An Analysis of Lithics at Calperum Station, South Australia, to Examine the Function of Late Holocene Mound Sites along the Lower Murray River

Submitted by

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Statement of Authorship

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

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Abstract

Anthropogenic earth mounds are a common site type in the Murray-Darling Basin. They have been the subject of extensive research in New South Wales and Victoria, but mound development and use in South Australia is less well understood. Based on regional surveys, it has been suggested that the earth mounds in the Riverland district of South Australia differ from many of the earth mounds in other parts of the basin in that different kinds of sites were related to different landform settings, and that activities were spatially segregated in this landscape.

In order to identify the kinds of activities that were taking place at the mounds, 195 stone artefacts from the surface of 14 mounds, their immediate vicinities and their broader context were recorded at Calperum Station. The assemblage was dominated by unmodified flakes and uniform knapping strategies with low levels of inter- and intrasite variability in the numbers of artefacts on the mounds, the raw materials used, and the size and form of artefacts. These findings support the proposition that the mounds were functionally specific loci of food and fibre processing activities, such as large animals and *Typha* spp. roots.

Large amounts of heat-shattered stone were also encountered in the study area, suggesting the use of both clay and stone heat retainers in the mounds or associated hearths. The results were overall consistent in many ways with results from other earth mound studies from the Murray-Darling Basin, particularly in regard to the scarcity of raw materials, the consistent use of small cores, flakes and tools, and the use of bipolar reduction strategies. The taphonomic processes active in the vicinity of the mounds suggest that potentially a large portion of the surface assemblage is likely to have been lost to the subsurface due to trampling and flooding events, particularly smaller artefacts. Further research is required to establish regional baseline assemblage variability and the extent of local taphonomic processes.

By focusing on the relationship between earth mounds and the associated stone artefacts, this study contributes to the archaeological understanding of inland riverine mound sites and the associated past hunter-gatherer behaviour in South Australia, Australia and globally by testing and extending the information available about mounds in the Riverland district of South Australia, comparing the results of this study to mound studies from riverine districts of southeastern Australia, and making explicit the relationship between stone artefacts and mounds at Calperum. Earth oven mounds are an international phenomenon that proliferated in the late Holocene, and this thesis extends the information about how stone artefacts and mounds intersect with each other, and how these activities are performed within the context of local subsistence patterns.

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1. Introduction

1.1 Background

The Murray-Darling Basin covers a large portion of the southeastern part of Australia, and is the country’s largest and most important water system. The basin is saucer shaped, low lying and intracratonic, extending approximately 850 km between longitudes 139° and 147° east, and 750 km from latitudes 32° and 37° south (Brown and Stephenson 1991:8). The Murray, Darling and other tributary rivers in this system are fed for the most part by runoff from the Great Dividing Range, with low rainfall in the semi-arid basin contributing very little to the flows (Evans 2013:15). Prior to the arrival of Europeans in 1788, the Murray River was one of the most resource rich and densely populated parts of Australia (Clarke 2009:147; Eyre 1845 Vol II; Mitchell 1839; Webb 1984).

Prior to 1788, the Murray River supported much larger populations of Aboriginal people than the surrounding semi-arid plains, and as a resource rich area, was likely to have had well-defined territorial boundaries with exclusive and corporate local organisation (Pardoe 1990:61). The south central corner of Calperum Station which contains a section of Murray River floodplain lies within the boundaries of the Erawirung people (Tindale 1974:211)[1]. Part of Calperum Station was granted native title, which is held by the River Murray and Mallee Aboriginal Corporation (RMMAC)[2].

Earth mounds are mounded deposits of earth, charcoal and burnt clay, created by Aboriginal people through the repeated use of cooking processes (Balme and Beck 1996:39; Bonhomme 1990:31; Coutts et al. 1976:3–4). They are found mostly in selected areas in the Murray-Darling Basin on floodplains and on the banks of the Murray River and its tributaries, as well as on the northern

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[1] Although it is noted that various versions of group boundaries exist. This is discussed in more detail in Burke et al. 2016.

