silcrete tools to scrape, saw, adze, plane, chop and wedge dry wood (Table 23). More striations were present on silcrete tools than on chert tools after scraping, sawing, adzing and planing, but the characteristics of those that were present were essentially the same across the two raw materials. Transverse motions using silcrete tools also resulted in perpendicular and occasionally oblique striations, while parallel tool movements produced parallel striations. On the three silcrete tools with 11–15 striations, densities were classified as 'low,' in contrast to some other experimental tools with the same number of striations, that were categorised as 'medium.' These classification differences are because striation density was interpreted in relation to the overall surface area of each individual tool. In this case the silcrete tools with 11–15 striations had a notably larger surface area than the chert tools with 11–15 striations. Edge scarring on the silcrete tools was relatively small (< 0.5 mm) across most tool motions but slightly larger (0.5–1 mm) after wedging, and was mostly clustered whenever present. Polish and smoothing again were located on high points only and distributed as a band on the working edge for all motions other than wedging, in which case the polish and smoothing were more isolated than continuous (Figure 43). While observed on all six silcrete dry wood-working tools compared to three of the six chert tools used for the same tasks, the extent of polish and smoothing on the individual tools was similar across the silcrete and chert. Polish was less invasive than edge scarring on the silcrete.

Table 23 Use-wear on experimental silcrete tools used to work dry wood (E. camaldulensis) *with a variety of motions.*

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**							
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X68 HA: 45 TEA: 37	11–15	L	2	W	PeO	N & F	n/a	n/a	n/a	n/a	n/a	n/a	M	MB	R	H	MO	BO	n/a	pol., str.
Saw X23 HA:80–90 TEA: 65	11–15	L	1	W	MPa	N	< 0.5	< 0.5	MPa	O	MC	MS	n/a	MB	S	H	MO	BO	n/a	str., pol., ES
Adze X19 HA:60–80 TEA: 63	11–15	L	1	W	MPe	F	< 0.5	< 0.5	MPe	O	MC	MF	L	M	S	H	U	BO	ES > pol.	all
Plane X15 HA:20–40 TEA: 88	6–10	L	1	W	PeO	N	< 0.5	< 0.5	MPe	O	MC	MF	M	MB	S	H	MO	BO	n/a	all
Chop X24 HA:65–90 TEA: 80	1–5	L	2	W	MPe	N	< 0.5	< 0.5	MPe	O & N	MC	MS	n/a	M	S	H	B	BO	ES > pol.	str., pol., ES
Wedge X25 HA:45–90 TEA: 85	1–5	L	2	N	MPe	F	0.5 – 1	0.5 – 1	R	O & N	MC	R	M	MB	R	H	B	S	ES > pol.	all



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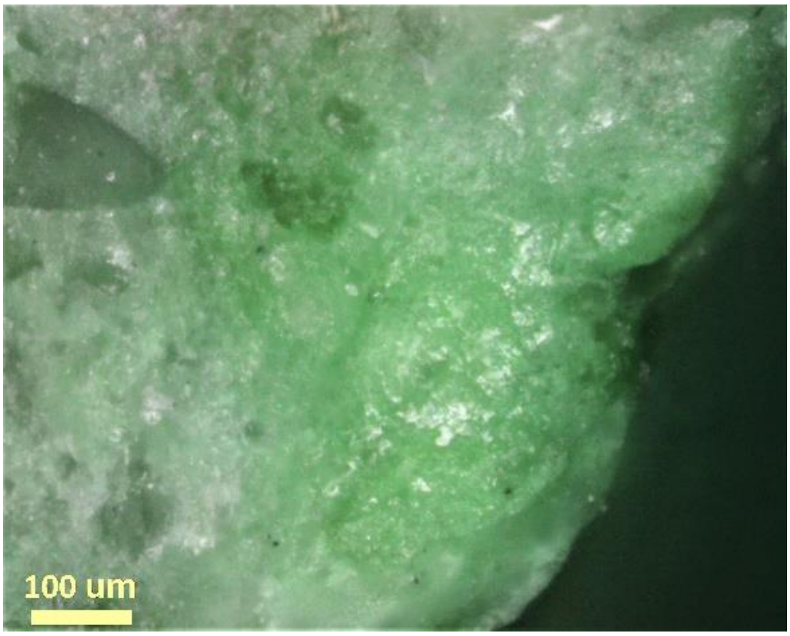


b

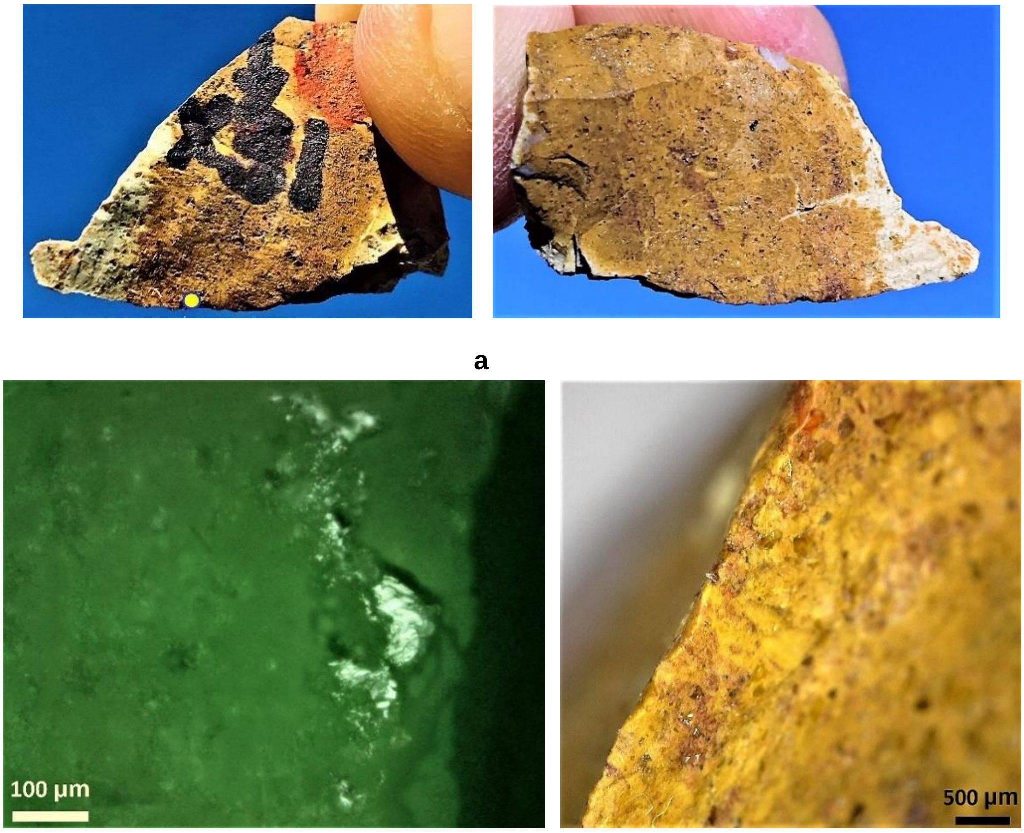
Figure 43 Experimental silcrete tool X25, which was used to wedge dry wood (E. camaldulensis). ***A****: macroscopic images; the circle indicates the location of polish seen in 'b.'* ***B****: isolated polish; x200 magnification.*

6.2.2.2 Silcrete: Fresh Wood (E. camaldulensis)

Multiple forms of use-wear were common after using six silcrete tools to work fresh wood (Table 24). Striations were observed on tools after each motion and all wide. Adzing fresh wood resulted in slightly fewer striations (n = 6–10) than on the tool used with the same motion on dry wood (n = 11–15). Edge scars were slightly longer on average after chopping fresh wood (0.5–1 mm compared to < 0.5 mm after chopping dry wood) and edges became rounded to a low extent after adzing fresh wood rather than the medium extent observed after the same tool motion was applied to dry wood. Polish and smoothing were observed on four tools (e.g., Figure 44), with none after chopping or wedging. However, most use-wear characteristics were similar after the working of both types of wood (fresh and dry) across the range of tool motions.

Table 24 Use-wear on experimental silcrete tools used to work fresh wood (E. camaldulensis) *with a variety of motions.*

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X31 HA: 45 TEA: 54	11–15	L	2	W	PeO	N & F	n/a	n/a	n/a	n/a	n/a	n/a	M	MB	R	H	MO	BO	n/a	pol., str.
Saw X43 HA: 80–90 TEA: 80	11–15	L	1	W	MPa	N	< 0.5	< 0.5	MPa	O	MC	MS	L	MB	S	H	MO	BO	n/a	str., pol., ES
Adze X36 HA: 60–80 TEA: 47	6–10	L	1	W	MPe	F	< 0.5	< 0.5	MPe	O	MC	MF	L	M	S	H	U	BO	ES > pol.	all
Plane X35 HA: 20–40 TEA: 76	6–10	L	1	W	PeO	N	< 0.5	< 0.5	MPe	O	MC	MF	L	MB	S	H	MO	BO	n/a	all
Chop X37 HA: 65–90 TEA: 71	1–5	L	2	W	MPe	N	0.5–1	< 0.5	MPe	O & N	MC	MS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
Wedge X40 HA: 45–90 TEA: 63	1–5	L	2	W	MPe	F	0.5–1	0.5–1	R	O & N	MC	R	M	n/a	n/a	n/a	n/a	n/a	n/a	str., ES, ER



a

b c

Figure 44 Experimental silcrete tool X31, which was used to scrape fresh wood (E. camaldulensis)*.* ***A****: macroscopic images; the circle indicates the location of polish seen in 'b.'* ***B****: striated polish; x500 magnification; most polish was distributed as a band on the edge but this is slightly away from it.* ***C****: a medium extent of edge rounding; Dino-Lite x65 magnification.*

6.2.2.3 Silcrete: Fresh Bone (Kangaroo)

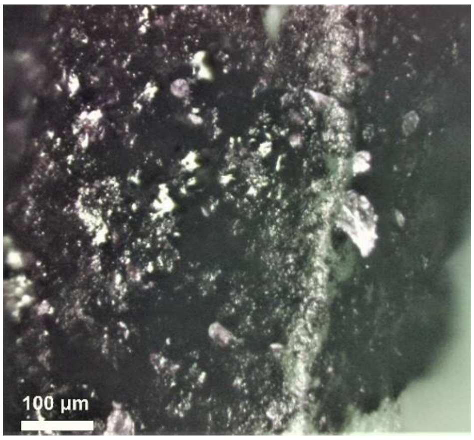
All four kinds of use-wear were present on silcrete tools after scraping and sawing fresh bone (Table 25). Striations were narrow and their densities low after both tool motions. Some striations ran perpendicular to the working edge after sawing, but the majority were oblique, whereas after scraping, most were perpendicular (Figure 45). Edge scars were slightly wider after sawing than after scraping and present on and near the working edge after both tool motions. The edge angle on the tool used for sawing was lower than that used for scraping, which may have contributed to the formation of axial terminations on the sawing tool. A medium extent of rounding was identified on the edge of each tool. Polish and smoothing were observed exclusively on the high points of the microtopography, as quantified with the use of the LSCM (Figure 45) (these and all 2-D and 3-D images of tool surface microtopographies in this thesis were produced using the data from the LSCM). The polish and smoothing on the scraping tool were distributed as a thin line on the tool edge, and on the sawing tool as a band away from the working edge—albeit with two minute discontinuities, each of around 10–20 µm (Figure 45). Sa and Sq values indicate that slightly rougher regions of the tool surface were polished but the difference compared to the smooth unpolished regions was minute (Figure 45).

Table 25 Use-wear on experimental silcrete tools used to scrape and saw fresh bone (kangaroo).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces (1/2)**	**Width**	**Orientation**	**Edge proximity**	**Mean length (mm)**	**Mean width (mm)**	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X08 HA: 45 TEA: 73	11–15	L	1	N	MPe	O & N	0.5 – 1	0.5 – 1	MPe	O & N	MC	MPe	M	MB	S	H	MO	BO	ES > pol.	all
Saw X56 HA: 80–90 TEA: 28	6–10	L	2	N	MO	N	< 0.5	0.5 – 1	MPe	O & N	MC	MA	M	MB	S	H	B	TLO	ES > pol.	all

a b

c



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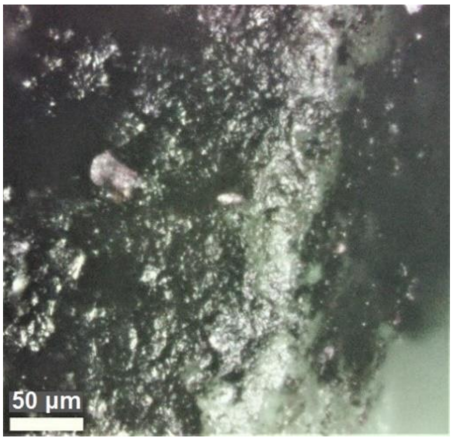

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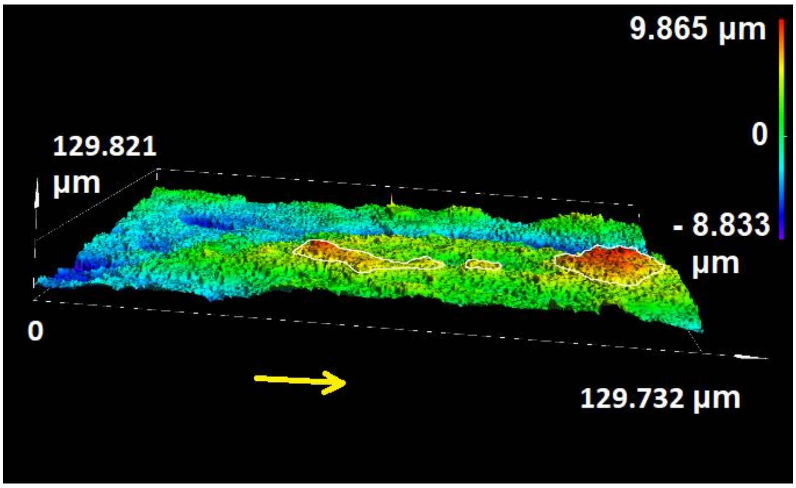

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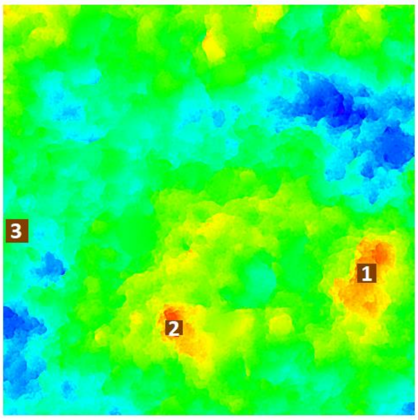


g

Sample	Polished or unpolished zone	Sq	Sa
1	Polished	0.319	0.247
2	Polished	0.290	0.232
3	Unpolished	0.434	0.357

h

*Figure 45 Experimental silcrete tools used to scrape (tool X08) and saw (tool X56) fresh bone (kangaroo). **A**: macroscopic images of X08; brackets indicate the working edge. **B**: a short, narrow striation. **C**: macroscopic image of X56; the distal edge is the working edge. **D**: moderately bright polish on only the high points of X56; x100 magnification. **E**: as for 'd' but x200 magnification. **F**: 3-D contour map of elevations on the surface of X56; polish is present only on peaks (red-yellow zones circled); the entire edge in the foreground is the (part of the) working edge and the arrow indicates the approximate direction of tool-use. **G**: 2-D height map showing locations sampled for surface roughness, on X56. **H**: key for 'g.'*

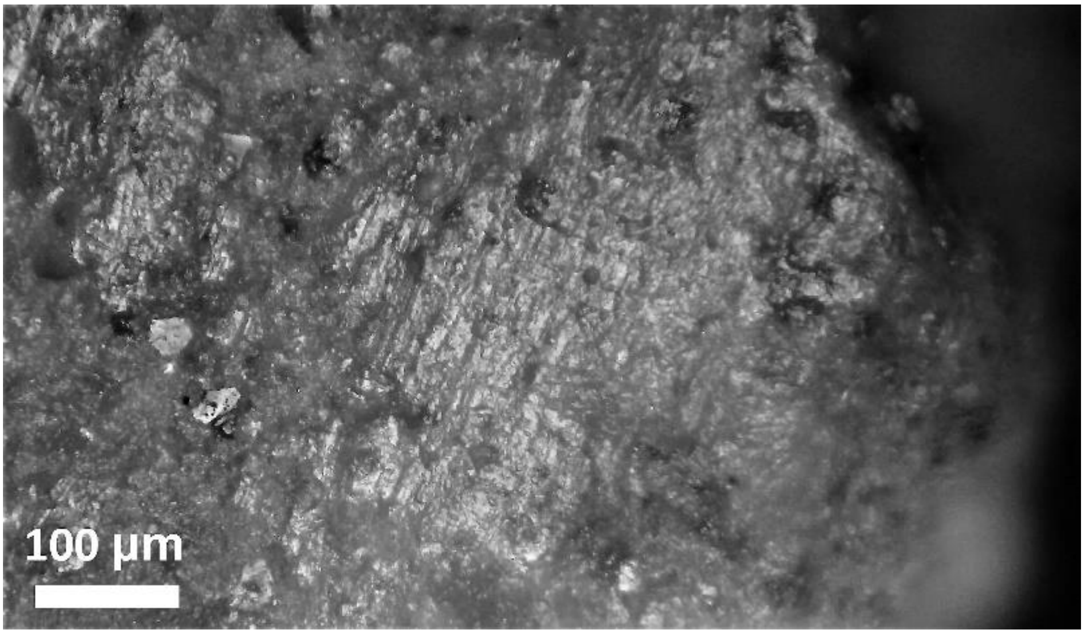
6.2.2.4 Silcrete: Dry Bone (Kangaroo)

Scraping and sawing dry bone with silcrete tools resulted in all four forms of use-wear (Table 26). A relatively low density of exclusively narrow striations was located on or near the working edge of each tool. Oblique striations predominated on the sawing tool, with the occasional perpendicular striations less frequent than on the tool used to saw fresh (as distinct from dry) bone. Axial terminations were created on most edge scars, which were typically relatively large and perpendicular to the working edge in plan view. Mostly, as was the case on experimental chert tools used to saw fresh bone, minute fractures were present within many edge scars. Edges were again rounded to a medium extent. Polish and smoothing were mostly smooth in texture, only present on the high microtopographic points, distributed as a band on the working edge (X03) or in isolated spots (X05; Figure 46), and less invasive than edge scarring.

Table 26 Use-wear on experimental silcrete tools used to scrape and saw dry bone (kangaroo).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X03 HA: 45 TEA: 23	11–15	L	1	N	MPe	O	0.5 – 1	0.5 – 1	MPe	O	MC	MA	M	MB	S	H	MO	BO	ES > pol.	all
Saw X05 HA: 80–90 TEA: 28	6–10	L	2	N	MPe	N	< 0.5	0.5 – 1	MPe	O & N	MC	MA	M	MB	S	H	B	Sp	ES > pol.	all

a



b

Figure 46 Experimental silcrete tool X05, which was used to saw dry bone (kangaroo). ***A****: macroscopic images; brackets indicate the working edge, while the circle indicates the location of polish seen in 'b.'* ***B****: striated polish; x200 magnification.*

6.2.2.5 Silcrete: Fresh Hide (Cow)

Striations, edge rounding, polish and smoothing were present on the silcrete tool used to scrape fresh hide (Table 27). Striations were predominantly parallel and all located within the polished zone. No edge scarring was observed, but a medium extent of edge rounding was apparent (Figure 47; Table 27). Polish (Figure 47; Table 27) was slightly duller than on edges of chert tools used for the same task (moderate compared to moderate-bright), rough in texture and unifacial. The polish and smoothing were distributed in patches on peaks and in valleys of the microtopography, including the small depressions left by the abrasive smoothing of higher microtopographic zones.

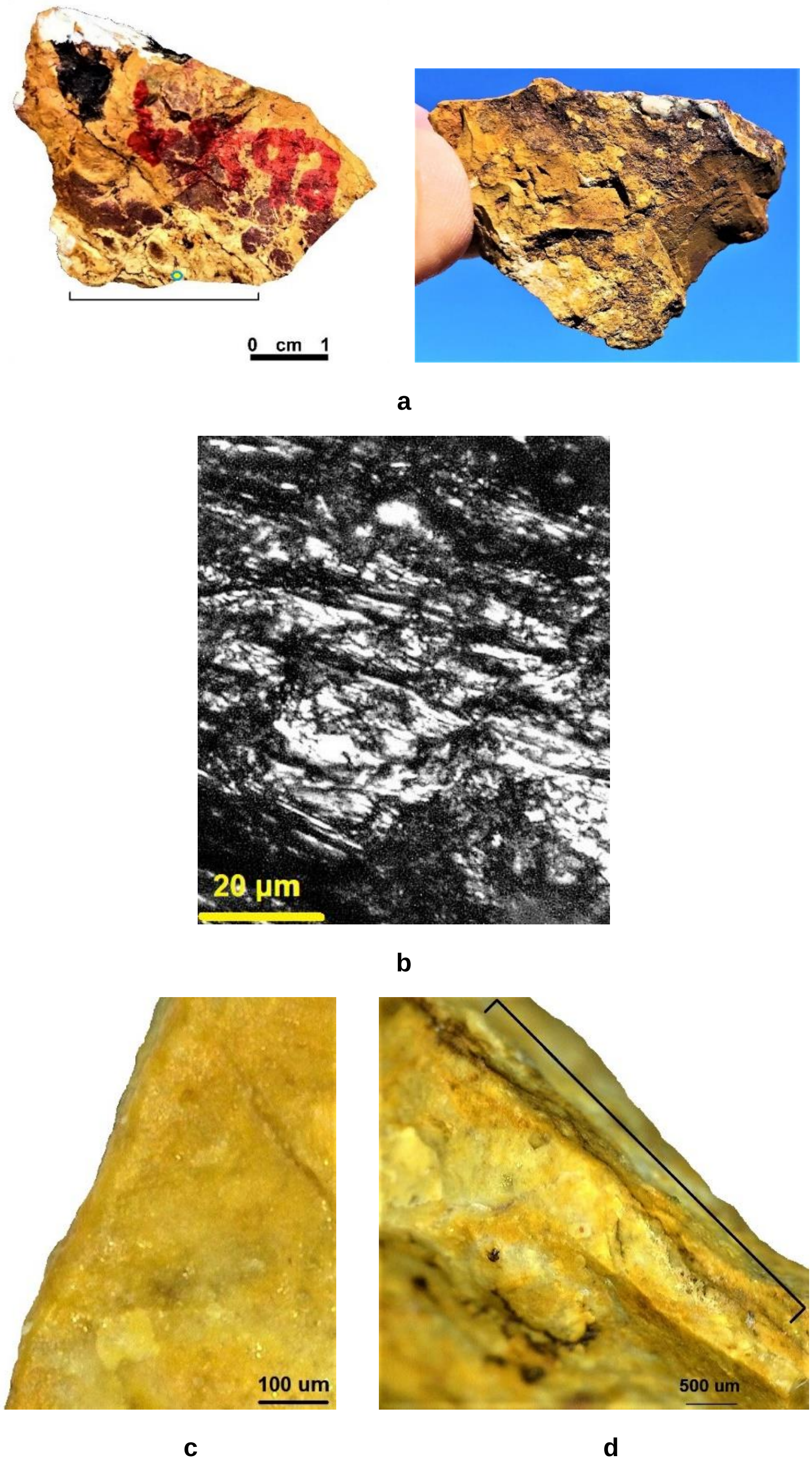


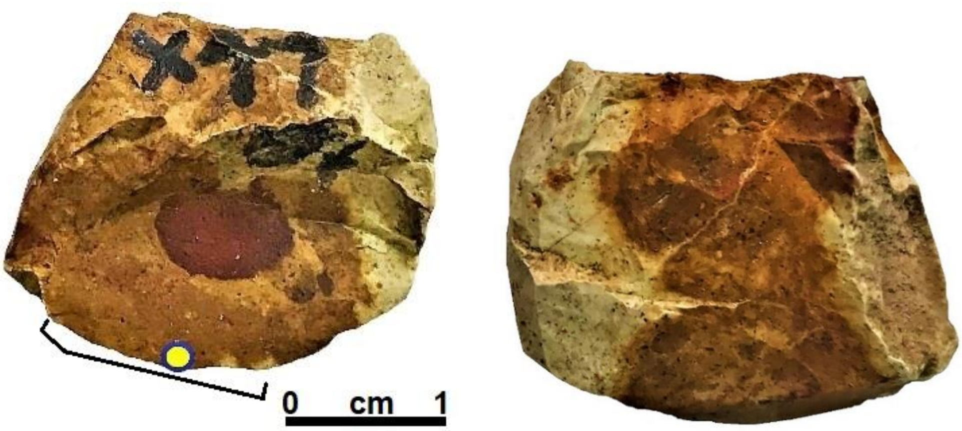
Figure 47 Experimental silcrete tool X93, which was used to scrape fresh hide (cow). ***A****: macroscopic images; brackets indicate the working edge, while the circle indicates the location of polish seen in 'b.'* ***B****: striated, rough polish; x200 magnification.* ***C****: a medium extent of edge rounding.* ***D****: end view of the rounded edge; Dino-Lite x50 magnification.*

Table 27 Use-wear on the experimental silcrete tool used to scrape fresh hide (cow).

	Striations						Edge Scarring						ER	Polish and Smoothing						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X93 HA: 45 TEA: 73	11–15	L	1	W	MPa	O & N	n/a	n/a	n/a	n/a	n/a	n/a	M	M	R	HL	U	Sp	n/a	str., pol., ER

6.2.2.6 Silcrete: Plant (Typha)

Cutting and scraping *Typha* with a silcrete tool led to all forms of use-wear other than edge scarring (Table 28). Striations were few (n = 5), low in density and wide. One striation was parallel to the working edge, two were perpendicular and two oblique. A medium extent of edge rounding was observed, as was a polish brighter than that on most tools used to work other materials across these experiments. The polish and smoothing were present in isolated spots on high and low points of the microtopography (Figure 48).



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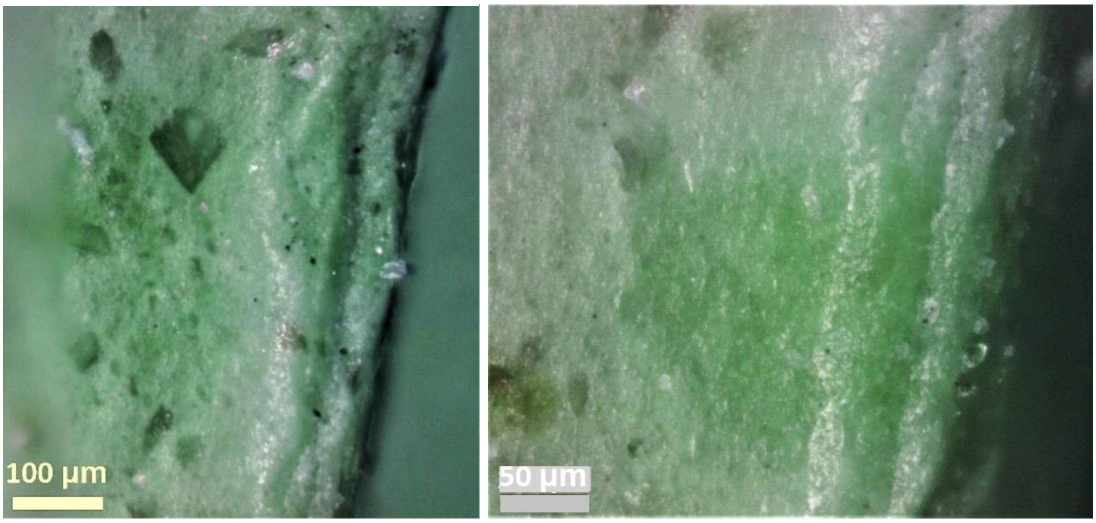


b c

Figure 48 Experimental silcrete tool X47, which was used to cut and scrape plant material (Typha)*. **A**: macroscopic images; brackets indicate the working edge, while the circle indicates the location of the polish seen in 'b' and 'c.' **B**: an isolated spot of polish; x100 magnification. **C**: the same polish; x200 magnification.*

Table 28 Use-wear on the experimental silcrete tool used to cut and scrape plant material (Typha).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Cut and scrape X47 HA: 80–90 (cut) and 45 (scrape) TEA: 46	1–5	L	2	W	R	N & F	n/a	n/a	n/a	n/a	n/a	n/a	M	B	S	HL	B	Sp	n/a	str., pol., ER

6.2.2.7 Silcrete: Meat (Lamb)

As was the case after using chert, no use-wear was detected on the silcrete tool after cutting and scraping meat (Table 29). The tool did not come into contact with bone or any hard substrate.

Table 29 Use-wear on the experimental silcrete tool used to cut and scrape fresh meat (lamb).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Cut and scrape X60 HA: 80–90 (cut) and 45 (scrape) TEA: 38	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

6.2.3 *Experimental Glass Tools*

6.2.3.1 Glass: Dry Wood (E. camaldulensis)

Results for the use-wear on glass and porcelain are derived from the working of three tools per tool motion for each worked material (rather than one tool each time for chert and silcrete). Scraping and sawing dry wood with glass always resulted in three or four forms of use-wear on the given tool (Table 30), and considerably more striations were present than on chert and silcrete tools used for the same tasks. However, as on the chert and silcrete, the striations on glass tools used to work dry wood were wide and directionally corresponded with the tool motion (Figure 49). Oblique striations were also common. Edge scarring was mostly small to medium in size (< 0.5 mm or 0.5–1 mm in length and width) and closely clustered. Feather terminations were present on edge scars for four of the six glass tools, while abrupt varieties were observed on three (one tool displayed both steps and feathers). Scars with oblique orientations were equally common after scraping and sawing. Polish was moderately bright, smooth in texture, on the high points of the microtopography and mostly distributed as a band on the edge. Of the three scraping tools, polish was more invasive than edge scarring on one, less invasive on another and equally invasive on the third. For the three sawing tools (one shown in Figure 49), polish was more invasive than edge scarring on one and less invasive on two.

Table 30 Use-wear on experimental glass tools used to scrape and saw dry wood (E. camaldulensis).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X65 HA: 45 TEA:44	21–25	H	1	W	PeO	O & N	0.5 – 1	0.5 – 1	MPe	O & N	CC	MF	n/a	MB	S	H	MO	BO	ES > pol.	str., pol., ES
Scrape X88 HA: 45 TEA:57	21–25	H	2	W	PeO	O & N	< 0.5	< 0.5	MO	O & N	CC	MF	n/a	MB	S	H	U	BO	ES < pol.	str., pol., ES
Scrape X13 HA: 45 TEA:81	6–10	L	1	W	PeO	O & N	< 0.5	< 0.5	MO	O & N	CC	SH	L	MB	S	H	U	BO	ES = pol.	all
Saw X70 HA: 80–90 TEA:86	6–10	M	2	W	PaO	N	< 0.5	< 0.5	MPa	O	CC	MF	n/a	MB	S	H	B	BO	ES > pol.	str., pol., ES
Saw X20 HA: 80–90 TEA:47	26–30	H	2	W	PaO	N & F	0.5 – 1	0.5 – 1	MO	O & N	MC	MS	n/a	M	S	H	B	BO	ES > pol.	str., pol., ES
Saw X61 HA: 80–90 TEA:71	26–30	H	2	W	PaO	N & F	< 0.5	< 0.5	MO	O & N	CC	SF	L	MB	S	H	MO	BA	ES < pol.	all

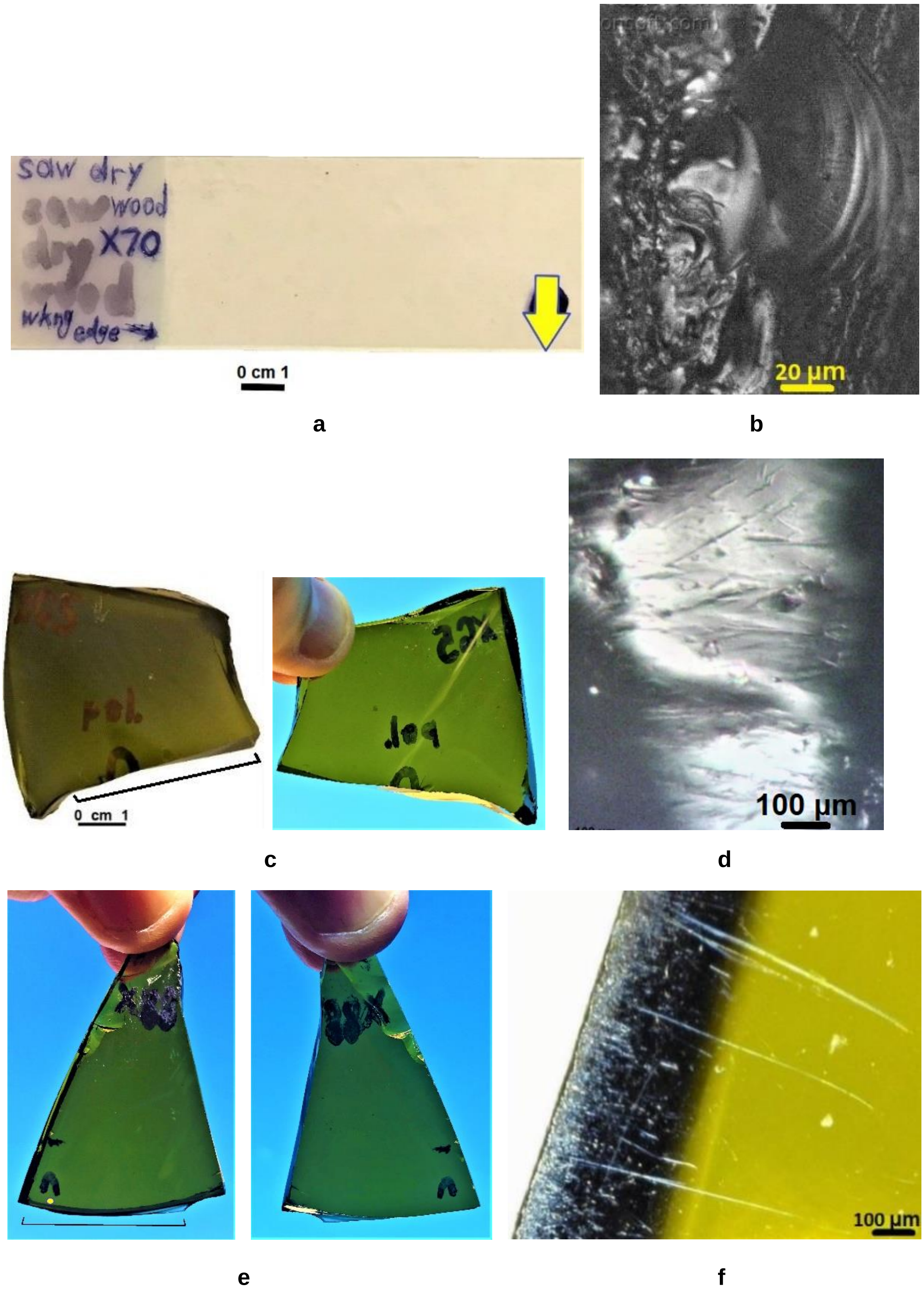


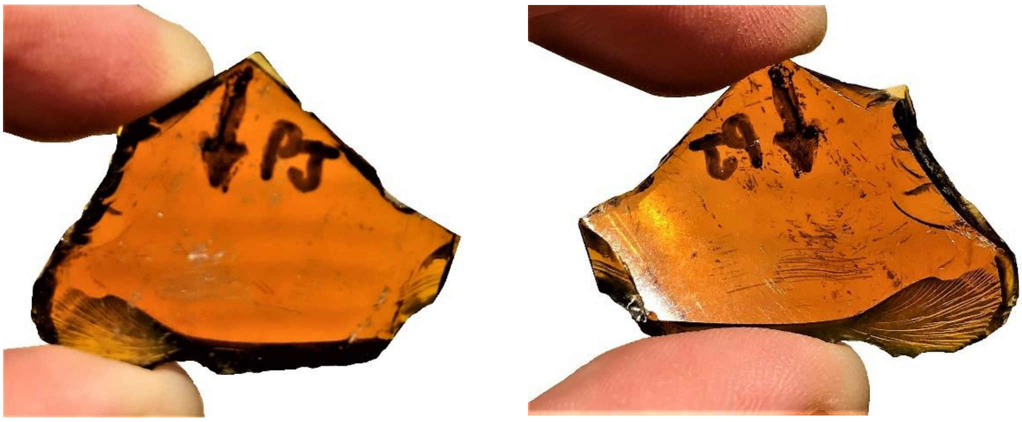
Figure 49 Experimental glass tools used to saw (tool X70) and scrape (tools X65 and X88) dry wood (E. camaldulensis)*. **A**: macroscopic image of tool X70; the yellow arrow indicates the location of polish seen in 'b.' **B**: polish that is less invasive than an edge scar on tool X70 (the working edge was to the left; fissures are also visible). **C:** macroscopic images of tool X65; brackets indicate the working edge, while black ink on the tool indicates the location of polish seen in 'd.' **D**: smooth, striated polish on tool X65; x500 magnification. **E**: macroscopic images of tool X88; brackets indicate the working edge. **F**: intense abrasion on and near the working edge of tool X88, as well as three perpendicular striations and several spots of woody residue (that were subsequently cleaned).*

6.2.3.2 Glass: Dry Wood Scraped by Traditional Owners for Demonstration

Glass shards used by TOs, PJ and TJ, to scrape dry wood on Country at Calperum Station, in order to smooth the wood, displayed some use-wear (Table 31). On the modern amber beer bottle shard used by PJ for two to three minutes, striations and edge scarring formed. Striations were orientated perpendicular to the working edge (Figure 50b) and although the orientations of most scars were also perpendicular, some were oblique (Figure 50c). The scars were small (< 0.5 mm) and closely clustered, with mostly feather terminations.

Table 31 Use-wear on glass tools used to 'finish' or smooth dry wood during demonstration on Country by TOs.

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then descript-tion; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Lightly scrape Philip Johnson; amber shard HA: c.45 TEA: 55	6–10	L	1	W	MPe	O & N	< 0.5	< 0.5	MPe	O & N	CC	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
Lightly scrape Timothy Johnson; clear shard HA: c.45 TEA: 71	6–10	L	1	W	MPe	O & N	< 0.5	< 0.5	MPe	O & N	CC	MF	M	MB	S	H	MO	BA	ES < pol.	all



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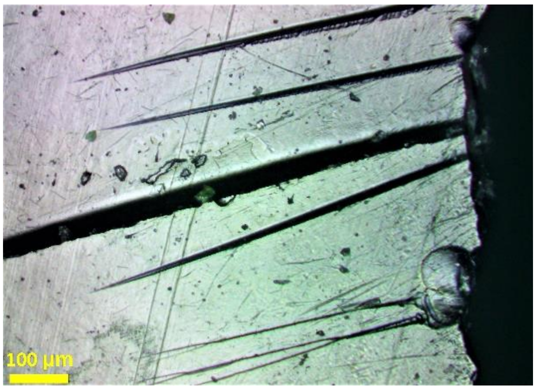
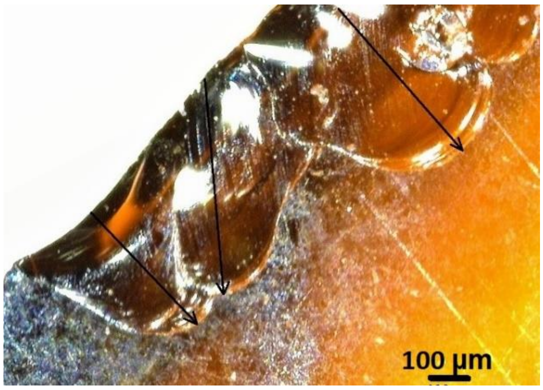
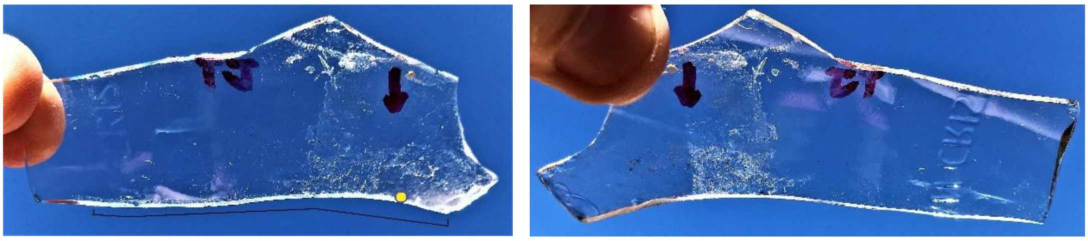




b **c**

Figure 50 Use-wear on amber glass tool used by TO, Philip Johnson, to smooth dry wood. ***A****: macroscopic images; the arrow on the tool indicates the working edge.* ***B****: perpendicular striations, as well as edge scarring and stress fracture lines.* ***C****: perpendicular and oblique edge scarring (left and right arrows show perpendicular scar axes while the middle arrow shows an oblique scar axis).*

On the clear shard from a modern spirits bottle used by TJ for five to six minutes, all forms of use-wear were present (Figure 51). Striations were wide and, like the edge scars, mostly orientated perpendicular to the working edge. The scars were small (< 0.5 mm), closely clustered and feather-terminated. The working edge became rounded to a medium extent and the polish was, among other characteristics, moderately bright and smooth.



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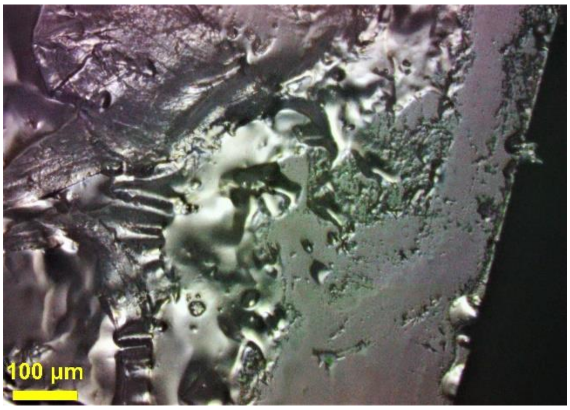

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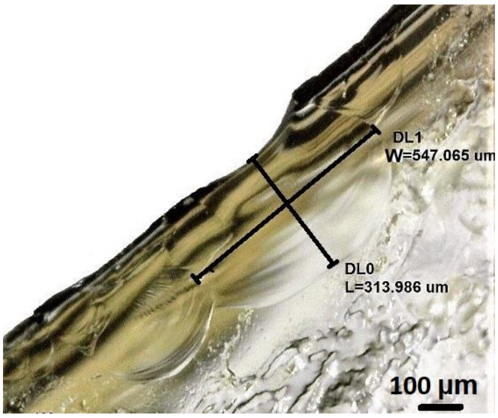

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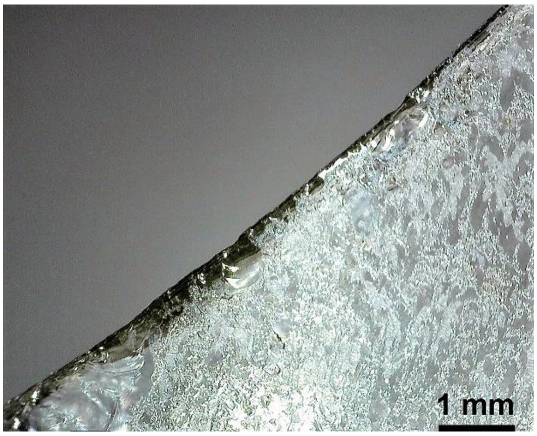


d

Figure 51 Use-wear on clear glass tool used by TO, Timothy Johnson, to smooth dry wood. ***A****: macroscopic images; brackets indicate the working edge, while the circle indicates the location of polish seen in 'b.'* ***B****: smooth, domed polish slightly away from the edge (some parts of the edge were also polished); x200 magnification.* ***C****: small edge scarring, with length and width measurements shown for one scar.* ***D****: a medium extent of edge rounding; Dino-Lite x50 magnification.*

During the oral history interview immediately prior to the demonstration, TJ and PJ alluded to having been taught by their antecedents to scrape dry wood:

SM: How did you learn to use the glass? Were you taught by your Elders?

TJ: Been taught by the Elders, ah.

PJ: Our grandfather.

TJ: This is who we got taught by, you know, they're the grandfathers but I got, I got taught from the wood carvers in the Riverland, old John Lindsay, Colin Cook, Teddy Roberts, or Ted Roberts, so that was my growing up with the artefacts.

However, it must be noted that the tool motion of scraping was applied by TJ and PJ in a different manner to that used in my tool-use experiments. TJ and PJ used the glass as a finishing tool, to smooth the wood and remove splinters and the like, rather than to assist in the shaping of the product, whereas scraping during the tool-use experiments aimed to contribute to the shaping of each given worked material (tool-use experiments were necessarily conducted prior to the demonstration by TJ and PJ). TJ and PJ made lighter contact with the glass on the wood, so use-wear may not have formed in the same manner or quantity. While TJ used his tool for five to six minutes and PJ for two minutes, their aim was to demonstrate the nature of glass use rather than to reflect the length of time that their tasks typically took. They explained that use-durations varied according to the sizes and roughness of the wooden artefacts. Some wooden walking sticks of the kind they typically pre-carved with other tools then smoothed with glass are of the same nature as the walking stick made in the Riverland seen in Figure 52 (which, based on the accession register, is probably the item purchased by the South Australian Museum [SAM] in 1987 from community member, the late John Lindsay). Other wooden items also currently held in the SAM from Calperum Station and adjacent Riverland regions include spears, shields and boomerangs.

TJ and PJ learned this finishing technique from their Elders:

SM: So, do you have any particular memories at all about how your Elders might have told about how they used to use it, use glass?

TJ: Nah it was always there when they showed us, you know, they used their thing just to finish it off, shine it up, that's about it, smooth it off.

SM: Do you remember seeing them doing that?

TJ: Yeah.

SM: Growing up, watching them doing that?

TJ: Yeah, what I say we learnt from them, we did the same.

TJ: Well we still use it (glass) on our carvings, just to get that smoothness, you know…yeah, we use that glass you know, 'til after we finish, to just shine it up or smooth it off, you know.

Figure 52 TO, Julie Cook, with a contemporary, carved wooden walking stick from the Riverland, at the SAM, 28 June 2018.

Drawing on stories orally passed down from previous generations, TJ speculated about the antiquity of the practice of smoothing wood with glass:

SM: Do you know roughly when your ancestors might have first started to use glass?

TJ: When the Europeans come I think. When the Europeans brought them in, there's old medicine bottles and, well any kind of bottles, you see old whisky bottles, anything out there.

The thickness of shards was a key criterion for tool selection by TJ and PJ. Their shards in the demonstration were quite thick (0.5–1 cm):

SM: And you were saying about when you get the glass from the old bit of bottle lying around. Did you prefer bits from any particular part of the bottle? Like you were saying, Philip, it has to be thick?

PJ: Yep, the thick part of the bottle they, they use.

SM: Right, and just the thick part, or?

PJ: Yep.

TJ: Bottom, sometimes the sides (of the bottle) but they, they blunt quicker, when you, when you do it, they, they like a file, they just go you know, in.

PJ: Some old bottles was thick on the walls going up, not like bottles these days, I wouldn't use these bottles these days.

SM: Too thin?

PJ: Too thin.

Cultural inferences by TJ and PJ suggest that their antecedents around Calperum Station worked glass and stone together in the same places and that they may have used the same pieces of glass (if not also stone) on multiple occasions:

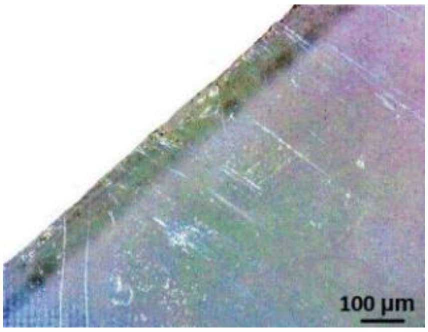
> **SM:** Do you know roughly where they might have done it on-site, like a camping site or something like that?
>
> **TJ:** Well when you look at the areas you see where they were sitting down. You see all the chert there, this is where it might be a good place to have a look, you might see glasses there as well.
>
> **SM:** Yeah, so they_
>
> **TJ:** 'Cos that's to say where they're chipping away, they could be making, making all their, ah, artefacts.
>
> **SM:** So when your ancestors had finished with the glass, would they do anything in particular with it or just_
>
> **PJ:** They'd probably store it, and save it for the next time they wanted to use it. Yeah.
>
> **TJ:** They wouldn't have been carried around with them, they would just use something else, or, shells from middens.

6.2.3.3 Glass: Fresh Wood (E. camaldulensis)

Scraping and sawing fresh wood with glass consistently produced many striations, albeit slightly fewer and in lower density than after the same tasks on dry wood (Table 32; Figure 53). All striations were again wide and their orientations corresponded with tool motions: parallel after sawing and perpendicular after scraping. Oblique striations were also common after both motions. Edge scars were again typically either < 0.5 mm or 0.5–1 mm in length and width, closely clustered and present on and near the working edges. The edges of two tools became rounded to a low extent. Polish and smoothing characteristics were the same as those on glass used to scrape and saw dry wood, aside from the rough rather than smooth textures on two tools (once each for sawing and scraping) and the distribution as a band away from, rather than on, the edge for two scraping tools. The LSCM quantification demonstrated that polish and smoothing developed exclusively on some microtopographic high points (Figure 53). Surface roughness values (Figure 53) show that some rougher areas of the tool surface were polished while others were not and the same applied for smoother areas. Differences are probably due to the aforementioned stages of polish development that occur on glass (Fullagar 1991), with some regions more developed than others, and possibly because different parts of the tool were used with varied intensity. Three or four forms of use-wear were present on all tools, as was the case on glass after working dry wood.

Table 32 Use-wear on experimental glass tools used to scrape and saw fresh wood (E. camaldulensis).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X30 HA: 45 TEA:88	11–15	M	1	W	PeO	O & N	0.5 – 1	0.5 – 1	MPe	O & N	CC	MF	n/a	MB	S	H	MO	BO	ES > pol.	str., pol., ES
Scrape X73 HA: 45 TEA:86	16–20	H	2	W	PeO	O & N	< 0.5	< 0.5	MO	O & N	CC	MF	n/a	MB	R	H	U	B	ES < pol.	str., pol., ES
Scrape X78 HA: 45 TEA:81	6–10	L	1	W	PeO	O & N	< 0.5	< 0.5	MO	O & N	CC	SH	L	MB	S	H	U	B	ES = pol.	all
Saw X32 HA: 80–90 TEA:78	6–10	M	2	W	PaO	N	< 0.5	< 0.5	MPa	O	CC	MF	n/a	MB	R	H	B	BO	ES > pol.	str., pol., ES
Saw X28 HA: 80–90 TEA:88	21–25	H	2	W	PaO	N & F	< 0.5	< 0.5	MO	O & N	CC	MS	n/a	M	S	H	B	BO	ES > pol.	str., pol., ES
Saw X38 HA: 80–90 TEA:51	21–15	H	2	W	PaO	N & F	0.5 – 1	0.5 – 1	MO	O & N	CC	MF	L	MB	S	H	MO	BA	ES < pol.	all



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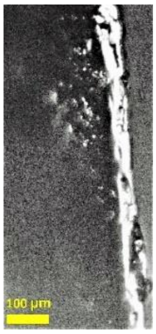

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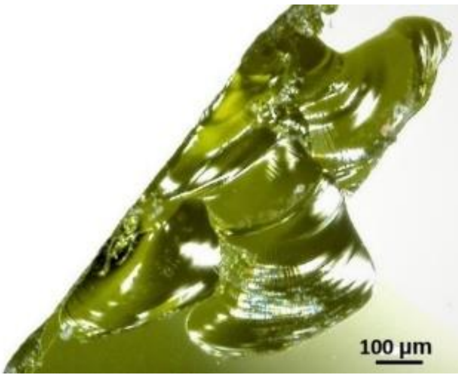

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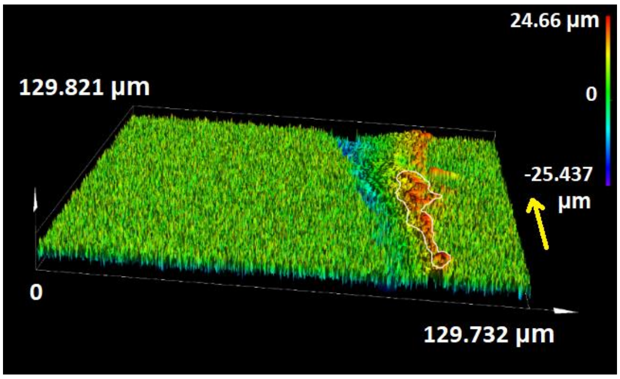

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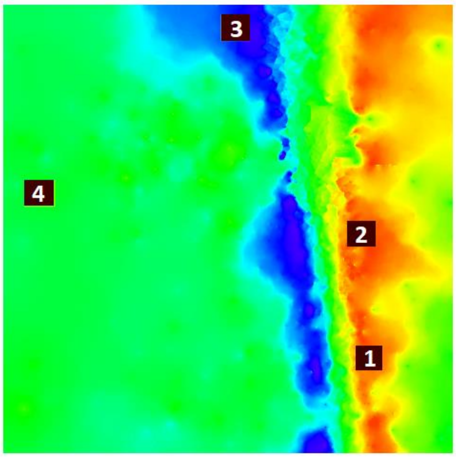

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Sample	Polished or unpolished zone	Sq	Sa
1	Polished	0.895	0.593
2	Polished	0.746	0.579
3	Unpolished	0.404	0.321
4	Unpolished	0.816	0.605

g

Figure 53 Experimental glass tools used to scrape (tool X30) and saw (tools X28 and X38) fresh wood (E. camaldulensis)*. **A**: perpendicular and oblique striations on X30. **B**: smooth polish distributed as a band on the edge of X28*[5]*; x500 magnification. **C**: macroscopic image of X38. **D**: closely clustered edge scarring with a range of orientations, on X38. **E**: 3-D contour map of elevations on part of the surface of X38: polish and smoothing are present only on high points and as a band away from the edge; the right edge is the (part of the) working edge, that is also seen below the arrow on the tool in 'C,' and the arrow indicates the approximate direction of tool-use. **F**: 2-D height map showing locations sampled for surface roughness. **G**: key for 'f.'*

[5] For here and elsewhere in the Results sections, optical light images of polish for the tools subjected to surface roughness measurements are not always of the same regions as those from which the surface roughness samples were taken; rather, the best optical image was prioritised on each occasion.

6.2.3.4 Glass: Fresh Bone (Kangaroo)

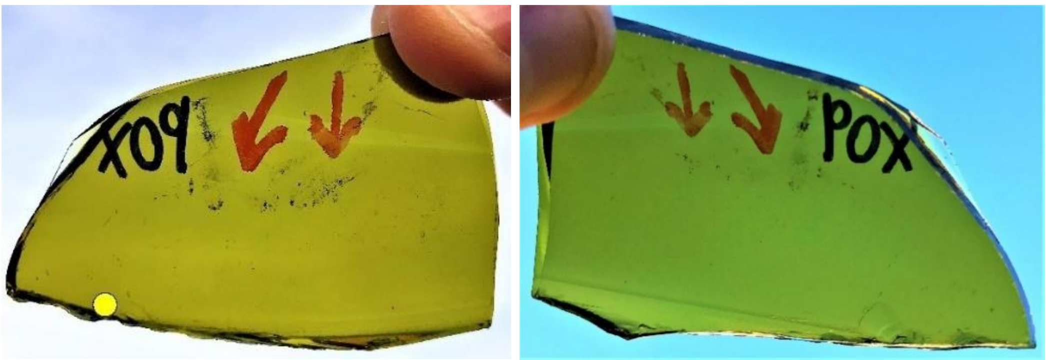
Traditional knowledge from TJ indicates that his and PJ's antecedents used glass to cut bone (and meat) during butchering activities:

> **TJ:** They would have used it for a lot of things, cutting the meat, you know, getting through the bone, you know. 'Cos that would have been sharper than what they used.

Sawing and scraping fresh bone using glass resulted in all forms of use-wear on five of the six tools (Table 33). Striations were present on each tool, typically in moderate to high density, with mostly parallel and perpendicular orientations for sawing and scraping respectively. Oblique striations were occasionally present. Edge scars were relatively large, on and near the working edge and closely clustered. Axial terminations were commonly observed and on the one retouched experimental tool that was used for sawing (X09), edge scars were recorded but sometimes indistinguishable from scars caused by the retouching (Figure 54). A low extent of edge rounding was identified on all but one sawing tool. Rough polish and smoothing were present exclusively on the high points of each tool (Figure 54) and predominantly on one face after scraping but bifacially after sawing. All sawing tools and two scraping tools (X11 and X58) had polish and smoothing that were less invasive than edge scarring.

Table 33 Use-wear on experimental glass tools used to scrape and saw fresh bone (kangaroo).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**							
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces (1/2)**	**Width**	**Orientation**	**Edge proximity**	**Mean length (mm)**	**Mean width (mm)**	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X11 HA: 45 TEA:38	11–15	M	1	N	PeO	O & N	0.5 – 1	0.5 – 1	MPe	O & N	CC	SA	L	MB	R	H	MO	BO	ES > pol.	all
Scrape X58 HA: 45 TEA:58	6–10	L	1	N	PeO	O & N	0.5 – 1	0.5 – 1	MPe	O & N	CC	MF	L	MB	R	H	MO	BO	ES > pol.	all
Scrape X57 HA: 45 TEA:23	6–10	L	2	N	PeO	O	< 0.5	< 0.5	MPe	O & N	CC	SA	L	M	R	H	MO	BO	ES = pol.	all
Saw X09 HA: 80–90 TEA:34	16–20	H	2	N	MPa	O & N	< 0.5	< 0.5	R	O & N	CC	SA	L	MB	R	H	B	St	ES > pol	all
Saw X17 HA: 80–90 TEA:89	6–10	L	2	N	PaO	O & N	1–1.5	1–1.5	MPe	O & N	CC	MS	L	M	R	H	B	St	ES > pol.	all
Saw X12 HA: 80–90 TEA:27	6–10	L	2	N	MPa	O	0.5 – 1	0.5 – 1	MPe	O & N	CC	SA	n/a	MB	R	H	B	SS	ES > pol.	str. & ES



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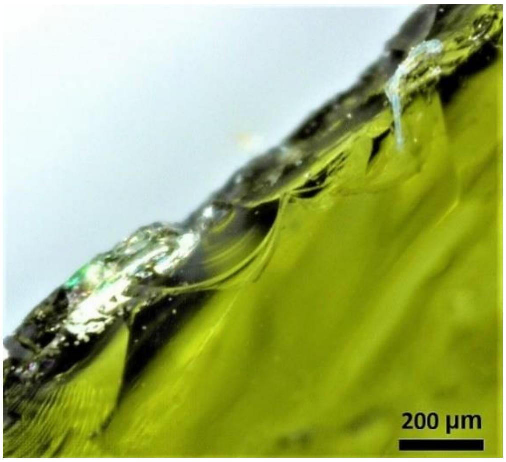

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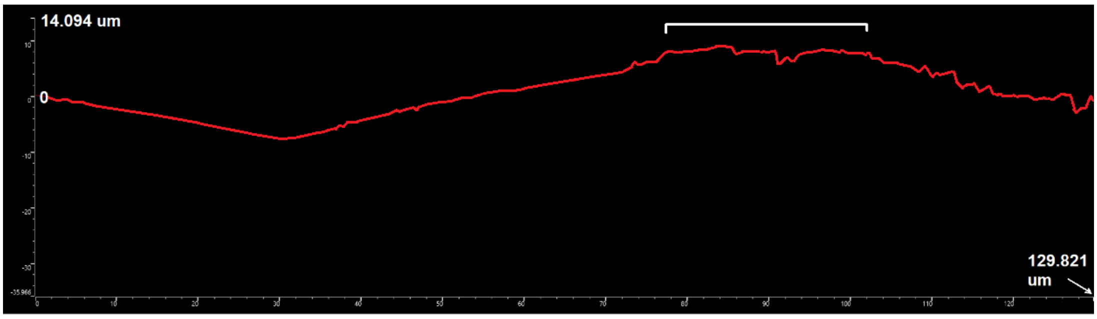


c

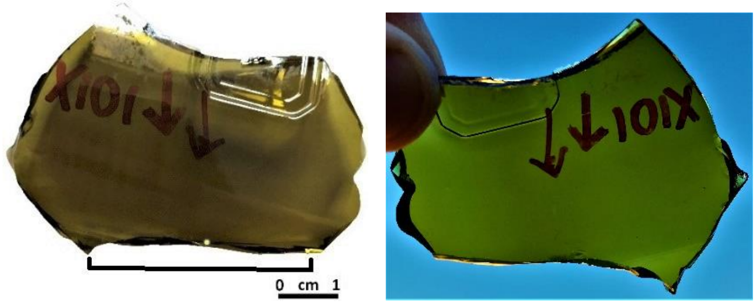
Figure 54 Experimental tools X09 and X17, which were used to saw fresh bone (kangaroo). ***A****: macroscopic images of X09; the circle indicates the location of scarring seen in 'b'.* ***B****: step-terminated edge scarring on X09, possibly from retouching.* ***C****: height profile for the surface of X17; the white bracket indicates that polish and smoothing from use are present only on microtopographic peaks.*

6.2.3.5 Glass: Dry Bone (Kangaroo)

Use-wear was common on glass used to saw and scrape dry bone (Table 34). Striations (Figure 55) were all narrow (< 2 µm) other than on one sawing tool (X97) on which they were still only 3–8 µm wide. Edge scarring was also comparatively large and present in close clusters. After sawing, edge scars often displayed axial terminations. A low extent of edge rounding was present on five of six tools, while relatively bright, rough polish and smoothing were present on the high microtopographic points of all tools (Figure 55b). Polish and smoothing were almost always less invasive than edge scarring, and small pits were occasionally present in or near the polished and smoothed surface.

Table 34 Use-wear on experimental glass tools used to scrape and saw dry bone (kangaroo).

	Striations						Edge Scarring						ER	Polish and Smoothing						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X76 HA: 45 TEA:31	6–10	L	1	N	PeO	O & N	0.5 – 1	0.5 – 1	MPe	O & N	CC	SA	L	MB	R	H	MO	BO	ES = pol.	all
Scrape X01 HA: 45 TEA:55	6–10	L	1	N	PeO	O & N	0.5 – 1	0.5 – 1	MPe	O & N	CC	MF	L	MB	R	H	MO	BO	ES > pol.	all
Scrape X106 HA: 45 TEA:51	6–10	L	2	N	PeO	O	< 0.5	< 0.5	MPe	O & N	CC	SA	L	MB	R	H	MO	BO	ES > pol.	all
Saw X101 HA: 80–90 TEA:43	16–20	H	2	N	MPa	O & N	< 0.5	< 0.5	MPe	O	CC	SH	L	MB	R	H	B	St	ES > pol.	all
Saw X97 HA: 80–90 TEA:61	6–10	L	2	W	PaO	O	1–1.5	1–1.5	MPe	O & N	CC	SH	L	M	R	H	B	SS	ES > pol.	all
Saw X14 HA: 80–90 TEA:62	6–10	L	2	N	MPa	O	0.5 – 1	0.5 – 1	MPe	O & N	CC	MS	n/a	MB	R	H	B	SS	ES > pol.	str. & ES



a

b

c d

Figure 55 Experimental glass tools used to scrape (tool X106) and saw (tool X101) dry bone (kangaroo). ***A****: macroscopic images of X106; brackets indicate the working edge, while the yellow circle indicates the location of polish seen in ‘b.’* ***B****: moderately bright polish on X106; x500 magnification.* ***C****: macroscopic images of X101; brackets indicate the working edge, while the yellow circle indicates the location of striations and edge scarring seen in ‘d.’* ***D****: parallel striations and edge scarring on X101.*

6.2.3.6 Glass: Fresh Hide (Cow)

TJ and PJ believe that their antecedents would have used glass for other purposes in addition to wood-scraping:

> **TJ:** They would have, you know, cutting the, easy cutting of kangaroo fur, you know, easy, it would just go straight through then.

Use-wear was present on all three experimental glass hide-scraping tools (Figure 56; Table 35). Striations were observed on two tools, few in number and mostly rough-bottomed (but some sleeks). They were wide and typically perpendicular to the working edge. Edge scars, although present on all tools, were also few, and small. Fresh fracture scars, such as that visible in Figure 56, indicate recent damage, which was of course the case with all experimental tools (but if present in archaeological assemblages may reflect post-depositional breakage). Working edges became rounded to a particularly higher extent than occurred as a result of working of other materials, and all polish and smoothing characteristics were the same on each of the three glass tools: moderate in brightness, rough, present on peaks and in valleys of the microtopography (Figure 56), unifacial, distributed as bands on the working edges and more invasive than edge scarring.

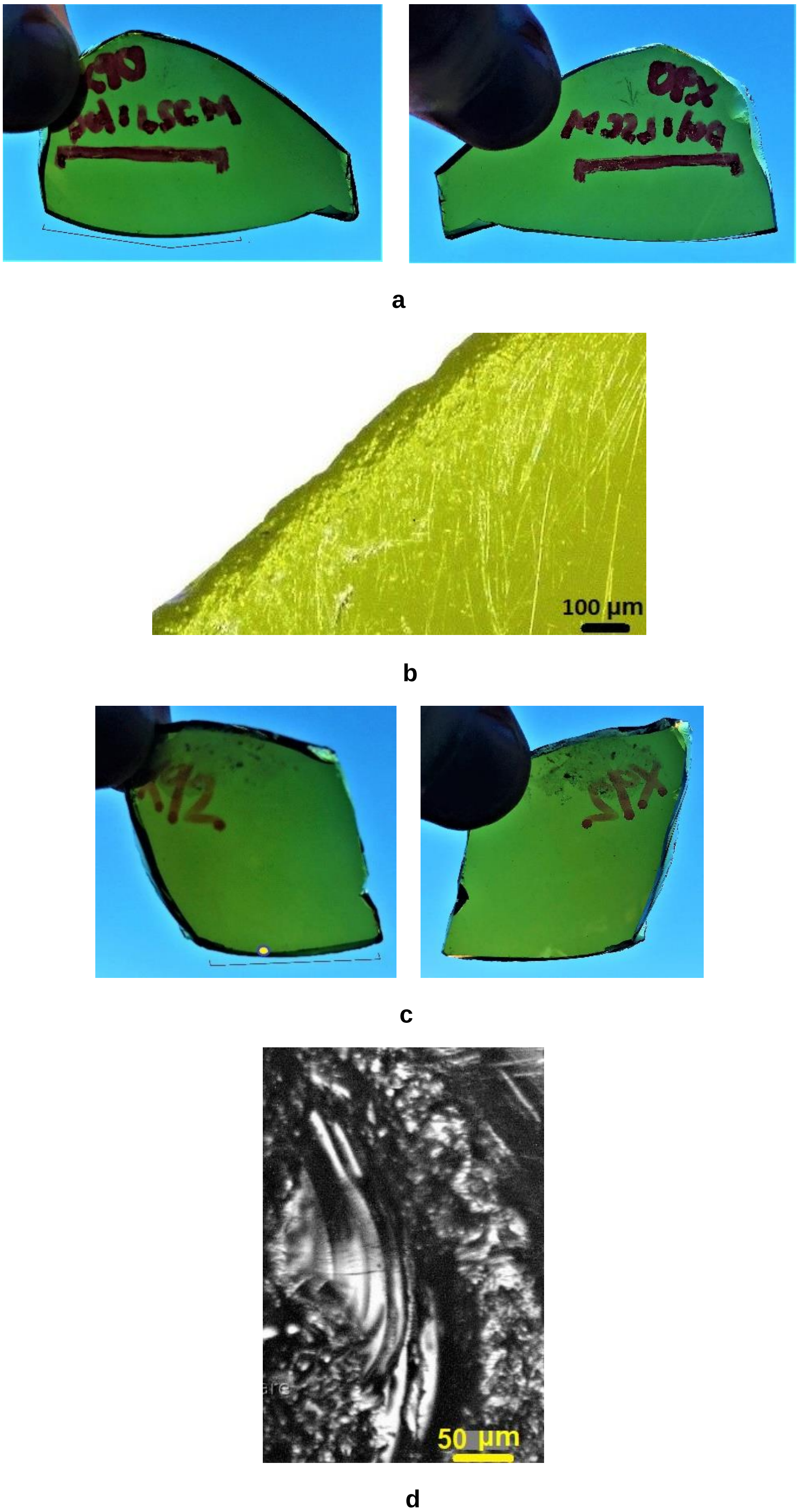


*Figure 56 Experimental glass tools X90 and X92, which were used to scrape fresh hide (cow). **A**: macroscopic images of X90; brackets indicate the working edge. **B**: marked edge rounding on X90; Dino-Lite x215 magnification. **C**: macroscopic images of X92; brackets indicate the working edge, while the circle indicates the location of polish seen in 'd.' **D**: rough polish exceeding a fresh edge fracture scar on X92; x200 magnification.*

Table 35 Use-wear on experimental glass tools used to scrape fresh hide (cow).

	Striations						Edge Scarring						ER	Polish and Smoothing						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape, tool 1 X90 HA: 45 TEA: 56	1–5	L	2	W	PeO	N & F	< 0.5	< 0.5	MPe	O & N	CC	MF	H	M	R	HL	U	BO	ES < pol.	all
Scrape, tool 2 X91 HA: 45 TEA: 63	1–5	L	1	W	MPe	O & N	< 0.5	< 0.5	MPe	O & N	MC	MF	M	M	R	HL	U	BO	ES < pol.	all
Scrape, tool 3 X92 HA: 45 TEA: 71	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O & N	CC	MF	M	M	R	HL	U	BO	ES < pol.	pol., ES, ER

6.2.3.7 Glass: Plant (Typha)

All forms of use-wear were present on each of the three glass tools used to cut and scrape *Typha* stems and reeds, albeit in low quantities (Table 36). Striations were low in density, narrow on two tools, present bifacially with random orientations and located near and far from the working edges. Edge scars were mostly perpendicular to and on the working edges, few in number and particularly small (in the '< 0.5 mm' category but often < 0.2 mm). A medium extent of edge rounding was observed on all tools. Polish was bright, as was the case on chert and silcrete tools used for the same task, and its texture was smooth on two tools but rougher on the other. A sharply distinct boundary was observed between the polished and unworked surfaces (Figure 57). Polish and smoothing were present on microtopographic high and low points, and on both faces of each tool. The distribution of polish and smoothing varied, occurring as a band on the edge of one tool, a thin line on the edge of another and spots and streaks on the third. When the polish and smoothing were distributed as a band on the edge they were more invasive than edge scarring, while for the tool where they were distributed as a thin line on the working edge, the invasiveness was equal. On the other tool, invasiveness was not recordable because the polish, smoothing and edge scarring were not in proximity to each other.

Table 36 Use-wear on experimental glass tools used to cut and scrape plant material (Typha).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Cut and scrape X102 HA: 80–90 (cut) and 45 (scrape) TEA: 61	6–10	L	2	W	R	N & F	< 0.5	< 0.5	MPe	O	MC	MF	M	B	S	HL	B	BO	ES < pol.	all
Cut and scrape X46 HA: 80–90 (cut) and 45 (scrape) TEA: 84	6–10	L	2	N	R	N & F	< 0.5	< 0.5	MPe	O	CC	MF	M	B	S	HL	B	TLO	ES = pol.	all
Cut and scrape X02 HA: 80–90 (cut) and 45 (scrape) TEA: 76	6–10	L	2	N	R	N & F	< 0.5	< 0.5	MPe	O	MC	MF	M	MB	R	HL	B	SS	n/a	all

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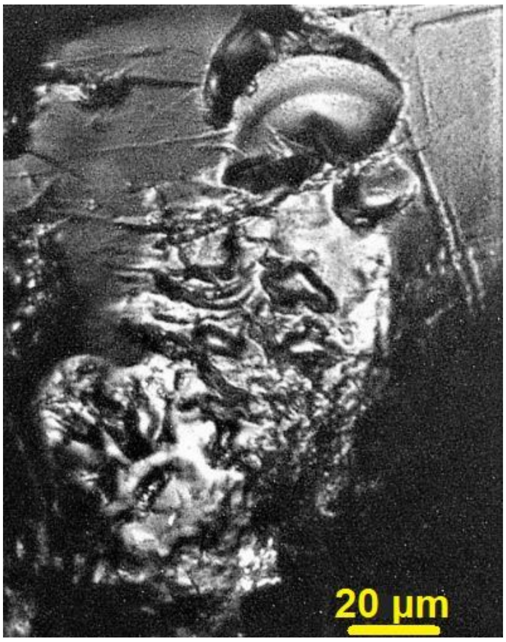


b

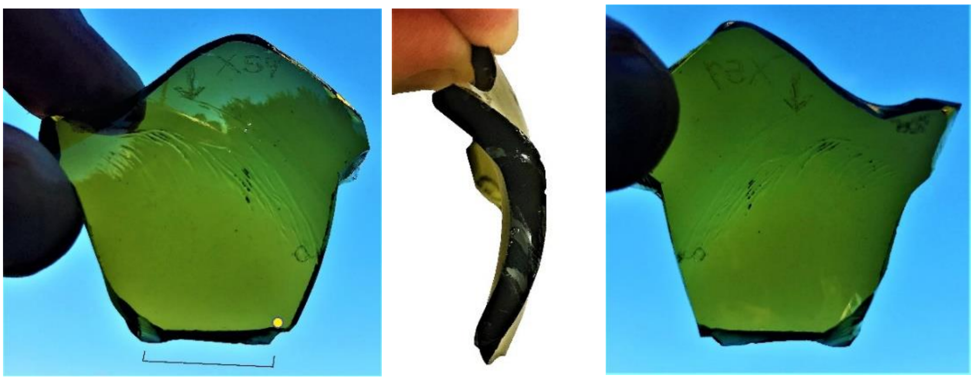
Figure 57 Experimental glass tool X102, which was used to cut and scrape plant material (Typha)*.* ***A****: macroscopic images; brackets indicate the working edge, while the circle indicates the location of the polish seen in 'b.'* ***B****: one part of the bright, smooth polish, with a distinct boundary between the polished and unpolished surfaces; x500 magnification.*

6.2.3.8 Glass: Meat (Lamb)

Some, albeit minimal, use-wear was observed on glass after cutting and scraping meat (Table 37). Striations were present on two of the three tools at low density and on both faces. They were wide, randomly orientated and present both near and far from the working edge. Edge scarring, though present on each tool, was scarce and less than 0.5 mm in mean length and width. The scars were mostly perpendicular, abruptly terminated, on and near the working edge and closely clustered. Before and after micrographs from virtually the same position on one tool demonstrate edge scarring as a result of use (Figure 58). On each tool, no edge rounding was present, but a dull polish had developed on the peaks and in valleys of the microtopography, with smooth textures and an approximately equal quantity of polish and smoothing on both tool-faces. Polish was always more invasive than edge scarring.

Table 37 Use-wear on experimental glass tools used to cut and scrape fresh meat (lamb).

	Striations						Edge Scarring						ER	Polish and Smoothing						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces (1/2)**	**Width**	**Orientation**	**Edge proximity**	**Mean length (mm)**	**Mean width (mm)**	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Cut and scrape X59 HA: 80–90 (cut) and 45 (scrape) TEA: 76	1–5	L	2	W	R	N & F	< 0.5	< 0.5	MPe	O & N	CC	MS	n/a	D	S	HL	MO	BO	ES < pol.	str., ES, pol.
Cut and scrape X63 HA: 80–90 (cut) and 45 (scrape) TEA:70	1–5	L	2	W	R	N & F	< 0.5	< 0.5	MPe	O & N	CC	MS	n/a	D	S	HL	MO	BO	ES < pol.	str., ES, pol.
Cut and scrape X64 HA: 80–90 (cut) and 45 (scrape) TEA:66	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O & N	CC	MS	n/a	D	R	HL	MO	BO	ES < pol.	ES, pol.



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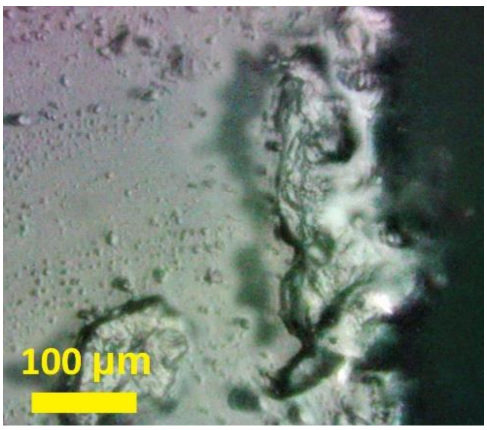

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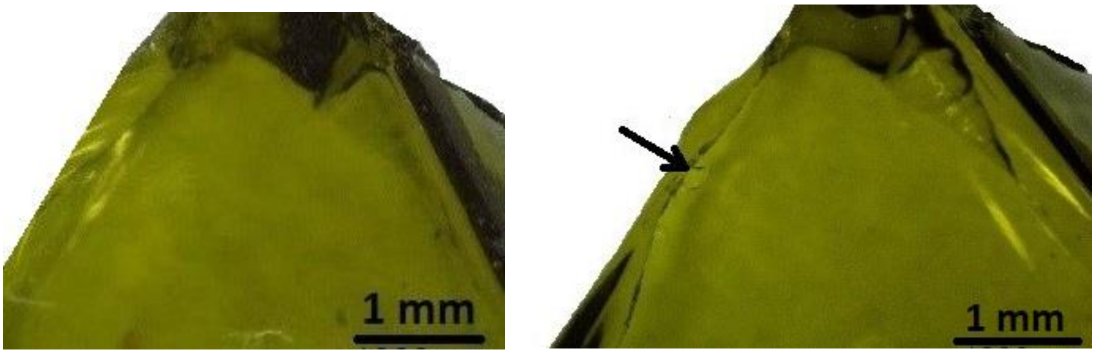


c **d**

Figure 58 Experimental glass tool X59, which was used to cut and scrape meat (lamb). ***A****: macroscopic images of opposite surfaces and side view showing curvature; brackets indicate the working edge (which included the 'front' and 'back' parts of this edge), while the circle indicates the location of polish seen in 'b.'* ***B****: polish; x500 magnification.* ***C****: before use; Dino-Lite x60 magnification.* ***D****: after use; Dino-Lite x60 magnification: the arrow indicates a scar that was present only after use.*

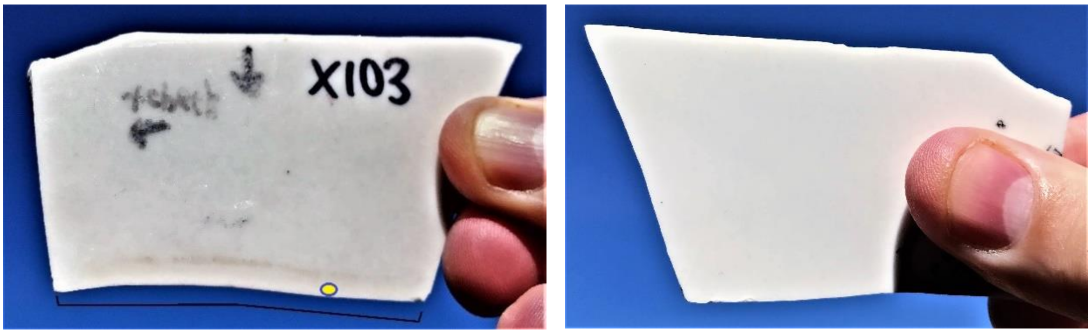
6.2.4 *Experimental Porcelain Tools*

6.2.4.1 Porcelain: Dry Wood (E. camaldulensis)

Use-wear on the three porcelain tools used to scrape and three to saw dry wood (Table 38) was similar to that observed on chert, silcrete and glass tools used for the same tasks. The presence of multiple forms of use-wear was common on all six tools. Striations (Figure 59) were in moderate or high numbers and densities, always wide and reflected tool motions in their orientations. Edge scarring was mostly small (< 0.5 mm in mean length and width). On the scraping tools, scars were orientated mostly perpendicular to the working edge, but were also oblique on occasion. On the edges of sawing tools, scarring was sometimes orientated parallel, but more commonly oblique, to the working edge. Edge rounding was observed on two tools, each to low extents. A moderately bright polish was observed on all tools, with smooth textures on four and rough textures on two. Polish and smoothing always developed exclusively on the high points of the microtopography (Figure 59) and, like striations and edge scarring, were mostly on and very close to the working edges. Although the surfaces of all of the experimental porcelain tools were mostly smooth and featureless, occasional raised parts were present, caused primarily by slight unevenness in the application of the glazing. The polish was less invasive than edge scarring after the working of dry wood.

Table 38 Use-wear on experimental porcelain tools used to scrape and saw dry wood (E. camaldulensis)*.*

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X71 HA: 45 TEA: 76	16–20	H	2	W	PeO	O & N	< 0.5	< 0.5	MO	O & N	CC	SF	L	MB	R	H	MO	BO	n/a	all
Scrape X69 HA: 45 TEA: 54	11–15	M	2	W	PeO	O & N	< 0.5	< 0.5	MPe	O & N	CC	MF	L	MB	S	H	B	BO	ES > pol.	all
Scrape X66 HA: 45 TEA: 60	11–15	M	2	W	PeO	O & N	0.5 – 1	0.5 – 1	MPe	O & N	CC	MF	n/a	MB	R	H	B	BO	ES > pol.	str., pol., ES
Saw X103 HA: 80–90 TEA: 86	11–15	M	2	W	MPa	O & N	0.5 – 1	< 0.5	MO	O & N	CC	SF	L	MB	R	H	B	BO	n/a	all
Saw X77 HA: 80–90 TEA: 76	11–15	M	2	W	MPa	O & N	< 0.5	< 0.5	MPa	O & N	CC	MF	n/a	MB	S	H	B	BO	ES > pol.	str., pol., ES
Saw X74 HA: 80–90 TEA:70	11–15	M	2	W	PaO	O & N	< 0.5	< 0.5	M	O & N	MC	MF	n/a	MB	S	H	B	BA	ES > pol.	str., pol., ES



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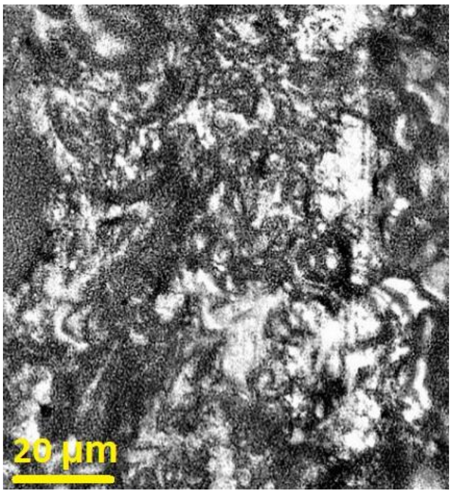
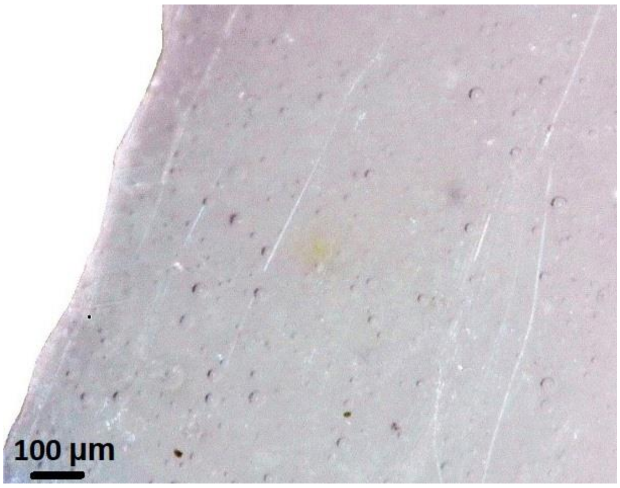




b

c

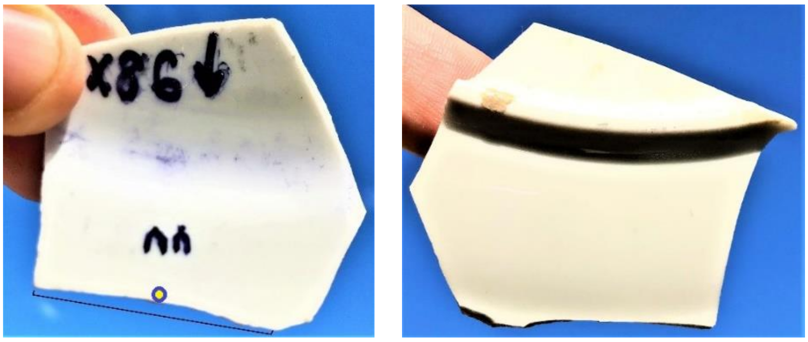
Figure 59 Experimental porcelain tool X103, which was used to saw dry wood (E. camaldulensis)*. **A**: macroscopic images; brackets indicate the working edge, while the circle indicates the location of the polish seen in 'b.' **B**: rough polish on peaks; x500 magnification. **C**: parallel striations; Dino-Lite x215 magnification.*

6.2.4.2 Porcelain: Fresh Wood (E. camaldulensis)

All forms of use-wear were observed on the three porcelain tools used to scrape and three to saw fresh wood (Table 39). Striations were typically present in moderate density, albeit slightly fewer in number on one scraping and one sawing tool in comparison to the numbers on the porcelain tools used to work dry wood. Oblique striations were again common after using both tool motions on fresh wood. Of the three tools used to scrape fresh wood, striations were present unifacially on two (and bifacially on the other), unlike after the scraping of dry wood when they were bifacially distributed on all three tools. The mean length and width of scars on all tools used to scrape and saw fresh wood was less than 0.5 mm, with oblique orientations and close clustering typical. Feather terminations were again prevalent and the working edge of each tool became rounded (to a low extent), in contrast to rounding on only three of six dry wood-working tools. Polish and smoothing were moderate-bright in brightness and present exclusively on the high points (Figure 60). Polish texture was always smooth and for two of the scraping tools the polish was present mainly on one tool-face.

Table 39 Use-wear on experimental porcelain tools used to scrape and saw fresh wood (E. camaldulensis).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X86 HA: 45 TEA:85	11–15	M	1	W	PO	O & N	< 0.5	< 0.5	MO	O & N	CC	SF	L	MB	S	H	MO	Sp	n/a	all
Scrape X79 HA: 45 TEA: 55	11–15	M	1	W	PO	O & N	< 0.5	< 0.5	MPe	O & N	CC	MF	L	MB	S	H	MO	BO	ES > pol.	all
Scrape X75 HA: 45 TEA: 76	11–15	M	2	W	PO	O & N	< 0.5	< 0.5	MPe	O & N	CC	MF	L	MB	S	H	B	BO	ES > pol.	all
Saw X83 HA: 80–90 TEA: 47	6–10	L	2	W	MPa	O & N	< 0.5	< 0.5	MO	O & N	CC	MF	L	MB	S	H	B	BO	ES = pol.	all
Saw X84 HA: 80–90 TEA: 78	11–15	M	2	W	MO	O & N	< 0.5	< 0.5	MO	O & N	CC	MF	L	MB	S	H	B	BO	ES > pol.	all
Saw X85 HA: 80–90 TEA: 49	11–15	M	2	W	MO	O & N	< 0.5	< 0.5	MO	O & N	CC	MF	L	MB	S	H	B	BA	ES > pol.	all



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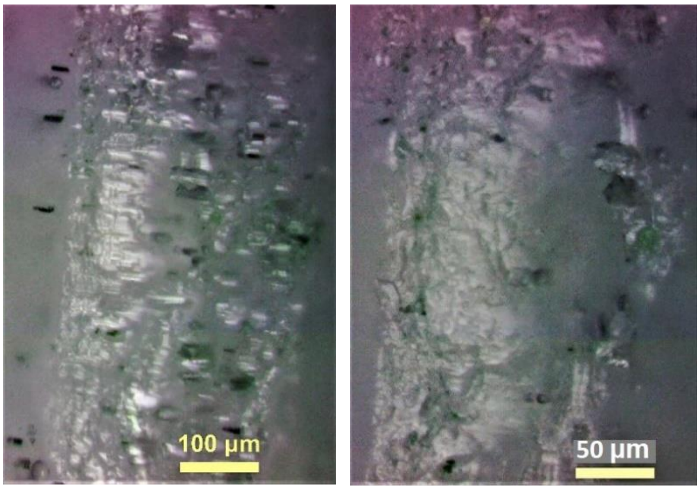
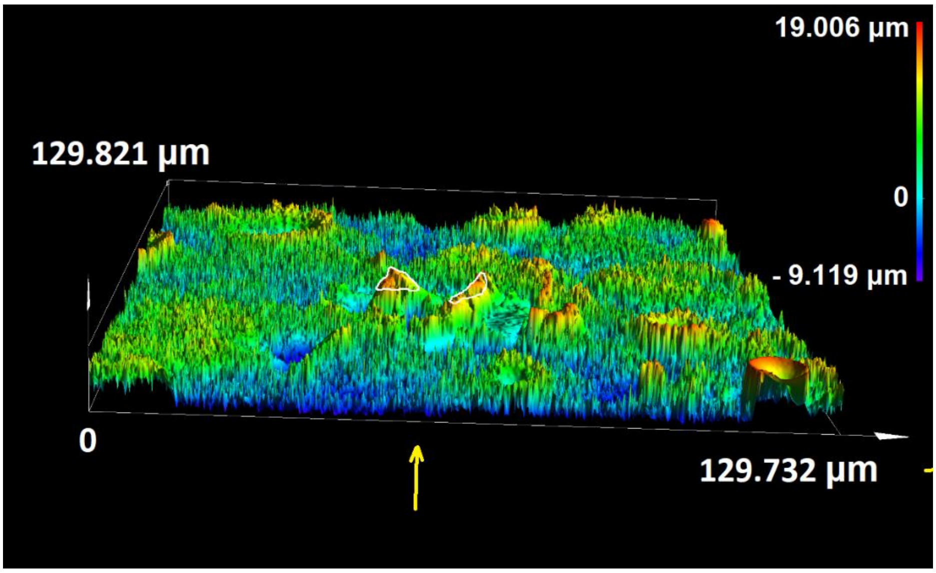


b c



d

Figure 60 Experimental porcelain tool X86, which was used to scrape fresh wood (E. camaldulensis). ***A****: macroscopic images; brackets indicate the working edge, while the circle indicates the location of polish seen in 'b' and 'c.'* ***B****: moderately bright, isolated spot of polish; x100 magnification.* ***C****: moderately bright, isolated spot of polish; x200 magnification.* ***D****: 3-D contour map of elevations on the surface; polish is present exclusively on (two) high points (no 2-D height map was available for this tool); the edge in the foreground is the (part of the) working edge and the arrow indicates the approximate direction of tool-use.*

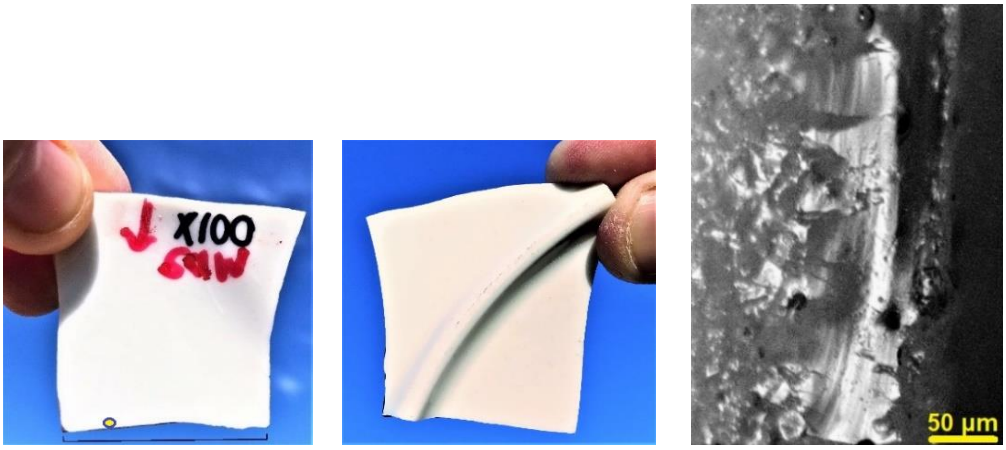
6.2.4.3 Porcelain: Fresh Bone (Kangaroo)

Sawing and scraping fresh bone with porcelain again produced abundant use-wear, with four of the six tools exhibiting all four major forms and the other two displaying all major forms apart from edge rounding (Table 40; Figure 61). Striations were narrow and present in high density. Edge scars were larger than the scars resulting from the working of other experimental materials and characterised by step terminations. Oblique orientations were common and the scarring was always closely clustered. A medium extent of edge rounding was present on two of the three tools used for scraping, and two sawing tools displayed low extents of edge rounding. Polish and smoothing were rough on two scraping and two sawing tools, and smooth on one tool for each motion. The polish was moderate or moderate-bright in brightness and present only on the microtopographic high points (Figure 61). A distributional difference occurred: on one scraping tool, polish was a thin line on the edge rather than a band, whereas on another scraping tool it was present in isolated spots (Figure 61). Polish was occasionally pitted (Figure 61) and less invasive than edge scarring on all occasions aside from one sawing tool where its extent matched that of the edge scarring.