[2] See *Turner v South Australia 2011* FCA 1313 (18 November 2011).

coastline (Balme and Beck 1996:39; Westell and Wood 2014:32). Age determinations for a number of Australian earth mounds indicate that the earliest earth mounds appeared in the mid-Holocene, with the majority of mounds dating to the last two thousand years (Coutts and Witter 1977:63–66; Johnston 2004:51; Jones 2016:16; Klaver 1998:162; Littleton et al. 2013:40-41; Martin 2006:150, 169–170; Williams 1988:93–95, 145). With 78% of earth mounds in the Murray-Darling Basin dated to less than 2000 years BP (Jones 2016:16), it is likely that the mounds at Calperum Station are also late Holocene in age, but none have been dated as yet.

Calperum[3] Station, located 15 km north of Renmark in the Riverland of South Australia (SA), was originally part of the Bookmark Station, established in 1864 for sheep and cattle grazing (Australian Government nd). Calperum Station is 242,800 hectares in size, mostly consisting of mallee bushland but also including a small section of Murray River floodplain (Australian Government nd). Since 1993 it has been part of a regional reserve. This research is part of the Calperum Station Research Project, a broad-ranging project which aims to investigate the pre-contact lifeways of Indigenous peoples on Calperum Station and in particular to explore the social and economic impacts of climate change over time. The project involves collaboration with the River Murray and Mallee Aboriginal Corporation (RMMAC), Flinders University staff as well as a number of students researching different aspects of the archaeology of this part of the River Murray. In this thesis I examine surface stone artefacts located on and near earth mounds at five locations adjacent to waterbodies on Calperum Station. These areas have been a focus of Aboriginal activity in the past, as evidenced by multiple mounds and other kinds of site types such as scarred trees, shell middens and stone artefacts at or near these locations. This study focuses, in particular, on exploring the relationship between the stone artefacts and the earth mounds.

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[3] ‘Calperum’ is possibly an anglicised version of the Erawirung word ‘Kalparum’, meaning ‘branch road’ or ’short cut’ (Tindale c.1934-c.1991).

1.2 Aims and Questions

This thesis contributes to the Calperum Station Research Project by examining the lithic assemblages associated with other earth mounds close to the Murray River sites and comparing them to lithic assemblages from other mound sites associated with the Murray River.

This research examines a surface assemblage of stone artefacts that are associated with earth mounds, using Calperum Station as a case study area to examine the artefact manufacturing processes, the function of artefacts, how they are related to the mounds, what taphonomic processes may have impacted on the artefacts and their surface visibility, and how they compare with stone artefact assemblages associated with mound complexes in other parts of Australia.

Mound construction has been linked to socioeconomic changes including a more sedentary lifestyle and increasingly systematic and energy intensive exploitation of resource rich habitats (Lourandos 1985:400; Wandsnider 1997:35). Understanding how the mounds are associated with other archaeological features, such as stone artefacts, can assist our understanding of how Aboriginal people were living in and using the Riverland during the mid–late Holocene.

The primary research question is:

- What can the surface stone artefacts on and near earth mounds at Calperum Station allow us to infer about the activities carried out at and near earth mound sites in the Calperum Station region? And how do such inferences correspond to previous conclusions about the actions of Aboriginal people around such features?

In the process of answering this question, it will also be necessary to consider the following subsidiary questions:

- What inferences can be drawn about mobility, raw material selection and distribution, knapping strategies, tool manufacture and use from the surface lithics?

- Are there differences between stone artefacts on and very close to the mounds in comparison to the artefacts away from the mounds?

- What taphonomic processes affect the stone artefacts in the vicinities of the mounds in the Calperum Station study area, and what impact do such processes have on interpreting the archaeological record in this region?

1.3 Significance

This research project assists in developing a greater understanding of the past lifeways of Aboriginal people in this part of SA during the mid–late Holocene. The Calperum Station Research Project was developed in collaboration with the River Murray and Mallee Aboriginal Corporation (RMMAC).