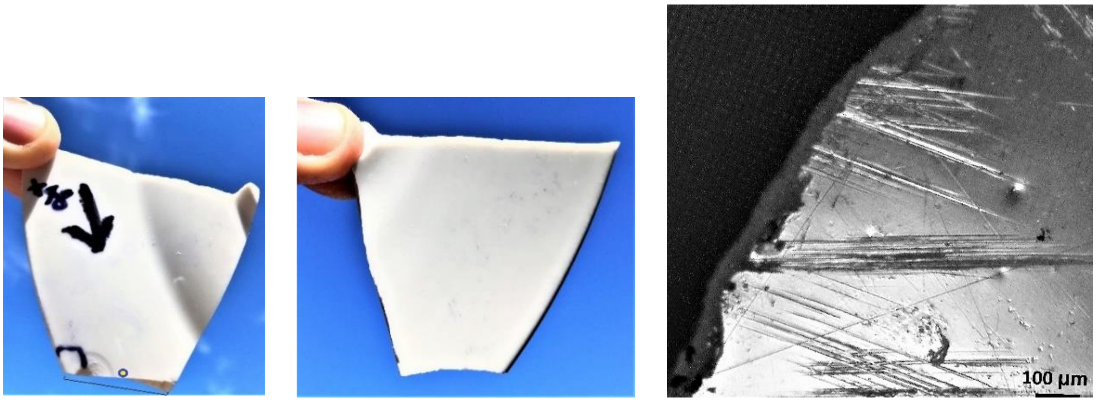
Table 40 Use-wear on experimental porcelain tools used to scrape and saw fresh bone (kangaroo).

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape X53 HA: 45 TEA: 61	16 – 20	H	1	N	MPe	N & F	1–1.5	0.5 – 1	MPe	O & N	CC	MS	M	MB	R	H	MO	BO	ES > pol.	all
Scrape X98 HA: 45 TEA: 39	21 – 30	H	1	N	PeO	N & F	1–1.5	0.5 – 1	MPe	O & N	CC	SA	n/a	M	R	H	MO	TLO	ES > pol.	str., pol., ES

Scrape X48 HA: 45 TEA: 73	16 – 20	H	2	N	PeO	N & F	1–1.5	0.5 – 1	MPe	O & N	CC	SA	M	MB	S	H	MO	Sp	ES > pol.	all
Saw X54 HA: 80–90 TEA: 41	11 – 15	H	2	N	MPa	N & F	0.5 – 1	0.5 – 1	MO	O & N	CC	SA	L	MB	R	H	B	BO	ES > pol.	all
Saw X100 HA: 80–90 TEA: 86	16 – 20	H	2	N	PeO	O & N	0.5 – 1	0.5 – 1	PeO	O & N	CC	MS	n/a	M	S	H	B	BO	ES > pol.	str., pol., ES
Saw X55 HA: 80–90 TEA: 77	21 – 25	H	2	N	PaO	O & N	0.5 – 1	0.5 – 1	MO	O & N	CC	MS	L	MB	R	H	B	BO	ES = pol.	all



a **b**

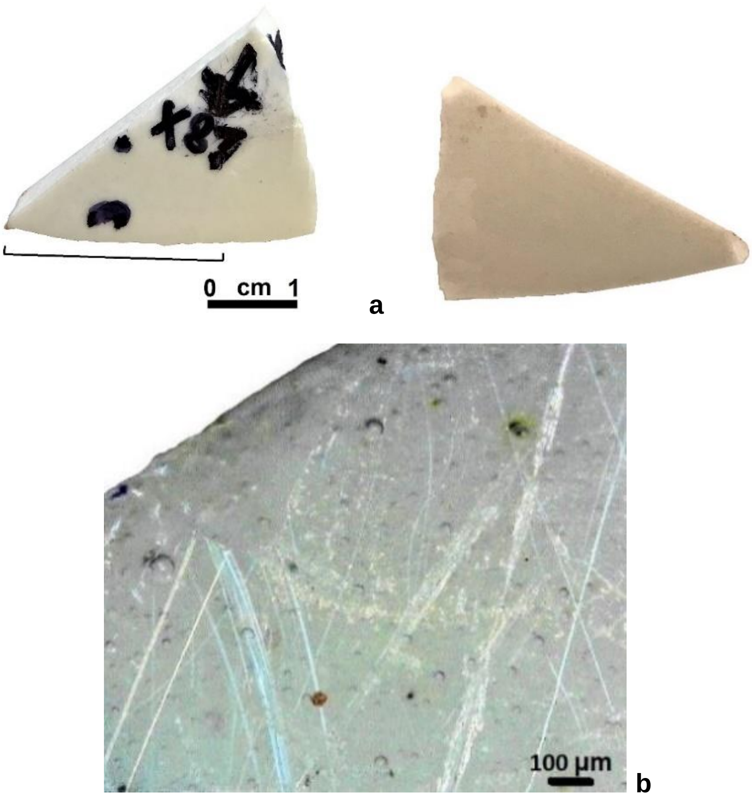


c **d**

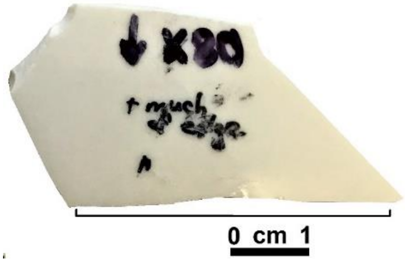
Figure 61 Experimental porcelain tools used to saw (X100) and scrape (X48) fresh bone (kangaroo). ***A****: macroscopic images of tool X100; brackets indicate the working edge, while the circle indicates the location of polish seen in 'b.'* ***B****: a somewhat pitted polish on the edge of tool X100; x500 magnification.* ***C****: macroscopic images of tool X48; brackets indicate the working edge, while the circle indicates the location of polish seen in 'd.'* ***D****: perpendicular and oblique striations on tool X48; Dino-Lite x235 magnification.*

6.2.4.4 Porcelain: Dry Bone (Kangaroo)

Striations (Figure 62) were present in considerably higher density on porcelain tools after scraping and sawing dry bone than on chert and silcrete tools used for the same tasks, and slightly greater in number than on the glass tools used for scraping and sawing bone. Narrow striations were present on all six porcelain bone-working tools, and the plentiful edge scars were up to 0.5 mm larger in mean length and width than those on tools used to work other materials. As on the tools used to scrape and saw dry bone, edge scars were characterised by step terminations. Five of the six working edges became rounded as a result of scraping and sawing dry bone, in contrast to one of the six glass tools used for the same tasks. Polish and smoothing developed predominantly in bands on the working edges but in isolated spots on one sawing tool (Figure 62). The polish was present mostly on peaks but also on other high points several microns microtopographically lower (Figure 62), and the Sa and Sq values again indicate relatively little difference between the rougher and smoother parts of the surface (Figure 62). Polish was also always less invasive than edge scarring. The full results are shown in Table 41.



b



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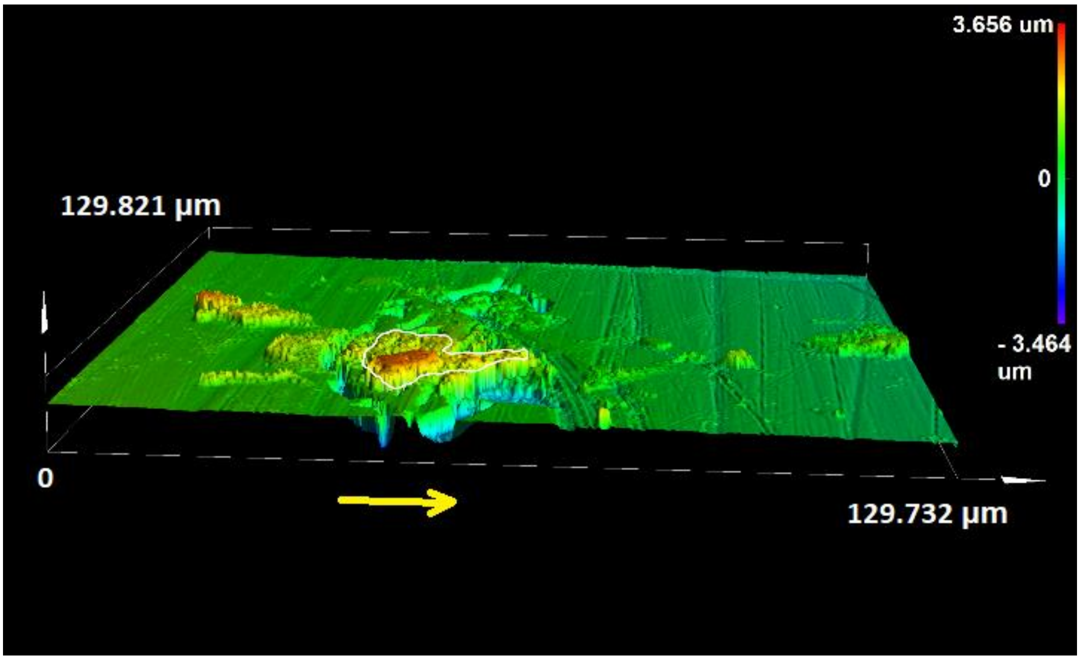

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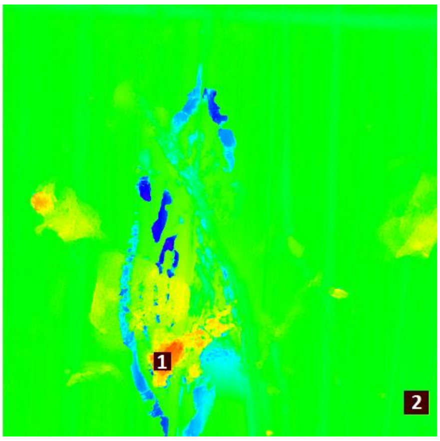


Sample	Polished or unpolished zone	Sq	Sa
1	Polished	0.151	0.091
2	Unpolished	0.019	0.012

e f

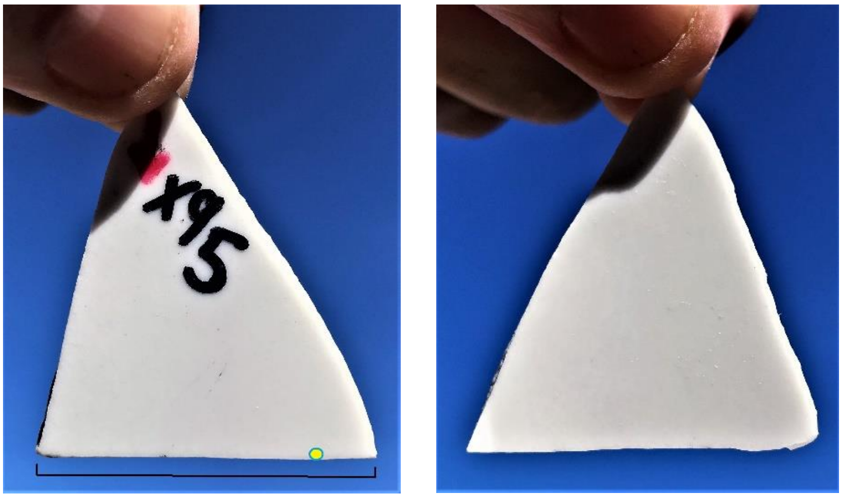
*Figure 62 Experimental porcelain tools used to scrape (tool X87) and saw (tool X80) dry bone (kangaroo). **A**: macroscopic images of tool X87; brackets indicate the working edge. **B**: oblique and perpendicular striations on tool X87; Dino-Lite x235 magnification. **C**: macroscopic images of tool X80; brackets indicate the working edge. **D**: 3-D contour map of elevations on the surface, showing polish (circled) on peaks and near peaks of tool X80; the edge in the foreground is the (part of the) working edge and the arrow indicates the approximate direction of tool-use. **E**: 2-D height map showing locations sampled for surface roughness. **F**: key for 'e.'*

Table 41 Use-wear on experimental porcelain tools used to scrape and saw dry bone (kangaroo).

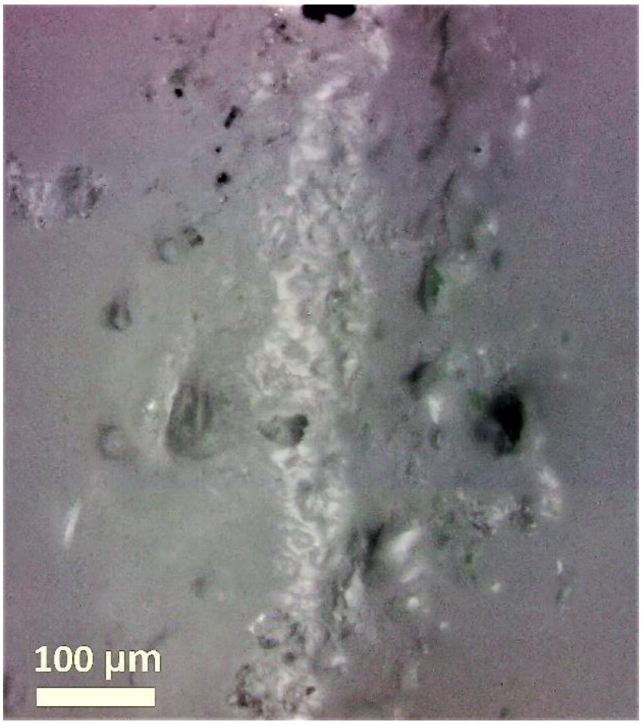
	Striations						Edge Scarring						ER	Polish and Smoothing						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape, tool 1 X87 HA: 45 TEA: 44	21–30	H	1	N	PeO	N	0.5 – 1	< 0.5	MPe	O & N	CC	MS	M	MB	R	H	MO	BO	ES > pol.	all
Scrape, tool 2 X72 HA: 45 TEA: 75	21–30	H	2	N	PeO	N & F	1–1.5	0.5 – 1	MPe	O & N	CC	MS	n/a	MB	R	H	MO	BO	ES > pol.	str., pol., ES
Scrape, tool 3 X06 HA: 45 TEA: 39	16–20	H	2	N	PeO	N & F	1–1.5	0.5 – 1	MPe	O & N	CC	SA	M	MB	R	H	MO	BO	ES > pol.	all
Saw, tool 1 X80 HA: 80–90 TEA: 74	11–15	H	2	N	MPa	N & F	0.5 – 1	0.5 – 1	MPe	O & N	CC	MS	L	MB	S	H	MO	Sp	ES > pol.	all
Saw, tool 2 X81 HA: 80–90 TEA: 56	21–25	H	2	N	PeO	O & N	0.5 – 1	0.5 – 1	MPe	O & N	CC	MS	L	M	R	H	B	BO	ES > pol.	all
Saw, tool 3 X82 HA: 80–90 TEA: 58	21–25	H	2	N	PaO	O & N	0.5 – 1	0.5 – 1	PeO	O & N	CC	MS	L	MB	R	H	B	BO	ES > pol.	all

6.2.4.5 Porcelain: Fresh Hide (Cow)

Fresh hide-scraping using porcelain tools produced varied amounts and forms of use-wear (Table 42). Striations were few in number, relatively wide and mostly rough-bottomed, although some sleeks were also present. Edge scarring was present on one of the three tools but scarce, and mean length and mean width of the scars was small (< 0.5 mm). The working edges became rounded to a medium extent on two tools and to a low extent on the other. Polish was present on two tools, with moderate brightness verging on dull. Its texture was rough and it formed on high points and in valleys (Figure 63). The polish was unifacial and distributed as spots and streaks, and more invasive than edge scarring on the one tool where these forms of use-wear were present in direct association.



a



b

Figure 63 Experimental porcelain tool X95, which was used to scrape fresh hide (cow). ***A:*** *macroscopic images; brackets indicate the working edge, while the circle indicates the location of polish seen in 'b.'* ***B:*** *relatively rough polish; x200 magnification.*

Table 42 Use-wear on experimental porcelain tools used to scrape fresh hide (cow).

	Striations						Edge Scarring						ER	Polish and Smoothing						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Scrape, tool 1 X95 HA: 45 TEA: 68	1–5	L	1	W	PeO	N & F	< 0.5	< 0.5	MPe	O & N	CC	MF	M	M	R	HL	U	SS	ES < pol.	all
Scrape, tool 2 X96 HA: 45 TEA: 47	1–5	L	2	W	PeO	N & F	n/a	n/a	n/a	n/a	n/a	n/a	M	M	R	HL	U	SS	n/a	str., pol., ER
Scrape, tool 3 X94 HA: 45 TEA: 63	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	L	n/a	n/a	n/a	n/a	n/a	n/a	ER only

6.2.4.6 Porcelain: Plant (Typha)

On each of the three porcelain *Typha*-processing tools, striations were few (1–5), unifacial, wide and randomly orientated (Table 43). Rough-bottoms and sleeks were predominant, with occasional intermittent striations. On two of the tools, striations were observed near and far from the working edge and on the other they were far from the edge. Edge scars, although present on each tool, were few in number and the mean length and width of the scarring was less than 0.5 mm. The working edge became rounded to a medium extent on two tools (one shown in Figure 64) and to a low extent on the other. Polish was observed on two tools and was bright, smooth, on peaks and in valleys, and more invasive than edge scarring. On one tool the polish was unifacial and distributed as spots and streaks while on the other it was predominantly, but not exclusively, on one face and distributed as a band on the edge.

Table 43 Use-wear on experimental porcelain tools used to cut and scrape plant material (Typha).

	Striations						Edge Scarring						ER	Polish and Smoothing						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces (1/2)**	**Width**	**Orientation**	**Edge proximity**	**Mean length (mm)**	**Mean width (mm)**	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Cut and scrape; tool 1 X104 HA: 80–90 (cut) and 45 (scrape) TEA: 84	1–5	L	1	W	R	N & F	< 0.5	< 0.5	MPe	O	MC	MF	M	B	S	HL	MO	BO	ES < pol.	all
Cut and scrape; tool 2 X105 HA: 80–90 (cut) and 45 (scrape) TEA: 68	1–5	L	1	W	R	N & F	< 0.5	< 0.5	MPe	O	CC	MF	M	B	S	HL	B	SS	ES < pol.	all
Cut and scrape; tool 3 X52 HA: 80–90 (cut) and 45 (scrape) TEA: 66	1–5	L	1	W	R	F	< 0.5	< 0.5	MPe	O	MC	MF	L	n/a	n/a	n/a	n/a	n/a	n/a	str., ES, ER

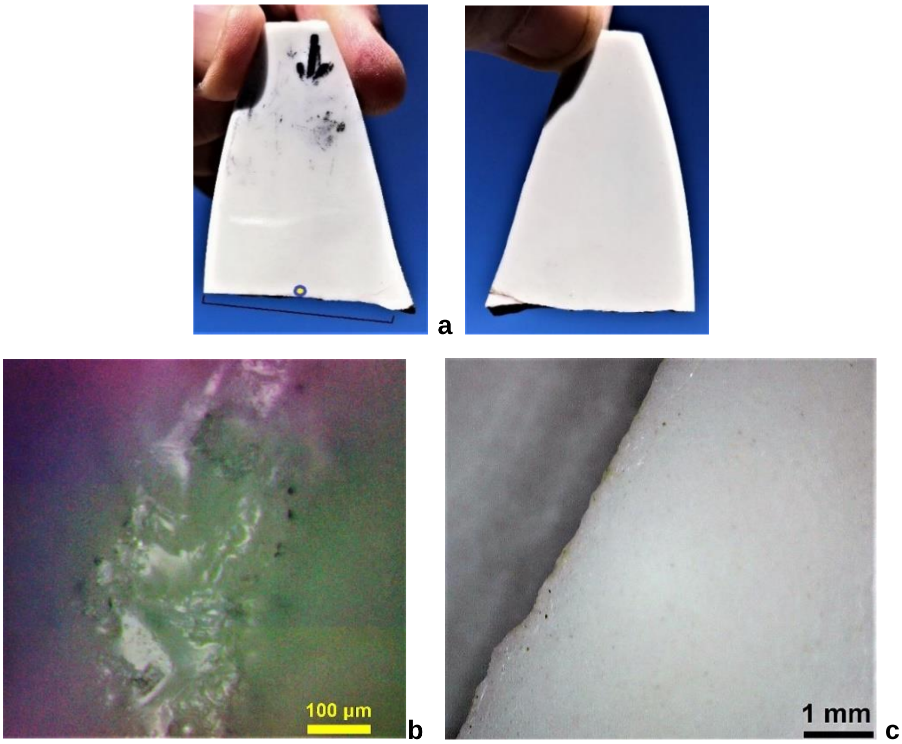


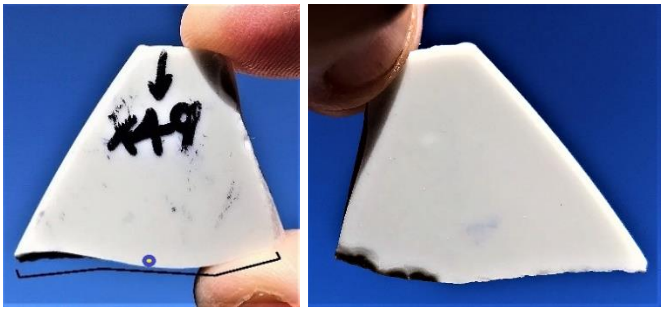
Figure 64 Experimental porcelain tool X105, which was used to cut and scrape plant material (Typha). ***A**: macroscopic images; brackets indicate the working edge, while the circle indicates the location of polish seen in 'b.' **B**: polish; x200 magnification. **C**: a medium extent of edge rounding; Dino-Lite x50 magnification.*

6.2.4.7 Porcelain: Meat (Lamb)

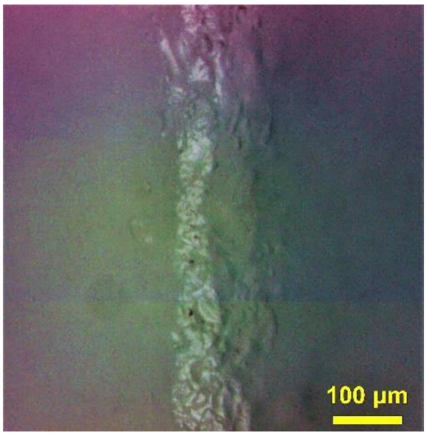
Although minimal, some use-wear was present on all three porcelain tools used for cutting and scraping meat (Table 44). On each tool striations were wide, few (n = 1–5), randomly orientated and on and near the working edge. Edge scars were absent on one tool and on the other two were scarce, less than 0.5 mm in mean length and width, orientated mostly perpendicular to and located on the edge, mainly in clusters and step-terminated. Polish and smoothing were observed on two tools and polish was dull to moderate in brightness, present on peaks and in valleys (Figure 65), on one tool-face more than the other and distributed as spots and streaks. Sa and Sq values indicate only minute differences in the roughness of the tool surface (Figure 65). On the one tool on which polish and edge scarring occurred in association, polish was more invasive.

Table 44 Use-wear on experimental porcelain tools used to cut and scrape fresh meat (lamb).

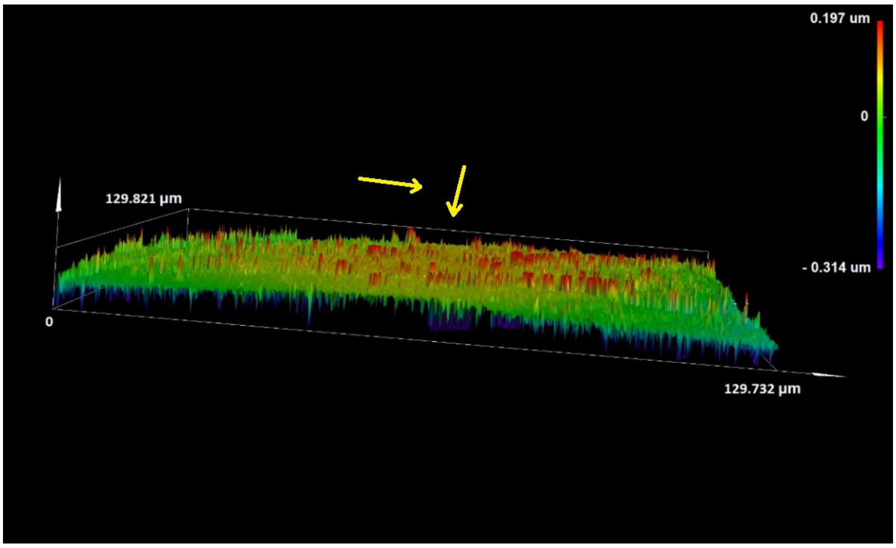
	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Tool Motion (then tool name; held angle; tool edge angle)	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
Cut and scrape; tool 1 X49 HA: 80–90 (cut) and 45 (scrape) TEA: 60	1–5	L	2	W	R	O & N	< 0.5	< 0.5	MPe	O	CC	MS	n/a	D	R	HL	MO	SS	ES < pol.	str., ES, pol.
Cut and scrape; tool 2 X51 HA: 80–90 (cut) and 45 (scrape) TEA: 73	1–5	L	2	W	R	O & N	< 0.5	< 0.5	MPe	O	CC	MS	n/a	D	S	HL	MO	SS	n/a	str., ES, pol.
Cut and scrape; tool 3 X50 HA: 80–90 (cut) and 45 (scrape) TEA: 68	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O	MC	MS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only



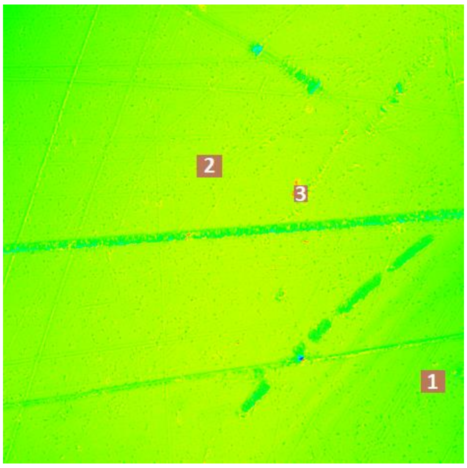
a



b



c



Sample	Polished or unpolished zone	Sq	Sa
1	Polished	0.045	0.026
2	Polished	0.033	0.019
3	Polished	0.103	0.077

d

e

Figure 65 Experimental porcelain tool X49, which was used to cut and scrape fresh meat (lamb). ***A****: macroscopic images; brackets indicate the working edge, while the circle indicates the location of polish seen in 'b.'* ***B****: polish; x200 magnification.* ***C****: 3-D contour map of elevations on the surface. A dull polish was present on this entire section of the surface, on high and low points; the far edge is the (part of the) working edge and the arrows indicate the approximate directions of tool-use.* ***D****: 2-D height map showing locations sampled for surface roughness.* ***E****: key for 'd.'*

6.2.5 Summary: The Experimental Assemblage

The following tables précis the comprehensive data provided above, to facilitate comparisons with the archaeological assemblage. Any consistencies and differences in use-wear characteristics are highlighted between the experimental chert, silcrete, glass and porcelain tools after the working of the same materials. Where a form of use-wear is not mentioned in the tables it is because it was absent. Because the present results complement current knowledge (as well as providing new evidence), each table should be interpreted with reference to earlier discussions, particularly Tables 4–6. 'ES' and 'ER' refer to edge scarring and edge rounding respectively.

Table 45 Précis of use-wear on experimental wood-working tools (E. camaldulensis)*.*

	Chert	**Silcrete**	**Glass**	**Porcelain**
Planing	*Dry wood:* ● Moderately bright polish on peaks only ● Low-density, wide, oblique striations ● Perpendicular ES *Fresh wood:* Same but no striations, and polish was slightly rougher	*Dry wood:* ● Moderately bright, smooth polish on peaks only ● Low-density, wide, perpendicular and oblique striations ● Perpendicular ES *Fresh wood:* Same but no striations	n/a (solely scraping and sawing conducted)	n/a (solely scraping and sawing conducted)
Scraping	*Dry wood:* ● Moderately bright polish on peaks only ● Low-density, wide, perpendicular striations ● Perpendicular ES ● Medium extent of ER *Fresh wood:* Same as for dry wood	*Dry wood:* ● Moderately bright, rough polish on peaks only, primarily on one artefact face and as a band on artefact edge ● Low-density, wide, perpendicular and oblique striations *Fresh wood:* Same as for dry wood	*Dry wood:* ● Moderately bright, smooth polish on peaks only, mostly unifacial ● High-density, wide, perpendicular and oblique striations, mostly unifacial ● Oblique ES ● Occasionally a medium extent of ER *Fresh wood:* Same except polish was smooth or rough, and there were fewer striations	*Dry wood:* ● Moderately bright, smooth or rough polish on peaks only ● Moderate to high-density, wide, perpendicular and oblique bifacial striations on and near edge ● Occasionally a medium extent of ER *Fresh wood:* Same except polish was smooth each time and ER was common

<table>
<tr><td>Sawing</td><td>Dry wood:
• Moderately bright, bifacial polish on peaks only
• Low-density, wide, parallel striations
• Parallel ES
• Low extent of ER
Fresh wood:
Same as for dry wood</td><td>Dry wood:
• Moderately bright, smooth polish on peaks only
• Low-density, wide, mostly parallel striations
• Parallel ES with mostly step terminations
Fresh wood:
Same but also occasionally a low extent of ER</td><td>Dry wood:
• Moderately bright or slightly dull, smooth polish on peaks
• High-density, bifacial, wide, parallel and oblique striations
• Parallel or oblique ES, hinge/feather termination
• Occasionally a low extent of ER
Fresh wood:
Same, except polish was smooth or rough and there were fewer striations</td><td>Dry wood:
• Moderately bright, rough or smooth polish on peaks only, less invasive than ES
• Moderate-density, bifacial, wide, striations mostly parallel
• Parallel or oblique ES
Fresh wood:
Same, except polish was smooth each time and ER was common</td></tr>
<tr><td>Chopping</td><td>Dry wood:
• Low-density, unifacial, wide, perpendicular striations
• Perpendicular ES with step terminations
• Low extent of ER
Fresh wood:
• ES only (and feather terminations)</td><td>Dry wood:
• Moderately bright, bifacial, smooth polish on peaks only
• Low-density striations, wide, perpendicular and far from edge
• ES larger, step terminations
Fresh wood:
Same</td><td>n/a (solely scraping and sawing conducted)</td><td>n/a (solely scraping and sawing conducted)</td></tr>
<tr><td>Adzing</td><td>Dry wood:
• Low-density, bifacial, wide, perpendicular striations
• Bending-initiated scars on thin edge
Fresh wood:
• Moderately bright or dullish, smooth unifacial polish on peaks only</td><td>Dry wood:
• Moderately bright or slightly dull, unifacial polish on peaks only
• Low-density, perpendicular, wide striations
• Perpendicular ES
Fresh wood:
Same but no striations</td><td>n/a (solely scraping and sawing conducted)</td><td>n/a (solely scraping and sawing conducted)</td></tr>
<tr><td>Wedging</td><td>Dry wood:
• Moderate-density, wide, bifacial perpendicular striations
• Isolated ES with step and hinge terminations
Fresh wood:
Same except for reduced striation density and ES is more clustered</td><td>Dry wood:
• Moderately bright, rough, bifacial polish on peaks only
• Low-density, perpendicular striations far from edge, mostly wide
• Random ES orientations
Fresh wood:
Same</td><td>n/a (solely scraping and sawing conducted)</td><td>n/a (solely scraping and sawing conducted)</td></tr>
</table>

Table 46 Précis of use-wear on experimental bone-working tools (kangaroo).

	Chert	**Silcrete**	**Glass**	**Porcelain**
Scraping	*Dry bone:* ● Moderately bright, smooth polish on peaks only and mostly one face ● ES more invasive than polish ● Low-density, perpendicular, mostly wide striations near edge ● Large ES with abrupt terminations *Fresh bone:* Same except no striations or ER	*Dry bone:* ● Moderately bright, smooth polish on peaks only and mostly one face ● Polish more invasive than ES ● Low-density, perpendicular striations on edge, mostly narrow ● Large ES with feather terminations ● Low extent of ER *Fresh bone:* Same	*Dry bone:* ● Moderately bright, smooth polish on peaks only and mostly one face; occurs as a band on the edge ● Low-density, wide, perpendicular and oblique striations on and near edge ● ES perpendicular, on and near edge, hinge and feather terminations ● Low extent of ER *Fresh bone:* Same	*Dry bone:* ● Moderately bright, smooth polish on peaks only and mostly one face and occurs as a band on the edge ● ES more invasive than polish ● High-density, narrow, perpendicular and oblique striations near and far from edge ● Large ES, most perpendicular with abrupt terminations ● Low extent of ER *Fresh bone:* Same except polish is occasionally rough and pitted, while extent of ER is medium
Sawing	*Dry bone:* ● Moderately bright, smooth, bifacial polish on peaks only ● Low-density, oblique, mostly wide striations near the edge ● Low extent of ER ● Often several scars with bending fractures and minute fractures within the scars *Fresh bone:* Same except even lower-density striations, and no polish nor edge rounding	*Dry bone:* ● Moderately bright, smooth, bifacial polish as isolated spots and on peaks only ● Large, mostly parallel ES with hinge and feather terminations ● Often several scars with bending fractures and minute fractures within the scars *Fresh bone:* ● Polish is the same except in that it occurs as a band away from the edge ● Striations were present, at a low-density, wide, parallel, bifacial and near the edge	*Dry bone:* ● Moderately bright, smooth, bifacial polish on peaks only, distributed as spots or spots and streaks, less invasive than ES ● High-density, bifacial, wide, parallel and oblique striations ● Parallel and oblique ES, with hinge or feather terminations ● Often several scars with bending fractures and minute fractures within scars *Fresh bone:* Same	*Dry bone:* ● Moderately bright or slightly dull, smooth, bifacial polish on peaks only, occurring as a band on the edge ● ES more invasive than polish ● High-density, narrow, parallel and oblique striations on and near the edge ● Large ES scars, mostly oblique, with mostly step terminations ● Low extent of ER ● Often several scars with bending fractures and minute fractures within *Fresh bone:* Same except polish is occasionally rough and pitted

Table 47 Précis of use-wear on experimental fresh hide-working tools (cow).

	Chert	**Silcrete**	**Glass**	**Porcelain**
Scraping	• Moderately bright, rough, unifacial polish on peaks and in valleys and distributed as a band on the edge • Medium to high extent of ER	• Moderately bright, rough, unifacial polish on peaks and in valleys and distributed in isolated spots, including depressions caused by edge rounding • Medium to high extent of ER	• Moderately bright, rough, unifacial polish on peaks and in valleys and distributed as a band on the edge • Polish is more invasive than ES • Striations are rare but wide, perpendicular and oblique • ES is rare but mostly perpendicular with feather terminations • Mostly a high extent of ER, but occasionally it is medium	• Dull to moderately bright, rough, polish on peaks and in valleys and distributed as spots and streaks • Striations are rare but are mostly wide and rough-bottomed but with some sleeks • Medium extent of ER

Table 48 Précis of use-wear on experimental plant-working tools (Typha)*.*

	Chert	**Silcrete**	**Glass**	**Porcelain**
Range of Motions	• Striations are rare but bifacial, wide, randomly orientated and near and far from the edge • Low extent of ER	• Bright polish • Striations are rare but wide and randomly orientated • Low to medium extent of ER	• Bright, mostly smooth but occasionally rough polish, sometimes domed, with varied distributions • ES is rare, small and mostly perpendicular, with feather terminations • Striations are rare but narrow or wide and randomly orientated	• Bright, mostly smooth polish on peaks and in valleys, mostly on one face and distributed as spots and streaks or a band on the edge • Polish is more invasive than ES • Low-density, unifacial, wide striations with random orientations • ES is rare and small • Medium extent of ER

Table 49 Précis of use-wear on experimental meat-working tools (lamb).

	Chert	Silcrete	Glass	Porcelain
Range of Motions	No wear detected	No wear detected	● Dull, smooth, poorly developed bifacial polish on peaks and in valleys, distributed as spots and streaks ● Polish is more invasive than ES ● Occasional, bifacial, wide striations, near and far from working edge, with random orientations ● ES is rare, small and mostly with abrupt terminations	● Dull, smooth, poorly developed polish on peaks and in valleys, distributed as spots and streaks and generally more on one face than another ● Occasional wide striations on and near the edge, with random orientations ● ES is rare, small and mostly perpendicular, with abrupt terminations

6.3 Chapter Summary

Results presented in this chapter provide an extensive basis for building on previously published experimental wear patterns and for interpreting use-wear on tools in the Calperum Station archaeological assemblage. Information from the trampling experiment can be used to make inferences about potential trampling traces on the archaeological artefacts and to support related decisions made during the screening process to select artefacts for detailed use-wear analysis. Data from the actualistic experiments using chert, silcrete, glass and porcelain to work a variety of materials with a range of tool motions complemented existing knowledge by incorporating the locally available tool stones (chert and silcrete) at the Station and by adding new data about use-wear on bottle glass and porcelain flakes, struck from insulators.

The most prominent pattern emerging from the tool-use experiments was that when use-wear was present it was invariably so in multiple forms. Several use-wear traits also became evident that, in conjunction with others, aid distinctions between worked materials and tool motions. After using tools with transverse motions, including scraping, planing and adzing, use-wear was typically orientated perpendicular in relation to the working edge. After the parallel tool motions of cutting and sawing, use-wear was consistently orientated parallel. Oblique use-wear was also occasionally present after transverse and parallel tool motions.

Chapter Seven: Discussion, Experimental Assemblage

This chapter discusses the interpretations from the use-wear analysis of the flakes from the trampling experiment, tool-use experiments and on-site demonstration by the TOs. Wear traits that emerged on flakes from the trampling experiment are investigated in terms of how they can aid detection of trampling and potentially other taphonomic processes among the archaeological assemblage. Use-wear on flakes from the tool-use experiments is then discussed for each tool raw material and experimental use, in terms of characteristics that can be used to assist diagnoses during examination of the archaeological assemblage. Comparisons are made with known use-wear traits from corresponding tasks undertaken in previous experimental studies. The chapter concludes with a summary of the use-wear from the tool-use experiments.

7.1 Trampling Experiment and Taphonomy

No conclusive macroscopically observable evidence of trampling emerged from the trampling experiments. The best macroscopic indicator of trampling in many assemblages may be a high proportion of flake breakage (Douglass and Wandsnider 2012:353, 356, 359; Eren et al. 2010; McBrearty et al. 1998:114). However, there is no fixed proportion of breakage that is widely accepted as 'high,' and in my experiment a quarter (n = 10) of the flakes broke. Further, flake movement within the sediment does not appear to be a consistently reliable indicator of trampling. Although trampling can cause such movement (Cahen and Moeyersons 1977; Richardson 1992), flakes can also move within the sediment as a result of natural processes (O'Connell and Allen 2004). In my trampling experiment, horizontal or vertical displacement was rare and any distances were minimal (a similar finding to that of Marwick et al. 2017). Of the less than a quarter of flakes that moved horizontally (n = 9), five had moved 1 cm and the furthest was 8 cm. Similarly, only five flakes were forced beneath the surface and on each occasion recovered from depths of 1 cm. Flake raw material was not a factor in influencing movement because there was no outstanding related pattern. Despite the overall minimal effect of trampling on flake movement, a particularly notable result was that every trampled flake became at least partially pressed into the surface. Yet even this is not a definitive indicator of trampling. As per earlier discussion, West Woolpolool is eroding (this was clearly apparent upon field observations over several seasons), so any embeddedness of artefacts may represent their gradual exposure from earlier burial or partial burial rather than trampling.

In contrast, microscopic analysis produced indicators of trampling wear. Two outstanding characteristics emerged: (i) striations and edge scarring were usually isolated and randomly distributed; and (ii) striations were always located either near or far from (mostly far from), but never on, the working edge. Further, there was no polish, smoothing or edge rounding on a single flake. Isolation and non-patterned distribution and orientation of edge scarring and other forms of wear are consistent with observations from many previous trampling experiments, including on chert (Shea and Klenck 1993; Tringham et al. 1974), chert and chalcedony (Rots and Williamson 2004), obsidian (Nielsen 1991), quartz and quartzite (Lemorini et al. 2014). This result informed an aspect of the analysis of the archaeological assemblage in that any artefact that displayed only isolated and randomly distributed wear was ascribed a ‘low confidence’ level for it having been used (other contextual factors were also considered). While the two characteristics described (plus the absence of polish, smoothing and edge rounding on all trampled flakes) are not themselves entirely diagnostic of trampling, because they may also appear on artefacts that were used by humans, they may serve as indicators when combined with contextual considerations.

Wear formed on almost all trampled flakes that moved but also on several that did not. Of the nine flakes that moved horizontally, the combination of striations and edge scarring was present on three: T3, T9 and T21, that moved 1 cm, 4 cm and 5 cm respectively. Edge scarring was the only form of wear on five flakes: T16, T22 and T34, each of which moved 1 cm; T4, that moved

2 cm; and T12 that moved 8 cm. No wear was identified on T17, which moved 1 cm. These results demonstrate that wear did not occur in the same forms or in quantities proportionate to the distances of movement. Wear was also present on several flakes that did not move horizontally or vertically: on T5, T15, T28 and T33 edge scarring was present, while on T27 striations and edge scarring were observed and on T36 there were striations. Of the five flakes that moved vertically (each 1 cm downwards), T23, T24 and T25 displayed striations and edge scarring, while no wear was observed on T1 or T11.

As a result, it is clear that wear on trampled flakes can be caused by abrasive contact with sediment even when there is no discernible or measurable movement of the flake from its original position (as per, e.g., Douglass and Wandsnider 2012:359; Hayes et al. 2018:100; Shea and Klenck 1993:187). It is also evident that such abrasive contact does not always result in wear (as per, e.g., Driscoll et al. 2015; Eren et al. 2010:3019). It is impossible to control all variables in trampling experiments, but future attempts may inform further about the potential influences of other factors on the development and nature of trampling wear, such as the weights and gaits of the tramplers, the types of footwear (e.g., even the abilities of different footwear to retain grit) and varied moisture levels in the given substrates.

7.2 Tool-use Experiments

One of the most telling results to emerge from the analysis of the experimental tool-use assemblage was that whenever there was any use-wear, three or four of the four main forms were commonly present. This was the case across all tool raw materials, tool motions and worked materials. Such an outcome does not suggest that the many previous analyses that have inferred use-wear on the basis of the presence and nature of fewer forms of use-wear are less accurate or robust. Rather, it indicates that the presence of several attributes is cause for high confidence for artefact usage and that 40 minutes of working tools is typically ample time for use-wear to develop, at least for the experimental tasks performed. Consequently, it is implied that archaeological artefacts used under similar circumstances that exhibit several or all forms of use-wear were not necessarily used for longer time periods. They may also have been used for shorter periods. In this manner, the experiments demonstrated the principle of middle-range theory where approximating archaeological conditions can assist interpretations of past behaviour. Previous experiments have regularly demonstrated that use-wear can form in less than 30 minutes (often after 5–15 minutes) when working a range of materials, such as various kinds of wood, grasses, palms, faunal bone and certain meats, using tools manufactured from obsidian (Kononenko 2011:38–39; Walton 2019:914–921, 924, 927–928, 930, 933–934, 937) and various types of stone (Clemente-Conte et al. 2015:71; Lemorini et al. 2019:4732; Pedergnana and Ollé 2017:47–52).

7.2.1 Experimental Chert Tools

7.2.1.1 Chert: Dry Wood (E. camaldulensis)

Use-wear on experimental chert tools used to work dry wood was consistent with that observed in previous experiments cited earlier. Striations were consistently low in density in relation to the tool surface area, always wide and present on and/or near the working edge. Their orientations corresponded with the parallel and transverse tool motions, with oblique striations occasionally present after either tool motion. The presence, on these experimental tools, of a number of edge scars with bending initiations is typical after adzing wood using a thin-edged tool with a low edge angle (Cotterell and Kamminga 1987:691). Bending initiations can also occur during other tool motions but their presence on only the adzing tool was almost certainly because this was the only tool with a particularly low edge angle (< 30º). Chopping and wedging dry wood has produced larger edge scars in earlier experiments (Kamminga 1982:63–64), but the prevalence of step terminations following these motions using the current experimental tools is again typical (Keeley 1980). Edge rounding was slightly more intense after scraping and planing (medium extent) than after sawing or chopping (low extent), but not all transverse motions produced edge rounding (none was observed after adzing).

The formation of polish and smoothing predominantly on one face of tools used to work wood with transverse motions is consistent with such directions mostly involving only one face coming into hard contact with the worked material. Similarly, the bifacial presence of polish and smoothing following the sawing of dry wood is consistent with the fact that for this movement the tool was held at a near 90º angle to the wood, allowing both faces to receive an approximately equal amount of hard contact with the wood. The presence of polish exclusively on high points of the microtopography was characteristic of numerous wood-working experiments (Hayes et al. 2014:85; Kimball et al. 2017:67; Rutkoski et al. 2020:40). Of particular note for the working of dry wood with chert tools is that use-wear was always present in at least three of the four major forms.

7.2.1.2 Chert: Fresh Wood (E. camaldulensis)

Similarities in aspects of use-wear on chert tools after the experimental working of dry and fresh wood are unsurprising in light of past experiments (Keeley 1980). In the current experiments, after processing either dry or fresh wood, striations were not abundant, regardless of tool motion, and their orientations corresponded with tool motions (parallel and transverse). Whenever striations were present they were on or near the working edge. Keeley (1980:36) and Hayden and Kamminga (1973:6) observed that fresh wood-working typically produced smaller edge scarring than dry wood-working, which may be expected given the principle that softer worked materials are typically more deeply penetrable by a tool and that fresh wood is often softer than dry wood. However, the mean widths and lengths of edge scars in the present experiments remained unchanged across dry and fresh wood, probably because of other variables, such as force applied by the wood-worker.

Subtle differences occurred in other aspects of edge scarring. After wedging dry wood, scars were mostly isolated, whereas wedging fresh wood produced mostly clustered scars. After adzing dry wood, axial terminations predominated, whereas after the same tool motion was applied to fresh wood, feather terminations were the most common variety. Edge rounding occurred to similar extents following dry and fresh wood-working, with minor variations across some tool motions.

Polish and smoothing characteristics were also similar after dry and fresh wood-working and with findings from previous experiments. For Keeley (1980:36), the different states of wood did not alter the development and nature of polish and smoothing and the same applied here. Polish and smoothing were present in the current experiments on the high points of the microtopography, which was also the case for Hayes et al. (2014:85), Kimball et al. (2017:67) and Rutkoski et al. (2020:40). During my experiments, wood-working polish was mostly distributed as a continuous band along the tool's working edge, a similar result to that obtained by Fullagar (1986a:180).

7.2.1.3 Chert: Fresh and Dry Bone (Kangaroo)

Bone is generally denser and much more resistant than wood (Keeley 1980:44) and the experimental use-wear results for both fresh and dry bone reflect this. The density of bone rendered futile all preliminary experimental attempts at chopping, wedging and adzing this material using such small tools (typically around 2.5 x 2.5 x 1 cm). This ineffectiveness was conceivably the same reason that most Aboriginal peoples, according to observations discussed earlier, appear to have preferred to predominantly scrape and saw this material. Striations and edge scar orientations from the experiments in this thesis were as expected: transverse for scraping and primarily parallel for sawing. The occasional oblique use-wear after sawing was probably due to unwitting, slight variations in the edge angle implemented and the fact that sawing itself did not always require precisely parallel motions. The narrow striations after scraping and sawing bone were particularly distinctive because, throughout the experiments across all other worked materials, striations were almost always wide. The regular edge rounding observed here was also identified by Kamminga (1982:51) and Kimball et al. (2017:68).

Other use-wear was distinctive to bone-sawing. The occasional micro-fracturing within bending scars after sawing is particularly diagnostic (Kamminga 1982:48–49) and step terminations are common (Kamminga 1982:48–49; Keeley 1980:44; Stevens et al. 2010:2675). Bone polish was slightly duller than that produced by wood-working, albeit in the same classification of moderate-bright, and sometimes contained tiny (≤ 2 μm) pits in its surface, as observed by Keeley (1980:43) and Fullagar (1986a:188).

7.2.1.4 Chert: Fresh Hide (Cow)

The absence of striations on experimental chert tools used to scrape hide was similar to observations made by Keeley (1980:50) and Mansur (1982:216). Kamminga (1982:31–36) also observed a lack of striations after a range of tasks involved in the butchering of kangaroo, including hide-scraping, skinning, 'light-duty' butchering (forequarters and hindquarters), 'heavy-duty' butchering (tail chopping) and cutting the meat. Lemorini et al. (2019:4740, 4745) detected occasional striations, though they used fenetized andesite and rhyolite tools, rather than chert. Edge scarring was also absent after I scraped hide using a chert tool. Similarly, Keeley (1980:50) and Mansur (1982:216) found that edge scarring on chert tools, used for the same task, was infrequent and minute when present. The extent of edge rounding identified in my experiments after the scraping of hide was higher than after the working of any of the other materials (as it was on the experimental silcrete, glass and porcelain hide-scraping tools). Markedly rounded edges were observed for the same activity by Fullagar (2014:249), Keeley (1980:50), Kimball et al. (2017:64, 66–67, 70), Lemorini et al. (2019:4740, 4745) and Stevens et al. (2010:2675). Polish was duller than that on wood-working and bone-working tools, probably because there is more moisture in fresh hide to act as a polishing agent.

7.2.1.5 Chert: Plant (Typha)

The random orientations and bifacial presence of striations observed after the processing of *Typha* are consistent with the application of multiple tool motions (cutting and scraping). Processing plant material does not always produce edge scarring (Stevens et al. 2010:2675) and the absence of scarring in this experiment is probably because most of the *Typha* reeds are soft. Although *Typha* has no phytoliths (Wallis 2003:211), polish was observed on this chert tool and all other experimental plant-processing tools. This is because plant silica is not the only factor involved in polish formation. Other polishing agents, such as water (Fullagar 1991:19; Hurcombe 1992:59), were intentionally involved in the experiments so as to approximate the conditions of the archaeological site.

7.2.1.6 Chert: Meat (Lamb)

The absence of use-wear on the chert tool used to cut and scrape meat is not unusual, with mixed results existing among the previously described experiments (Kamminga 1982:34–36; Keeley 1980:53; Kimball et al. 2017:67–68; Kirgesner 2019:4–5; Pawlick and Thissen 2017:106–107). While a range of factors influence the potential of tool edges to become rounded, such as the tool edge angle, the quantity of any lubrication and/or grit between the surfaces of the tool and worked material, as well as tool grain sizes (Fullagar 2014:249; Kamminga 1982:17; Lerner 2007; Lombard 2005:285), previous experiments and analyses have demonstrated that after processing meat, edge rounding is commonly absent or rare (Fullagar 1986a:187; Kamminga 1982:34). Similarly, striations are seldom present (Kirgesner et al. 2019:5; van Gijn 2010:63) and edge scarring is infrequent and minimally developed (Keeley 1980:24–25, 55; Kirgesner et al. 2019:5; van Gijn 2010:63).

Mixed results have been obtained in previous experiments for the presence of polish and smoothing after using chert tools to process meat. Kamminga (1982:34–36) and Kimball et al. (2017:67–68) found that polish and smoothing were rare, while Kirgesner et al. (2019:4) observed that they were common. Differences may be attributable to variations between the experiments in the amount of sand, grit or polishing agents, or to extents with which tools were able to penetrate the worked material. Fresh meat, experimentally processed by Kamminga (1982:34–36) and Kimball et al. (2017:67–68), is softer and therefore more penetrable than the frozen meat processed by Kirgesner et al. (2019:4). However, Kirgesner et al. (2019:4) also observed polish and smoothing on tools used to work fresh meat, adding complexity to the potential reasons for the differences in the formation of polish and smoothing that may only be resolvable through further experimental meat-processing studies.

7.2.2 Experimental Silcrete Tools

7.2.2.1 Silcrete: Dry and Fresh Wood (E. camaldulensis)

Use-wear characteristics on silcrete tools were similar after the working of dry and fresh wood with a variety of tool motions, as was the case for chert tools used for the same tasks. Striation characteristics were very similar across silcrete and chert wood-working tools. Transverse tool motions resulted in mostly perpendicular and occasionally oblique striations. The presence of some oblique use-wear after sawing is unsurprising (as applied for the chert tool used for this task) given that this motion at times requires slight twisting of the tool within the sawn groove. Nonetheless, after predominantly parallel motions, parallel striations were common on both silcrete and chert. Edge scarring was more often clustered on silcrete and the feather termination on the silcrete tool used for adzing dry wood is expected rather than the bending-initiated and axial-terminated scars seen on the thin-edged chert adzing tool, because the silcrete tool edge was more obtuse. The microtopography of the zones with polish and smoothing appears more influenced by the density, moisture content and hardness of the worked material than by the edge angle of the tool margin. Both the dry and fresh wood were denser than softer plants and meat, and the polish and smoothing were present exclusively on high points for the silcrete as well as the chert—in contrast to their presence typically on both high and low microtopographic points after working softer materials, as discussed below.

Comparability between the use-wear on not only the experimental but also the archaeological silcrete tools in this thesis with the use-wear observed on silcrete tools by Kamminga (1982) is useful, but limited. The only motions for wood-working using silcrete tools in my experiments that are comparable to those used by Kamminga (1982) are chopping, sawing and scraping (Kamminga also adzed wood but using a haft, whereas mine were hand-held). Further, polish and striation characteristics are not comparable because, in the absence of a metallographic microscope, Kamminga (1982) could not observe fine details of these features. After chopping wood, Kamminga (1982:148; tools #256–258) observed large, step-terminated edge scars, some hinge-terminated scars and no edge rounding. After my chopping experiments I also observed predominantly step-terminated scars and no edge rounding, but there were also striations on one tool and striations and polish on another. Kamminga (1982:154; tool #288) observed bending fractures along most of the edge of the tool he used to saw wood, along with moderate edge rounding on prominences. Bending fractures were fewer on tools from my sawing experiments, and on one of my sawing tools there was no edge rounding while on the other there was a low extent. I also observed striations and polish. After scraping wood with hand-held silcrete tools, Kamminga (1982:161–162; tools #343–345) macroscopically observed visible edge scars, but none were visible microscopically. There were also small areas of abrasive smoothing, and some prominences between fractures became rounded (Kamminga 1982:161–162). After undertaking the same task, I did not observe any edge scarring but there was a medium extent of edge rounding, as well as striations and polish.

The similarities in the use-wear across chert and silcrete wood-working tools from my experiments suggest that, in these cases, the use-wear is affected more by the tool motions and worked materials than by the different stone raw materials. This is somewhat unexpected given the earlier discussion of the differences in use-wear resulting from experiments on tools made from quartzite (which shares similar properties with silcrete) (Pedergnana and Ollé 2017). In particular, the more frequent presence of polish and smoothing on silcrete tools used to work dry wood (six of six tools) than on chert dry wood-working tools (three of six tools) is surprising because quartz crystals in the matrix of silcrete are harder, which suggests that they may be less likely to be polished and smoothed (yet they were polished and smoothed). The increased frequency of smoothing on the silcrete wood-working tools compared to the chert tools may be attributable to a coincidentally greater abundance of sand, grit and other smoothing agents during the silcrete experiments. The broad similarities between the use-wear on the experimental chert and silcrete tools may be because both raw materials were fine-grained (as per criteria in Webb and Domanski 2008:557).

7.2.2.2 Silcrete: Fresh and Dry Bone (Kangaroo)

Scraping and sawing dry bone with silcrete tools produced use-wear that could be reasonably expected from the attrition that occurs during the working of a hard material (Akoshima 1987; Keeley 1980:42–44; Kamminga 1982:48, 51; Kimball et al. 2017:68; Stevens et al. 2010:2675). Few differences existed across chert and silcrete tools in the nature of use-wear after scraping and sawing dry bone. The presence of narrow striations on both kinds of stone, rare in these experiments after working materials other than bone, supports Keeley's (1980:43) observation for chert. Distinctive bending fracture scars with micro-fracturing within were present on the silcrete tool used to saw bone. This characteristic is consistent with Kamminga's (1982:48–49, 136–137; tools #166–167) results on silcrete tools used to saw bone (discussed earlier, including Table 7), as well as with my experimental chert bone-sawing tool—although it was not observed by Pedergnana and Ollé (2017:51, 55) on quartzite tools used for the same task. Occasional differences existed in the use-wear on my chert and silcrete bone-working tools, such as the slightly greater size of the edge scarring on chert. However, these variations are minor and the primary aim of the chert and silcrete experiments was not to compare the use-wear between the two kinds of stone, but to determine whether the use-wear was generally consistent with the broad base of existing knowledge and to compare the experimental use-wear to any on the same raw materials in the archaeological assemblage.

Fresh bone is still a relatively dense, hard material so the similarity with the use-wear after the working of dry bone with a silcrete tool was expected. For example, relatively large edge scars were produced as a result of fresh bone-working. The directionality of the use-wear consistently reflected the tool motions, and characteristic bone-working attributes were again present: frequent axial terminations for bending scars and occasional minute fractures contained within these scars (Kamminga 1982:48–49); and pitting in the polish (Keeley 1980:43). Pitting may be the result of dissolving bone apatite crystals during cleaning with hydrochloric acid (Keeley 1980:43). The presence of polish and smoothing exclusively on high microtopographic points was quantified with the use of the LSCM and the related 3-D contour map, and unsurprising given that the hardness of bone makes hard contact between the bone and the tool microtopographic valleys difficult. As was the case for all experimental tools on which surface roughness was sampled, the Sa and Sq values showed negligible difference between the roughness of the parts of the tool surface on which polish developed.

7.2.2.3 Silcrete: Fresh Hide (Cow)

Use-wear on the silcrete tool used to scrape fresh hide was essentially the same as that on the chert tool and mostly typical according to previous studies of hide-working using a range of tool raw materials (Conte and Romero 2008:256–257; De Angelis 2014:30; Hurcombe 1992:45–46; Keeley 1980:49–50; Kimball et al. 2017:64, 66–67, 70; Lemorini et al. 2019:4740, 4745; Mansur

1982:216; Stevens et al. 2010:2675). Use-wear on two silcrete tools used by Kamminga (1982:41–42, 123; tools #65–66) to de-flesh fresh kangaroo skin is less comparable. On one tool (#65) there was 'very modest edge rounding' and some edge fracturing, but, for Kamminga (1982:123), both features were so unobtrusive that if present on an equivalent archaeological tool they would not normally be identifiable. On the other silcrete skinning tool (#66) there was 'edge rounding and blunting on the spurs between bending fractures' (Kamminga 1982:123).

However, as discussed earlier, silcrete shares many properties with other quartzose stones, and aspects of use-wear observed on quartzite tools used experimentally by Pedergnana and Ollé (2017:49–50) to scrape hide are similar with the traits on my experimental silcrete tool. In both cases, striations, polish and edge rounding were present. I observed no edge scarring, while Pedergnana and Ollé (2017:49–50) identified a minimal quantity. In each experiment, the polish was rough in texture and its presence in small depressions on my experimental tool has also previously been known to occur on chert tools used for hide-scraping (Keeley 1980:50). A medium rather than high extent of rounding may have developed on my experimental tool because it was rarely dropped into the sandy substrate, thereby minimising the amount of abrasive agents. The parallel, rather than perpendicular orientation of the striations on my experimental tool may be the result of the occasional unwitting application of a sawing motion.

7.2.2.4 Silcrete: Plant (Typha)

The varied directionality of the use-wear on the silcrete tool after plant-processing is expected given the use of both cutting and scraping motions. Similarly, the bifacial presence of both the striations and polish is consistent with the considerable contact applied to both faces of the tool during the combined application of these tool motions. While variations occur across plant species and tool raw materials, the presence of striations, edge rounding and polish and smoothing is common after the processing of various kinds of plant material—and edge scarring, though not present on this occasion, is also known to occur (Kononenko 2011; Luong et al. 2019:11; Ulm et al. 2009:114). The polish was brighter than that present after the working of other materials in these experiments and its presence on the high and low points of the microtopography is unsurprising given that the softness of this plant, in comparison to most wood, bone and other materials, facilitates deeper contact from the tool.

7.2.2.5 Silcrete: Meat (Lamb)

The absence of use-wear after experimentally cutting and scraping meat using silcrete is the same as the case for the chert meat-working tool. However, this absence of use-wear does not imply that any archaeological artefact on which no use-wear was detected was used to process meat. Rather, any such artefact may have been used for insufficient time for use-wear to occur, or not used at all. It has also been previously demonstrated that meat-processing can indeed lead to observable use-wear, even if in limited quantities, on silcrete (Kamminga 1982:35, 118, 120), quartzite (Pedergnana and Ollé 2017:49, 55) and other tool raw materials, such as chert and glass/obsidian (Aoyama 1995:13; Hurcombe 1992:43–44; Kamminga 1982:34–35; Keeley 1980:24–25, 55; Kimball et al. 2017:67–68; Kirgesner et al. 2019:5). For example, on a silcrete tool used to chop kangaroo tail, Kamminga (1982:120; tool #44) observed moderate blunting along the entire working edge.

7.2.3 Experimental Glass Tools

7.2.3.1 Glass: Dry and Fresh Wood (E. camaldulensis)

Glass proved to be highly effective for working most materials because of its sharpness. Anecdotally, body shards were as, or more effective than, those from bottle bases provided that they were at least around 0.5 cm thick, because of their regularly sharper edges and relative ease of holding—

supporting the observation by Wolski and Loy (1999) of the often underestimated utilitarian value ascribed to non-base shards. As was the case on the chert and silcrete tools used for the same tasks, a pattern of commonality existed in the use-wear after using glass tools to saw and scrape both dry and fresh wood. Such consistency adds further weight to the possibility that the kind of wood affected the use-wear less than did the tool motion.

Striation and edge scarring characteristics were similar across the stone and glass used to work wood, albeit not without some differences. On each tool raw material after all relevant wood-working tool motions, striations were wide and their directions corresponded with the tool motions. However, many more striations were visible on glass because of the contrast with the smooth, almost featureless surface of moulded glass and fresh fractures. The surfaces of most stone materials are not as smooth and have many features, so this contrast is not as pronounced. Glass is less tough and scratches more easily, which probably also accounts for the more frequent observation of oblique striations on glass after both sawing and scraping. Abrupt edge scar terminations were slightly more common on glass after wood-working than they were on chert or silcrete wood-working tools, and oblique, rather than solely parallel use-wear, inclusive of edge scarring, was slightly more often present after sawing with glass than after the same motion using either kind of stone. While oblique use-wear across stone and glass wood-working tools tended to occur marginally more regularly after the use of transverse motions, it is evident that obliqueness is not uncommon after parallel tool movements.

Polish and smoothing characteristics on glass tools used to scrape and saw dry and fresh wood were also similar with those on chert and silcrete tools used for the same tasks. On each occasion, the polish was interpreted as ‘moderate-bright’ in brightness and, along with abrasive smoothing, observed on the high points of the tool microtopography. Polish textures were smooth on chert and glass tools used to saw and scrape both kinds of wood, but rough on the silcrete scraping tools. The invasiveness of polish and smoothing varied on glass and was not often able to be recorded for scraping and sawing using chert and silcrete because the edge scars and polish were not always present in direct association. However, when recordable, edge scarring was typically more invasive than polish across tool raw materials and tool motions, regardless of whether the wood was dry or fresh. Kamminga (1982:82) also found that use-wear patterns were similar on chert tools after sawing dry and fresh wood, as did Keeley (1980:35–36) across a range of tool motions. Keeley (1980:36) did, however, observe less polish and smoothing after the working of dry wood because this material was harder than fresh wood and therefore more resistant to penetration by a tool.

7.2.3.2 Glass, Dry Wood Scraped by Traditional Owners for Demonstration

TJ and PJ used the flaked glass as 'finishing tools' for smoothing wood and the formation of use-wear after their brief use-durations supported past experiments that demonstrated the formation of use-wear after as little as five minutes (e.g., Walton 2019:914–921, 924, 927–928, 930, 933–934, 937). However, it is notable that PJ worked his tool for two minutes and striations and edge scarring formed but polish or rounding did not, whereas TJ worked the wood for five to six minutes and all forms of use-wear formed. One tool each is too small a sample size to make robust conclusions about the rate of polish and edge rounding formation during this type of activity but future experiments could investigate this issue. Scraping undertaken for smoothing purposes only, rather than for contributing to the shaping of an item, is the same task reportedly undertaken by other Aboriginal peoples, as indicated in the oral histories discussed earlier (Beck and Somerville 2005:477; Harrison 2004:176). The varying orientations of edge scars on the shard used by PJ reflected the occasional minor adjustments he made with his tool orientation and motion, from perpendicular to slightly oblique angles. These variations appeared to be natural responses and adjustments to angles, pressure and wood surface variations that may have been typical of similar wood-working tasks in the past.

Cultural memories, knowledge and the wood-working demonstration shared by TJ and PJ provided valuable insights into and inferences about how their antecedents around Calperum Station used glass. This valuing of ethnographic information represents another invocation in this thesis of a core principle of middle-range theory (Binford 1977, 1978, 1987; Hodder 1982:155–161; Rowland 2014:4; Stemp et al. 2015:423–424; Tolstevin 2011). 'Finishing' or smoothing appears to have been a major purpose for TJ and PJ. Distinguishing between kinds of scraping may be difficult or impossible under use-wear analysis, but as a general principle it may be the case that scraping tools used for shaping an item display more extensive use-wear than finishing tools. Given the additional force and perhaps time required in scraping for shaping purposes, it may be expected that there would be a greater density and perhaps size of edge scars on scraping tools as compared to finishing tools (on which scarring is not desirous because it may interfere with the smoothing process).

While PJ described his antecedents' preference for using glass derived from thicker parts of bottles, his allusion to older bottles possessing thicker walls suggests that body shards, rather than solely bottle bases, were considered useful by his antecedents for working wood. This is in keeping with observations by Wolski and Loy (1999:69, 71), Harrison (2003:318) and McNiven et al. (2017:185–186) concerning the value placed on body shards. TJ's raising of the possibility that glass and stone tools were manufactured in the same locations over time provides some support for the contextual association of the artefacts retrieved for this study and for artefact production and/or use being intentionally conducted at this site because it was physically removed from the European gaze. TJ also alluded to the use of glass early after European arrival, inferring that old whisky and medicine bottles were potential sources of the material. Although some speculation was involved in these comments, they were informed by his and PJ's oral traditions and cultural knowledge.

7.2.3.3 Glass: Fresh and Dry Bone (Kangaroo)

Use-wear on glass was similar after sawing and scraping fresh and dry bone and consistent with the current results for the same experimental tasks using chert and silcrete tools. Use-wear was also consistent with that from previous experiments working bone with tools made from obsidian and other raw materials (Aoyama 1995:133; Hurcombe 1992:46–48; Kamminga 1982:48; Keeley 1980:42–44; Kimball et al. 2017:68; Stevens et al. 2010:2675; Walton 2019:927), establishing a well-informed basis for aiding the identification of bone-working in the archaeological assemblage. Distinctions in the use-wear resulting from wood-working and bone-working are also facilitated by several differences that emerged experimentally amid the otherwise existing pattern of commonality. Striations were often narrow after bone-working but not so after wood-working and were fewer in number. Even the rare wide striations that formed during bone-working, were, at typically 3–8 μm, narrower than those resulting from wood-working, which were commonly wider than 8 μm. Edge scars were larger and wider on glass tools after scraping and sawing dry bone compared to the same tasks on wood, with more randomly orientated and abrupt terminations. After sawing bone using glass (and other tool raw materials), bending scars with axial terminations and occasional micro-fractures within were again a particularly distinguishing feature. Bone polish and abrasive smoothing was similar to that resulting from wood-working but sometimes less developed and slightly duller, albeit still relatively bright. As was observed by Aoyama (1995:133) and Walton (2019:927) on obsidian tools, occasional pitting was present within the polish and smoothing on the glass tools used to saw and scrape bone. The overriding similarities in use-wear after the working of fresh and dry bone complicates the ability to confidently distinguish the use-wear between these bone varieties in an archaeological assemblage. However, consistent differences are evident after bone-working and wood-working.

7.2.3.4 Glass: Fresh Hide (Cow)

TJ and PJ again emphasised the importance of the sharpness of glass to both their antecedents' and their own ongoing use of glass tools. This knowledge contributed to the decision to prioritise the retrieval in the field of glass artefacts with sharp edges. The presence of only few striations and edge scars on the current experimental glass tools used to scrape fresh hide was to be expected given that fresh hide is relatively soft. However, a particularly distinctive use-wear attribute emerged after hide-scraping when compared to the nature of the same characteristic after the working of other materials: as was the case on the chert and silcrete hide-scraping tools, edge rounding typically occurred more frequently and to a particularly high extent. Aoyama (1995:132) and Hurcombe (1992:45–46) observed similar extents of edge rounding on obsidian hide-scraping tools.

7.2.3.5 Glass: Plant (Typha)

The random striation orientations on the experimental glass tools used to process *Typha* reflect the use of both cutting and scraping motions, while the presence of narrow rather than wide striations on two of the three tools is consistent with the observation by Walton (2019:914) of narrow striations on obsidian tools used to process similarly soft kinds of plant material. Elsewhere during the present experiments narrow striations were only observed after the scraping and sawing of bone. Their presence on the *Typha*-processing tools indicates that this characteristic, though rare, is not exclusively diagnostic of the working of a single material. Therefore, whenever narrow striations are present on archaeological tools, other use-wear attributes are required to contribute to distinctions. The particularly small sizes of the edge scars on the glass tools (classified in the smallest category of < 0.5 mm but often at the lower end of this scale), were similar to observations made by Kononenko (2011:39) for obsidian tools used to process relatively soft plants. Given the smallness of the edge scars, it is unsurprising that polish was more invasive on the tool where it was distributed as a band (≥ 11 μm wide) on the edge.

Congruent with this principle is the equal extent of invasiveness observed on the tool where polish was distributed as a thin line (≤ 10 μm wide) on the edge. The brighter nature of the polish after using glass to process plants, compared to other materials, is consistent with the brightness on chert and silcrete tools used for the same task, and a particularly distinguishing aspect of the polish on the glass used to process the *Typha* was the sharply distinct boundary between the polished and unworked surfaces. This feature is normally typical of the working of relatively hard plant materials (Luong et al. 2019:10).

7.2.3.6 Glass: Meat (Lamb)

TJ's and PJ's contributions again emphasised the significance of the sharpness of glass and they inferred that their antecedents used glass tools to cut meat. In contrast to the working of meat using chert and silcrete tools, the cutting and scraping of meat with glass did result in use-wear. However, the minimal amount of use-wear is consistent with results and interpretations from previous studies. While Hurcombe (1992:43–44) found that striations were rare on obsidian tools after meat-working, Fullagar (1986a:187) observed their presence occasionally and their formation in my experiments may have been facilitated by occasional flecks of bone within the meat and/or by sand on the meat acting as an abrasive agent. Regardless, the random orientations of the striations reflected the varied tool motions used in meat-processing. The same tool motions were applied during the present plant-working experiments, after which striations were also randomly orientated. The scarcity and small sizes of the edge scarring on the glass meat-processing tools is predictable (Hurcombe 1992:43–44; Stemp and Awe 2014:235) and probably attributable to the softness of meat. The absence of edge rounding is expected (Aoyama 2009:13; Fullagar 1986a:187; Gorman 2000:208; Hurcombe 1992:43–44), as is the formation of abrupt terminations. The polish extended over 1 mm inwards from the tool edge, consistent with experimental results from Kirgesner et al. (2019:5), albeit that they used chert.

7.2.4 Experimental Porcelain Tools

7.2.4.1 Porcelain: Dry and Fresh Wood (E. camaldulensis)

Use-wear on porcelain tools used to scrape and saw dry and fresh wood was present on the freshly fractured, rather than glazed surfaces and, as applied to the chert, silcrete and glass wood-working tools, was similar after the working of both kinds of wood. The regularity of oblique use-wear on the porcelain wood-working tools (which was also the case on the chert, silcrete and glass tools) was probably because during experiments requiring parallel or transverse tool motions, slight, brief adjustments in orientations are occasionally required. Striations were present on both faces of all three porcelain tools used to scrape dry wood but only on one face of two of the three porcelain tools used to scrape fresh wood. The difference is probably attributable to coincidentally different degrees of contact between the faces of each tool and the wood, rather than to any difference between working dry and fresh wood. Consistent with this inference is the presence of polish and abrasive smoothing on mainly one face for each of the same two porcelain fresh wood-scraping tools.

The regularity of use-wear across chert, silcrete, glass and porcelain wood-working tools again suggests that tool raw material is not the major factor in variation. On porcelain, striations occasionally occurred closer to the working edge, but edge scars terminated abruptly on two of the six wood-working tools: the same proportion as that for chert (four of 12 tools) and silcrete (four of 12 tools) and similar to that for glass (three of six tools). Polish was consistently moderately bright and present on the high points of the microtopography after wood-working using all tool raw material types.

7.2.4.2 Porcelain: Fresh and Dry Bone (Kangaroo)

Use-wear on porcelain tools used to scrape and saw fresh and dry bone was similar to that on chert, silcrete and glass tools used for the same purposes. Narrow striations were present on all tools of each raw material after bone-working, suggesting that this characteristic, while not exclusive to bone-working (as discussed), is a constant feature resulting from the working of this material (as was also observed by Keeley [1980:43], albeit on chert tools). One difference in striation characteristics after scraping and sawing bone across the tool raw materials was that striations were present in considerably greater density on porcelain than on chert and silcrete. Striations were also more frequent on porcelain than on glass (but not always denser in relation to total artefact surface area). Generally, little difference in striation frequency would be expected between glass and porcelain given that glass is highly susceptible to such scratching, and indeed Walton (2019:927) found that striations were common after bone-working using obsidian tools. Edge scars on the experimental porcelain tools were not only large after scraping and sawing dry bone but consistently up to 0.5 mm longer and wider than the scars on the chert, silcrete and glass bone-working tools. The relative frequency of step terminations on porcelain, primarily after sawing both dry and fresh bone, was also observed on the corresponding glass tools. Abrupt scar terminations (step scars) are expected on stone tools used to work hard materials such as bone (Stevens et al. 2010:2675), as are the regular bending fracture initiations and axial terminations that occurred after sawing using a low edge angle—as per Kamminga's (1982:48–49) observations on fine-grained silicate tools used to saw fresh kangaroo tibias. Polish developed predominantly in bands on the working edges of each porcelain tool, as was the case with chert and silcrete (other than on the silcrete tool, X05, which was used for sawing dry bone, where the polish was distributed as isolated spots). Like on the glass tools (and X05), the polish was occasionally present in spots and streaks. Nine of the 12 porcelain working edges became rounded as a result of working dry and fresh bone, compared to four of 12 for glass, three of four for silcrete and two of four for chert.

7.2.4.3 Porcelain: Fresh Hide (Cow)

Striations on porcelain tools used to scrape fresh hide were of the same nature as those on glass: few in number (none were on chert but 11–15 were on silcrete), relatively wide and rough-bottomed or sleeks. The rarity of striations is consistent with observations by Vieugué (2015:94) for Bulgarian Neolithic potsherd tools and van Gijn and Hofman (2008:28) on experimental tools used for the same task. Edge scarring on porcelain hide-scraping tools was also rarely present (n = 1 of 3 tools), which is again consistent with observations by Vieugué (2015:94) and van Gijn and Hofman (2008:28), as well as with the wear patterns on my other experimental hide-scraping tools made from chert, silcrete and glass. Edge rounding was present to similar extents on all hide-scraping tools across the different tool raw materials in this thesis. When polish was present after hide-scraping using chert, silcrete, glass and porcelain, its texture was always rough and it was present on the high and low points of the microtopography. The polish was typically moderate to dull in brightness, in contrast to the bright polish observed by Vieugué (2015:94), and distributed either as a band on the working edge or in isolated spots. The similarity of the use-wear characteristics across tool raw materials in this and the previous studies again suggests that the worked material, in this case fresh hide, was more influential on the nature of use-wear than was the tool's raw material.

7.2.4.4 Porcelain: Plant (Typha)

Use-wear on porcelain tools used to process the plant material was similar to that across the experimental chert, silcrete and glass tools used for the same tasks and to the use-wear on obsidian tools used to process similarly soft material in previous experiments (Aoyama 2009:13; Hurcombe 1992:41–42; Kononenko 2011:39; Walton 2019:914, 920). In particular, common characteristics included a scarcity or absence of striations and edge scarring, a noticeably brighter polish than that present after the working of many other materials—as was also observed by van Gijn and Hofman (2008:28)—and generally random use-wear orientations. This consistency of use-wear across tool materials and previous experiments constitutes robust evidence for any inferences for plant-processing among the archaeological tools.

7.2.4.5 Porcelain: Meat (Lamb)

Although use-wear was present on all porcelain tools used to cut and scrape meat, it was relatively minimal and comparable to the outcomes for meat-working with glass tools. Meat-processing produced no use-wear on chert or silcrete and overall the least use-wear of all experimental worked materials. The few striations that formed on the porcelain and glass meat-processing tools (1–5 on two of the three porcelain tools and 1–5 on two of the three glass tools) probably did so because sand was added to the meat in order to approximate the Calperum Station environment; and potentially because of contact with small remaining segments of bone from which parts of the meat were scraped. The nature of the edge scarring and the presence of dull to moderately bright polish on the porcelain are similar to the characteristics on glass tools used for cutting and scraping meat.

Across all current porcelain experiments the use-wear on porcelain tool edges was similar to the use-wear on stone and glass tool edges that were used for the same tasks. This is somewhat unexpected because even though the chert and silcrete were fine-grained, the surface and even unglazed sections of porcelain are not particularly similar. The use-wear similarities across the tool raw materials indicates again that at least for these cases the use-wear is probably influenced more by the worked materials and tool motions than by a tool's raw material.

7.3 Tool-use Experiments: Summary

The use-wear observed on the experimental stone tools is broadly consistent with use-wear previously reported for similar types of tool raw materials used for the same kinds of task (Berehowyj 2013; Faulks et al. 2011:311; Kamminga 1982, 1985; Keeley 1980; Kimball et al. 2017; King 2017b; Kirgesner et al. 2019; Lemorini et al. 2019; Lerner 2007; Linton et al. 2016; Luong et al. 2019; Rutkoski et al. 2020; Solheim et al. 2018:565; van Gijn 2010:63, 81). Use-wear on the bottle glass is comparable to that described in past analyses for obsidian tools used for similar activities (Aoyama 2009:13; Hurcombe 1992:40–47; Kononenko 2011; Walton 2019) and use-wear on porcelain extends knowledge concerning flaked ceramic tools, an area of study that is still in its relative infancy. A pattern of similarity existed in the use-wear on glass and porcelain tools used for the same tasks.

Across the tool raw materials, transverse and parallel movements mostly resulted in perpendicular and parallel use-wear respectively. In particular, striations were consistently perpendicular to the working edge following scraping, planing and adzing, while they were parallel after sawing or cutting. The scarring and polish directionality also followed this pattern. For both transverse and parallel tool motions, oblique use-wear was occasionally present and transverse motions regularly resulted in use-wear primarily on one tool-face, in contrast to the two tool-faces on which use-wear was typically present after parallel tool motions.

For each tool raw material, broad classes of worked material can be discerned based on consistencies that emerged from the experiments. In many cases, glass and porcelain tools displayed slightly greater numbers and higher densities of striations than did chert or silcrete. This may be because the stone is harder but also because striations may be more easily visible on glass and porcelain because of their smooth, almost featureless surfaces. Use-wear on chert and silcrete tools was similar after the working of the same materials, probably largely because the silcrete was similarly fine-grained. On all tool materials, edge scars were typically around 0.5 mm larger after bone-scraping and sawing than after the working of other materials; and after sawing bone, axial terminations and minute fractures within larger bending scars were common (as per Kamminga 1982:48–49). Scraping bone also regularly produced distinctive micropitting within the polish and smoothing. Hide-scraping was particularly distinguishable by the presence on the tools of a notably high extent of edge rounding. In general, polish resulting from wood-working was slightly brighter than that on bone-working tools but duller than on tools used to cut, scrape and saw *Typha*. After the processing of softer materials, polish and smoothing were typically more invasive than edge scarring and present on and in microtopographic peaks and valleys, whereas after harder materials were worked, polish and smoothing were less invasive and normally developed only on peaks. The influence that each tool edge angle may have had on scarring cannot be directly determined given its complex interplay with other variables but as a broad principle, bending-initiated scars with axial terminations occurred predominantly on tools with lower rather than higher edge angles. Abrupt (step) scar terminations were common after the working of harder materials and bipolar edge scarring was observed on tools used to wedge wood. Meat-processing produced the least diagnostic use-wear. The basis is now established for the consideration of the archaeological assemblage.

Chapter Eight: Results, Archaeological Assemblage

This chapter presents the results of the use-wear analysis of the archaeological assemblage, which, after screening, consisted of 62 artefacts. Initially, broad technological and related descriptions of the assemblage are provided. Results are then categorised according to the artefact raw material, in order to most efficiently address the research question: *how did Aboriginal people at (two sites within) Calperum Station, South Australia, incorporate introduced glass and porcelain into their pre-existing stone technology and toolkits following permanent European colonisation?*

A range of technological attributes was present among the Calperum Station assemblage. A number of stone flakes retained a clear ventral surface, including at least a bulb of percussion and platform, while on many there was also a discernible point of force applied during detachment from a core, as well as fissures, compression waves, ring cracks, flake terminations and erraillure scars. However, of the glass and porcelain artefacts, only one of each tool material were flakes: glass artefact WLW01 was a proximal flake and porcelain artefact TI03 a complete flake. Each displayed a bulb of percussion, platform, ring crack, point of force application and compression waves. No other glass or porcelain pieces exhibited macroscopically visible morphology irrefutably demonstrative of artefact status. There were no formal tool types of glass, porcelain or stone or any platform preparation or overhang removal. Almost all artefacts were 2–4 cm in length and width and between 0.25 and 1 cm thick. Of the 16 chert artefacts, 13 were complete flakes and three proximal flakes, while of the 13 silcrete artefacts, three were complete flakes, one a proximal flake and eight flaked pieces (pieces that were not complete, proximal, medial or distal flakes but which displayed characteristics reflecting the knapping process, such as fracture planes or compression waves).

Some form of wear was detected on 34 of the 62 archaeological artefacts: ten of 16 on chert, two of 13 on silcrete, 18 of 25 on glass and four of eight on porcelain. There was no hafting wear but interpretations of whether, and if so how, the wear is use-related, are provided in the Discussion (Chapter Nine). The remainder of this chapter outlines the results for the archaeological assemblage according to artefact raw materials. The raw data is displayed in relevant tables and specific observations are made for individual artefacts that displayed multiple forms of use-wear. Examples of use-wear are shown in optical microscope images and LSCM images, which quantify the depths of the surface microtopography at which polish and smoothing were present.

8.1 Chert Artefacts

Table 50 summarises the wear present on each archaeological chert artefact ('WLW' is an acronym for 'West Lake Woolpoolool' and refers to the primary site for this study, West Woolpoolool). One chert artefact exhibited all four forms of wear, two displayed three forms, three displayed two forms, four displayed one form and on six artefacts there was no wear.

Table 50 Summary of the wear on the archaeological chert artefacts.

Artefact Number	Striations	Edge Scarring	Edge Rounding	Polish and Smoothing
WLW 26	x	✓	x	x
WLW 27	✓	x	✓	✓
WLW 28	x	✓	✓	✓
WLW 29	✓	✓	✓	✓
WLW 30	x	x	x	x
WLW 31	x	✓	x	x
WLW 32	x	✓	x	x
WLW 33	x	x	x	x

WLW 34	x	✓	x	✓
WLW 35	x	x	x	x
WLW 36	x	✓	x	✓
WLW 37	x	x	x	x
WLW 38	x	✓	x	✓
WLW 39	x	✓	x	x
WLW 40	x	x	x	x
WLW 41	x	x	x	x

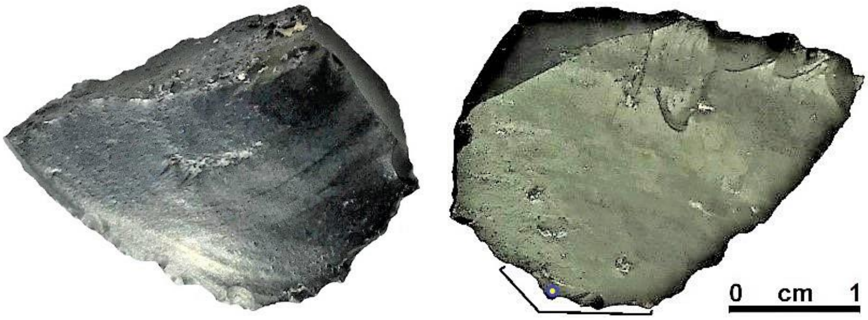
Full details of the wear observed on the chert artefacts are outlined in Table 51. Striations were observed only on two artefacts and were low in density, wide and classified as ‘near’ or ‘near and far from’ the working edges. Whenever edge scarring was present the scars were small (< 0.5 mm in mean length and width). The scars were mostly either perpendicular or oblique, while axial terminations, which were relatively rare, were present on two artefacts. Polish and smoothing were identified on five of the six artefacts and on each occasion present on the microtopographic high and low points.

Table 51 Details of the wear on archaeological chert artefacts.

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Artefact Number	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
WLW 26	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O	MC	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
WLW 27	1–5	L	2	W	MPa	N & F	n/a	n/a	n/a	n/a	n/a	n/a	M	MB	S	H	B	BO	n/a	str., pol. & ER
WLW 28	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MO	O	MC	MF	M	B	R	HL	MO	Sp	ES < pol.	pol., ES & ER

WLW 29	6–10	L	1	W	MPe	N	< 0.5	< 0.5	MO	O	CC	MS; one axial	M	M	S	H	MO	Sp	n/a	all
WLW 30	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 31	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O	MI	MS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
WLW 32	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
WLW 33	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 34	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O	MC	MA	n/a	MB	S	HL	MO	SS	ES < pol.	pol., ES
WLW 35	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 36	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O	MI	MF	n/a	M	S	HL	U	St	n/a	pol., ES
WLW 37	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 38	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O	MC	MF	n/a	M	R	HL	U	St	ES < pol.	pol., ES
WLW 39	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O & N	MC	MS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
WLW 40	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 41	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Artefact WLW27 is a complete, black flake approximately 3 (length) x 2 (width) x 0.7 cm (thick) (Figure 66). It displayed a clear bulb of percussion and compression waves and the working edge is the minimally retouched distal margin (this is the only artefact in the Calperum Station assemblage that was retouched). A low density of wide striations was present on both the ventral and dorsal faces, orientated mostly perpendicular to and located near and far from the working edge. No edge scarring was observed but the working edge had become rounded to a medium extent. A moderately bright, smooth polish was present exclusively on the high points of the microtopography, as quantified with the use of the LSCM (Figure 66). Polish was present on both faces of the artefact and distributed as a band on the working edge, but because there were no edge scars, its relative invasiveness could not be recorded.