Significance to Community

This research is significant to RMMAC because it allows insights into the lives and activities of their antecedents. The cultural features remaining at Calperum Station provide the traditional owners of this area with a tangible connection to their ancestors, and this research provides information that assists in the development of appropriate monitoring and protection for these features.

Significance to the Region

Earth mounds are a common Aboriginal cultural feature of the Murray-Darling Basin, and floodplains in other parts of Australia. Detailed archaeological studies have been conducted at a number of these locations in New South Wales and Victoria, but detailed studies of earth mounds, lithics or other archaeological features of the Riverland district are less common (see Westell and Wood 2014). This thesis thus contributes towards addressing this gap.

Significance to Mound Studies

This thesis extends the information available about mounds in the Riverland district of South Australia. Earth mounds have been recorded in relation to their distribution in the Riverland but little research has been conducted in relation to stone artefacts associated with these mounds (Westell and Wood 2014:56). This study also extends the information available about the local site complex to which these mounds belong. It contributes to current theoretical debates about occupation patterns, subsistence strategies and technology relating to earth mound use in the Murray-Darling Basin in particular, and to earth mounds in Australia in general, by investigating theories about earth mound development and use, and comparing them to the Calperum Station context. The literature on mound studies in Australia indicates that the ways in which artefacts are associated with earth mounds vary according to the Aboriginal groups' usage patterns, and for this reason, this study includes analysis of artefacts in the vicinity of the mounds.

Significance to Australian Lithic Studies

The relationship between earth mounds and any associated stone artefacts is usually not the focus of mound studies and frequently small assemblages make it difficult to draw conclusions (Coutts et al. 1979; Johnston 2004; Martin 2006; Williams 1988). As a point of difference, this study focuses on this relationship. Understanding how the stone artefacts that are associated with mounds fit in with the development and use of mounds in the Riverland allows comparisons to be drawn with other mound-associated lithic assemblages around Australia.

Significance to International Lithic Studies

Mounds formed as a result of heat retainer cooking processes—an international phenomenon that also developed in North America and Europe in the mid-Holocene, processes that became increasingly significant in the late Holocene (Martin 2006:72–73). In Australia, the development of mounds as a result of these processes also proliferated in the last 2500 years (Brockwell 2006:50; Martin 2006:96; Westell and Wood 2014:34; Williams 1988:216–218). The development of these kinds of mounds indicates a large-scale change in food processing practices during this period

(Wandsnider 1997:35). Understanding the role of stone artefacts in this kind of cooking process in the context of an Australian example, or their use in relation to other activities at these site types, extends our understanding of how these two kinds of archaeological remains intersect with each other, and how these activities are performed within the context of local subsistence patterns.