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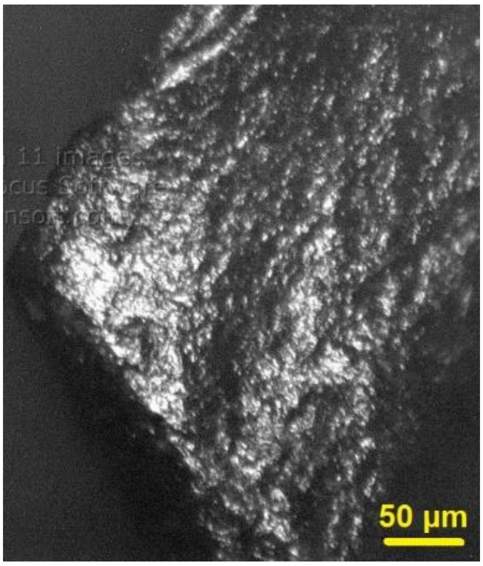

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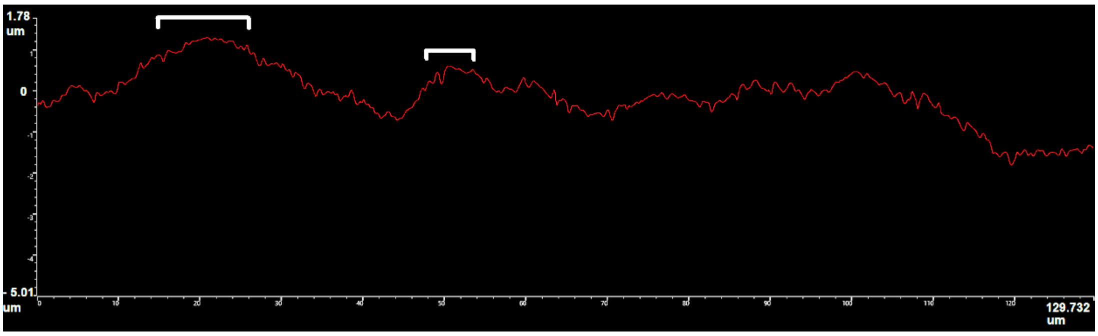
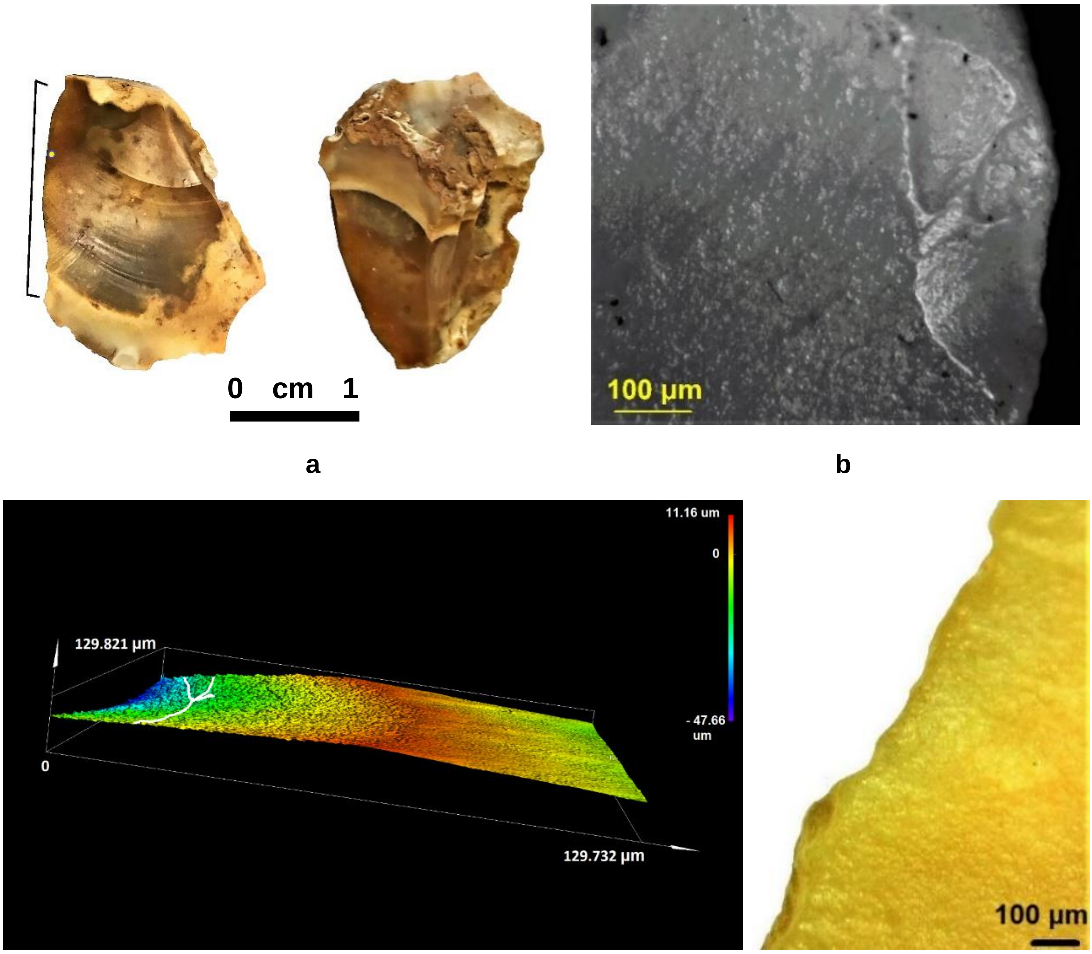


c

Figure 66 Archaeological chert artefact WLW27. ***A****: macroscopic images of ventral and dorsal surfaces; brackets indicate the region with wear, while the circle indicates the location of polish seen in ‘b.’* ***B****: moderately bright polish; x500 magnification.* ***C****: height profile image of the surface roughness; white brackets indicate that polish and smoothing are present exclusively on high points.*

Artefact WLW28 (Figure 67) is a complete flake, approximately 3 (length) x 2 (width) x 0.5 cm (thick). A platform, ring crack, compression waves and fissures were visible and wear was identified on most of the left lateral margin with the ventral surface facing ‘up.’ Small (< 0.5 mm in mean length and width) edge scarring was present, mostly with oblique orientations in relation to the working edge. The scars were mostly on the edge and in close clusters, with feather terminations. A medium extent of edge rounding was associated with a bright, somewhat rough polish located on the high and low points of the microtopography and predominantly on one face of the tool. Sa and Sq values show that in this case one part of the polish was present on a slightly rougher area of the tool (Figure 67f, sample point 1), while the other two sample points (one from a polished zone and the other from an unpolished zone) were from slightly smoother parts of the tool. The polish was mostly distributed as spots and less invasive than the edge scarring.



a b

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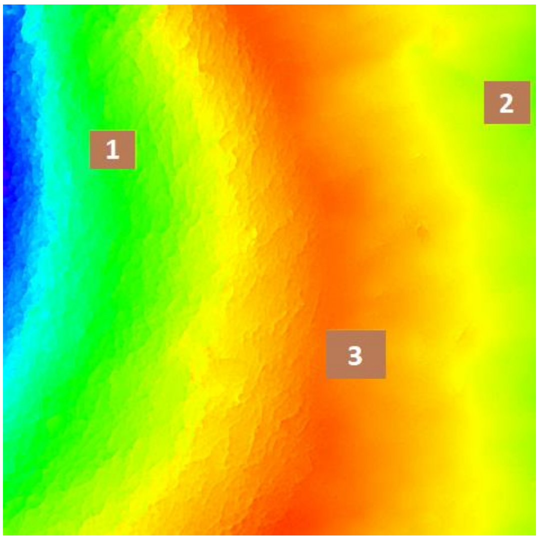
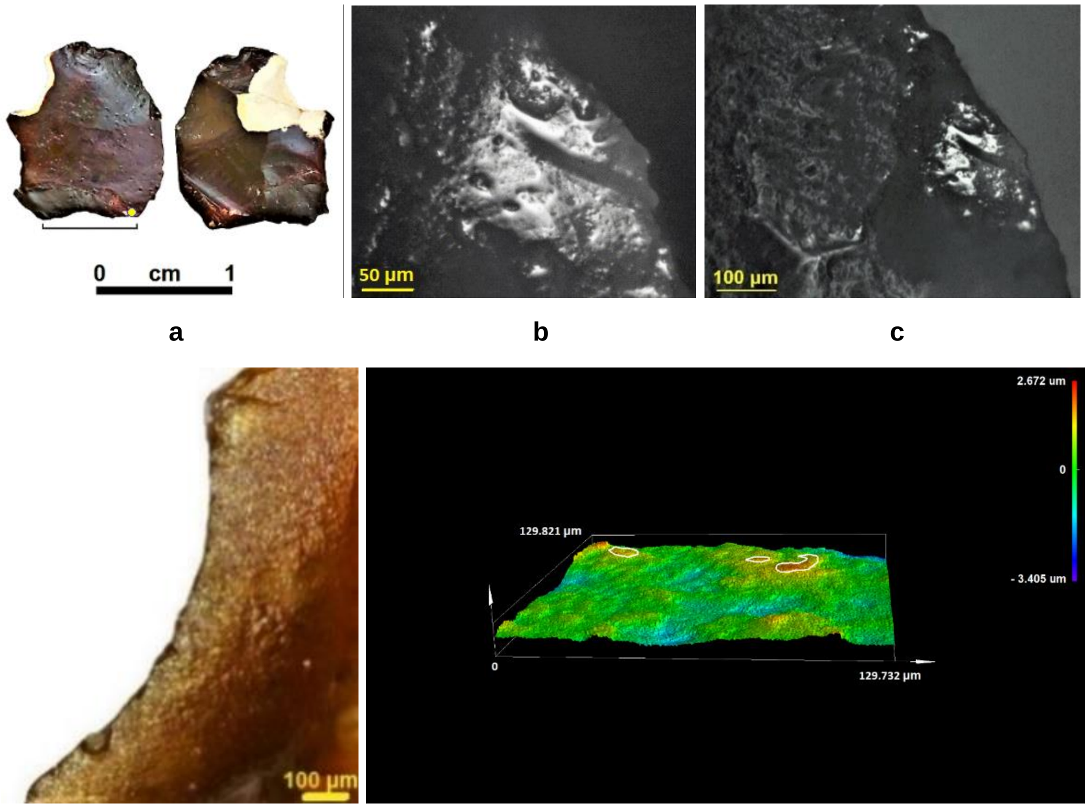


Sample	Polished or unpolished zone	Sq	Sa
1	Polished	0.927	0.731
2	Polished	0.164	0.130
3	Unpolished	0.284	0.221

e **f**

Figure 67 Archaeological chert tool WLW28. ***A****: macroscopic images of ventral and dorsal surfaces; brackets indicate the region with wear, while the circle indicates the location of polish seen in ‘b.’* ***B****: a relatively bright polish; x200 magnification.* ***C****: 3-D contour map of elevations on the surface; the white marks indicate one of the several spots of polish and smoothing that were on this tool; the left edge is the (part of the) working edge and there is no arrow to indicate the direction of tool-use because evidence is inconclusive.* ***D****: moderate edge rounding; Dino-Lite x220 magnification.* ***E****: 2-D height map showing locations sampled for surface roughness.* ***F****: key for ‘e.’*

All forms of wear were present on tool WLW29. On this 1.5 (length) x 1 (width) x 0.75 cm (thick) complete flake (Figure 68) was a low density of wide striations, most of which were orientated perpendicular to and located near the working edge. Scarring with mostly oblique orientations was observed on the edge, in close clusters, with one (bending-initiated) scar exhibiting an axial termination and minute fractures within (Figure 68). The working edge had become rounded to a medium extent and polish and smoothing were present exclusively on higher points of the microtopography (Figure 68). All sampled surface roughness measurements were similar (Figure 68).



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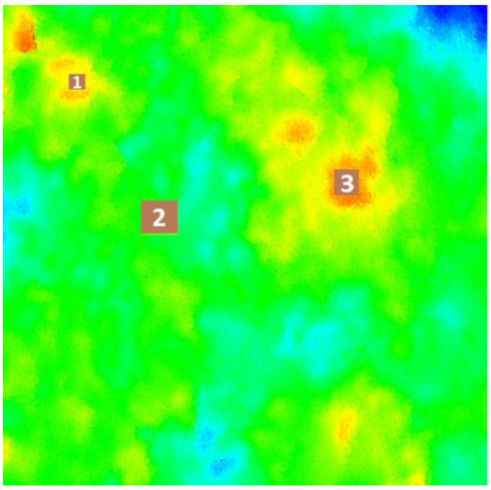
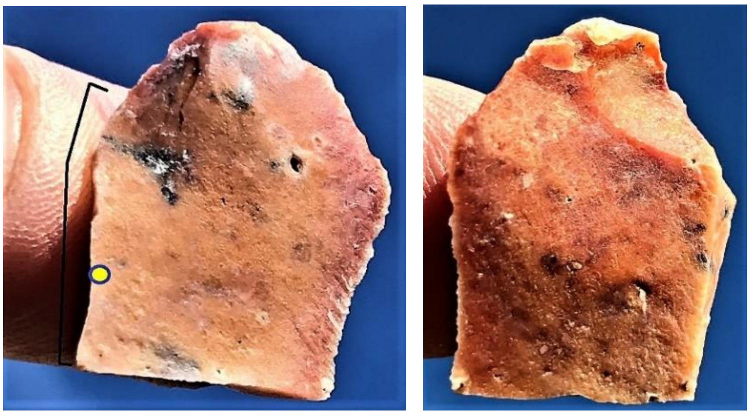


Sample	Polished or unpolished zone	Sq	Sa
1	Polished	0.107	0.085
2	Unpolished	0.156	0.126
3	Polished	0.061	0.048

f g

*Figure 68 Archaeological chert tool WLW29. **A**: macroscopic images of ventral and dorsal surfaces; brackets indicate the region with wear, while the circle indicates the location of polish seen in 'b–c.' **B**–**C**: smooth, domed polish predominantly on high points; B = x200 magnification, C = x100 magnification. **D**: the solitary scar with an axial termination and minute fractures within; Dino-Lite x235 magnification. **E**: 3-D contour map of elevations on the surface; white circles indicate the presence of polish and smoothing only on high points; the far edge is the (part of the) working edge and there is no arrow to indicate the direction of tool-use because evidence is inconclusive. **F**: 2-D height map showing locations sampled for surface roughness. **G**: key for 'f.'*

In contrast, two forms of wear were present on WLW34, a 2.5 (length) x 1.5 (width) x 0.5 cm (thick) proximal flake (Figure 69). Striations and edge rounding were not observed but several small (< 0.5 mm in mean length and width) edge scars were present, orientated mostly perpendicular to the edge, in clusters and often axial-terminated (Figure 69). Scars appeared relatively fresh compared to the weathered surface of the artefact, suggesting that the scars were created some time after the detachment of this flake. Smooth-textured polish and smoothing were present on peaks and in valleys (Figure 69), more so on one face of the artefact than the other, distributed as spots and streaks and more invasive than edge scarring.



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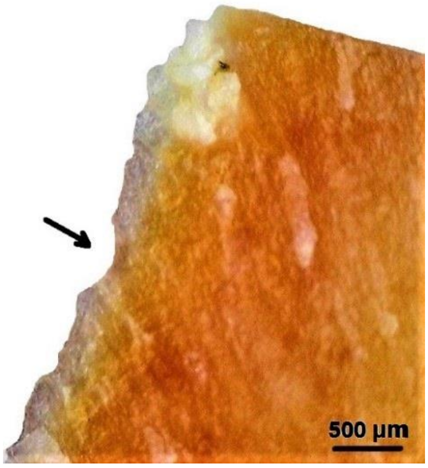

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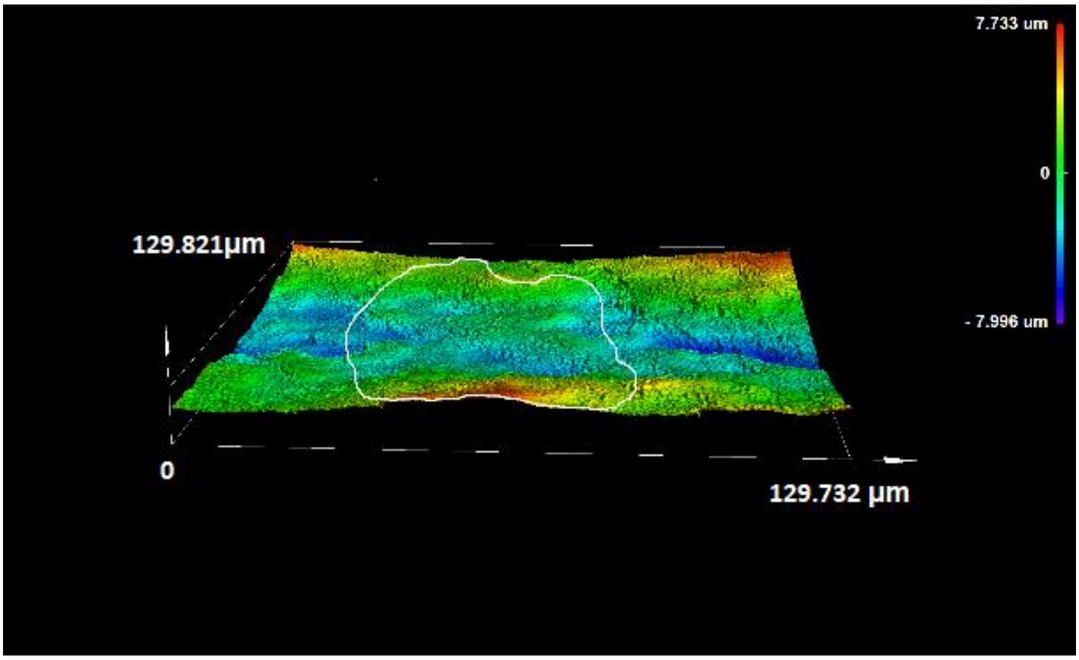

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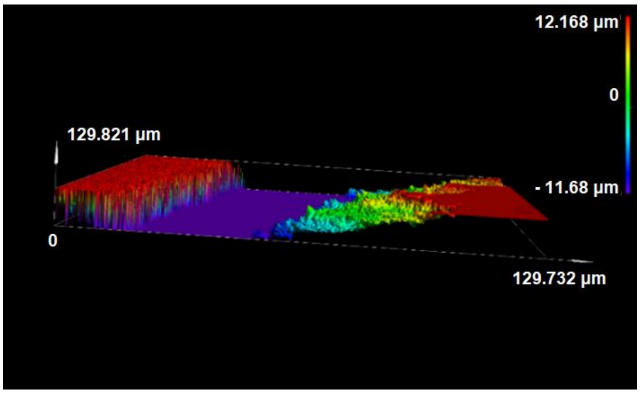
Figure 69 Archaeological chert artefact WLW34. ***A****: macroscopic images of ventral and dorsal surfaces; brackets indicate the region with wear, while the circle indicates the location of the polish seen in 'c.'* ***B****: edge scar (bending-initiated) with axial termination; Dino-Lite x55 magnification.* ***C****: a patch of polish on peaks and in valleys; x200 magnification.* ***D****: 3-D contour map of elevations on the surface; the white circle indicates the presence of polish and smoothing on peaks and in valleys; the far edge is the (part of the) working edge and there is no arrow to indicate the direction of tool-use because evidence is inconclusive.*

WLW36 and WLW38 also displayed edge scarring and polish and smoothing, but no striations or edge rounding. WLW36 is a 3 x 1.5 x 0.5 cm smooth browny-yellow chert proximal flake and WLW38 is a 2.5 x 1.75 x 0.3 cm dark brown complete flake with a clear bulb, ring crack, compression waves and platform. Edge scarring on both artefacts was small (< 0.5 mm in mean length and width), orientated perpendicular to and located on the edge. Scarring mostly occurred in clusters and feather terminations were predominant. Polish and smoothing were 'moderate' in brightness, present on peaks and in valleys (Figure 70), located exclusively on one face of each artefact and distributed as spots and streaks. Polish was smooth on WLW36 but rough on WLW38.

a



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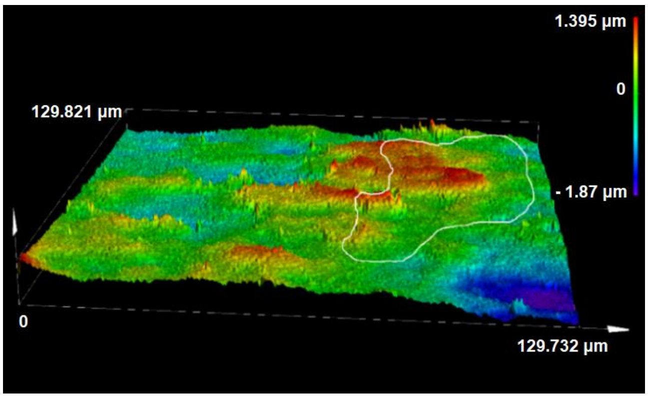

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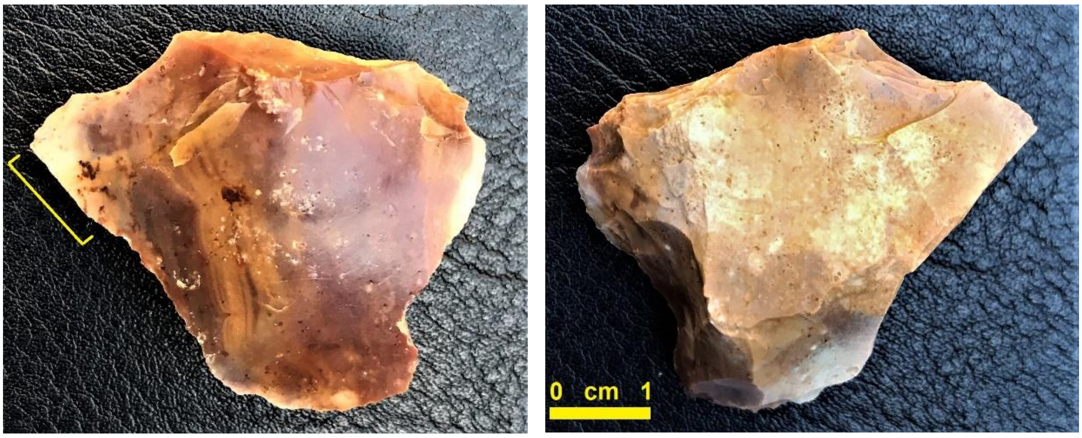
Figure 70 Archaeological chert artefacts WLW36 and WLW38. ***A****: macroscopic images of ventral and dorsal surfaces of WLW36; brackets indicate the region with wear, while the circle indicates one location of polish and smoothing; scale bar = 1 cm.* ***B****: 3-D contour map of elevations on the surface of an entire polished area of WLW36; polish is on peaks and in valleys; the foreground edge is the (part of the) working edge and, as is the case for 'D,' there is no arrow to indicate the direction of tool-use because evidence is inconclusive.* ***C****: macroscopic images of ventral and dorsal surfaces of WLW38; brackets indicate the polished area, while the circle indicates one location of polish and smoothing; scale bar = 1 cm.* ***D****: 3-D contour map of elevations on the surface of WLW38; polish is on high and lower points, albeit not the lowest (dark blue); the foreground edge is the (part of the) working edge.*

Of the remainder of the chert artefacts, the only wear displayed was scarce edge scarring on WLW26, WLW31, WLW32 and WLW39. WLW31 is a proximal flake, while the others are all complete flakes. On each artefact the scars were small (< 0.5 mm in mean length and width), mostly perpendicular to and on or near the working edges. The six scars on WLW32 were less than 50 microns in length and width and on WLW31 and WLW32 the scars were mostly isolated. Steps were the main form of fractures on WLW31 and WLW39 (Figure 71).



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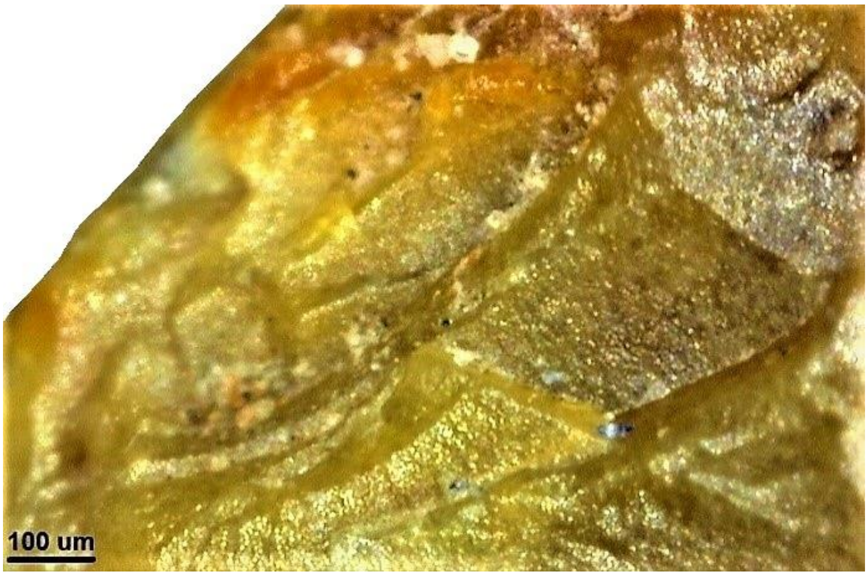


b

*Figure 71 Archaeological chert artefact WLW39. **A**: macroscopic images of ventral and dorsal surfaces; brackets indicate the location of edge scarring. **B**: small, stacked step fractures; Dino-Lite x235 magnification.*

8.2 Silcrete Artefacts

Wear was present on two of the 13 archaeological silcrete artefacts (Table 52).

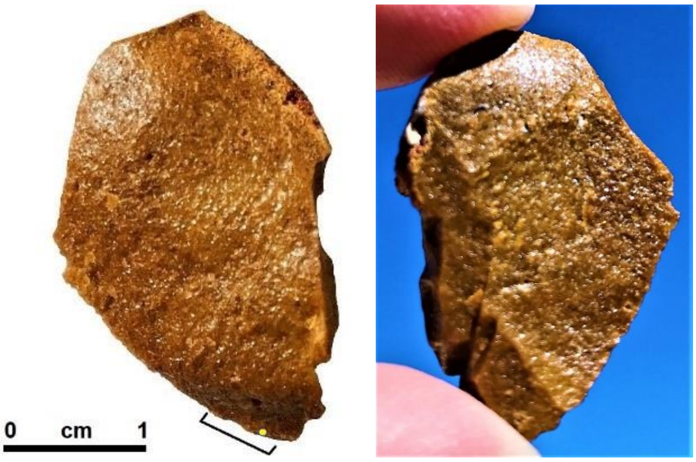
Table 52 Summary of the wear on the archaeological silcrete artefacts.

Artefact Number	Striations	Edge Scarring	Edge Rounding	Polish and Smoothing
WLW 42	x	x	x	x
WLW 43	x	x	x	x
WLW 44	✓	x	x	x
WLW 45	x	✓	x	✓
WLW 46	x	x	x	x
WLW 47	x	x	x	x
WLW 48	x	x	x	x
WLW 49	x	x	x	x
WLW 50	x	x	x	x
WLW 51	x	x	x	x
WLW 52	x	x	x	x
WLW 53	x	x	x	x
WLW 53_2	x	x	x	x

Full details of the wear are seen in Table 53. On WLW44, a 2.5 x 1 x 0.25 cm browny-red flaked piece, only striations were observed. These four striations were wide, present only on one face of the artefact and perpendicular to and on the edge. Several, mostly clustered edge scars were present on WLW45, a 2.5 x 1.5 x 0.5 cm brown complete flake with a particularly clear bulb of percussion (Figure 72). Also on WLW45 was a moderately bright, rough polish developed in isolated spots on peaks and in valleys of one artefact face (Figure 72).

Table 53 Details of the wear on archaeological silcrete artefacts.

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Artefact Number	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
WLW 42	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 43	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 44	1–5	L	1	W	MPe	F	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. only
WLW 45	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MO	O & N	MC	MF	n/a	MB	S	HL	MO	Sp	n/a	pol., ES
WLW 46	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 47	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 48	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 49	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 50	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 51	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 52	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 53	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 53_2	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a



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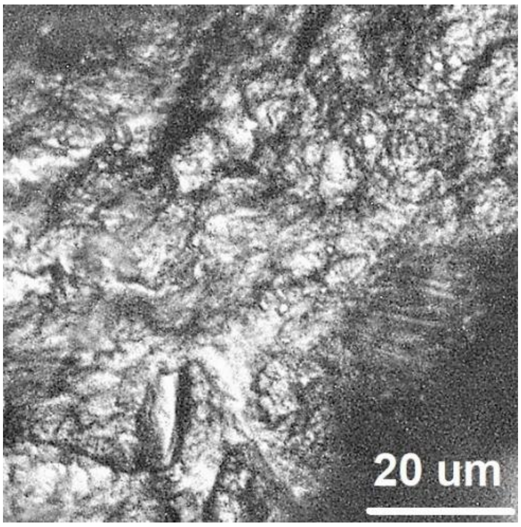


b

Figure 72 Archaeological silcrete artefact WLW45. ***A****: macroscopic images of ventral and dorsal surfaces; brackets indicate the region with wear, while the circle indicates the location of polish seen in 'b.'* ***B****: rough polish on high and low points (fissures on a fresh fracture surface are also visible); x500 magnification.*

8.3 Glass Artefacts

Of the 25 archaeological glass artefacts, 18 displayed some form of wear, with four forms of wear on four artefacts and three forms on three artefacts (Table 54). Of these 18, 17 were body shards and most were straight, with little or no curvature, which suggests that they were from bottle walls. The other artefact (WLW25) was a part bottle base/part bottle wall fragment. None of the 25 glass artefacts bore diagnostic dating information, discussed earlier, in forms of bottle manufacturer marks or evidence of certain manufacturing techniques (Burke et al. 2017; Shueard and Tuckwell 1993). Nonetheless, the artefacts were coloured either dark green or amber. Dark green glass bottles were manufactured before 1880 (Burke et al. 2017:449), while beer bottles were mostly produced in amber from 1875 to 1900 and from 1914 until the present (Hutchinson 1981:254; Lockhart 2006:50). However, these are broad time frames that may not directly correspond to when the artefacts were used by Aboriginal peoples. The temporal imprecision further demonstrates the value of the site context and oral histories: in combination, the physical association between the stone and glass artefacts, broad dates obtained by Westell et al. (2020:6, 12) (discussed earlier, in 'Site Descriptions'), and TO cultural knowledge of their ancestors using glass, indicates that glass tools were probably used for the first time early after initial contact and the practice continued up to the present. The presence of dark green and amber glass tools suggests that the site was visited across a broad time period.

Table 54 Summary of the wear on the archaeological glass artefacts.

Artefact Number	Striations	Edge Scarring	Edge Rounding	Polish and Smoothing
WLW 01	✓	✓	✓	✓
WLW 02	✓	✓	✓	x
WLW 03	✓	✓	x	x
WLW 04	✓	✓	✓	x
WLW 05	x	x	x	x
WLW 06	✓	✓	✓	x
WLW 07	✓	✓	x	x
WLW 08	✓	✓	✓	✓
WLW 09	✓	✓	x	x
WLW 10	x	✓	x	x
WLW 11	x	x	x	x
WLW 12	✓	✓	✓	✓
WLW 13	✓	✓	x	x
WLW 14	x	x	x	x
WLW 15	✓	✓	x	x

WLW 16	x	x	x	x
WLW 17	x	x	x	x
WLW 18	✓	✓	x	x
WLW 19	✓	x	x	x
WLW 20	x	x	x	x
WLW 21	x	✓	x	x
WLW 22	✓	✓	✓	✓
WLW 23	x	x	x	x
WLW 24	✓	✓	x	x
WLW 25	x	✓	x	x

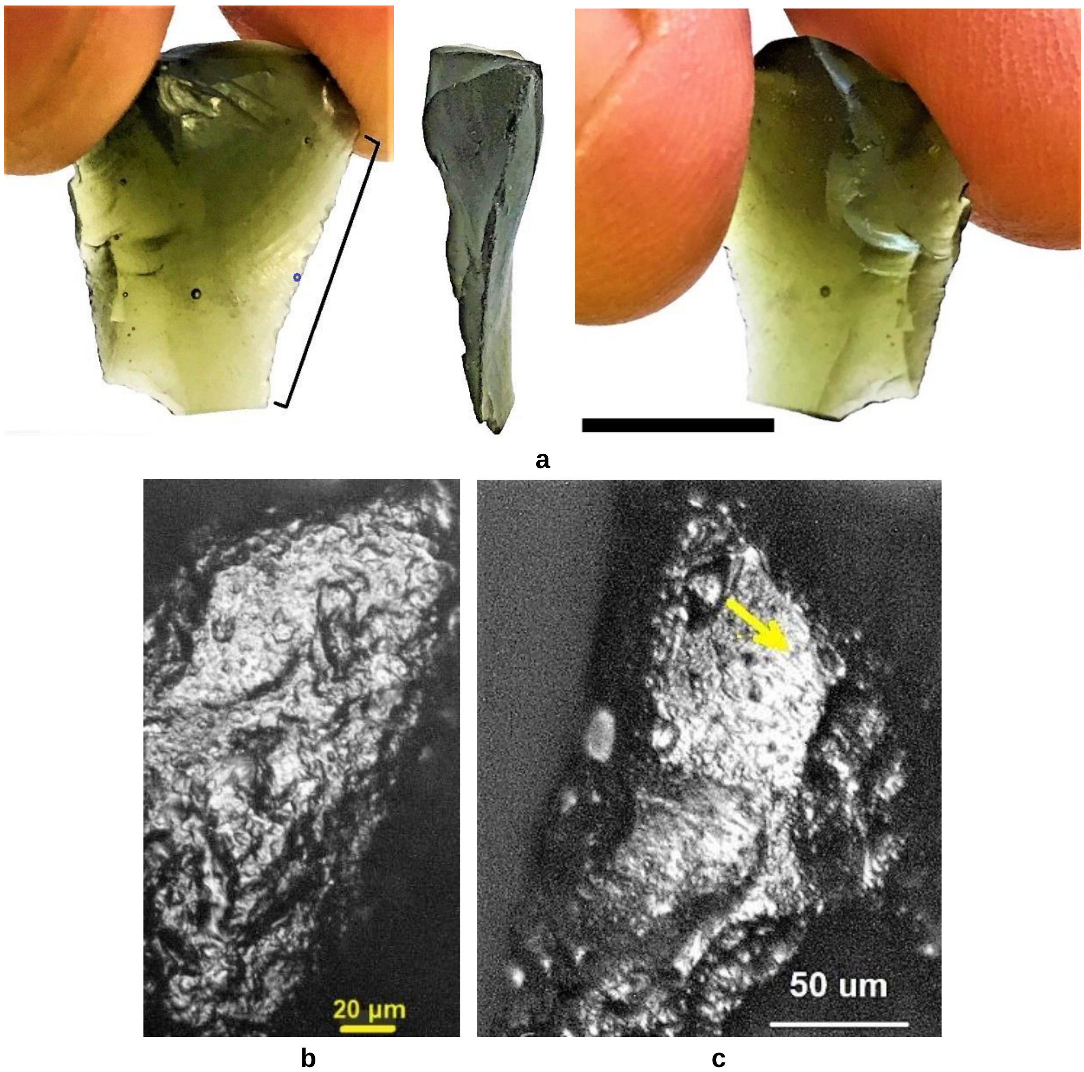
From the full details of the wear on the glass artefacts (Table 55), it is evident that when striations were present they tended to be so in greater numbers than on chert and silcrete artefacts, and the edge scars were occasionally larger and reasonably often abruptly (step) terminated. Striations and edge scars were orientated predominantly perpendicular to the working edge and occasionally oblique. When edge rounding was observed it was commonly associated with other forms of wear, and polish and smoothing were present on four artefacts.

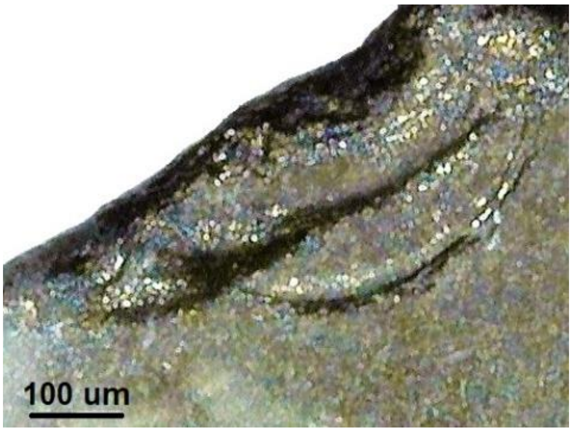
Table 55 Details of the wear on archaeological glass artefacts.

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Artefact Number	**Number**	**Density**	**Art. faces** (1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
WLW 01	16–20	H	1	N	PeO	O & N	0.5–1	0.5–1	MPe	O & N	CC	MS	L	MB	S	HL	MO	BO	ES > pol.	all
WLW 02	6–10	L	2	W	PeO	N & F	0.5–1	0.5–1	MPe	O & N	CC	FH	M	n/a	n/a	n/a	n/a	n/a	n/a	str., ES., ER
WLW 03	6–10	L	2	W	PeO	O & N	< 0.5	< 0.5	MPe	O & N	CC	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
WLW 04	21–25	H	2	W	R	N & F	< 0.5	< 0.5	MPe	O	CC	SH	M	n/a	n/a	n/a	n/a	n/a	n/a	str., ES., ER
WLW 05	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

WLW 06	16–20	H	1	W	PeO	O & N	< 0.5	< 0.5	MPe	O	CC	MF	L	n/a	n/a	n/a	n/a	n/a	n/a	str., ES., ER
WLW 07	11–15	H	2	W	MPe	O & N	0.5–1	0.5–1	MO	O	CC	MS; some axial	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ED
WLW 08	6–10	M	2	N	MPe	O & N	0.5–1	0.5–1	MPe	O & N	CC	MS; some axial	L	MB	R	H	MO	TLO	ES > pol.	all
WLW 09	1–5	L	2	W	R	O & F	< 0.5	< 0.5	MPe	O	MI	SH	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
WLW 10	0	n/a	n/a	n/a	n/a	n/a	0.5–1	0.5–1	MPe	O & N	MC	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
WLW 11	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 12	6–10	M	2	W	PeO	N & F	0.5–1	0.5–1	MPe	O	CC	SA	L	MB	R	HL	U	St	ES > pol.	all
WLW 13	11–15	M	2	W	R	N & F	< 0.5	< 0.5	MPe	O	MI	MH	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
WLW 14	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 15	21–25	H	2	W	R	O & F	< 0.5	< 0.5	MO	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
WLW 16	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 17	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 18	21–25	H	2	W	R	N & F	0.5–1	0.5–1	MPe	O & N	MI	SH	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
WLW 19	1–5	L	2	W	R	N & F	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str. only
WLW 20	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 21	0	n/a	n/a	n/a	n/a	n/a	< 0.5	< 0.5	MPe	O & N	MI	HF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only
WLW 22	21–25	H	2	N	PeO	N & F	0.5–1	0.5–1	MPe	O	CC	SA	L	MB	R	H	U	BO	ES > pol.	all
WLW 23	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
WLW 24	26–30	H	2	W	R	N & F	< 0.5	< 0.5	R	O & N	MI	R	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
WLW 25	0	n/a	n/a	n/a	n/a	n/a	0.5–1	0.5–1	MPe	O	MI	MS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	ES only

Artefact WLW01, a body shard measuring approximately 2 x 1 x 0.5 cm, is one of the five glass artefacts on which there were all forms of wear, and the only knapped glass piece (as distinct from shard or bottle base). Difficulties often involved in attempting to macroscopically diagnose glass fragments as artefacts were discussed earlier (Chapter Three), and this dark olive-green, straight (not curved) proximal flake represents one of the relatively rare occasions where macroscopically observable traits provided compelling evidence for artefact status: it displayed a clear ventral surface with a bulb of percussion, fissures and compression waves (Figure 73). Microscopically, a high number and density of striations were observed on one face of the tool. The striations were narrow, orientated perpendicular and oblique to and located on and near the working edge. Edge scars were common, slightly larger than most in the assemblage (0.5–1 mm in mean length and width compared to the more common < 0.5 mm) and also orientated perpendicular to and located on and near the working edge. Scars were closely clustered and step fractures common (Figure 73), with occasional axial terminations, while the edge became rounded to a low extent. A moderately bright, smooth, striated polish was located on the high and low points of the microtopography (Figure 73), and less invasive than the edge scarring. The area sampled using the LSCM, and shown in Figure 73c, represents an exception to the overall distribution of the polish as a band on the edge.





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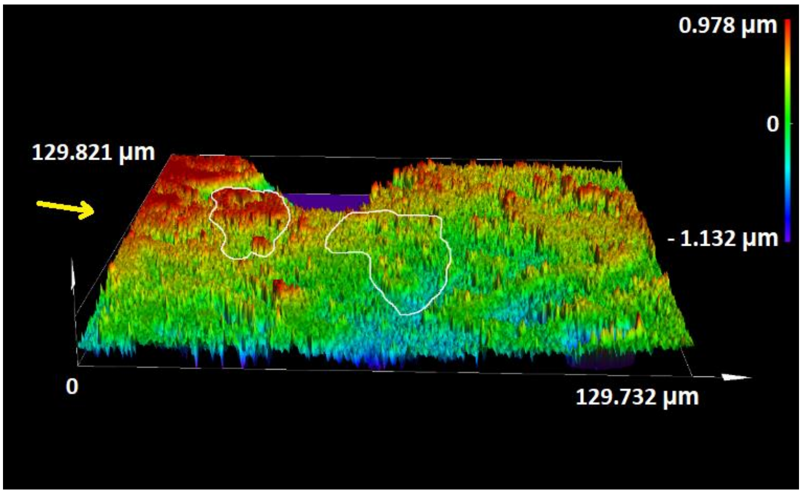

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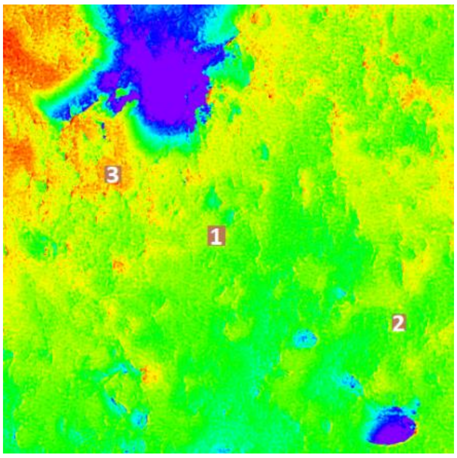


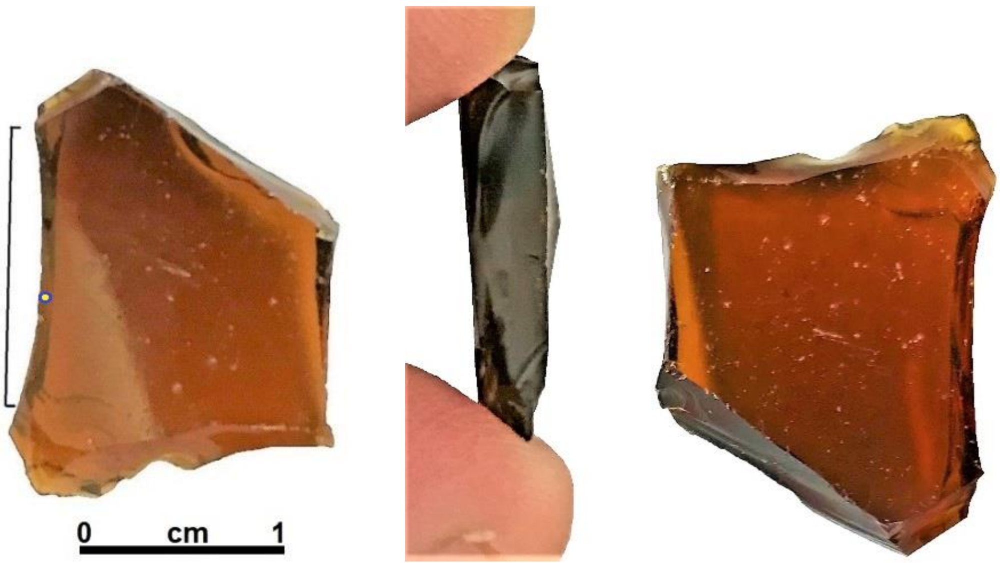
f

Sample	Polished or unpolished zone	Sq	Sa
1	Polished	0.128	0.095
2	Unpolished	0.151	0.113
3	Polished	0.088	0.068

g

Figure 73 Archaeological glass tool WLW01. ***A****: macroscopic images of ventral surface, cross-section and dorsal surface (scale bar = 1 cm); brackets indicate the region with wear, while the circle indicates the location of polish seen in 'b–c.'* ***B****: polish on peaks and in valleys; x500 magnification.* ***C****: striations visible within polish (indicated by yellow arrow); small pits can also be seen nearby; x500 magnification.* ***D****: abrupt (step) edge scarring.* ***E****: 3-D contour map of elevations on the surface; white outlines indicate the locations of polish on peaks and in valleys; the left edge is the (part of the) working edge and the arrow indicates the approximate direction of tool-use.* ***F****: 2-D height map showing locations sampled for surface roughness.* ***G****: key for 'f.'*

Of the other glass artefacts to display all four forms of wear, the characteristics on body shards WLW08, WLW12 and WLW22 (Figures 74–76) were similar, and consistent with some aspects of the wear on WLW01. As on WLW01, striations were narrow on WLW08 and WLW22, while they were wide on WLW12. On WLW01, WLW12 and WLW22 they were present on both faces, while they were on one face of WLW08. They were particularly high in density on WLW22, and on all three (WLW08, WLW12 and WLW22), orientated perpendicular and/or oblique to the working edges—another aspect of wear consistent with WLW01. Also like on WLW01, edge scarring was prolific on WLW08, WLW12 and WLW22, although slightly larger than on WLW01 as well as most others (0.5–1 mm compared to the more common < 0.5 mm, as described above for WLW01), and axial terminations were common. On each of WLW08, WLW12 and WLW22, the working edge became rounded to a low extent and the moderately bright, rough polish was occasionally striated, in a similar manner to that on WLW01. Macroscopically, WLW08 and WLW12 were straight, with negligible curvature, whereas WLW22 derived from a slightly curved part of a bottle (Figure 76).



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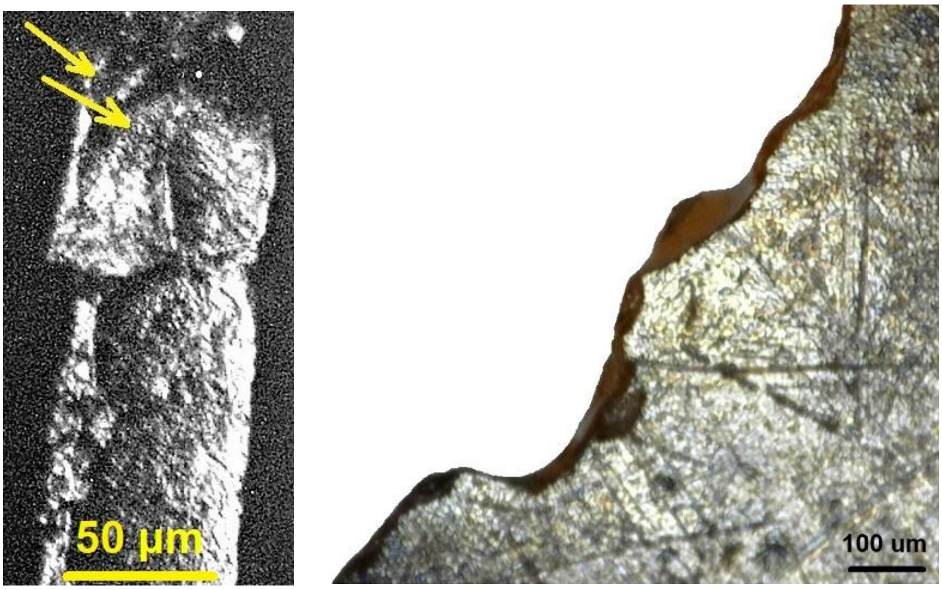
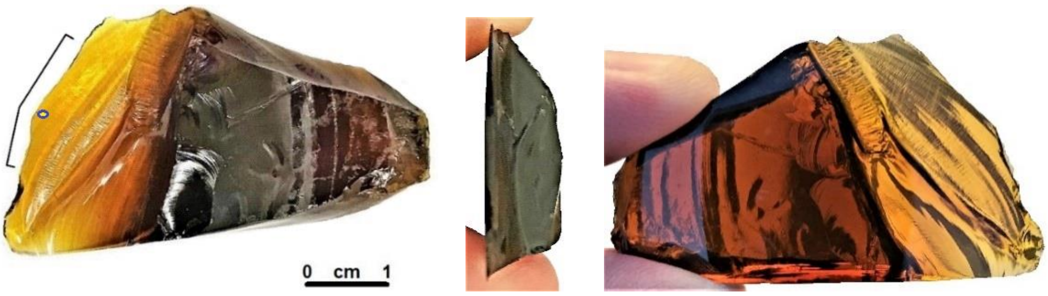


b c

*Figure 74 Archaeological glass tool WLW08. **A**: macroscopic images; brackets indicate the region with wear, while the circle indicates the location of polish seen in 'b.' **B**: striated polish, indicated by yellow arrows; x500 magnification. **C**: bending-initiated scar with axial termination (striations are also visible); Dino-Lite x215 magnification.*



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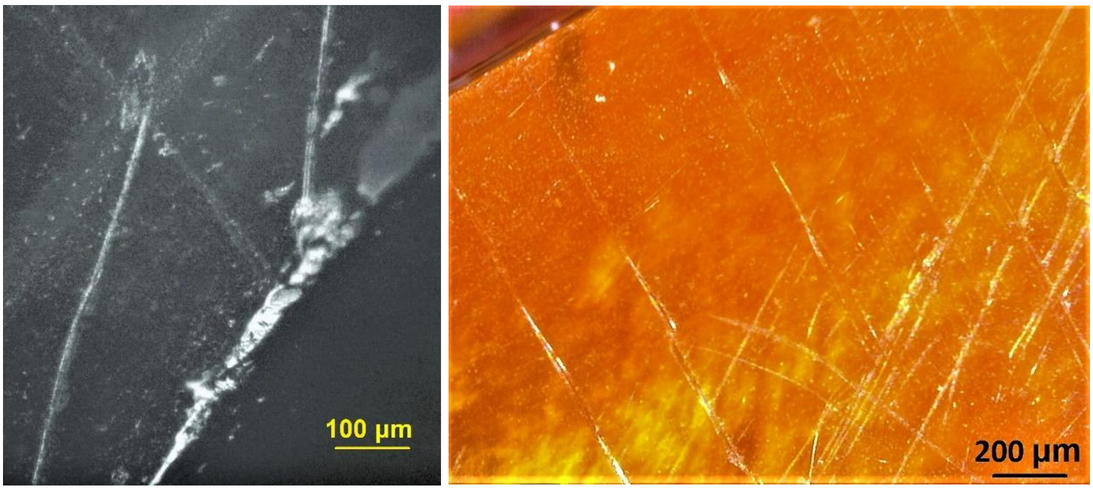


b c

*Figure 75 Archaeological glass tool WLW12. **A**: macroscopic images; brackets indicate the region with wear, while the circle indicates the location of polish seen in 'b.' **B**: two oblique and one (faint) perpendicular striation; x200 magnification. **C**: other oblique and perpendicular striations; Dino-Lite x235 magnification.*

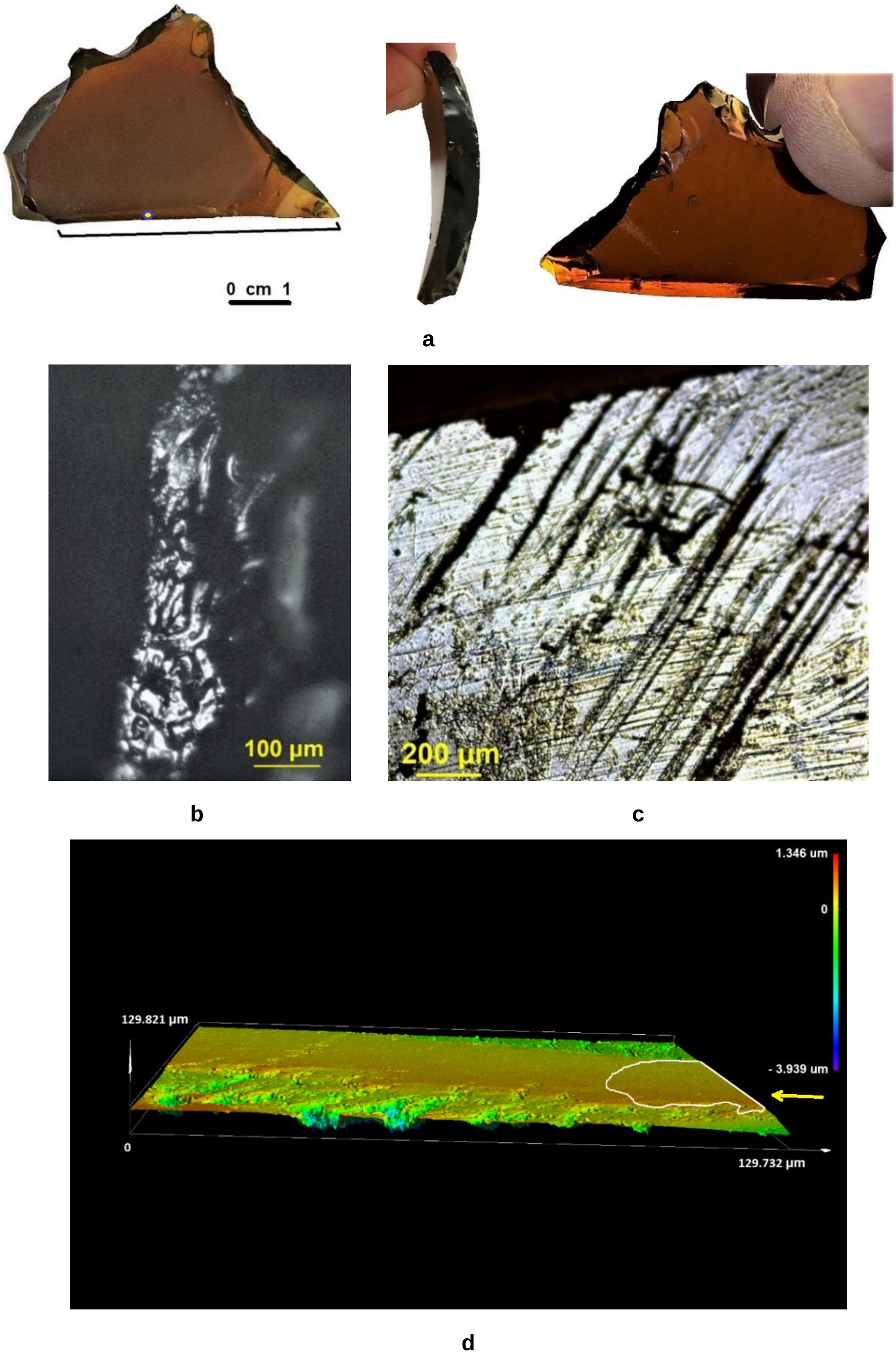
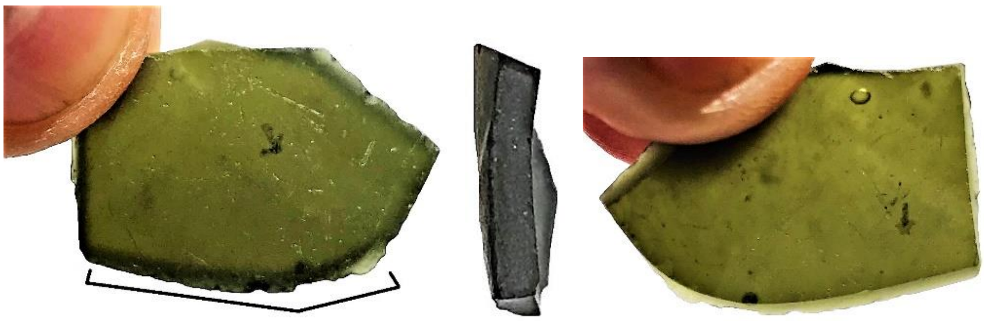


*Figure 76 Archaeological glass tool WLW22. **A**: macroscopic images; brackets indicate the working edge (in the centre image, this edge is facing), while the circle indicates the location of polish seen in 'b.' **B**: a moderately bright polish on high points; x200 magnification. **C**: a series of oblique striations; Dino-Lite x200 magnification. **D**: 3-D contour map of elevations on the surface, indicating the presence of polish exclusively on peaks and as a band on the working edge; the right edge is the (part of the) working edge and the arrow indicates the approximate direction of tool-use.*

Glass body shards WLW04 and WLW06 displayed striations, edge scarring and edge rounding but no polish or smoothing. The striations were wide and high in density in relation to the artefacts' surface areas. On WLW04 they were present on both faces, with a broad range of orientations, whereas on WLW06 the striations were unifacial, perpendicular and oblique (Figure 77). Edge scars were closely clustered on both artefacts and mostly perpendicular to the working edge (an exception seen in Figure 77b), while the edge became rounded to a medium extent on WLW04 and a low extent on WLW06.



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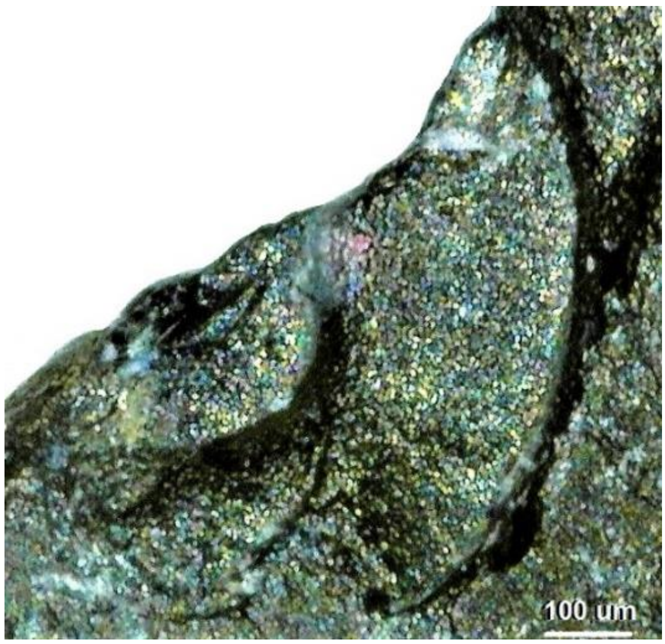

b

c

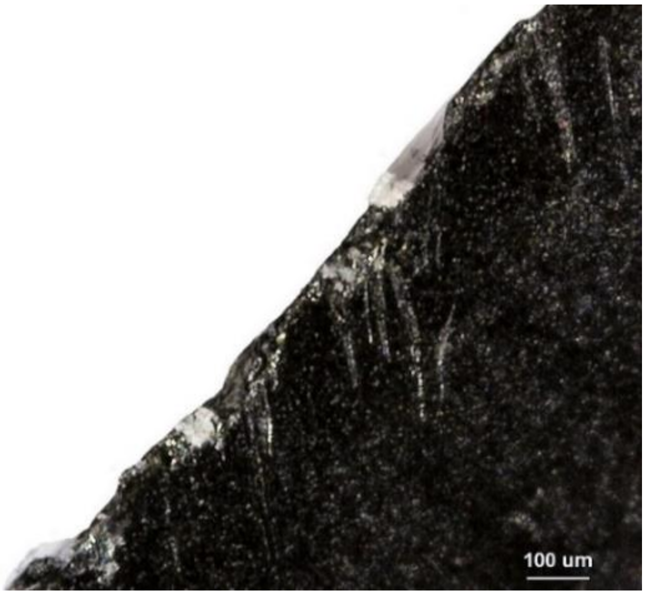

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Figure 77 Archaeological glass artefacts WLW04 and WLW06. ***A****: macroscopic images of WLW04; brackets indicate the region with wear.* ***B****: edge scars with oblique orientations, on WLW04; Dino-Lite x225 magnification.* ***C****: macroscopic images of WLW06; brackets indicate the region with wear and the side view shows curvature.* ***D****: oblique (near perpendicular) striations on WLW06; Dino-Lite x210 magnification.*

The other glass artefact to display three forms of wear was WLW02, a 3 x 3 x 0.5 cm very dark olive-green body shard that until held in front of light appeared dark black—as is typical with this kind of glass (Ulm et al. 2009:115). Striations were fewer than on WLW04 and WLW06, numbering 6–10, and bifacial and wide, with perpendicular and oblique orientations. Edge scars were again somewhat larger than most in the assemblage (0.5–1 mm compared to < 0.5 mm), also perpendicular to the working edge and closely clustered. Terminations were evenly divided between hinge (Figure 78) and feather varieties, with occasional step fractures. The working edge became rounded to a medium extent and polish and smoothing were not detected.

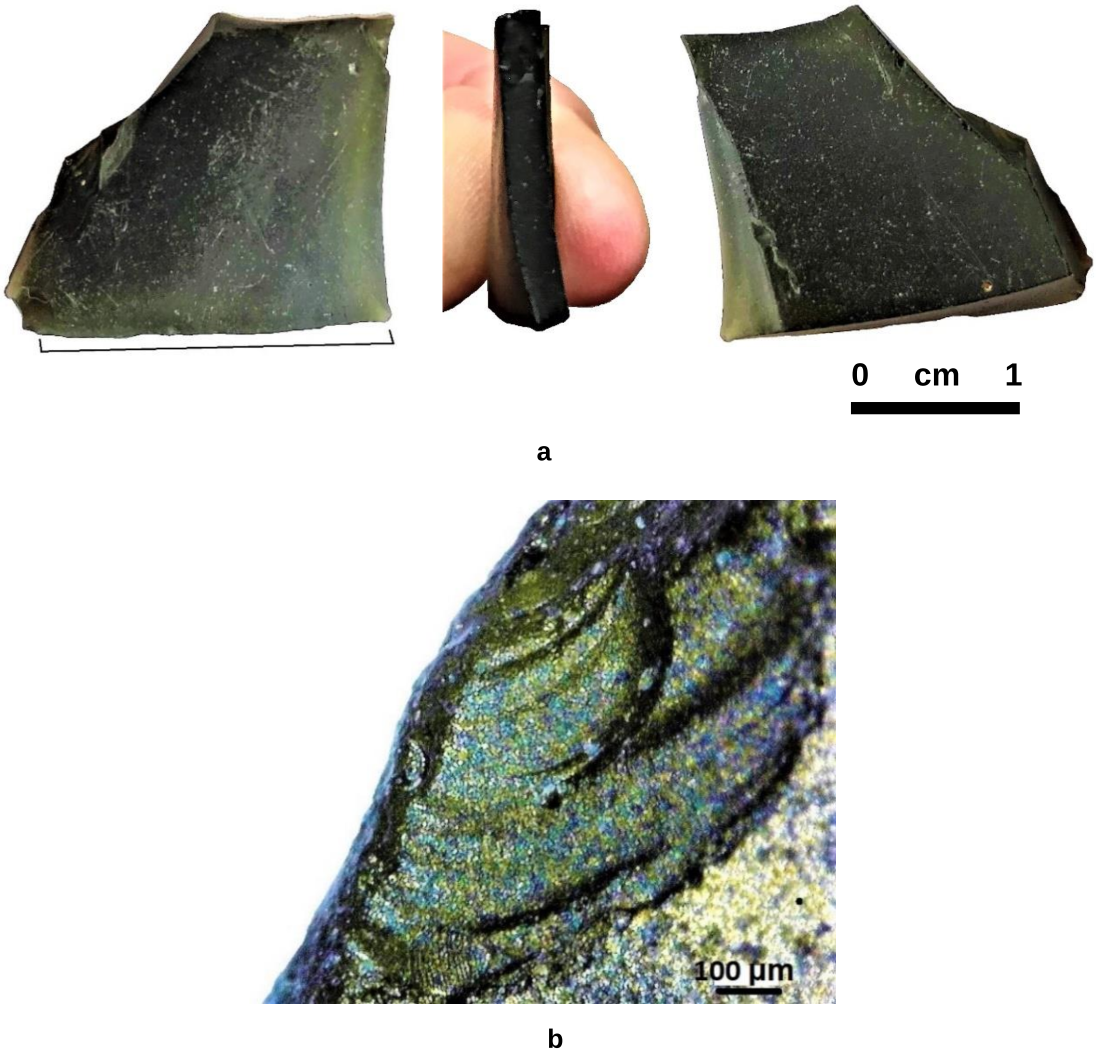


Figure 78 Archaeological glass artefact WLW02. ***A****: macroscopic images; brackets indicate the region with wear and the side view shows almost no curvature.* ***B****: multiple edge fracture scars with step and hinge terminations; Dino-Lite x220 magnification.*

Striations and edge scarring, but no edge rounding, polish or smoothing were present on body shards WLW03, WLW09, WLW13, WLW15, WLW18 and WLW24. On each artefact striations were wide and on both faces. They were low-density on WLW03 and WLW09, medium-density on WLW13 and high-density on WLW15, WLW18 and WLW24. The striations were orientated in multiple directions on all other than WLW03, in which case they were perpendicular and oblique. Mean edge scar length and width was < 0.5 mm on each artefact other than WLW18, whose mean length and width was 0.5–1 mm. Scarring was perpendicular on the majority of these artefacts and mostly isolated, other than on WLW03, where it was closely clustered.

Edge scarring was the only form of wear present on WLW10, WLW21 and WLW25, while on WLW19 striations were the sole form. WLW10 is a thick brown 6.5 x 3 x 0.5 cm body shard, most of whose edge scars were macroscopically visible, with a mean length and width of 0.5–1 mm. The scars were orientated mostly perpendicular, located on and near the working edge and mostly clustered. Similarly sized scars were on the brown 8 x 5 x 1.5 cm half bottle base that is WLW25. These scars were mostly perpendicular but isolated, as they were on WLW21, a 4 x 2 x 0.5 cm brown body shard. Striations on body shard WLW19 were few in number but present on both faces, wide, randomly orientated and near and far from the closest edge.

8.4 Porcelain Artefacts

Some form of wear was present on four of the eight archaeological porcelain artefacts, while all forms were present on artefact TI07 and none on TI01, TI02, TI04 or TI08 (Table 56) (‘TI’ refers to the Telegraph Insulator site).

Table 56 Summary of the wear present on the archaeological porcelain artefacts.

Artefact Number	Striations	Edge Scarring	Edge Rounding	Polish and Smoothing
TI01	x	x	x	x
TI02	x	x	x	x
TI03	x	x	✓	✓
TI04	x	x	x	x
TI05	✓	✓	x	x
TI06	✓	✓	x	x
TI07	✓	✓	✓	✓
TI08	x	x	x	x

Full details of the wear are seen in Table 57. When striations were present they were medium in density, bifacial, wide, randomly orientated and located near and far from the closest edges. Edge scarring, present on TI05, TI06 and TI07, was small (< 0.5 mm in mean length and width) and mostly perpendicular to the edges, while an edge on TI03 and one on TI07 became rounded to a low extent. Polish, present only on TI03 and TI07, was bright or moderately bright, smooth, located on peaks and in valleys (which may have been created by unevenness in the glazing or on parts of the unglazed surface), bifacial and distributed each time as a band away from the edge.

Table 57 Details of the wear present on archaeological porcelain artefacts.

	Striations						**Edge Scarring**						**ER**	**Polish and Smoothing**						
Artefact Number	**Number**	**Density**	**Art. faces** 1/2)	**Width**	**Orientation**	**Edge proximity**	**Mean length** (mm)	**Mean width** (mm)	**Orientation**	**Edge proximity**	**Density**	**Scar terminations**	**Extent**	**Brightness**	**Texture**	**Microtopography**	**Extension**	**Distribution**	**Invasiveness**	**Use-wear associations**
TI01	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TI02	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TI03	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	M	B	S	HL	B	BA	n/a	pol., ER
TI04	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	on	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
TI05	11–15	M	2	W	R	N & F	< 0.5	< 0.5	MPe	O & N	MI	MS	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
TI06	11–15	M	2	W	R	N & F	< 0.5	< 0.5	MPe	O & N	MI	MF	n/a	n/a	n/a	n/a	n/a	n/a	n/a	str., ES
TI07	11–15	M	2	W	MPe	N & F	< 0.5	< 0.5	MPe	N	MC	MF	L	M	S	HL	B	BA	ES < pol.	all
TI08	0	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Artefact TI03 was an intentionally knapped, complete 3 x 1.5 x 1 cm flake with a clear bulb of percussion, point of force application and platform (Figure 79). Some cortex was also retained on the distal margin. Striations and edge scarring were absent but one edge was rounded to a low extent and a bright, smooth, occasionally pitted polish was present equally on both faces, on high and low points (Figure 79).

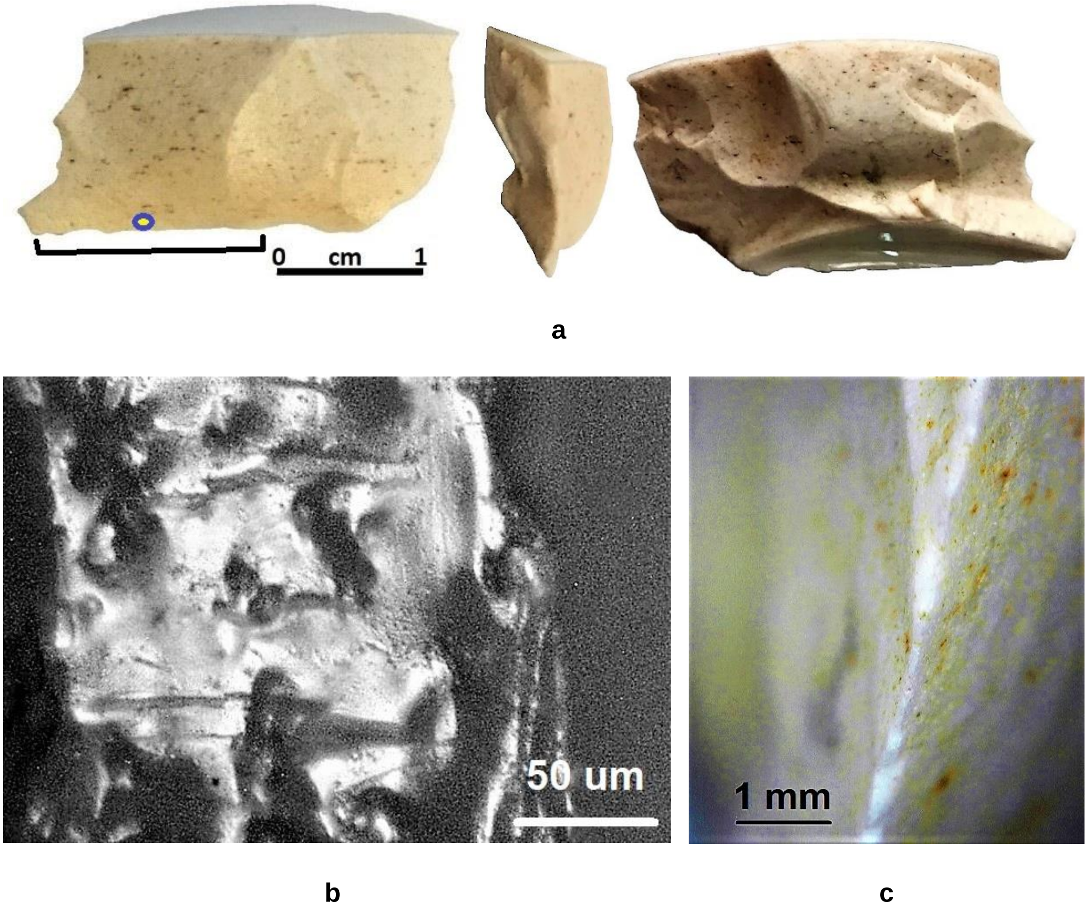
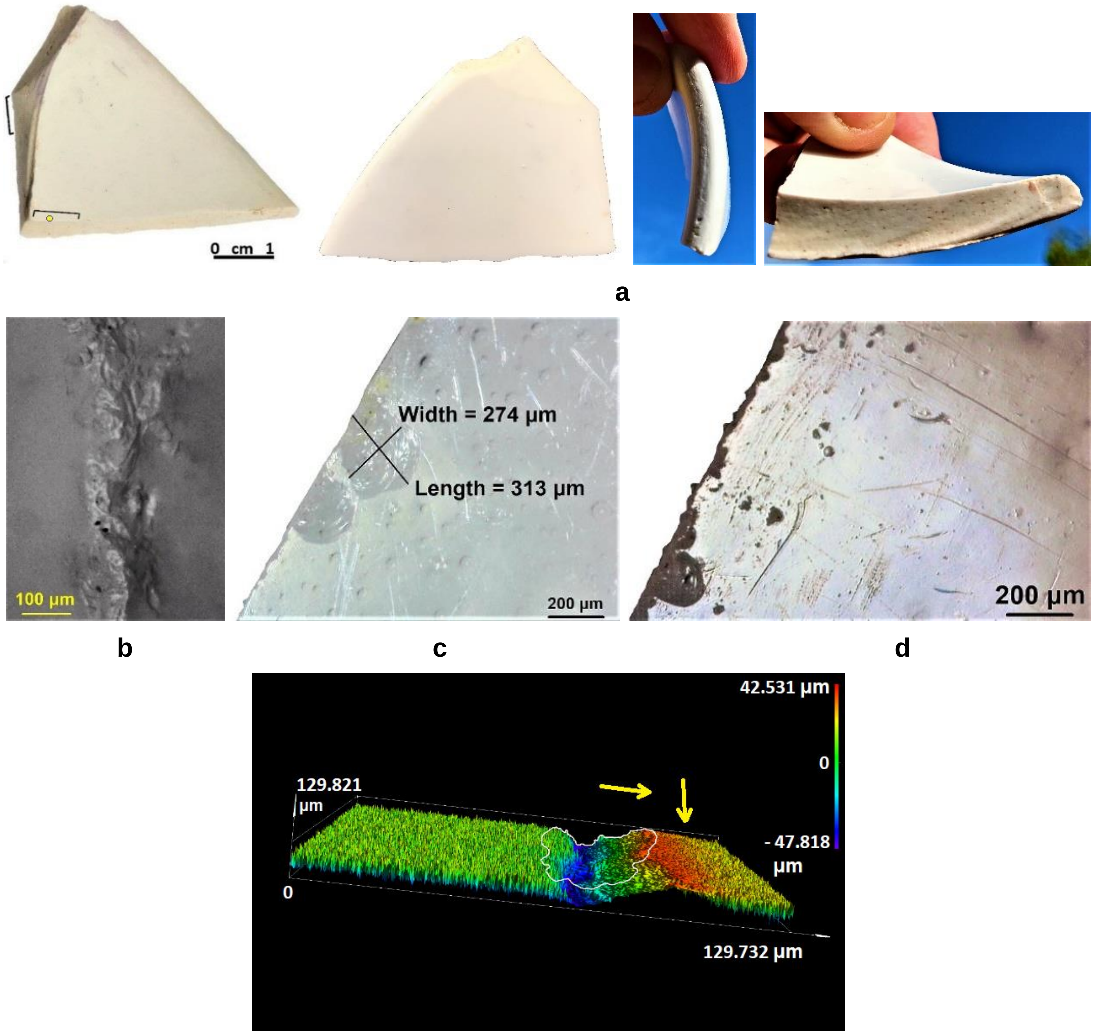
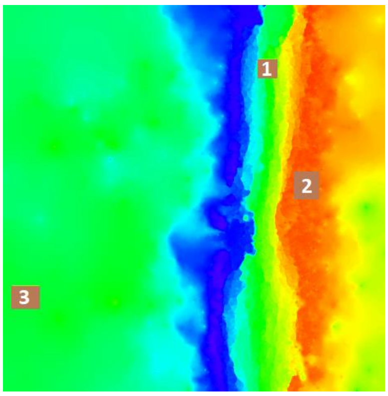


*Figure 79 Archaeological porcelain artefact TI03. **A**: macroscopic images of ventral, side and dorsal surfaces; brackets indicate the region of wear, while the circle indicates the location of polish seen in 'b.' **B**: smooth polish with some micropitting visible (the edge is to the left); x500 magnification. **C**: top view of a low extent of edge rounding; Dino-Lite x55 magnification.*

Polish, striations, edge scarring and edge rounding were present on two edges of TI07, a 5 x 4 x 0.8 cm shard (Figure 80). The 11–15 striations were on both faces, wide, mostly perpendicular and clustered near and far from the edge. Edge scars were few in number, small (in the category '< 0.5 mm' but often < 0.3 mm in length and width), also mostly clustered and perpendicular to the edge. Both edges had become rounded to a low extent and the polish was moderate in brightness, smooth, present on peaks and in valleys, distributed as a band away from the edge and more invasive than edge scarring.



e



f

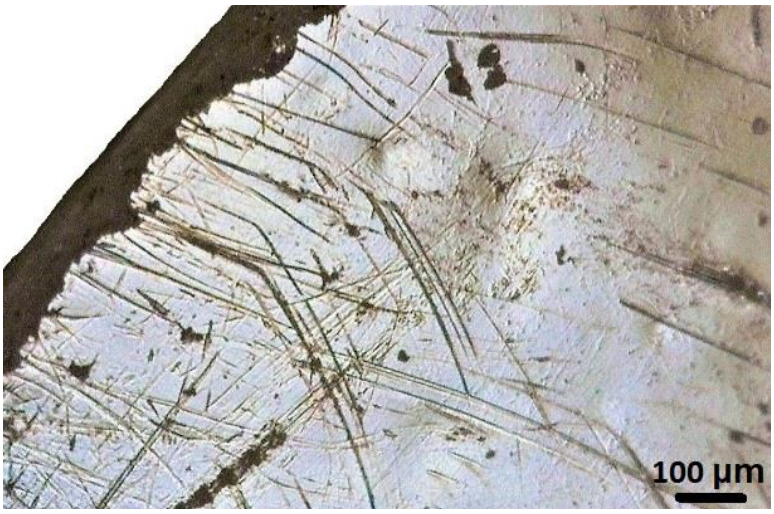
Sample	Polished or unpolished zone	Sq	Sa
1	Polished	2.470	2.030
2	Polished	0.776	0.606
3	Unpolished	0.101	0.072

g

*Figure 80 Archaeological porcelain tool TI07. **A**: macroscopic images of both faces, cross-section showing curvature and underside showing edge thickness; brackets indicate the locations of wear, while the circle indicates the location of polish seen in 'b.' **B**: polish on peaks and in valleys; x200 magnification. **C**: small edge scarring; Dino-Lite x235 magnification. **D**: mostly perpendicular striations (edge scarring also visible); Dino-Lite x215 magnification. **E**: 3-D contour map of elevations on the surface, demonstrating the presence of polish on peaks and in valleys; the right edge is the (part of the) working edge and the arrows indicate the probable directions of tool-use. **F**: 2-D height map showing locations sampled for surface roughness. **G**: key for 'f.'*

TI05 and TI06, both 4 x 2 x 0.5 cm shards, displayed a moderate density of striations on both faces and while their orientations were classified overall as 'random,' many were perpendicular (Figure 81). Edge scars were isolated on TI05 and mostly clustered on TI06.

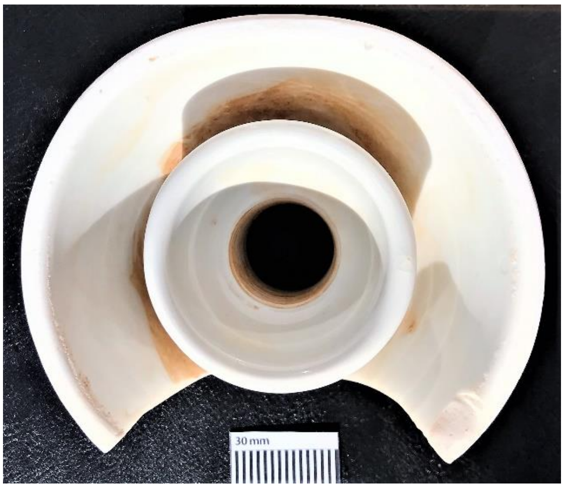
a



b

Figure 81 Archaeological porcelain artefact TI05. ***A****: macroscopic images; brackets indicate the region with wear.* ***B****: perpendicular, oblique and parallel striations; Dino-Lite x215 magnification.*

Artefact TI08 (Figure 82) was the only near-complete insulator present at the Telegraph Insulator site (there were no complete insulators). A concavity is present but there was no negative bulb of percussion or point of force application to suggest that this scar was the result of direct-percussion flaking. No shards from the site refitted with TI08.



a

b

c

Figure 82 Archaeological porcelain artefact TI08. ***A****: top view.* ***B****: bottom view.* ***C****: side (angled) view.*

8.5 Chapter Summary

The use-wear analysis of the archaeological assemblage indicates that some form of wear was present on 34 of the 62 artefacts. Most stone artefacts are small (< 4 cm in length), complete or proximal flakes and only one is retouched. The glass and porcelain artefacts are also small and there are no formal tool types of any raw material. Body shard fragments constitute the overwhelming majority of glass artefacts and only one glass and one porcelain artefact were flakes. Aspects of the wear are consistent with use-wear on experimental flakes used for particular purposes and with use-wear on tools used in previous experiments by others. Other features of the wear are potentially consistent with trampling and other taphonomic processes. This evidence can now be considered in terms of how it may address the key question in this research, concerning the Aboriginal utilisation of introduced glass and porcelain.

Chapter Nine: Discussion, Archaeological Assemblage

The key research question of this thesis concerns how past Aboriginal peoples around (two sites within) Calperum Station incorporated introduced glass and porcelain into their lifeways following permanent European colonisation in the 1830s. In response to this question, this chapter begins by addressing questions and possibilities arising from earlier discussions. For the remainder of the chapter, discussion focusses on interpretations from the use-wear analysis of the archaeological tools and related knowledge and perspectives from TOs. Drawing on this knowledge, along with that obtained from the current and previously published experiments, inferences are made about the nature of tool functions at Calperum Station and the technological responses by Aboriginal peoples to European colonisation.

9.1 Questions and Possibilities from Earlier Discussion

Unequivocal use-wear evidence for the use of glass and porcelain demonstrates that Aboriginal peoples at Calperum Station incorporated introduced European materials into their technology. The research question, concerning how they did so, can therefore be addressed.

Prior to doing so, several contextual questions and possibilities arising from earlier discussion require consideration. One issue concerned the regional availability of materials to be worked. All materials worked during the experiments for this project were readily available in the past around Calperum Station. This was attested to by cultural knowledge from TOs (Timothy Johnson and Philip Johnson, pers. comm. 2020), field observations of flora and recorded observations from early Europeans (Angus 1847; Eyre 1845 2:244–295). Kangaroo, sheep and other fauna provided sources of meat, bone and hide, and there is an abundance of *Typha*, river red gum, black box and numerous other potentially utilised plants.

Another possibility raised earlier was that specific dating information would be available on glass bottles in the field. Ultimately this was not the case, but, as discussed in the previous chapter, glass tool-use probably began during relatively earlier post-contact periods, based on the use-wear evidence on dark green glass (manufactured pre-1880s; Burke et al. 2017:449). Subsequent continuity in glass tool-use is indicated by (i) the use-wear evidence on amber glass, bottles of which, as also discussed previously, were not manufactured until the 1880s (Hutchinson 1981:154; Lockhart 2006:50); and (ii) the TO knowledge and demonstration attesting to the ongoing use of glass tools in the Riverland community, up to the present. The lack of specific dating information from glass was not an issue: fine chronological resolution was not imperative for this project because the research question, as it relates to introduced materials, concerns any time post-contact (and the bottle glass [and porcelain] can only be from this period. Approximate dates for the porcelain artefact with use-wear are discussed below). A (non-diagnostic) clay pipe stem was also present at West Woolpoolool, alongside the stone and glass artefacts, providing further contextual support for post-contact occupation of the site, regardless of who may have used the pipe.

A further possibility was that there would be evidence for tool-use related to conflict. There was no such use-wear evidence on artefacts from either site. TJ and PJ inferred that their antecedents manufactured chert spear tips, and at least one item from Calperum Station that is listed in the SAM accession register for RMMAC (#77467) is a spear with a wooden tip—so variations may have existed in the forms of spear tips. Regardless, spears may have been exclusively hunting tools, and detecting violence-related purposes can be impossible without vigorous supporting contextual evidence, such as the embedding of an artefact in a skeleton at the location and time of a known conflict (e.g., 'Narrabeen Man'; Fullagar et al. 2009; McDonald et al. 2007:877, 880–881). No formal or other artefact morphologies were present in the Calperum Station assemblage that could be even tenuously linked with conflict on the basis of comparison with other assemblages.

There was no evidence for hafting in the Calperum Station assemblage. This also discounts the possibility that any of the artefacts were used as armatures, such as projectiles or projectile tips (Fernández-Marchena et al. 2020; Fullagar et al. 2009:263–268; Lombard 2020; Maguire et al. 2021; McDonald et al. 2007; Rots and Plisson 2013; Villa et al. 2010). Use-wear evidence for projectiles typically requires multiple forms of evidence and conducive contexts, but there were no potential indicators in this assemblage, such as bright striations, particular kinds of impact fractures associated with step-terminated scars around the tips and/or edges, or width-wide bending fractures (Fernández-Marchena et al. 2020:16; Rots and Plisson 2013:159). Retouch was present on only one artefact and not in a manner remotely akin to that typically on spear barbs or tips, while no artefacts took the form of points.

Earlier discussion implicitly inferred the possibility of evidence for the practice of opium-smoking that was undertaken in other regions by some early Chinese Australians (Galloway 2005:112–113). There was no positive evidence for this activity around Calperum Station, as no pontil had been removed from any glass bottle base (including among artefacts observed in but not retrieved from the field).

9.2 Tool Uses Inferred from the Use-wear Analysis

Of the 62 artefacts subjected to use-wear analysis, eight were interpreted as definitely used. Four of the eight were classified as 'definitely used, with convincing evidence for the worked material' and the other four under 'definitely used but worked material uncertain.' A further seven of the 62 artefacts were interpreted as 'probably used but worked material uncertain' and 18 as 'possibly used but worked material uncertain.' On occasion, tools displaying the same forms of use-wear, such as polish and edge scarring, were interpreted differently because of the varied nature of these characteristics on the individual tools. Tool edge angles were measured for artefacts that were interpreted as definitely used. The 29 artefacts that did not display any wear were classified under ‘no evidence for use.’

Presumptions based on artefact morphology were avoided. In any case, there were no widely accepted formal types based on macroscopically observable morphology, such as adzes, backed artefacts or Kimberley points that might suggest a particular function or perhaps symbolic purpose (Dickinson 2021; Harrison 2003). The morphology of an artefact is dynamic during its lifetime, with many factors involved in the creation of its final form. Some of these factors, such as pre-existing flaws in a rock, often render it beyond the ability of a knapper to control the fracture path, discounting the notion that artisans consistently employed mental templates for artefact morphologies (Clarkson 2007:37; Cotterell and Kamminga 1987; Flenniken and White 1985; Holdaway 1995:793; Macgregor 2005; Pelcin 1997:1109–1112; Rolland and Dibble 1990:484–493; Speth 1972; Tallavaara et al. 2010:2246–2448; Webb and Domanski 2008:557). Consequently, unless widely accepted formal types exist in an assemblage, tool morphology may not be a reliable indicator of tool use. Tool morphology has also been demonstrated to have often been of less importance to Indigenous Australian and overseas knappers than edge quality (Cane 1992; Harrison 2003:318; Hayden 1977; White 1967:409–412). Similarly, while the manufacture of complete flakes or the application of retouch may suggest an intent to use, it does not follow that such artefacts were definitely used and that other broken or unretouched flakes were not (Harrison 2003:318; McNiven et al. 2017:185–186; Wolski and Loy 1999).

Inferences for tool use at Calperum Station are provided in the following paragraphs. Discussion is sequenced according to artefact raw materials, in accordance with the aims of the research question.

9.2.1 Chert Artefacts

Of the 16 chert artefacts, three (WLW27, WLW28 and WLW29) were interpreted as ‘definitely used but worked material uncertain.’ A further three (WLW34, WLW36 and WLW38) were classified as ‘probably used but worked material uncertain’ and four (WLW26, WLW31, WLW32 and WLW39) as ‘possibly used but worked material uncertain.’ There was no use-wear on six artefacts (WLW30, WLW33, WLW35, WLW37, WLW40 and WLW41).

Artefact WLW27 is interpreted as definitely used based on the presence, nature and combination of most forms of use-wear. The worked material is probable but not conclusive. Parallel striations on both faces of the tool demonstrate a sawing or cutting motion, and the tool edge angle was 56º. However, use-related edge scarring was not definitively distinguishable from the scars created during the process of retouch. The use of the LSCM confirmed observations made under the conventional metallographic microscope that polish and smoothing were present exclusively on microtopographic peaks, which suggests that a harder material was processed (Keeley 1980:43). Bone-sawing is improbable given that no micropitting or minute fractures within edge scars were observed (as per Kamminga 1982:48–49) and the edge scars were not particularly large, in contrast to the scar sizes on tools used to saw bone during my experiments (scar sizes were observed but not formally recorded for WLW27 because of the possibility that they were retouch scars). The combination of these use-wear attributes on WLW27, along with the fact that the polish was moderately bright and distributed as a band on the edge, suggests the sawing or cutting of wood. Bright polish and its distribution as a band on the edge was common in my chert wood-working experiments.

Artefact WLW28 is interpreted as definitely used because of the presence and physical proximity of closely clustered edge scarring, edge rounding and polish and smoothing. While not compelling, there is more convincing evidence for the worked material than for WLW27, but the tool motion is unknown due to the absence of striations and other clear directional use-wear. The closely clustered edge scars were few in number, small (< 0.5 mm in mean length and width) and less invasive than the polish and smoothing. The working edge, with an angle of 73º, became rounded to a medium extent, the polish was bright compared to most other artefacts in the assemblage and the polish and smoothing were present on peaks and in valleys. These use-wear characteristics are similar with those on chert tools used in past experiments to process softer materials (Linton et al. 2016:1041; Luong et al. 2019:10; Stevens et al. 2010:2675; van Gijn 2010:39). Several attributes are also similar to those on the chert tool (X45) used to work *Typha* in my experiments. On these bases, WLW28 was probably used for the processing of softer plant material, such as the readily available *Typha* reeds. Such a use would be consistent with the conclusion by Jones et al. (2017:51), based on their investigations of archaeological material from earth mounds at Calperum Station, that *Typha* (roots) was cooked for consumption and processed to extract the fibre.

The presence and nature of striations, edge scarring, edge rounding and polish and smoothing attest to the definite use of WLW29. Although evidence for the working motion is not definitive, transverse movements are possible. The striations are orientated perpendicular to the working edge and the presence of polish and smoothing predominantly on one face of a tool has been observed, for example, after planing (Solheim et al. 2018:565). However, a transverse motion other than planing could also have been implemented with WLW29, particularly given that the working edge became rounded to a medium extent and Lerner (2007:61) found that edge rounding was rare after planing. A transverse, rather than parallel tool motion, is also suggested by the presence of the striations on only one face of the tool and that of the polish and smoothing predominantly on one face. Sawing or cutting are improbable given that these motions normally result in bifacial use-wear and did so consistently throughout my experiments across tool raw materials and worked materials. The thin edge (< 1 mm) and low edge angle (33º) would also make sawing or cutting difficult due to the likelihood of more regular breakage (and although there were step-terminated scars, these edge traits are also probably the reason for the axial termination).

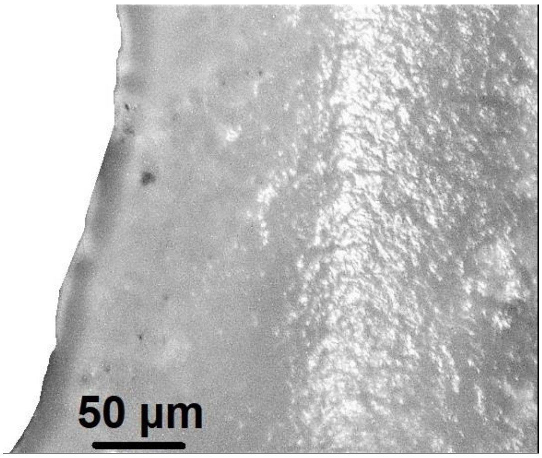
The material worked by WLW29 is also uncertain. Although the presence of a bending-initiated scar with an axial termination and minute fractures inside the scar suggests the sawing of bone (Kamminga 1982:48–49), the above discussion described reasons for the improbability of sawing and this scar was the only such one on the tool. Further, the striations were wide rather than the narrow varieties that previous experiments (Keeley 1980:43) and those from this thesis demonstrated are common after the processing of bone. Nonetheless, the predominance on WLW29 of step fractures and the location of the polish only on peaks suggests that a harder material was worked. Wood-working can therefore not be precluded. However, the polish was only moderate in brightness rather than the typically brighter polish that results from the working of wood. Polish was also distributed in spots, in contrast to the polish on chert tools used to work wood during my experiments, which was commonly distributed as bands on the working edges.

Edge scarring in association with polish indicates that WLW34 was probably used. However, use is not definite because the physical association between the two forms of wear was not as close as that on other artefacts and overall there was relatively little wear development. There is insufficient evidence for a worked material or tool motion. No striations or edge rounding were present and no minute fractures were contained within the few edge scars that might suggest bone-sawing (Kamminga 1982:48–49). Instead, the axial terminations (and bending-initiated scars) may have been the result of a thin working edge and low edge angle, common in planing. Nonetheless, it is possible that WLW34 was used to process fresh meat. The edge scars were particularly small (in the category ‘< 0.5 mm’ but often < 0.25 mm in length and width) and the polish was moderately dull, extended further than 1 mm into the artefact from the working edge and present on peaks and in valleys. Similar aspects of use-wear were observed after meat-working during my experiments and by others in past experiments with chert tools (Kamminga

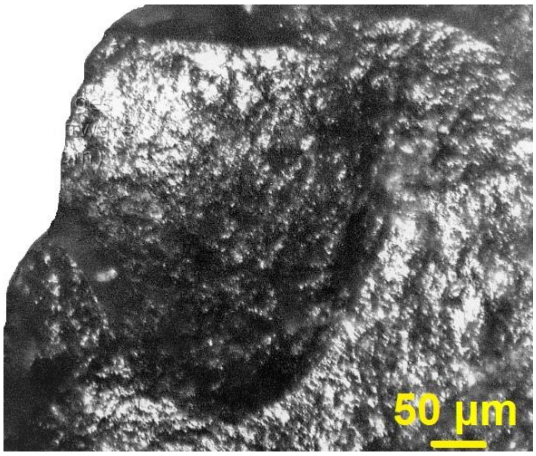
1982:34–36; Keeley 1980:53; Kirgesner et al. 2019:5; van Gijn 2010:63). The possibility of meat-processing offers some support to the inference by Thredgold (2017:140) and Thredgold et al. (2017:110), based on their macroscopic technological analysis, that Aboriginal peoples around other sites at Calperum Station used chert tools to process food, albeit that this inference was based on artefacts concentrated within the vicinity of earth mounds.

Artefacts WLW36 and WLW38 exhibited use-wear similar to each other and to WLW34 and are interpreted as probably used, based on the same reasoning. There were no clear directional indications for tool motion(s). On WLW38 the polish extended inward further than 0.5 mm from the edge but on WLW36 it extended less than 0.5 mm (despite its presence away from rather than on the edge) (Figure 83). Kirgesner et al. (2019:6) observed that the decisive use-wear difference resulting from working fresh and frozen meat using chert tools was not the brightness or other characteristics of polish but the extent of its invasiveness: further than 0.5 mm after fresh meat and less than 0.5 mm after frozen meat. This observation caters for the possibility that WLW38 was used to process fresh meat, particularly given the other use-wear similarities with WLW34.

Kirgesner et al.'s (2019:6) observation also implies that WLW36 may have been used to process frozen meat. However, this is contextually improbable because Aboriginal peoples around Calperum Station (and most European settlers) would not have had ready access to freezing resources in the nineteenth and perhaps up to the mid-twentieth centuries. The climate was not sufficiently cold for permafrost to develop and because frozen meat is hard, more step fractures would be expected rather than the feather terminations that were predominant. Nevertheless, the lesser invasiveness of the polish on WLW36 than on WLW38 suggests that WLW36 was used to process a slightly harder material than fresh meat. Even so, the material would not have been particularly hard because of the similar nature of the remaining characteristics of the use-wear with those on WLW34 and WLW38: small edge scarring (< 0.5 mm in mean length and width) and an absence of step fractures, as well as polish and smoothing that was more invasive than edge scarring and located on peaks and in valleys.



a



b

Figure 83 Polish on WLW36 and WLW38. ***A****: WLW36, with polish away from the edge but less invasive than 0.5 mm.* ***B****: WLW38, with polish within and beyond an edge scar, extending over 1 mm inwards from the working edge (beyond the boundaries of this image); both images = x500 magnification.*

Of the remaining four chert artefacts exhibiting wear, in the sole form of edge scarring, the evidence suggests only a remote possibility of use, with no indications of its nature. Few scars were present on WLW26, WLW31, WLW32 and WLW39, and on WLW31 and WLW32 the scars were mostly isolated. With such infrequent scars, no patterning existed on any of the four artefacts that might indicate intentional use. Rather, the wear probably represents trampling. Scars on the flakes from the trampling experiments were also isolated and without pattern in distribution or directionality, and none displayed polish or edge rounding. Other taphonomic processes cannot be precluded but the close agreement in the nature of the wear on these archaeological artefacts and the experimentally trampled flakes demonstrates the significant value of the trampling experiment and subsequent wear analysis for distinguishing between use-related and non-use-related wear.