1.4 Thesis Outline

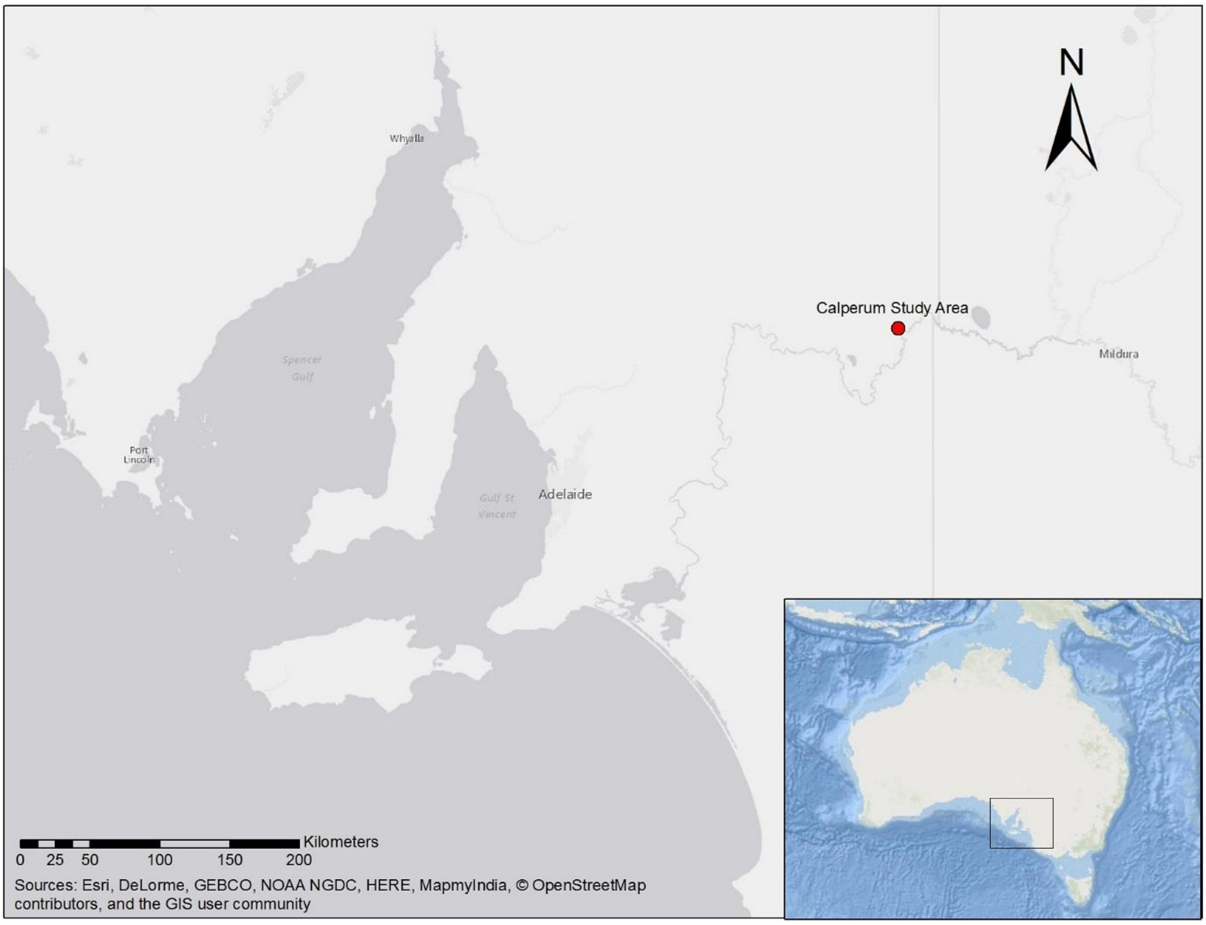
Chapter 2 provides an overview of the study area, beginning with descriptions of the study areas, followed by the Aboriginal and historic histories of the study area. It concludes with the broader geomorphological context. Chapter 3 reviews the study of earth mounds in Australia, beginning with a definition of earth mounds before providing ethnohistorical accounts of earth mound use and distribution. Earth mound studies from the Murray-Darling Basin are reviewed before examining analyses of mound related lithics, and mound studies from South Australia. The connections between earth mounds and intensification theories, and between lithics and usewear and residue studies are also explored. Chapter 4 provides an overview of the major taphonomic processes that are likely to have been active in the study area, and describes how this may have impacted artefacts in the study area. Chapter 5 presents key ideas from Kuhn (1995) and Mackay (2005), providing a theoretical foundation for analysing mobility patterns from the stone artefacts in the vicinity of the mounds. Chapter 6 introduces the field methods that were employed at Calperum Station, including the ethics and community approvals, descriptions of the stone raw materials encountered during the survey, the recording scheme employed and descriptions of the measurements. Chapter 7 presents the results of the field recording, including summary tables and graphs. Chapter 8 discussed the results and contextualises them against other mound studies from the Murray-Darling Basin, and Chapter 9 employs the results to answer the research questions. Further information about the raw materials sources and the full data set from the field recording are provided in the Appendix.