Chert artefacts WLW30, WLW33, WLW35, WLW37, WLW40 and WLW41 displayed no wear. As a result, they were classified under 'no evidence for use.'

9.2.2 Silcrete Artefacts

Relatively minimal comment can be made for the silcrete artefacts in this Calperum Station assemblage because only two (WLW44 and WLW45) of 13 displayed wear and the wear was scarce. Because of this scarcity, comparisons cannot be made with the use-wear observed on experimental silcrete tools (discussed earlier) by Kamminga (1982), archaeological silcrete tools by Berehowyj (2013), McDonald et al. (2007) and Fullagar et al. (2009), or on quartzite or quartz tools (Fullagar 1986b; Pedergnana and Ollé 2017). The four striations on WLW44 were isolated and with no use-wear in association cannot be confidently interpreted as use-related. Rather, they may also have been caused by trampling. This artefact is interpreted as possibly used and if this were the case, the perpendicular orientations of the striations suggest a planing, scraping or adzing motion.

Artefact WLW45 was possibly used, based on the presence of the polish and edge scarring. However, the polish was distributed as isolated spots and the scarring infrequent, albeit mostly clustered. Such wear may have been caused instead by natural processes, including movement resulting in abrasion with sediment if the artefact was at some point buried (as occurred during my trampling experiments). If WLW45 was indeed used by Aboriginal people, the presence of particularly small edge scars (mostly < 0.2 mm in length and width) and the location of the polish on valleys and in peaks, hints at the processing of a softer material because such material allows deeper surface penetration by the artefact edge. No clear directional use-wear was present to infer tool motion(s). All remaining silcrete artefacts were classified under 'no evidence for use,' and with no form of wear on any, there were no signs of trampling or other taphonomic processes.

9.2.3 Glass Artefacts

Of the 25 glass artefacts, four (WLW01, WLW08, WLW12 and WLW22) were interpreted as 'definitely used with convincing evidence for the worked material.' Three (WLW02, WLW04 and WLW06) were interpreted as 'probably used but worked material uncertain,' while 11 (WLW03, WLW07, WLW09, WLW10, WLW13, WLW15, WLW18, WLW19, WLW21, WLW24 and WLW25) were classified as 'possibly used but worked material uncertain.' On seven artefacts (WLW05, WLW11, WLW14, WLW16, WLW17, WLW20 and WLW23) there was no use-wear. Of the 18 artefacts classified as either definitely, probably or possibly used, 17 were body shards (WLW25 was a 'possibly used' part bottle base/part bottle wall fragment), which discounts any presumption that thick bottle bases were mostly preferred for the manufacture of glass tools (Harrison 2003:318; Wolski and Loy 1999).

Given the scarcity of parallel use-wear orientations on most of the 25 pieces (some parallel directions were present among the 'random' striation classification), it is inferred that glass tools were used with predominantly transverse motions. However, sawing and/or cutting cannot be precluded because occasional oblique striations and edge scars were present and such oblique orientations sometimes occurred after sawing and cutting with the experimental glass tools. When striations were present on the archaeological glass tools, their typically high densities in relation to the tools' surface areas were consistent with the striation densities on the experimental glass tools.

Use-wear on artefact WLW01 indicates definite use and several aspects provide convincing evidence for the worked material. In a rare occurrence among both the experimental and archaeological assemblages, the striations were narrow (< 2 μm). The edge scars were larger (0.5–1 mm in mean length and width) than those on many of the other archaeological artefacts and mostly step-terminated, along with some axial terminations. The axial terminations were probably more a product of the thinness of the edge (1–2 mm) rather than tool edge angle, because the angle of 71º is not acute; albeit that the exact angle at which any of the archaeological tools was held cannot be known. Edge scarring was more invasive than polish and smoothing and no micro-fracturing was visible within the scarring, while the working edge became rounded to a low extent. Many micro-pits, mostly sized 1–2 square microns, were present within the polish, which was moderately bright and well-developed, suggesting that WLW01 was worked for at least 15 minutes (Aoyama 1995:133; Walton 2019:927). All of these use-wear characteristics are consistent with the use-wear on most of the experimental bottle glass tools used for scraping bone (tools X01, X09, X11, X12, X14, X17, X57, X58, X76, X97, X101 and X106) and with the wear on obsidian tools used for the same tasks in previous experiments (Aoyama 1995:133; Walton 2019:927, 934). Using glass to scrape bone is also a task that TJ and PJ inferred was undertaken by their antecedents. The most notable use-wear difference was that polish and smoothing on WLW01 formed on peaks and in valleys rather than only on peaks. However, this may be attributable to scraping meat or other softer material in addition to bone, suggesting the possibility of multifunctionality for this tool.

Further evidence exists for bone-scraping on artefacts WLW08, WLW12 and WLW22. Striations were narrow on WLW08 and WLW22, located on the working edges and in moderate to high density with transverse (and occasional oblique) orientations. Edge scarring was frequent, step and axial terminations predominated, micropitting was present and edges became rounded to a low extent (tool edge angles were slightly varied: WLW08 = 68º; WLW12 = 44º; and WLW22 = 51º). The formation of polish and smoothing on only the peaks for two of these tools (WLW08 and WLW22) attests to the working of a harder material, the other tool (WLW12) displaying bright polish and smoothing on microtopographic high and low points in a manner similar to WLW01. Use-wear on these three tools demonstrates definite use, with all evidence consistent with that from my experiments (referred to above) and previous experimental bone-scraping using glass/obsidian tools (Aoyama 1995:133; Walton 2019:927, 934). Bone tools were not observed in the surveyed regions at Calperum Station but may nonetheless be present at other sites within the Station and region, particularly given that they have been recovered from sites along the Lower River Murray (Hale and Tindale 1930; Hutchinson 2012; Wilson et al. 2021). It may also be possible that bone was worked at Calperum Station primarily during butchering and/or craft activities. Working bone for as little as five minutes can create discernible use-wear (Walton 2019:901, 927).

Glass body shards WLW04 and WLW06 were probably, but not definitely used and no clear evidence exists for the worked material. Therefore, these shards cannot be conclusively classified as tools. The probability of use is inferred due to the closely associated, numerous, densely packed striations, edge rounding and closely clustered rather than isolated edge scarring. Some, albeit not definitive indications exist for tool motions were these shards indeed used. The presence of striations bifacially on WLW04 suggests cutting or sawing, but striations can also occur on both faces of a tool as a result of other motions and their orientations were random rather than predominantly or exclusively parallel. On WLW06 the location of striations on a single face indicates that a parallel motion is improbable. The mostly perpedicular orientations of the striations further suggests a transverse tool motion but, because oblique striations were also present, cutting or sawing cannot be precluded. Medium and low extents of edge rounding on WLW04 and WLW06 respectively do not in these cases assist the identification of the potentially worked material given the absence of corroborating polish or other clear use-wear indicators. There was not, for example, an abundance of step fractures to indicate the working of harder materials, while the rounding of edges can result from working a range of materials (Kononenko 2011:22, 24–25, 31, 39; Walton 2019:920, 934). For both WLW04 and WLW06, as is the case for all artefacts in the Calperum Station assemblage, no evidence exists for wedging or chopping and if these shards were indeed used, a range of motions was probably involved. The lack of chopping and wedging in the assemblage is unsurprising given that the tools were small (typically around 2.5 cm long, 2.5 cm wide and < 1 cm thick) and these tool motions are more effectively implemented with more sizeable, robust tools—as was apparent in my experiments.

Although WLW02 also displayed striations, edge scarring and edge rounding, some traits differ from those on WLW04 and WLW06. Striations were fewer, while edge scars were slightly larger and not as often abruptly terminated. WLW02 was probably used, based on the same reasons described for WLW04 and WLW06, and while the perpendicular orientations of edge scarring and striations suggest a transverse motion, the possibility of sawing or cutting is retained on the basis of the oblique striations on both faces of the shard. Despite the presence of a moderate extent of edge rounding, the combination of wear characteristics does not provide sufficient evidence to infer the worked material.

None of the glass shards WLW03, WLW07, WLW09, WLW13, WLW15, WLW18 and WLW24 can be confidently categorised as probably or definitely used. Rather, they are classified as 'possibly used but worked material uncertain.' The improbability that these seven shards were used is primarily because the wear was minimal, isolated and randomly orientated. Although these characteristics do not automatically preclude use, they too are characteristic of the wear on the trampled flakes from the experiments conducted in this thesis and with a range of taphonomic processes described in other studies discussed earlier (Lemorini et al. 2014; Martindale and Jurakic 2015:34, 38; Rots and Williamson 2004; Shea and Klenck 1993; Tringham et al. 1974). Each shard also exhibited the combination of striations and edge scarring but no polish or edge rounding, which, in light of the same key results for my experimentally trampled flakes, adds weight to the possibility of trampling compared to other taphonomic processes—even though there was no breakage among these archaeological shards. All striations on this group of archaeological shards were wide, which was common during the tool-use experiments after working a range of materials using glass tools (and tools of other raw materials), although wide rather than narrow striations reduces the possibility of bone-working according to experimental results. The somewhat ‘crazed,’ scattered nature of the striations was similar to those often observed macroscopically during the tool-use experiments on shards prior to use.

Minimal evidence exists for the use of WLW10, WLW19, WLW21 and WLW25. These shards are also classified as ‘possibly used but worked material uncertain.’ A solitary form of wear was present on each shard in scarce quantities and isolated rather than clustered. The macroscopic visibility of edge scarring, as applied to WLW10, can be one indicator of taphonomic causation (Gorman 2000:266; Martindale and Jurakic 2015:38; Shea and Klenck 1993; Tringham et al. 1974). Isolated wear can sometimes result from the use of a tool, as, for example, with the isolated rather than densely packed striations observed by Kononenko (2011:25) after the scraping of hard wood using obsidian tools. However, the striations on tools in Kononenko’s (2011:25) analysis were more patterned, despite being isolated from each other, and associated with other forms of use-wear. In contrast, the striations on WLW19 (the only one of these four pieces on which striations were present) were few in number (n = 1–5), not associated with other use-wear and randomly orientated.

No wear was evident on WLW05, WLW11, WLW14, WLW16, WLW17, WLW20 or WLW23. Consequently, these glass pieces were classified under ‘no evidence for use.’ The absence, on glass tools in this assemblage, of use-wear indicative of wood-working is notable in light of the TO demonstration of glass tools for smoothing wooden items and the possibility that the same task had been applied by their ancestors to the several wooden items from Calperum Station that are currently held in the SAM. However, inferences by TJ and PJ, based on knowledge passed down to them from previous generations, attest to the possibility that glass tools were, nonetheless, indeed used for smoothing wooden items.

9.2.4 Porcelain Artefacts

Of the eight porcelain artefacts, one (TI07) was interpreted as 'definitely used but worked material uncertain.' Another (TI03) was classified as 'probably used but worked material uncertain,' while two (TI05 and TI06) were 'possibly used but worked material uncertain.' There was no wear on the remaining four porcelain artefacts (TI01, TI02, TI04 and TI08). In contrast to the porcelain shards from Papua New Guinea analysed by Kintanar (2014), there was no evidence, such as knife or spoon cut marks or abrasion, for cutlery having been used on the porcelain. Rather, the use-wear evidence indicates that the porcelain was used to work other materials.

TI07 attests to the adoption of introduced porcelain by Aboriginal peoples at Calperum Station. The presence of all forms of use-wear in association on two edges (one tool edge angle = 47º; the other = 73º) constitutes original evidence for Aboriginal Australians using porcelain as a tool for working other materials, rather than as an end-product itself. The worked material is uncertain. Plant-processing is possible given that on the experimental porcelain tools used to cut and scrape plants (tools X52, X104 and X105) there were, like on TI07, few edge scars and those present were small (< 0.5 mm in mean length and width), as well as some edge rounding and smooth-textured polish on peaks and in valleys. However, slight reservations exist because the polish on the experimental porcelain tools, as well as on ceramic tools used by van Gijn and Hofman (2008:28) to experimentally process fresh reeds, along with the ceramic plant-processing tools from the western Sydney site discussed earlier (Munt 2021; Munt and Owen in press 2021), was brighter than that on TI07.

It is less probable that TI07 was used to work a relatively hard material. Several use-wear features are similar between the experimental porcelain tools used to work wood, the ceramic wood-working tool from western Sydney (Munt 2021; Munt and Owen in press 2021) and TI07. Primarily, the similarities were with the striations and edge scarring. However, the polish and smoothing on TI07 were distributed as a band away from the edge. This distribution was also the case for two of the 12 experimental porcelain tools used to scrape wood (X74 and X85), but on another eight of these 12 tools the polish and smoothing were distributed as bands on the edges and on the other tool (X86) as isolated spots. Further, on all experimental wood-working tools and the ceramic wood-working shard from western Sydney (Munt 2021; Munt and Owen in press 2021), polish and smoothing were present exclusively on microtopographic high points. In contrast, the peaks and valleys of TI07 were polished and smoothed.

Evidence from my experimental porcelain tools does not support TI07 being used to work bone. The relatively blunt edges on experimental porcelain shards often rendered ineffective any attempt to scrape, saw, cut or otherwise process such a hard material. However, these experimental tasks were nonetheless completed and several differences emerged in the use-wear when compared to that on TI07. On the experimental tools used to scrape and saw bone, striations were narrow and in high density relative to the tools' surface areas (tools X06, X48, X53–55, X72, X80–82, X87, X98 and X100). Edge scarring was mostly 0.5–1 mm in mean length and width (sometimes 1–1.5 mm) and step-terminated, while polish and smoothing were present only on the high points of the microtopography. In contrast, the striations on TI07 were wide and in medium density, edge scarring was mostly < 0.5 mm in length and width, and feather-terminated, while polish and smoothing were on high and low points.

It is also improbable that TI07 was used to scrape fresh hide or meat. Although two of the three experimental porcelain tools used for fresh hide-scraping displayed some wear similar to that on TI07, they exhibited few striations and edge scars, as well as a rough, unifacial polish distributed as spots and streaks (tools X93 and X95; whereas on tool X94 edge rounding was the only form of use-wear). These traits are also not consistent with the pattern of use-wear on ceramic tools used by van Gijn and Hofman (2008:28) for experimental hide-processing. Further, Shamanaev (2002:144) found fresh and very dry hide impossible to process using ceramic tools because of constant slipping of the edge upon contact with the hide (he reported better success after the hide had been preliminarily scraped using stone tools). On my experimental porcelain meat-processing tools (tools X49–X51), further differences in the use-wear emerged in comparison to that on TI07: there were few striations, no edges became rounded and the polish was dull and distributed as spots and streaks (on one of the three experimental tools, X50, edge scarring was the only form of use-wear present).

TI07 would probably have been used with both transverse and parallel tool motions. A transverse motion is indicated by the predominantly perpendicular orientations, in relation to the working edges, of the striations and edge scars. Although the exact kind of transverse movement is not definitive, scraping appears the most probable given that polish and smoothing were present on both faces of the tool and during the experiments this trait was evident more often after scraping than planing or adzing. A parallel tool motion is also indicated by the presence of the polish and smoothing equally on both faces of TI07, a use-wear characteristic that occurs as a result of both faces of a tool coming into a similar amount of hard contact with the worked material. Experiments supported this indication in that polish and smoothing were often present on both faces of porcelain tools used with parallel motions.

Artefact TI03, the only intentionally knapped, complete porcelain flake, is interpreted as probably used based on the nature of the polish and smoothing and associated edge rounding. However, no clear pattern exists between the use-wear resulting from the experimental working of any individual material with porcelain tools and the wear on TI03, so the worked material is uncertain. No striations or edge scarring were present on TI03 and the polish and smoothing were on peaks and in valleys, extending inward further than 1 mm from the working edge. On this basis, fresh meat was possibly worked, but this inference is based on similar wear characteristics on tools made from chert rather than porcelain (Kimball et al. 2017:67–68; Kirgesner et al. 2019:4–5; van Gijn 2010:63) (there are no previous studies involving porcelain tools used to process meat). In contrast to the use-wear characteristics on TI03, the porcelain meat-processing tools from my experiments exhibited striations, edge scarring, no edge rounding and a dull polish predominantly on one face of each tool, distributed as spots and streaks.

TI03 may have been used to scrape hide. Experimentally scraping fresh hide with three porcelain tools (tools X94–X96) resulted in few or no striations or edge scarring and a medium extent of edge rounding on two tools (with a low extent on the other). This accords with the absence of striations and edge scarring and the presence of a medium extent of edge rounding on TI03. However, the absence of features is rarely a reliable form of evidence, and, in addition, the polish on the experimental hide-scraping tools was moderate in brightness, rough and unifacial, whereas on TI03 it was bright, smooth and bifacial. While aspects of the use-wear differ from the use-wear on my experimental tools, they correspond with several observed by Vieugué (2015:94). Given such mixed results from the few previous hide-scraping experiments with ceramic tools, hide-processing with TI03 cannot be confirmed or precluded.

A greater probability is that this tool was used to process plant material. While striations and edge scarring were present on the experimental plant-processing porcelain tools (and absent on TI03), neither form of wear was prolific. A medium extent of edge rounding was present on two of the three experimental porcelain tools used to process plants and a low extent on the other. Polish was present on two experimental plant-processing tools and bright, smooth and located on peaks and in valleys. On one of these tools the polish was present only on one face and distributed as spots and streaks. On the other experimental tool, it was present on both faces in approximately equal quantities and distributed as a band away from the working edge. These polish characteristics are similar with those on TI03, where the polish was bright—as observed by van Gijn and Hofman (2008:28) after using ceramic fired at high temperatures to process reeds for five minutes—and located on peaks and in valleys, present equally on both faces and distributed as a band away from the edge.

However, the archaeological context of the Telegraph Insulator site suggests that were TI03 indeed used to process plant material, it may not have been for cooking or fibre-processing. The nearest reliable water source, Lake Woolpoolool, was around two kilometres distant, and there were no hearths or earth mounds in the vicinity and no other evidence of occupation for any length of time. It cannot be precluded that this artefact was used elsewhere and brought to the Telegraph Insulator site, but the location of the site along the telegraph line discounts this possibility. Instead, craft or other activities may have been undertaken, such as basket-weaving, matting or the manufacture of plant-based clothing items. Although TO oral histories did not allude to such uses of porcelain, these or similar tasks may have been undertaken, particularly given that they are known to have been conducted by other Indigenous groups (e.g., Harkin 2020:157–158; Hurcombe 2014:17, 136, 149). For example, among Ngarrindjeri Aboriginal peoples in the south-east of SA, basket-weaving was conducted not only for creating baskets but as a metaphor for familial and cultural interrelations, whereby the adding of each layer of reed symbolised familial growth (Harkin 2020:157–158).

Inferences for tasks undertaken with TI03 are further limited by the lack of definitive use-wear for the tool motion(s), although parallel movements are probable. The bifacially equal presence of polish and smoothing suggests a roughly even extent of hard contact with the worked material on both faces of the tool, but my experiments demonstrated that bifacial use-wear can also occur, albeit less regularly, across the tool raw materials after transverse motions. Others, such as Keeley (1980) and Solheim et al. (2018:565), made the same observations for chert tools. Transverse motions therefore cannot be precluded. However, in the absence of striations and edge scarring on TI03, there were no clear indicators of use-wear directionality.

Minimal evidence exists for use of the remaining porcelain shards. TI05 and TI06 were interpreted as 'possibly used but worked material uncertain,' based on the existence and moderate density of the striations and the presence of edge scarring. However, the edge scars were mostly isolated. The orientations of the striations on these shards were sometimes perpendicular but mostly random, suggesting that any tool-use that may have occurred involved the application of a range of motions. Trampling cannot be precluded as a cause of the scarring and striations, but there was little breakage of shards at the Telegraph Insulator site that might otherwise support this possibility. No use-wear was evident on TI01, TI02, TI04 or TI08.

9.3 A Note Regarding Surface Roughness Measures

Across the experimental and archaeological assemblages, encompassing tools of each raw material, the surface roughness between polished and unpolished areas, indicated by Sa and Sq measures, did not show an overarching pattern. The sample size of artefacts whose surface roughness was measured was indeed relatively small (n = 15) due to the aforementioned expense and limited access to the LSCM. Future research may expand on this. However, for the glass and porcelain tools in particular, polished areas were sometimes rougher and at other times smoother (even if roughness differences were often minor), both across different tools and for the same tool. For example, on TI07 (porcelain), one sample from the polished area was 2.47 (Sq) and 2.03 (Sa), another sample from the polished area was 0.101 (Sq) and 0.072 (Sa), and the sample from the unpolished region was 0.776 (Sq) and 0.6 (Sa). The differences on glass and porcelain tools, in comparison to the stone, may be because of the way that polish forms on smooth surfaces, as discussed earlier (Fullagar 1991): the initially smooth surfaces become roughened after a short amount of use then with extended use the rough areas are smoothed and polished (further investigations could be made in future concerning polish formation on porcelain). Potentially, the differences in roughness values help to reflect not only the parts of a tool that were and were not used but also the intensity of tool use (where a greater difference in roughness values indicates a greater difference in tool-use intensity).

9.4 New Materials, Pre-existing Ways

The above interpretations for tool-use at Calperum Station, summarised in Table 58, attest to Aboriginal peoples incorporating introduced glass and porcelain into their pre-existing ways of using technology. This behaviour mirrors that evident from the continuities and changes made around the Station from before and after contact in the procurement and use of bark (Dardengo et al. 2019:61), and potentially in the use of natural followed by bottle glass in light of the tektite find (Roberts et al. 2020a). Glass use, in particular, has evidently been a continuing legacy, currently practised by TJ, PJ and other Aboriginal people in the Riverland community. It cannot be precluded that scraping bone with glass tools was a new use in this region given that there is no positive use-wear evidence for this activity on the stone materials. However, the scraping and sawing of bone is a well-known task undertaken with stone tools by many pre-contact Aboriginal groups (Attenbrow et al. 2009:2768; Coutts et al. 1976:55; Langley 2016:202; Mulvaney 1962:7–10) and oral evidence from TOs indicates that it did occur around Calperum Station. On this basis, glass tools appear to have replaced stone for bone-scraping, although future research (discussed below) could further inform this possibility. Use-wear evidence and TO knowledge also attests to the continuation of pre-existing tool motions with glass and porcelain. Further, although no positive use-wear evidence was observed for the use of glass tools to work wood, the possibility that this activity occurred is supported by TJ’s and PJ’s inferences.

Table 58 Levels of confidence for uses inferred for the archaeological artefacts according to raw material.

	No. of Artefacts	**Definitely Used, with Convincing Evidence for Worked Material**	**Definitely Used but Worked Material Uncertain**	**Probably Used but Worked Material Uncertain**	**Possibly Used but Worked Material Uncertain**	**No Use-wear Evidence for Use**
Chert	16	0	3	3	4	6
Silcrete	13	0	0	0	2	11
Glass	25	4 (scraping bone)	0	3	10	8
Porcelain	8	0	1	1	2	4
TOTAL	62	4	4	7	18	29

No evidence exists to indicate that glass and porcelain artefacts constituted materials worked using other tools for any purpose (i.e. glass and porcelain were the tools, not the worked materials). No new uses by Aboriginal peoples, such as for windows or pottery, were evident. Symbolism remains a possibility, particularly given the symbolic and aesthetic value ascribed elsewhere in the country to glass artefacts, such as Kimberley points and tektites (Akerman 1975:117–118; Allen et al. 2018:48–61, 76; Baker 1957:1, 17; Harrison 2002a, 2003; McNamara and Bevan 2001:27–28; Rowland 2014:137–151). However, no oral history evidence from TJ or PJ alluded to symbolism and this purpose is not typically detectable through use-wear analysis, particularly when there are no formal tool types in an assemblage.

There is no evidence for any particular relationship between the two sites in this study. The sites may or may not have been visited during the same periods. The presence of the used dark green glass at West Woolpoolool suggests visitation closer to initial contact (1830s–1840s), while the used amber glass, which was manufactured later (post-1875; Hutchinson 1981:154; Lockhart 2006:50), suggests further visitation over subsequent decades. The Telegraph Insulator site cannot have formed before the 1870s when the telegraph line was constructed. There is no overlap of material across the sites, no other evidence of exploitation of telegraph insulator material was observed during field transects along the entire telegraph line and the sites themselves are separated by three kilometres.

The probable different periods of visitation to the sites suggests that sources for the raw materials changed over time. Europeans' presence, infrastructure and activities would have impacted Aboriginal peoples' abilities to move as freely in the landscape as they had previously. As a result, it probably became more difficult to access the distant (15–20 km) sources of stone raw material and this may have contributed to Aboriginal peoples increasingly valuing the somewhat more easily sourced introduced glass. At the earliest possible time that the amber glass (and porcelain) was used (1870s), the Ral Ral hotel was no longer standing and overlanding in the region had ceased (Roberts et al. in press 2021). Consequently, glass could no longer be obtained from the hotel or bottles discarded by overlanders. Calperum Station was being used for pastoral activities and the amber glass bottles may have instead been retrieved from rubbish dumps by Aboriginal peoples, as was the case, for example, at some Native Mounted Police camps in Queensland (Perston et al. 2021). Europeans may even have 'paid' Aboriginal people, who occasionally provided their labour on the Station, with beer bottles, given similar practices of non-monetary 'payments' operating elsewhere (Kartinyeri and Anderson 2008; Smith 2000:81; Tutty 2020:55, 59–61). Alternatively or additionally, glass may have been transported by Aboriginal peoples among local or regional networks. The porcelain may have been used as an alternative to stone and glass when access was difficult, but was more likely exploited opportunistically given that only one shard in the present assemblage bore use-wear evidence.

It is possible that Aboriginal peoples around Calperum Station responded to European colonisation not only by maintaining their traditional technological practices while incorporating new materials, but by choosing to do so in a space physically removed from any outside influence. Such behaviour was enacted by Indigenous peoples in other parts of Australia and the world (as discussed earlier), and both West Woolpoolool and the Telegraph Insulator site formed in locations several kilometres away from the main European thoroughfares. Oral information from TOs was not explicit about potential motives for peoples using the artefacts at a distance from European centres but these behaviours may have reflected an assertion of autonomy and Aboriginality in the face of a colonialist culture, with selective engagement further indicated by the involvement of some Aboriginal peoples at the Station in employment in European industries (Anon. 2 August 1829:4; Roberts et al. in prep. 2021). Like other groups across the country, Aboriginal peoples around the Station had their lives ‘turned upside-down’ by permanent European colonisation. Conducting pre-existing traditional activities away from colonial centres at the Station was probably a powerful way in which Aboriginal peoples maintained a sense of their own identity and culture, which were otherwise being continually and dramatically threatened in ways that were impossible to anticipate and never previously occurred. This strategy may also have been a mechanism for avoiding potential conflict, which was probably particularly essential in the early post-contact period, given the extensive violence that occurred in the western-central River Murray/Riverland region up to at least the 1840s (Burke et al. 2016; Tutty 2020:16, 19, 40, 45–47, 50–64, 107, 109–113, 115).

9.5 Chapter Summary

Discussion in this chapter focused on the interpretations derived from the use-wear analysis of the archaeological tools, complemented by TO cultural knowledge, with inferences made in response to the research question. It concentrated predominantly on the artefacts that were interpreted as definitely used (n = 8), as well as on others considered probably used (n = 7). I outlined that middle-range-theory was employed in this thesis primarily by conducting experiments in an environment akin to the archaeological setting and using ethnographic information to complement empirical data, in order to provide holistic bases for inferences about technological behaviour. Eight of the 62 artefacts were interpreted as definitely used, including four glass tools, three chert tools and one porcelain tool that were used in manners consistent with pre-existing ‘traditional’ practices. On this basis, complemented by the relatively distant location of the sites, it was suggested that Aboriginal peoples may not only have intentionally maintained their pre-contact technological systems while incorporating new materials, but sought to do so away from any external European influences.

This behaviour may have represented an expression of autonomy and Aboriginality by peoples whose world became rapidly, vastly and permanently altered by the permanent presence of Europeans in the landscape. A similar explanation, described earlier, was most recently offered by Perston et al. (2021) for glass-flaking by Aboriginal Native Mounted Police troopers from Queensland. The artefacts made from introduced bottle glass and porcelain at Calperum Station may have come to be considered by Aboriginal peoples as ‘Aboriginal’ items, as was the case, for example, for Aboriginal peoples in regard to match tins at Old Lamboo in WA (Harrison 2002b:72) and Indigenous Eastern Pequot peoples in colonial North America, who ascribed similar values of cultural ‘ownership’ to introduced bottle glass, ceramic vessels and metal buttons (Silliman 2009:217–227). Although use-wear evidence from the Calperum Station assemblage was compelling only for bone-scraping using glass tools, the use-wear on other glass and porcelain artefacts, combined with TO knowledge, indicates that Aboriginal peoples around the Station probably incorporated the new materials into their lifeways for a diverse range of tasks that had previously been undertaken using stone tools. Adapting technologically mirrors the behaviour of other Indigenous groups in similar circumstances, such as Andaman Islanders (Gorman 1995:90; Man 1883:380), American Chinookans (Simmons 2014:106–120), Patagonians and Tierra del Fuegans (Charlin et al. 2016:320–321; De Angelis 2014; Delaunay et al. 2017:1333–1340).

9.6 Limitations and Future Research Directions

These interpretations and the methods used in this thesis could be built upon in several ways by future research. In particular, further, extended field surveys across a greater proportion of the Station may identify additional sites with concentrations of glass, stone and porcelain tools, whose analysis may assist in understanding the extent to which technological practices at the West Woolpoolool and Telegraph Insulator sites are representative of those at the Station as a whole. Few other sites have been identified at the Station during the several surveys undertaken for previous projects (Dardengo 2019; Jones 2016; Incerti 2018; Ross 2018; Thredgold 2017) or the two other concurrent doctoral theses that involve other sites within the Station. During my field surveys along the telegraph line there was no further evidence observed for the exploitation of telegraph insulator material. Nevertheless, Calperum Station covers a vast 242,500 hectares and given the environmental setting of West Woolpoolool, other areas with sandy substrates and ephemeral lakes could, at least initially, be prioritised for surveys. Should additional appropriate sites exist at other locations within the Station, the analysis of material in a future project may add further weight to the interpretation in this thesis that Aboriginal peoples at the Station intentionally undertook their technological practices away from any European influence.

Were further similar sites to be found, close examination of artefacts could be undertaken for the preservation of residues. Residue analysis may extend the knowledge derived from use-wear investigations. Although residues were not preserved on artefacts from West Woolpoolool or the Telegraph Insulator site, preservation conditions at other sites may be more favourable. Use-wear analysis was sufficient for robust inferences for the nature of use of several tools from Calperum Station but evidence was inconclusive for the worked material and/or tool motion on others. Residue analysis may assist in detecting uses that were not observed by use-wear analysis alone, and could further complement the use-wear investigations by helping to determine the taxa of materials that were processed. This information could then be used to further consider issues concerning past behaviour at (and beyond) the Station, such as that raised by Dardengo (2019), about reasons for continuities and changes in Aboriginal peoples' exploitation of tree species from before and after contact. In light of the evidence for the use of glass to scrape bone at West Woolpoolool, other tools used for the same purpose may exist elsewhere within the Station. Residue analysis of any such tools may indicate the type of bone material. If stone tools were also recovered that were used to process bone and at least a broad pre- and post-contact chronology established (discussed below, regarding potential excavations), it may be possible to compare the fauna that was exploited before and after contact. These comparisons could expand existing knowledge, for example, concerning the known Aboriginal practice in some regions of targeting European livestock as one response to European colonisation (Cole 2004:174–180; Connor 2002:48; Elder 2003:27–41; Foster et al. 2001:13–28; Gould et al. 1971:165; McNiven and Russell 2002:28, 30, 34, 37; Pearson 1984; Ryan 2008; Smith 2007:13–14; Williamson 2002:78–79).

To further extend upon the research from this thesis, future projects could seek finer chronological resolution for stone artefacts within the Station. Any glass and porcelain can only have been used post-contact and while most stone artefacts are probably pre-contact, some are likely to be post-contact (TO knowledge attests to the continuation of the use of chert tools post-contact). This thesis concentrated on surface sites, as requested by site directors, but a further study could implement a systematic programme of excavations at West Woolpoolool, which may uncover dateable artefacts. Analysis of any such artefacts would then be able to examine the question of whether tools made from the introduced materials entirely replaced stone tools for some purposes—as appears to be the case, from this analysis, for glass tools replacing stone for bone-scraping; and as occurred at other sites in Australia (Akerman 1978:489; Akerman et al. 2002:22; Harrison 2002a; Head and Fullagar 1997:422–424; Jones 2008:119–120). Such analysis could also contribute further evidence concerning the use of silcrete. Although there was no evidence for use among the surface silcrete artefacts at West Woolpoolool, robust inferences that this material was not used at the site can only be made following excavations. Even then the possibility that silcrete tools were used and taken elsewhere could not be precluded (and further surveys could explore the issue). Presuming appropriate preservation has occurred for any excavated silcrete, detecting uses would be greatly enhanced by the application of (aforementioned) residue analysis. In my experiments, use-wear was particularly difficult to identify on silcrete tools, possibly because silcrete is tougher than glass and porcelain, and because this material has a considerably irregular surface microtopography.

Analysis of excavated artefacts could also compare the microscopic signs of trampling wear that were observed on flakes from my experiment. When wear formed on trampled flakes, even unbroken specimens, it was in the combination of (i) isolated, randomly distributed striations and/or edge scars; and (ii) striations near or far from the closest edge but never on it. Additionally, no polish, smoothing or edge rounding occurred. Because such wear can also individually be caused by other non-use-related mechanisms, a greater sample of experiments, involving surface and sub-surface flakes, would expand the data and potentially establish increasingly robust microscopic indicators of trampling.

TO knowledge and tool-use experiments were invaluable in this thesis and could be used similarly in future use-wear investigations at other Australian sites to enable a fuller understanding of past tool-uses. Involving TO knowledge in the design of experimental programmes can focus the range of potential worked materials to be investigated. In this thesis, TOs’ knowledge about the range of locally available materials that their ancestors processed, along with the probable tool motions and tool raw materials, assisted in determining experimental tasks. Future tool-use experiments could also consider additional materials. Were the opportunity presented to begin my experiments anew, I would add to the worked materials further wood and plant taxa, including bark and tree roots, as well as aquatic creatures, shell, reptiles, feathers and human hair. Understanding the use-wear on experimental stone, glass and porcelain bark-processing tools could assist in identifying any future excavated tools at West Woolpolool that were used for this purpose and further inform knowledge gained from Dardengo’s (2019) analysis of culturally modified trees at Calperum Station.

The methods used in this thesis could be applied to similar future investigations concerning Aboriginal peoples’ incorporation of introduced materials at a wider scale across SA’s Riverland and Australia. Similar studies in the Riverland would contextualise the past technological behaviour evident at Calperum Station, as would analyses of introduced materials in adjacent regions along the River Murray in Victoria and NSW. Given the intensity of cross-cultural encounters in this broad region (Burke et al. 2016), sites such as at the Rufus River conflict and many other surrounding areas along the Overland Stock Route may hold potential for further investigations about early Aboriginal-European interactions and any additional uses that Aboriginal peoples may have made for bottle glass.

Similarly, the methods could be used to reinvestigate previous studies of contact sites around Australia. In particular, earlier macroscopic glass analyses could be revisited, providing that the artefacts have been effectively curated, to clarify any doubts concerning diagnoses of artefact status. This and determining the nature of any uses would add considerably to our understanding of the past site functions and technological adaptations. Sites could include, among others, Oyster Cove in Tasmania (Allen and Jones 1980), Singleton in NSW (McCarthy and Davidson 1943), Lake Condah in Victoria (Rhodes and Stocks 1985), Onkaparinga in SA (Freeman 1993) and Wybalenna off the coast of Tasmania (Birmingham 1992:121). Functional investigations could also be applied to macroscopic studies of glass where evidence for artefact status is compelling, such as at Native Mounted Police camp sites in Queensland (Barker et al. 2020; Perston et al. 2021; Wallis et al. 2019). A full-scale use-wear analysis could be undertaken for glass assemblages where only some forms of use-wear have been examined, including at McLaren Vale in SA (Walshe et al. 2019) and Weipa in Queensland (Foghlú et al. 2016). This thesis has demonstrated, for the first time in Australia, that porcelain was sometimes used for working other materials, rather than solely as an end-product. Other sites in Australia that are in association with early telegraph lines, or have porcelain or other forms of ceramic in other contexts, could be investigated to establish the extent to which similar practices occurred elsewhere. This may include, for example, the porcelain adze from Kangaroo Island in SA (Walshe and Loy 2004). In doing so, additional layers may be added to our understandings of the complexity of early Aboriginal-European encounters.

Finally, the full potential of the use of LSCM was not realised in this thesis, but further studies may establish whether it would be worthwhile for it to become a standard technique in use-wear analysis. Its main purpose is to quantify observations concerning the microtopographic depths of polish and smoothing made under conventional optical microscopy, thus reducing analyst subjectivity and enabling more productive comparisons across studies. In this thesis the LSCM confirmed my prior observations on each occasion (albeit with occasional fluctuations in surface roughness). To this extent it provided valuable quantitative support. By extrapolation, it may provide similar support for corresponding observations made by others during previous experiments conducted before the advent of this microscopy. In contrast, this also suggests that the LSCM may not add to or improve upon analysts' observations. However, LSCM has rarely been applied in such archaeological investigations and in this thesis, costs restricted the sample to 15 artefacts. The use of the LSCM demonstrated that although roughness differences were often relatively small (fractions of a micron), polish was more common on rougher parts of the surfaces of chert and silcrete tools, but that this was not always the case for glass and porcelain tools. I suggested that this may be because of the manner in which polish forms on tools made from these smoother materials and because of varying intensities of tool-use across not only tools of different raw materials but also of different parts of the same tool. This question and the overall value of the use of the LSCM in such applications may be resolved by a greater number of similar future studies involving a wide array of tool raw materials.

Chapter Ten: Conclusions

The primary focus of this analysis was to determine how Aboriginal people around two sites at Calperum Station, SA, adapted to permanent European colonisation from the 1830s by incorporating introduced glass and porcelain into their existing technology. Few previous archaeological investigations had previously been undertaken for the Riverland region despite the historically documented, intensive cross-cultural encounters that occurred there (Burke et al. 2016). While introduced materials are known to have been used by many Aboriginal groups across Australia, this thesis is the first to investigate the manner in which glass and porcelain were used in this key region of contact.

Use-wear evidence demonstrated that both introduced materials were adopted. Of the eight artefacts interpreted as definitely used, four were glass body shards used to scrape bone, while one was a porcelain shard used probably for processing a relatively soft form of plant (although evidence is inconclusive for the worked material). Three chert tools were definitely used but there was no evidence for the use of silcrete tools. The glass may have replaced stone for some purposes, such as bone-scraping, but oral histories indicated that Aboriginal peoples in the region also continued to use chert after permanent European colonisation. Conducting future excavations and use-wear analysis of any recovered artefacts may help to resolve this issue concerning any extents to which glass and/or porcelain replaced or complemented stone tools, as well as the question of whether silcrete was used at West Woolpoolool. Although porcelain from the Telegraph Insulator site was definitely used, the evidence for use was only compelling on one shard, and no other complete or near-complete insulators or shards were observed along other parts of the two kilometre telegraph line. Glass may have been preferred over porcelain at Calperum Station because of its sharpness and it would probably have been easier to access in comparison to targeting telegraph lines. The used dark green glass body shard, manufactured pre-1880s (Burke et al. 2017:449), may have been obtained from the Ral Ral hotel or a bottle discarded by an overlander, while the three used amber glass body shards were manufactured after 1875 (Hutchinson 1981:154; Lockhart 2006:50) and possibly sourced from rubbish dumps around the Station.

The sharpness of the working edge seems to have been the primary or sole criterion for tool selection across tool raw materials at the Station. Large tool size was evidently not important given that most were around 2.5 cm in length, while only one tool (WLW27, chert) was retouched (and the retouch was minimal); and no additional investment was made in tool manufacture, such as the production of formal types. This evidence suggests that tool morphology was not a prime consideration, if at all, which was also the case for Aboriginal peoples from the Western Desert (Cane 1992; Hayden 1977) and for New Guinean highlanders (White 1967:409–412).

Some knapping may have occurred at West Woolpolool. Of the 32 stone artefacts analysed, 20 were either complete or proximal flakes. There were also cores and many other chert, silcrete and glass shards present, that were not retrieved for analysis due primarily to edge preservation issues. However, the cores were few (n = < 5), there were no conjoining artefacts and only one of the 25 glass artefacts (WLW01) displayed physical evidence of direct percussion. Knapping was therefore probably either minimal, occurred predominantly elsewhere or people may have carried cores and any possible larger tools with them as they left. Instead, the glass artefacts probably derived from bottles that were smashed onto the ground.

This thesis contributed several new perspectives on the early interactions between Aboriginal peoples and European colonisers. First, despite the Riverland being a key region of early contact in SA (Burke et al. 2016), the manner in which Aboriginal peoples incorporated introduced materials for flaking and use had not been investigated until now. The evidence obtained during this research extended our knowledge by demonstrating that Aboriginal peoples around at least parts of Calperum Station maintained their pre-contact uses for technological systems while also selectively adapting them to changing circumstances. This knowledge demonstrated that the ability and willingness of Aboriginal Australians to adapt their technological and other practices over tens of previous millennia did not cease in the Riverland upon permanent European colonisation. Second, in this, the first use-wear project undertaken on Aboriginal uses for porcelain shards in Australia, analysis revealed that the one definitely used porcelain shard was used to work other materials rather than as a finished product itself. Previously, porcelain had only been known, via ethnographic observations, to have been used as end-products, such as spear barbs (Anon. 1887:4; Jones 2008:126; Moyal 1984:54; Noone 1949:112; Veth and O'Connor 2005:5). Finally, direct oral evidence from TOs was used in this thesis to supplement the scientific use-wear methods. In doing so, unique TO knowledge was preserved for future generations and used to assist in the design of tool-use experiments, and a direct cultural context was added to the use-wear information. Consequently, a more holistic perspective of past uses for technology and reasons for such uses was able to be provided.

The maintenance of traditional practices along with the technological adaptability evident at Calperum Station may represent an intentional assertion of Aboriginal autonomy in a new social and technological world. Similar behaviour was manifest around Calperum Station with the post-contact use, by Aboriginal peoples, of steel axes (Dardengo et al. 2019), and is consistent with the practices of many other Indigenous groups around Australia and overseas (Charlin et al. 2016:320–321; Delaunay et al. 2017:1333–1340; Gorman 2000; Harrison 2002a and b, 2006; Jones 2008:126; May et al. 2017:703; Perston et al. 2021; Simmons 2014:106–120; Smith 2001:26–28; Veth and O'Connor 2005:5; Walshe and Loy 2004). The continuation of pre-existing uses for technology also either intentionally, sub-consciously or unwittingly subverted any European attempts that may have been made to 'civilise and Christianise' Aboriginal peoples at Calperum Station by forcing them to abandon their old ways in favour of European practices.

Evidence suggests that post-contact visits to West Woolpoolool may have been spread over many decades, and that pre-contact visits may have occurred over hundreds or possibly even thousands of years. This is indicated by TO knowledge, the dates obtained by Westell et al. (2020:6, 12) (OZX283, OZX284), the presence of middens, additional stone and glass artefacts (not analysed due to preservation issues), burials 20 metres outside of the site boundary, and the large, approximately 17,000 square metre size of the site. Inferring more precise durations of occupation would be problematic because evidence such as the quantity of artefacts is also influenced by factors such as knapping strategies (Clarkson 2007:133). There were neither hearths nor other concentrations of charcoal visible on the surface to indicate extensive cooking events—although the presence of the middens indicates that some food-processing probably occurred—which, along with the probably minimal on-site knapping, suggests that visitations were not long-term.

The Telegraph Insulator site was probably visited only once. With only the porcelain telegraph insulator material present, there was no evidence for pre-contact visitation and the site covered only approximately 15 square metres. It was located around part of the old telegraph line and, in particular, within the vicinity of several fallen wooden pylons that would have been part of the telegraph line. There was no occupation debris or other artefacts within the vicinity, suggesting that Aboriginal peoples directly and opportunistically targeted the insulator material, flaking and using it on-site before moving on. Artefact TI07 was the only porcelain shard to have definitely been used and TI03 the only intentionally knapped porcelain shard. Were this site occupied for any length of time there would probably have been more used and knapped material, in association with other forms of artefacts, and it would have been larger. None of the porcelain shards refitted with the near-complete insulator that was present so it is possible that the insulators from which these particular shards were smashed were carried with people as they moved on. The fact that the insulator was nearly complete, rather than more fully exhausted, supports the notion that this site was used briefly and opportunistically. Along with the lack of exploitation of any other telegraph insulator material along the telegraph line, it also suggests that porcelain may have been regarded as a useful addition to stone and glass but not highly valuable as a staple material for the manufacture and use of tools.

There is no evidence for any relationship between West Woolpoolool and the Telegraph Insulator sites. They may have been visited at different times, particularly if the Telegraph Insulator site was only visited once; and different materials were present and the sites separated by three kilometres. However, the probable short-term visits to both sites, rather than longer occupation, is consistent with patterns of mobility inferred in previous archaeological studies for the Station (Jones 2016; Jones et al. 2017; Ross 2018; Ross et al. 2019; Thredgold 2017; Thredgold et al. 2017), as well as with historical observations of the seasonal movement of groups from the region (Eyre 1845 2:252, 372; Sturt 1833 2:135).

Several possibilities exist in relation to the evidence for bone-scraping with the glass tools at West Woolpoolool. Food-processing, an activity inferred by Thredgold et al. (2017), Incerti (2018) and Jones et al. (2017:51) for other sites and types of sites within Calperum Station, was possibly undertaken. Bones may have been scraped predominantly during butchering activities, as cutting and scraping meat cannot be precluded for chert artefacts WLW36 and WLW38, and TOs indicated that their ancestors did indeed undertake this activity using glass tools. However, there was no positive use-wear evidence on any glass or other tool in the assemblage for cutting and scraping meat or any other form of food-processing activity. Another possibility is that the glass tools were used in the manufacture and/or maintenance of bone tools that were deposited elsewhere. This activity is consistent with the traditional knowledge provided by TOs concerning activities undertaken by their ancestors, and is beyond detection by use-wear analysis. Alternatively, the glass tools may have been used for craft purposes. Other Aboriginal Australians occupying the Lower Murray River in SA created bone ornaments (Berndt et al. 1993:271; Clarke 2018a:29–42; Eyre 1845 2:166–167; Harvey 1939) and tools (Wilson et al. 2021), and it can never be precluded that a range of other practices were undertaken in the past that no longer occur and/or are no longer known (Hurcombe 2014:5–6, 165). The type of bone that was scraped with the glass tools is not known but a further possibility is that this activity was performed on European livestock, obtained as a response to the European presence in the landscape. Such activity is known among Aboriginal peoples in other parts of Australia (Armand 2003; Cole 2004:174–180; Connor 2002:48; Elder 2003:27–41; Foster et al. 2001:13–28; Gould et al. 1971:165; McNiven and Russell 2002:28, 30, 34, 37; Pearson 1984; Ryan 2008; Smith 2007:13–14; Williamson 2002:78–79).