2. Site Description, Cultural and Geomorphological Context

This chapter introduces the study area, beginning with descriptions of the sites visited during fieldwork. The Aboriginal cultural history of the region, as described by ethnohistorical accounts, is followed by a brief account of the European history of Calperum Station in both its early and modern forms. A brief geomorphological history of the study area is provided at the end of this chapter.

2.1 Site Descriptions

The study area is located on the banks, paleo channels and floodplain of the Murray River at Calperum Station, close to the SA border with New South Wales (NSW) and Victoria (Figure 1). The Murray River is the dominant landscape feature of this semi-arid region.



Sources: Esri, DeLorme, GEBCO, NOAA NGDC, HERE, MapmyIndia, © OpenStreetMap contributors, and the GIS user community

Figure 1: Murray River and the study area, South Australia. Map by Jarrad Kowlessar.

The mound locations discussed in this study are indicated in Figure 2.

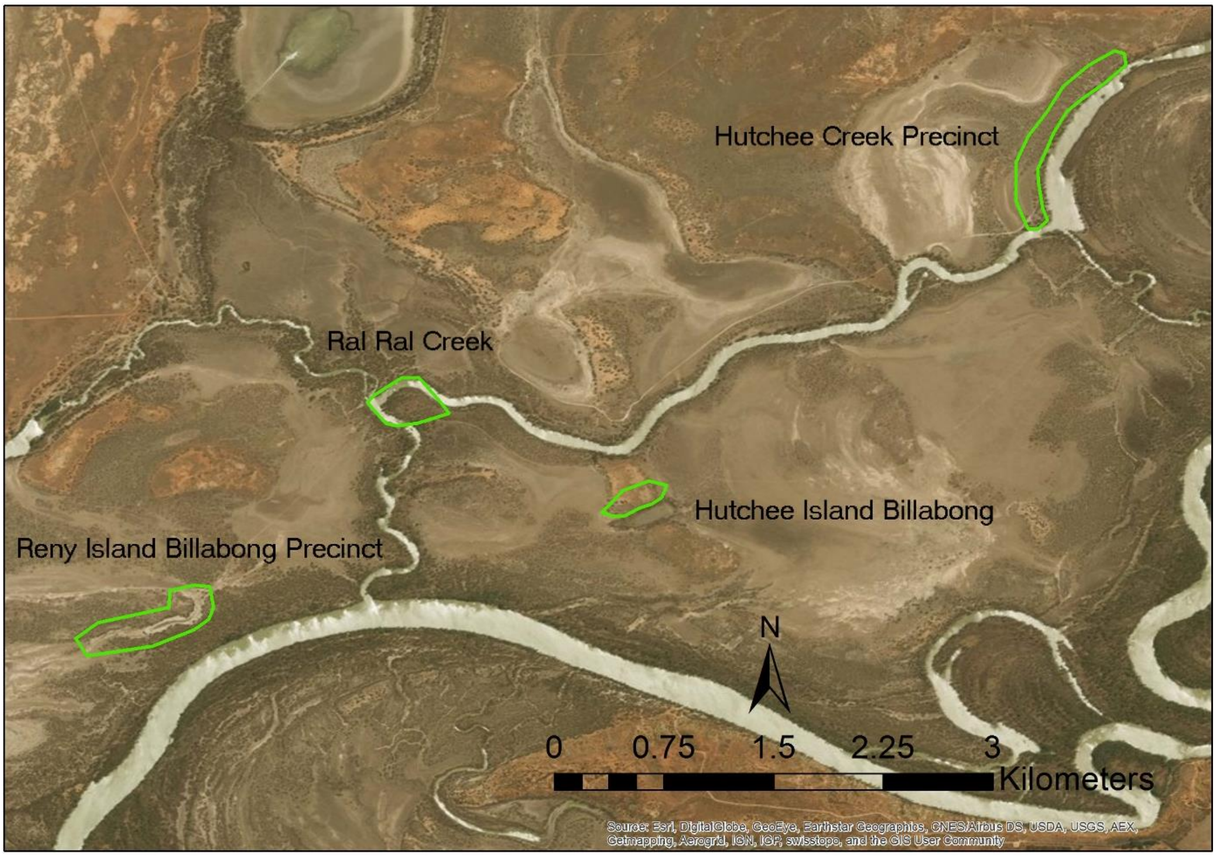


Figure 2: Mound locations discussed in this thesis. Map by Alexander Moss 2017.[4]

2.1.1 Reny Island Billabong Precinct

The Reny Island billabong is a small relict section of a paleochannel very close to the current course of the Murray (Figures 3–6). The area to the south between the Murray River and the billabong is thickly vegetated with mostly Black Box, a variety of saltbushes including *Atriplex* spp., Nitre Bush (*Nitraria billardierei*) and lignum with some *Eucalyptus camaldulensis*. On the northern side, a few *Eucalyptus largiflorens* trees, Nitre and lignum bushes line the edge of the billabong, but beyond that to the west, north and east there is little vegetation on the floodplain apart from Round-Leaf Pigface

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[4] Only the study area zones, and not the site locations, are indicated on this map as requested by RMMAC and required by the *Aboriginal Heritage Act 1988*.

(or Rounded Noon-Flower) (*Disphyma crassifolium*). *Mesembryanthemum* spp. was identified on the surface of many of the mounds, but not in any other locations (see also Jones 2016).

Water levels in the billabong are artificially maintained by a pump at the northern tip. The Reny Island billabong held water in the September 2015 field season, but was dry during the April 2016 visit. Duckweed (*S. polyrhiza*) growing on the surface of the shallow water blanketed the margins of the billabong as the water evaporated, restricting surface visibility and identification of artefacts, particularly small ones. Surface visibility on the margins of the billabong was better in 2016 as the duckweed (*S. polyrhiza*) had dried further and either shrunk to thin flakes or was gone altogether. The Reny Island billabong was dry during the April 2016 fieldwork (Figure 6), but survey of the billabong bed did not identify any artefacts. Several kinds of cultural heritage were identified around the margins of the billabong; five earth mounds and one utilised natural mound on the edge of the levee bank, as well as a small shell midden and scar tree (Jones 2016:68). These mounds were recorded in detail and analysed by Jones (2016).

Figure 3: Northern end of Reny Island billabong facing northeast, vegetation borders the water's edge. Photograph J. Thredgold, September 2015.

*Figure 4: Chert knapping floor in foreground, located east of the northern tip of the Reny Island billabong. Round-Leaf Pigface (*D. crassifolium*) covers the foreground and beyond that is the narrow strip of vegetation that extends along the billabong's northern margin. Photograph J. Thredgold, September 2015.*

Figure 5: Ground cover on the northeastern side of the Reny Island billabong. Photograph J. Thredgold, September 2015.

Figure 6: Dry Reny Island billabong bed, looking west from the centre of the larger water-holding area. Photograph J. Thredgold, April 2016.

2.1.2 Hunchee Island Billabong Precinct

The Hunchee Island billabong mounds (Figure 7) were situated on the northern side, close to the eastern end of the lagoon. The mounds were on the eastern edge of a red sandy rise that the lagoon intersects, although sediments around the very edge of the lagoon were grey as per the other locations. The lagoon is ringed with saltbush and lignum interspersed with a few *E. largiflorens*. The red sandy rise is likely to be a relict and eroded section of what Gill (1973:43–44) refers to as the Rufus Formation, or, following Prendergast et al. (2009:58), as a relict section of the Neds Corner Land System. The cliffs on the southern side of the Murray River in the Murtho Forest Reserve are visible from the mounds.