The formation of the West Woolpoolool and Telegraph Insulator sites several kilometres from the main European thoroughfares may further indicate the exercising of some degree of Aboriginal agency in the engagement with colonialist society. The users of the tools maintained pre-existing technological practices away from the colonial gaze, which is another behaviour consistent with that of many other post-contact Indigenous peoples across Australia (Allen 2008; Beck and Somerville 2005; Bell 2014:116–117; Birmingham and Wilson 2010; Di Fazio and Roberts 2001:48; Gibbs and Harrison 2008; oral histories in Bell 2014:116–119; Paterson 2006:104, 106–107; Paterson 2011:254; Veth and O'Connor 2005:10; Walshe et al. 2019:205–207) and the world (King 2017a:540–545; Panich and Schneider 2015:52–53; Schneider 2015:697, 699–700, 705–706; Spielmann et al. 2006:624, 631–633, 639–643). Selective engagement by Aboriginal peoples at Calperum Station with colonialist society was further evident through their provision of labour on the Station, particularly in the early post-contact decades (Anon. 2 August 1829:4; Roberts et al. in prep. 2021). While inferring motives is complex, occupying and conducting technological activities at such physically removed locations may also have been partially an avoidance strategy in response to European colonisation, particularly in the early post-contact years when conflict and violence in the broad region was intense (up to the early 1840s; Burke et al. 2016; Tutty 2020:16, 19, 40, 45–47, 50–64, 107, 109–113, 115). These possibilities indicate the complexities involved in cross-cultural interactions.

Living cultural memories, knowledge and inferences from TOs provided valuable insights about past technological practices, inaccessible through use-wear analysis. No use-wear evidence existed among the archaeological assemblage for the use of glass to work wood. While an absence of evidence does not automatically preclude this possibility, it is consistent with Thredgold's (2017:125) inference for the scarcity of wood-working at Calperum Station, which she based on her observation of a solitary tula adze. However, wood can be worked using a variety of tools, not only tulas, and TOs inferred, based on knowledge passed down from previous generations, that their antecedents may indeed have used glass for this task. It is also possible that glass was used to 'finish' (smooth) or otherwise shape wooden spears, shields and boomerangs from the Station that are currently held in the South Australian Museum. TJ and PJ further added to the use-wear evidence from this thesis with their inference that their ancestors may have used glass to process meat, and chert for spear tips (they also suggested that glass could have been used for spear tips but this is intuitively less likely given that glass used for such a purpose would probably immediately break). Meat-processing was only hinted at by the use-wear evidence and there was no use-wear evidence for spear tips or other forms of weaponry. TO knowledge also complemented the use-wear evidence when it did exist, such as for the use of glass tools to scrape bone. Their knowledge then at times extended upon use-wear evidence, as with their information that at least one reason for their ancestors scraping bone was to maintain and manufacture bone tools.

This thesis has further demonstrated the value of experimental archaeology, a tenet of middle-range theory, which is particularly valuable for use-wear analysis. Because use-wear develops differently across tool raw materials, working motions and environmental conditions, experiments approximating archaeological conditions are one of the most effective ways to facilitate understandings about related processes and results. The tool-use experiments conducted for this thesis, along with the on-site demonstration by TOs, were particularly necessary for bottle glass and porcelain, given the relative paucity of prior investigations of use-wear on these materials. As was the case for the few previous microscopic analyses of flaked glass in Australia, my use-wear analysis effectively overcame the difficulties involved in the diagnosis of artefactual glass that had beset many previous macroscopic studies. The presence of use-wear predominantly on glass body shards at the Station supported previous analyses demonstrating that the extent of the past use of these parts of glass bottles has been underestimated, particularly in deference to bottle bases (Harrison 2003:318; Wolski and Loy 1999).

The trampling experiment provided results which may assist future use-wear analyses. There were no robust macroscopically observable indicators of trampling, so a high proportion of breakage in an assemblage probably remains the best macroscopic indicator (Douglass and Wandsnider 2012:353, 356, 359; Eren et al. 2010; McBrearty et al. 1998:114). However, several consistent microscopic wear patterns emerged. Although some aspects of the wear, taken individually, can also be caused by factors other than trampling, the wear in combination may assist distinctions between use-related and non-use-related wear. First, when striations or edge scarring were present on trampled flakes, they were isolated and there was no patterning in their distribution or directionality. Second, any striations were always located either near or far from, but never on, the flake edge. Finally, there was no polish, smoothing or edge rounding on any of the 40 trampled flakes. These characteristics formed the basis of inferences that several of the archaeological artefacts at West Woolpoolool that were interpreted as having a low probability of use had instead possibly been trampled.

The use of glass following permanent European colonisation has had an ongoing effect on the Aboriginal use of technology in the Riverland. Formal stone tool types were not replicated at the Station using glass (or porcelain) at the sites investigated in this study, in contrast, for example, to some Aboriginal groups in WA who manufactured glass Kimberley points, previously made from stone, for the purposes of trade with European colonisers (Akerman 1978:489; Akerman et al. 2002:22; Harrison 2002a). However, the ongoing use of glass in the contemporary Riverland Aboriginal community is a legacy of European colonisation and suggests that this material became a valued ‘Aboriginal’ cultural item rather than an item for purposes such as trade with Europeans. Similar value has been ascribed by other Aboriginal groups to introduced items, such as metal match tins (Harrison 2002b:72).

South Australia’s Riverland can now be understood, for the first time, as a region in which post-contact Aboriginal peoples from two sites selectively adapted their pre-existing stone technological frameworks to incorporate uses for introduced glass and porcelain. Evidence is compelling for technological dynamism in the face of an incoming, unfamiliar society. Previous, macroscopic technological investigations focused on the nature of stone artefact manufacture and involved other sites within Calperum Station (Incerti 2018; Thredgold 2017; Thredgold et al. 2017). Through microscopic use-wear analysis of tools made from glass and porcelain, this thesis has extended from existing understandings by creating new knowledge about technological and related behaviours from a different time period (post-contact) and at new sites within the Station. Future studies may benefit similarly from the addition or prioritisation of microscopic over macroscopic analyses. A key methodological advancement in functional analysis was highlighted in this research: the incorporation of traditional knowledge. Such knowledge has not always been included in past use-wear analyses, so more complete understandings about past tool functions achievable by the full participation of Aboriginal peoples at each stage of functional analysis is yet to be realised. The involvement of current knowledge and practices of Aboriginal peoples from other areas of the Riverland and Australia in future research designs, including in the selection of raw materials and tasks performed in tool-use experiments, would provide traditional perspectives that have often been lacking in written historical accounts, and, potentially, outcomes for major archaeological issues that are unobtainable through scientific methods alone.

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Appendix

Appendice 1: Example of written update to RMMAC

simondmunt@gmail.com
25 August 2020

Dear RMMAC and Community Members

RE: INTERIM REPORT ON SIMON MUNT PHD PROJECT: ***Use-wear Analysis of Aboriginal Flaked Stone, Glass and Porcelain at Calperum Station, South Australia***

It is with great pleasure that I present the following interim report to you. I am now 1 year and 11 months into this three year full-time equivalent project involving your ancestors.

As you may recall the goal of the project is to examine some of the stone, glass and porcelain artefacts from two particular sites at Calperum Station, to see whether, and if so how, your ancestors used them.

'Use-wear analysis' means analysing under a microscope any tiny signs of wear that may have occurred on an artefact because someone used it.

One site at Calperum Station is the main one for this project and is west of Lake Woolpoolool. This is where the stone and glass was. The other site is around 2 km from that and is where the porcelain was.

There are several components of this project:

1. Field survey, with RMMAC cultural monitors
2. Experimental archaeology
3. Demonstration of ongoing use of glass by Timothy Johnson and Phillip Johnson
4. Use-wear analysis of the experimental artefacts

5. Use-wear analysis of the archaeological artefacts i.e. from Calperum Station and
6. Return of the artefacts to Country according to cultural protocols

So far numbers 1–4 above have been completed. The following summarises each step.

Field surveys

Three field trips were undertaken over 2018 and 2019, the first two to identify and study the sites and the third to collect the artefacts for analysis. The image below shows Julie Cook and me setting up a total station at the site at Lake Woolpoolool in 2019.

Experimental archaeology

I conducted experiments using pieces of stone, glass and porcelain that I procured from donors from non-archaeological contexts. Experiments involved the use of these pieces to use motions such as scraping, sawing and chopping to work wood, animal bone, plant material, dry hide and fresh meat.

Afterwards I looked at the wear that resulted from these activities under the microscope. This helped me to understand what kinds of wear typically occurred after what kind of activities.

I did this in order to help me to recognise similar forms of wear that might exist on the archaeological artefacts and then infer how your ancestors used them. I also compare similar results from previous experiments that others have done.

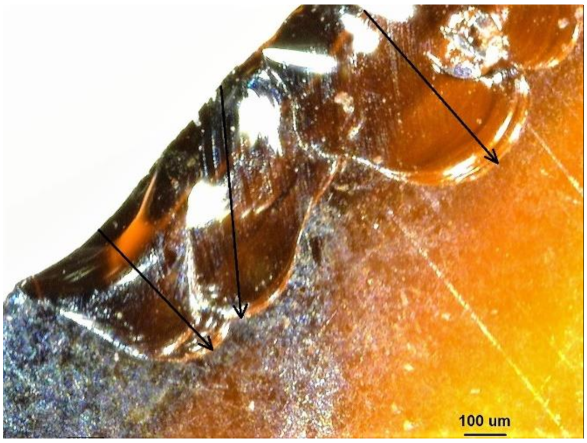
<u>Demonstration of ongoing use of glass by Timothy Johnson and Phillip Johnson</u>

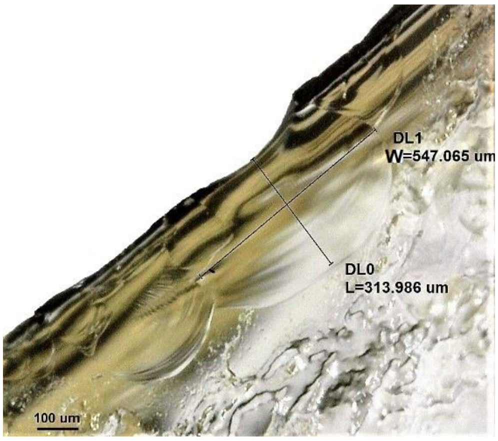
At Calperum Station in 2019 Timothy Johnson and Philip Johnson were kind enough to demonstrate how they use glass to work wood. They gave me their pieces of glass that they used and I analysed them under the microscope. After just 5 minutes of use there was some use-wear on both pieces.

There are four main forms of use-wear:

(i) Polish and smoothing
(ii) Striations or scratches
(iii) Edge scarring and
(iv) Edge rounding, where the edge of an artefact becomes rounded after being used quite a lot.

The images below show TJ and PJ during their demonstration and TJ's artefact on the bottom left, with edge scarring and striations, and PJ's artefact on the bottom right, with edge scarring.



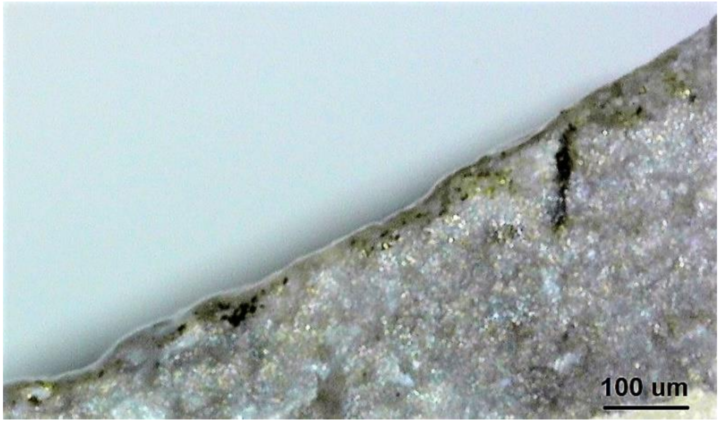


<u>Use-wear analysis of the experimental artefacts</u>

Use-wear analysis of the experimental artefacts, including TJ’s and PJ’s, showed that certain patterns do often appear that are distinctive of the working of a certain material (wood, bone etc.).

Use-wear analysis also shows that striations and other aspects of use-wear typically occur on artefacts in the same direction as the direction that the person moved the artefact. So we can get a good idea of whether a tool was used to saw or scrape or chop etc.

The image below left shows the scraping of dry hide during an experiment, using an experimental tool made from chert/flint. The below right image was taken from a microscope. It is so close-up that in total it represents less than a millimetre. But before the artefact was used to scrape hide this edge was straight. As you can see, the microscope image shows that the edge then became quite rounded. That is typical of hide-working. So this is just one example of how we might be able to tell how an actual artefact was used!



So now there are just two stages left in the project:

(i) Use-wear analysis of the archaeological artefacts i.e. from Calperum Station and

(ii) Return of the artefacts to Country according to cultural protocols

Unfortunately I have been delayed by a few months in analysing the archaeological artefacts because of Covid-19 related restrictions to the Flinders University laboratory. But now this is no longer an issue and there are about 62 artefacts to analyse.

Once this has been done I then of course have to write up the rest of the project. So all this will take up the rest of the time. Finally, once any following publications may be finished, I look forward to discussing the manner in which you wish for the artefacts to be returned to Country.

So all up it appears that I may be finished the project by early 2022.

As always I extend my warmest thanks again to you for the privilege of being involved in this project. I have greatly enjoyed getting to know many of you during the field trips and hope to continue this ongoing relationship with you. You are also welcome to email me at any time on the above address.

It is my sincere wish that through this project I am able to contribute even just a small amount of knowledge about the past activities of your ancestors.

Kind regards

Simon Munt

Appendice 2: A further example of written update to RMMAC

21 April 2021

RE: Update on use-wear artefact analysis from Calperum Station for PhD project by Simon Munt, Flinders University

Dear RMMAC Directors and Members

I am pleased to write to you to provide an update of my progress in analysing artefacts from Calperum Station as part of the combined Flinders University/RMMAC project.

It has been a while since I have last had the opportunity to see you in person, through fieldwork, and I hope you are all well.

You may recall from my previous update that I have been analysing under a microscope some glass, stone and porcelain artefacts from a site at Calperum Station. I have now completed the analysis, which involved 62 artefacts in total. The main aim was to see if there was microscopic evidence that showed:

(i) Whether these particular artefacts had been used; and
(ii) If so, how.

Through the privilege of interviewing Timothy Johnson and Philip Johnson, I learned through their traditional knowledge that past Aboriginal peoples in the Calperum Station region used glass tools, for purposes such as scraping and smoothing wood.

By investigating the artefacts under the microscope, I aimed to see whether there would be any scientific evidence that would complement this knowledge and perhaps suggest any other past uses.

Results demonstrate that there is indeed scientific evidence ('use-wear') for Aboriginal peoples around the region using materials introduced by

Europeans. This shows that Aboriginal peoples around Calperum Station continued the willingness to adapt their technological practices to changing circumstances—in this case the European invasion—just like they and other Aboriginal peoples around the country had also been doing for many thousands of years.

In total, there was evidence for use on 8 of the 62 artefacts, which is a typical proportion in comparison to most assemblages.

In particular, the scientific evidence showed that:

(i) Four glass artefacts were used for scraping bone
(ii) Three stone (chert) artefacts were definitely used, though evidence was inconclusive for the material that was worked
(iii) One porcelain artefact was definitely used to work another material, but again the evidence was inconclusive concerning which material

Until now there have only been two previously published use-wear studies about the past use of glass by Aboriginal Australians. So this study adds some relatively rare scientific evidence.

Historical records indicate that some Europeans in the decades following invasion observed Aboriginal peoples in other parts of Australia using porcelain from telegraph insulators as spear tips. This Calperum Station project, however, is the first to examine porcelain insulator material using microscopic use-wear analytical techniques.

The evidence that a porcelain shard from Calperum Station was definitely used is the first evidence that I know of in Australia that shows that Aboriginal peoples used porcelain as tools for working other materials (i.e. rather than exclusively as end-products themselves, like spear-tips).

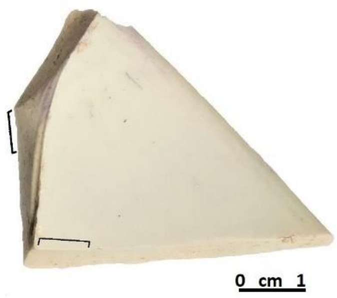
On the next page you can see images of the porcelain tool.

May I also take this opportunity to once again thank you for your terrific support during this project. It has been a privilege to be able to contribute some knowledge and I hope that you find it interesting and useful.

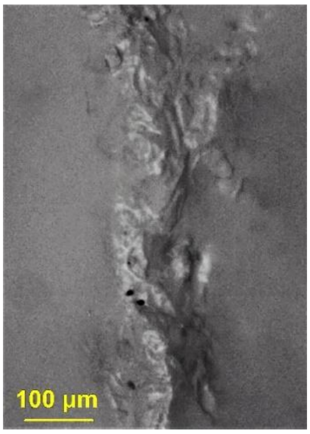
I am due to submit my thesis in late September this year and look forward to the chance to chat with you again before too long.

Kind regards

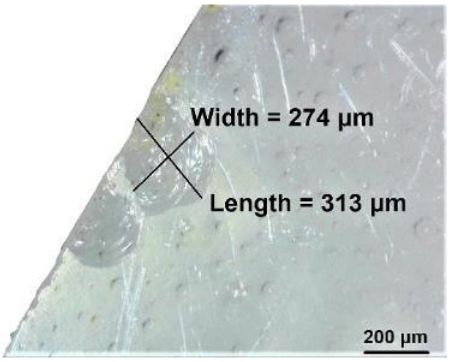
Simon Munt

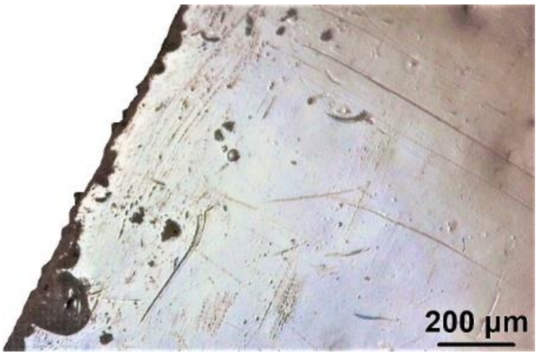


This is a photo of the porcelain shard. The brackets indicate where there was evidence of use.



This is a photo of part of the porcelain shard, from the microscope: the white parts are called ‘polish’ and this helps to prove that the shard was used.





These are photos of edges of the porcelain shard, from the microscope. On the left you might be able to see two little ‘scars’: these were created as the tool was used. On the right you can also see a scar or two, as well as several ‘scratches’: the scratches help to indicate the directions that the tool was moved in while being used.

Appendice 3: Transcript of oral history interview conducted by Simon Munt and Amy Roberts, with interviewees Timothy Johnson and Philip Johnson at the old outdoor dining hall at Calperum Station, South Australia, 7 May 2019. Transcribed by Simon Munt, 9–11 May 2019.

- 'AR' = Amy Roberts, 'SM' = Simon Munt, 'TJ' = Timothy Johnson, 'PJ' = Philip Johnson

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START OF INTERVIEW

AR: So, we're here interviewing Timothy Johnson and Philip Johnson on 7th May, at the Calperum Station, old shearing quarters, so often for the tape we just talk about getting you to say just a little bit about your family history, just to make sure we've got everything right, so would you mind just saying about who your parents are and where you were born and some things like that?

TJ: Ah, well, our father, mother was Arthur Johnson and mother was ah Daisy Abdulla.

AR: Ah, ok, yep.

TJ: Ah yeah Abdulla Disher.

AR: Yep, ah huh.

TJ: There's a Disher.

AR: Yep, and um…

TJ: Mum's mother was ah, Margaret Disher.

AR: Yep.

PJ: Margaret Disher's dad was Tim Disher, Tim Disher's mum was Nelly Perry.

TJ: Married Sam Disher.

PJ: Married Sam Disher, that's it.

AR: Ok, so that's the Perrys that we were just talking about, so that was Sarah's sister.

TJ: Yeah Sarah's sister, there's seven of them.

AR: Ah huh, are the Johnsons from Adnyamathanha?

TJ: Ah, no, ah…

AR: Different Johnsons?

TJ: Just, yeah different Johnsons, he picked his last name because he got put in a home so he took up Johnson.

AR: Ah ok.

TJ: But his, his grandma…his mother was Winnie…

PJ: Windlass.

TJ: Windlass.

AR: Ah, ok. And how many siblings are there? I've lost track (laughter).

TJ: I think seven (pause) ah who's this for, us or...?

AR: Yeah that's all right, we don't have to go through all of that. And when and where were you born, TJ?

TJ: Ah, Barmera.

AR: Yep.

TJ: 1968.

AR: And Philip?

PJ: Barmera, 1963.

AR: …when we came out once before, you were telling me that you used to come to near the station and camp, around here?

PJ: Yes.

TJ: Slaney's Creek.

AR: Yep.

PJ: That's with old Tim Disher. That's our great grandfather. Our grandmother's dead.

AR: So he used to come around here as well?

TJ: Yeah we used to come back and down…

AR: You used to come back in?

TJ: Didn't have these, ah, parks or anything.

AR: And what did you say it was called? Slaney's?

TJ: Slaney's Creek.

AR: Slaney's Creek.

TJ: 'cos they knew, I think they knew where the cod was.

AR: Oh ok (laughter).

TJ: That's the cod, the area.

PJ: As well as this was part of old Tim Disher's land. Where he was brought up.

AR: Ok, and what kind of things would you do when you're camping here?

TJ: Go fishing, yabbying.

AR: And would you get a boat to come in, or drive in?

PJ: We'd drive in.

AR: Drive in. Ok, do you (to SM) want to ask a bit about the glass?

SM: Yeah, you know basically my project is about looking at how your Elders used glass and so on, so, I was just looking mainly to work out how they would have used glass. Can you tell us a bit about how you use glass at the moment?

TJ: Well we still use it on our carvings, just to get that smoothness, you know.

SM: So you make, you showed me some of those walking sticks, and what sort of other items do you make?

TJ: Boomerangs, coolamon and a couple of waddies, throwing sticks, yeah.

PJ: A few spears.

TJ: A few spears, yeah.

TJ: Yeah, we use that glass you know, 'til after we finish, to just shine it up or smooth it off, you know.

AR: Oh ok.

SM: And your Elders always used different varieties of objects for different things, and sometimes metal axes and so on, so is there any particular reason you continue to use glass, rather than, say, like a metal knife or anything like that?

TJ: It's more sharper.

SM: Right.

TJ: Sharper, and cleaner, ah smoother it's better.

SM: Yeah. And what sort of sizes of pieces of glass do you often use?

PJ: Probably just enough size to get in your hand, you know, to scrape the wood.

SM: Yeah. Any particular type of glass that you like?

TJ: Oh, any glass, as long as it's sharp.

SM: Oh ok.

PJ: But it had to be thick glass, so it didn't shatter, you know, when you make, neat little, tiny bits of glass on the wood. Yeah it had to be thick glass.

TJ: Beer bottles, yeah any empty bottles we find on the track, you know

SM: And do you, ah, sharpen it up at all, or is it sharp enough already?

TJ: As soon as you'd smash 'em they're already sharp, you know, you see you're just looking for nice… like a knife kind of, yeah, thin edges. You should try and, should try and smash one, so…

PJ: Sometimes they would smash it 'til they get to the right, ah right, what they want.

TJ: Yeah, yeah, right edge.

SM: So after a while if it gets a bit blunt…

TJ: You just change over to another glass or turn it around.

SM: You don't bother sharpening it or anything?

TJ: Nah.

PJ: Nah, 'cos it'll probably end up too small.

SM: And how did you learn to use the glass? Were you taught by your Elders?

TJ: Been taught by the Elders…

PJ: Our grandfather.

TJ: This is who we got taught by, you know, they're the grandfathers but I got, I got taught from the wood carvers in the Riverland, old John Lindsay, Colin Cook, Teddy Roberts, or Ted Roberts, so that was my growing up with the artefacts.

AR (to PJ): And how about you?

PJ: I just learned from my old grandfather.

AR: Which one, which grandfather?

PJ: That was, Harold Abdulla.

AR: Oh ok.

PJ: There was, ah, my grandmother, Margaret Abdulla's husband

AR: Oh ok.

PJ: Yeah she was, ah, Margaret Disher, Harold Abdulla. But I got taught by him, you know, because he was the old grandfather.

SM: And we were talking before about those objects in the museum, but if perhaps you could just tell us a bit for the tape about, if you know anything about who made those, why they did it…

TJ: Same three that ah showed us how they make 'em, there's a few of ours as well in there, so I wouldn't mind having a look, you know.

SM: Yeah.

AR: Do you know who, did they ever say who taught them?

TJ: Ah that's a hard one because, yeah they would of said the grandfathers but you know, could have been passed down, shown them, so…

PJ: Yeah I'm sure, Colin, he got taught by..ah who was that we were talking about before? Old, old…

AR: Tarby?

PJ: Tarby, yeah that's it.

AR: Oh ok.

PJ: Yeah Tarby Mason.

AR: Yep.

PJ: Yeah that's who he, I'm sure he got taught by him, yep.

AR: That makes sense doesn't it, yeah.

PJ: Yep. That's like, passed down over generations. Because that was his old uncle, see.

SM: So, do you have any particular memories at all about how your Elders might have told about how they used to use it, use glass?

TJ: Nah it was always there when they showed us, you know, they used their, thing just to finish it off, shine it up, that's about it, smooth it off.

SM: Do you remember seeing them doing that?

TJ: Yeah.

SM: Growing up, watching them doing that?

TJ: Yeah, what I say we learnt from them, we did the same.

SM: Yeah.

AR: Would they use glass for other things apart from wood?

TJ: I reckon cutting the animals, skinning them…

AR: Yeah right.

TJ: Cutting meat, 'cos it would have been sharp, you know. It would have been there. They're on the middens, you know, the shells

PJ: And chert.

TJ: Mm, chert, they would have, easy, another one they would have used for cutting.

AR: Yep.

SM: So there's stone and glass?

TJ: Stone and glass I reckon.

SM: And do you know whether they preferred stone or glass for any particular different things?

PJ: Well it all depends, like I said the chert stone that was the sharpest, compared to just normal stone you see laying around you know, and to me that was just like glass.

TJ: They would have made the spear heads out of them so, yeah we run into a few of them over the border you know.

SM: They made the spear heads out of chert?

TJ: Out of chert.

SM: And what were the spear heads made out of? Did they use chert to make the spear heads or the spear heads themselves were chert?

PJ: They…chipped until it formed into a spear head.

SM: Ah, ok.

PJ: See that's why you've got a lot of little tiny bits of chert…

TJ: Laying around there.

PJ: When you go into places you see them laying around.

SM: And they'd be sharp?

PJ: Yep.

TJ: Yeah.

AR: Did you ever see the Elders using stone?

TJ: Ah, no.

AR: Not so much?

TJ: Not in the…

PJ: Not nowadays, but probably back in our mums' and our grandfathers' days.

TJ: Yeah I reckon Uncle John and Uncle Colin would have seen all the, they would have seen that with the, ah, grandfather Tarby there.

AR: Did they ever talk about that?

TJ: Ah, not normally…

AR: About, the, like remembering people using stone or anything?

TJ: Ah, no.

AR: Not so much, yeah.

TJ: Not so much.

SM: Do you know how the old people got the glass, where they got it from?

TJ: Europeans, when they brought 'em in, you know when they…

SM: Yeah.

TJ: So they probably used, you know, 'cos the middens wasn't probably that sharp, or blunt out as well, so the glass, they would have found them old bottles, old medicine bottles, just what you see laying around now.

AR: Yeah (laughter).

SM: Do you remember whether they used them just with their hands, or did they attach them to a wooden handle or anything, the pieces of glass that is, when they worked glass?

TJ: Ooh, that's a good one isn't it, no I don't think so but it, they just used it, that's be a good idea to find out if there's any resin on the glasses, if you can find some.

SM: What about you guys, just, just with your hands?

TJ: Just with our hand, yes.

SM: Yeah.

AR: And we were talking before around the camp fire, the type of wood that you use, so you use the, how do we say it, *putjara*?

TJ: *Putjara.*

AR: *Putjara* (laughter).

TJ: It's called *putjara* wood…

PJ: We got another name for it.

AR: Is that, is that the native willow, is it the…

TJ: No it's just, oh, I just had it on me just then, Craig [Westell] just finished telling me and I just, yeah...

AR: Coobar…

TJ: Coobar.

AR: Coobar.

TJ: Coobar, it's two-toned, two-tone wood.

AR: Ah ha.

TJ: I just say they get that whiteness around and the brown in the middle.

AR: Like the walking sticks out there.

TJ: That's the same trees that they use.

SM: So you like that just for the decorative, the colour?

TJ: That's what they use, yeah…

SM: The white and the brown.

TJ: Yep.

SM: Did you like any particular sort of thickness of wood, a really thick bit or?

TJ: No, just the right size, yeah. Take a lot of time to knock it out of the big wood, you know.

SM: Mm.

TJ: But there's different woods, there's gum, gum roots for the boomerangs, ah what else, ah, black box for the shields, the coolamons I mean, the shields would have been ah gum trees, yep, gum trees, just the bark they use that, yeah.

PJ: Yeah.

SM: And you were saying about when you get the glass from the old bit of bottle lying around. Did you prefer bits from any particular part of the bottle? Like you were saying, Philip, it has to be thick?

PJ: Yep, the thick part of the bottle they, they use.

SM: Right, and just the thick part, or..?

PJ: Yep.

SM: Yeah, right.

PJ: Because, ah…

AR: So it that more like the bottom of the base?

TJ: Bottom, sometimes the sides but they, they blunt quicker, when you, when you do it, they, they like a file, they just go you know, in.

PJ: Some old bottles was thick on the walls going up, not like bottles these days, I wouldn't use these bottles these days.

SM: Too thin?

PJ: Too thin.

SM: Yeah ok. That's interesting.

AR: Yeah it is isn't it.

SM: All right, ah do you know roughly when your ancestors might have first started to use glass?

TJ: When the Europeans come I think. When the Europeans brought them in, there's old medicine bottles and, well any kind of bottles, you see old whisky bottles, anything out there.

SM: Do you know roughly where they might have done it on-site like a camping site or something like that?

TJ: Well when you look at the areas you see where they were sitting down. You see all the chert there, this is where it might be a good place to have a look, you might see glasses there as well.

SM: Yeah, so they…

TJ: 'cos that's to say where they're chipping away, they could be making, making all their artefacts.

SM: So when your ancestors had finished with the glass, would they do anything in particular with it or just…

PJ: They'd probably store it, and save it for the next time they wanted to use it. Yeah.

TJ: They wouldn't have been carried around with them, they would just use something else, or, shells or middens.

AR: And the type of objects, like we were just looking at some photographs from the museum, there's clubs, or waddies…Do you make them in the same shape as what you were taught by your Elders?

PJ: Yeah.

TJ: Yes.

AR: Ok. So what, um, so you've said there's waddies…

TJ: Boomerangs, waddies, ah, spear.

PJ: Coolamons.

TJ: Yeah the coolamon's there but I just use the old, ah, any woodland that's in a curve.

AR: In the shape, yep.

TJ: Yep, and just use that, instead of going out wasting them.

AR: Yep, ok.

SM: I'm really interested in how your ancestors, and you guys, move, at particular motions, like scraping or slicing, or anything like that. Do you know of any particular method that you would use, or you varied?

PJ: We always followed the grain, ey.

TJ: Followed the grain 'cos you, 'cos you come upwards you could cut yourself or you could damage the, damage the wood.

PJ: And put splinters in your hands.

TJ: Mm.

AR: So we'll do some videoing, we'll get you to demonstrate it so we can get it on the video.

TJ: Yep, what, with some glass?

AR: Yeah, with some glass in that tub over there (laughter).

SM: Also, I'm not sure if you're comfortable talking about it, but we're interested in that, in the awful conflicts that happened at the start, when Europeans came, but do you know of any use of glass for things like weapons or anything like that?

TJ: Don't really know, that, wouldn't have, they wouldn't have had glass in them confrontations at the time, you know.

SM: No I guess not.

TJ: Only when they came.

SM: After.

TJ: Yeah after. Wouldn't have a clue, but I can't see no thing, there was just, ah, chert, that was sharper than glass.

SM: Mm, mm.

PJ: Probably, probably did made a spearhead or something out of the glass.

TJ: Someone, yeah, could have tried it. Just never found any glass that looking like a spear head, you know. Well, that's another thing that you could, might find, you know.

SM: Mm.

AR: And so it's really common, isn't it, among the community for people to use glass, other people have spoken to me, how they remember Lushville and the Berri Rodeo Grounds where people would camp on the fringes of towns, people using glass there as well, so it was really common amongst many families, to use it, would you say?

TJ: Yeah, well 'cos they would have, you know, cutting the, easy cutting of kangaroo fur, you know, easy, it would just go straight through then, you're not trying to use that, ah, shell one for sharpening.

AR: Oh yeah.

TJ: Middens, yeah.

AR: Ok.

TJ: They would have used it for a lot of things, cutting the meat, you know, getting through the bone, you know. 'cos that would have been sharper than what they used.

AR: And do you think your children are going to be interested in taking up making the wooden objects with glass? Do they watch what you're doing? (laughter)

AR: We'll have to show them when ah, when they, know how to use the axe, or…

AR: Bit older?

TJ: Bit older, yes.

PJ: Yes.

AR: But it's something you'd like to see people continue…

TJ: That's, yes, 'cos it's a, it's a dying art, there's no, nothing, all the old fellas have passed away, you know, and we need to pass it on.

AR: Exactly, yeah.

PJ: Mm. Especially carving yeah.

AR: Yeah.

TJ: Yeah.

PJ: There's not much young people who do anything like that.

AR: Mm.

TJ: We did have one shot up here, but the funding run out, though um, Mullet, Chris Koolmatrie and…

PJ: My two brothers still do it, they still do it, they got learned by the two best people, or three of them, to do that.

AR: And with the wooden objects, so you have the waddies, and the boomerangs and things like that, did the Elders ever talk to you about each object…

TJ: Yeah, well they showed, they showed us how to use them. They showed us how to use them, 'cos we used it for when we used to, ah, chuck a old pram wheel and we used to, you know, stand on one side and make it out that it was a rabbit, you know, so we just practised…

AR: Oh practice? Yeah (laughter).

TJ: Practise, ah, throwing at it, yeah.

AR: With the boomerang?

TJ: No, with the waddies.

AR: Oh the waddies, yep.

TJ: That way, yeah.

AR: So you'd pluck a rabbit on the head or something (laughter)?

TJ: Yeah, rabbits.

PJ: The boomerang, they would of got told how to bend it to make it fly.

AR: Yeah.

PJ: See, that's what they would have got taught.

AR: And were there famous people in your community who could throw boomerangs and who were kind of doing that kind of thing?

TJ: Probably Jimmy James.

AR: Jimmy James, yep.

TJ: And the three of them who showed us how to do the wood carving.

AR: Yep. Ah, they were good throwers as well were they?

TJ: Yeah they, well they had to, you know, so they wouldn't ah, you know, well make em and, they wouldn't just sell them without um flying or anything.

AR: (Laughter) Ok, have to test them all out.

TJ: Yeah, test them all out.

AR: And who would they sell them to?

TJ: Um, a few of the locals, there's always up and down Uncle John all the time, you know, for his, ah, carvings, ah, tourists.

AR: Ah ha.

SM: And who tended, did any women, or females, tend to make anything with the glass at all, or use glass for anything?

PJ: I don't know.

TJ: They might have used it for their weaving, cutting their weaving and all that, you know, getting the nice strip out of it or, you know, you know.

PJ: On grass.

AR: You cut the reeds off.

TJ: I reckon when the glass came in they would have used it for mostly every cutting thing, you know, 'cos it's sharper than the, than the, what they would have used, flake.

AR: Mm, exactly.

SM: Ok.

AR: Maybe, a little bit about, with the wooden objects, we talked a bit out the Jerry Mason Centre, and, was that kind of a, just a space where people made more objects and taught the next generation and, was there anything kind of about that era that you remember?

TJ: There was always making up objects just to sell em for ornaments and things…

AR: Ok.

TJ: Or, or we had different, you know, making goannas on the, on the flat board, snakes…

TJ: Birds, standing up on the logs, you know.

TJ: Yeah. So we made different objects.

AR: Yep.

TJ: Yeah. And yeah, there should be some of them, should be in the, in the art, in SA museum.

AR: I've read records where the Elders would sell those objects like going way back into the early part when the mission days and things like that. I don't know if you've ever…

TJ: Would have done it, tucker.

PJ: Of course. Well, well, bit of money see, buy food for themselves.

AR: Yeah exactly, yeah. Ok.

TJ: Well they used, as I say, do you know, it's the… you know, skins and, trade em, you know, fur.

AR: Yep.

TJ: Or you know, flour, bread, whatever, tea. It's around about '60's isn't it?

PJ: Yeah.

AR: Yeah.

SM: Do you know if any other groups might have used glass nearby, and, that wasn't really from your group?

TJ: Don't know. But I reckon…

PJ: Yeah I think it would have went Australia-wide, you know, the glass itself. Yeah.

AR: Did the Raukkan mob use glass and make objects like, you know people at Gerard, do you know?

TJ: They would have done the same.

AR: Did the same yeah.

TJ: It would have been sharper so they would have used it anywhere.

AR: Mm. But in the recent period they don't make the same kind of objects and things that you make, do they?

PJ: No, no it's because of the area they're from.

AR: Yeah.

PJ: See they, they would have had, um_oh make, if they would have made spears, they would have made spears with um, what do you call them, coming over?

TJ: Reeds. You got ah, the spikes.

PJ: Spikes, yeah.

AR: Oh yeah.

TJ: For sea fishing.

PJ: Yeah, for sea fishing…Compared to the river mob, they wouldn't have had sort of like that…

TJ: Maybe we should compare that, from the sea to the river…

AR: Yeah.

TJ: 'cos you see the different making of the, the, their style.

AR: Yeah. Ok. Anything else? Have we, have we forgotten to ask an important question (laughter)?

TJ: Yeah, I don't know.

SM: Oh there were some other objects in the museum, we were thinking that might have been made for some reasons that we're not sure about, like some commemorative objects or from European explorers; might, I guess, have a look at that when you come to the museum?

AR: That might be something to do there.

TJ: Yeah, yeah, 'cos we, yeah it would be good to go and have a look, 'cos you might see something different that…

SM: Yeah, yeah, and there was that Aboriginal flag there.

TJ: Yeah, well that we never come across.

AR: Ok.

SM: Oh well, thanks very much!

TJ: Mm.

AR: Great, thank you, well we'll turn the tapes off and we'll set up the video, and we might put a bit of a tarp down so we can catch the glass if you're doing anything. The station owners might not want us leaving glass shards around (laughter).

TJ: Yeah, well we'll do that.

END OF INTERVIEW.

Appendice 4: Table summarising tool names, raw materials and uses from the tool-use experiments.

Table A1 Summary of tool names, raw materials and uses from the tool-use experiments.

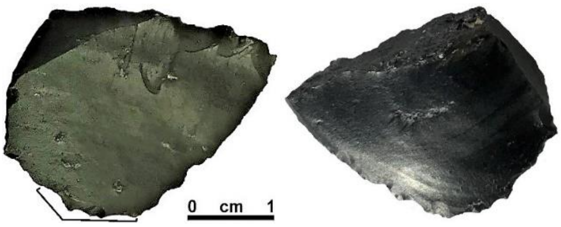
Tool Number	Raw Material (C, S, G, P)	Use	Tool Number	Raw Material (C, S, G, P)	Use	Tool Number	Raw Material (C, S, G, P)	Use
X01	G	scrape dry bone	X37	S	chop fresh wood	X73	G	scrape fresh wood
X02	G	cut, scrape plant	X38	G	saw fresh wood	X74	P	saw dry wood
X03	S	scrape dry bone	X39	C	chop fresh wood	X75	P	scrape fresh wood
X04	C	saw dry bone	X40	S	wedge fresh wood	X76	G	scrape dry bone
X05	S	saw dry bone	X41	C	adze fresh wood	X77	P	saw dry wood
X06	P	scrape dry bone	X42	C	saw fresh wood	X78	G	scrape fresh wood
X07	C	scrape dry bone	X43	S	saw fresh wood	X79	P	scrape fresh wood
X08	S	scrape fresh bone	X44	C	scrape fresh bone	X80	P	saw dry bone
X09	G	saw fresh bone	X45	C	cut, scrape plant	X81	P	saw dry bone
X10	C	saw fresh bone	X46	G	cut, scrape plant	X82	P	saw dry bone
X11	G	scrape fresh bone	X47	S	cut, scrape plant	X83	P	saw fresh wood
X12	G	saw fresh bone	X48	P	scrape fresh bone	X84	P	saw fresh wood
X13	G	scrape dry wood	X49	P	cut, scrape meat	X85	P	saw fresh wood
X14	G	saw dry bone	X50	P	cut, scrape meat	X86	P	scrape fresh wood
X15	S	plane dry wood	X51	P	cut, scrape meat	X87	P	scrape dry bone
X16	C	plane dry wood	X52	P	cut, scrape plant	X88	G	scrape dry wood
X17	G	saw fresh bone	X53	P	scrape fresh bone	X89	C	scrape fresh hide
X18	C	saw dry wood	X54	P	saw fresh bone	X90	G	scrape fresh hide

X19	S	adze dry wood	X55	P	saw fresh bone	X91	G	scrape fresh hide
X20	G	saw dry wood	X56	S	saw fresh bone	X92	G	scrape fresh hide
X21	C	scrape dry wood	X57	G	saw fresh bone	X93	S	scrape fresh hide
X22	C	adze dry wood	X58	G	scrape fresh bone	X94	P	scrape fresh hide
X23	S	saw dry wood	X59	G	cut, scrape meat	X95	P	scrape fresh hide
X24	S	chop dry wood	X60	S	cut, scrape meat	X96	P	scrape fresh hide
X25	S	wedge dry wood	X61	G	saw dry wood	X97	G	saw dry bone
X26	C	wedge dry wood	X62	C	cut, scrape meat	X98	P	scrape fresh bone
X27	C	chop dry wood	X63	G	cut, scrape meat	X99	G	scrape fresh bone
X28	G	saw fresh wood	X64	G	cut, scrape meat	X100	P	saw fresh bone
X29	C	scrape fresh wood	X65	G	scrape dry wood	X101	G	saw dry bone
X30	G	scrape fresh wood	X66	P	scrape dry wood	X102	G	cut, scrape plant
X31	S	scrape fresh wood	X67	S	plane dry wood	X103	P	saw dry wood
X32	G	saw fresh wood	X68	S	scrape dry wood	X104	P	cut, scrape plant
X33	C	wedge fresh wood	X69	P	scrape dry wood	X105	P	cut, scrape plant
X34	C	plane fresh wood	X70	G	saw dry wood	X106	G	scrape dry bone
X35	S	plane fresh wood	X71	P	scrape dry wood	-	-	-
X36	S	adze fresh wood	X72	P	scrape dry bone	-	-	-

Notes

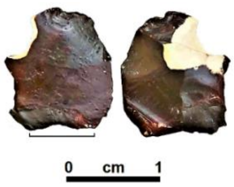
Under ‘Raw Material,’ ‘C’ = chert, ‘S’ = silcrete, ‘G’ = glass and ‘P’ = porcelain

Appendice 5: Macroscopic images of all archaeological artefacts interpreted as definitely used.

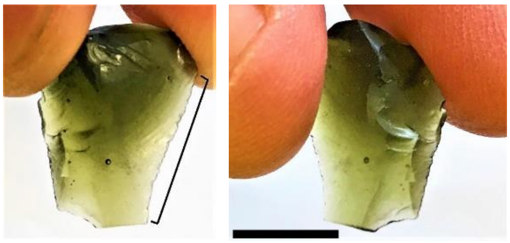


WLW27, chert

WLW28, chert

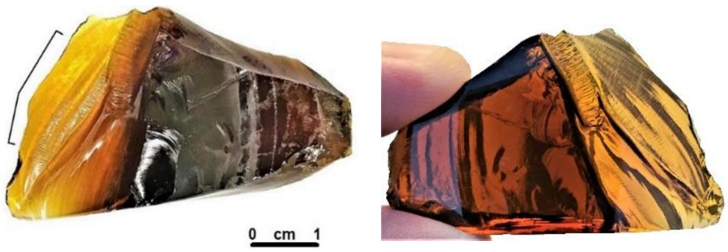


WLW29, chert

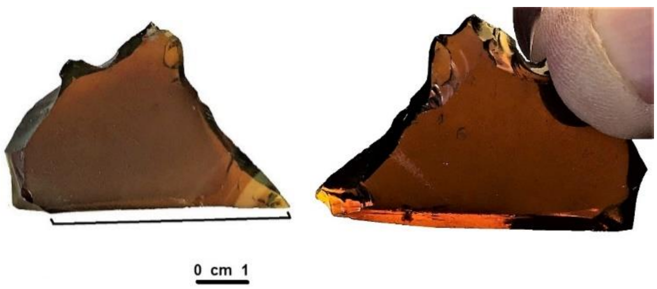


WLW01, glass

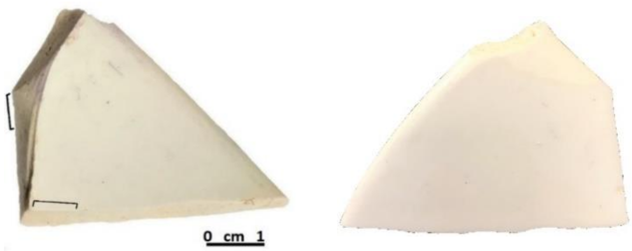
WLW08, glass



WLW12, glass



WLW22, glass



TI07, porcelain