Figure 7: Hunchee Island billabong, looking southwest from the mound. Cliffs on the southern side of the Murray River are just visible as a thin band of orange on the horizon. D. crassifolium *covers the surface of the billabong. Photograph J. Thredgold, April 2016.*

2.1.3 Hunchee Creek Precinct

The Hunchee Creek mounds (Figures 8 and 9) all lie on the northwestern side of the eastern end of the creek as it curves around Little Hunchee Island. The creek is lined on the northwestern bank with *E. largiflorens* and *E. camaldulensis*, interspersed with lignum and saltbush. Beyond the line of trees on the bank, there are few trees, again mostly just a thin distribution of lignum and saltbush. The sediment is grey gilgai clay and light sand. Water levels in this creek are artificially maintained by a system of sluices.

Figure 8: Hunchee Creek North precinct looking northeast, in the vicinity of HCN23. Photograph J. Thredgold, April 2016.

Figure 9: Hunchee Creek North precinct, looking south along the track, in the vicinity of HCN23. Photograph J. Thredgold, April 2016.

2.1.4 Ral Ral Creek East Mounds

The Ral Ral Creek east mounds (Figure 10) were situated just south of the Hunchee and Ral Ral Creek intersection on Hunchee Island (on the eastern side of Ral Ral Creek). They are also located on the grey gilgai clay, with *E. camaldulensis* and *E. largiflorens* trees, and lignum and saltbush vegetation. The Ral Ral Creek area included both clear and thickly vegetated areas, and large amounts of tree litter, leading to variable visibility during survey.

Figure 10: Ral Ral Creek area looking west. The water and opposite side of the bank are visible on the left of the photograph. Photograph J. Thredgold, April 2016.

2.2 Aboriginal and Historical Context

The earth mounds that are the focus of this study fall within the former First Peoples of the River Murray and Mallee Native Title Claim which incorporates a number of narrower Aboriginal groupings that existed prior to the arrival of European (see Tindale [1974] and Berndt and Berndt [1993]) (Figures 11 and 12). Part of the claim area was successfully determined via consent, which is managed by RMMAC.[5] The study area falls within the boundaries of the Erawirung, as described by Tindale (1974:211). Tindale's (1974:211) notes on the Erawirung indicate that they were a small group that was part of a larger group society. The Erawirung were also referred to as Jirau (Tindale 1974:211) or Yirau (Berndt and Berndt 1993—see Figure 11). The boundaries indicated by Berndt and Berndt (1993) and Tindale (1974:211) (see Figures 11 and 12) are not the only renderings in existence; a full account of the ethnohistorical and anthropological literature regarding the groups in this section of the Murray River is beyond the scope of this study.

Early historical accounts and research on the Aboriginal people living along the Murray River suggest that the river was densely populated by many different groups (Birdsell 1953:185; Clarke 2009:147; Eyre 1845 Vol II; Mitchell 1839; Owen 2004; Sturt 1833:120–126, 135; Webb 1984). The laws and customs of these groups were quite different to those of groups to the north and west, particularly in regard to initiation practices, and also different to each other (Brown 1918; Clarke 2009; Pardoe 1995:704; Pate and Owen 2014; Taplin 1879), despite many shared cultural practices (Pardoe 1995:711). In his description of the Erawirung, Tindale (Tindale 1974:211; and see also Woolmer 1974:21) makes mention of a chert quarry at Spring Cart Gully (see Figure 14 and Appendix 1), a high quality resource which the group owned and defended, which suggests territoriality. Indicators of disease and dietary stress have been found in Central Murray Aboriginal populations at rates of incidence and duration much higher than in other populations in Australia (Webb 1984). The results showed patterns of stress quite different to those in other areas, suggesting a different lifestyle along the Murray River (Webb 1984:170). Webb (1984) suggested that this was due to particularly dense populations in the narrow Central Murray area, already under stress from problems such as parasite infestation, depending on abundant but heavily exploited resources.

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[5] *Turner v South Australia 2011* FCA 1313 (18 November 2011).

Figure 11: Berndt et al.'s (1993:304) map of Lower Murray Aboriginal tribes including Renmark district. Figure removed due to copyright restrictions.

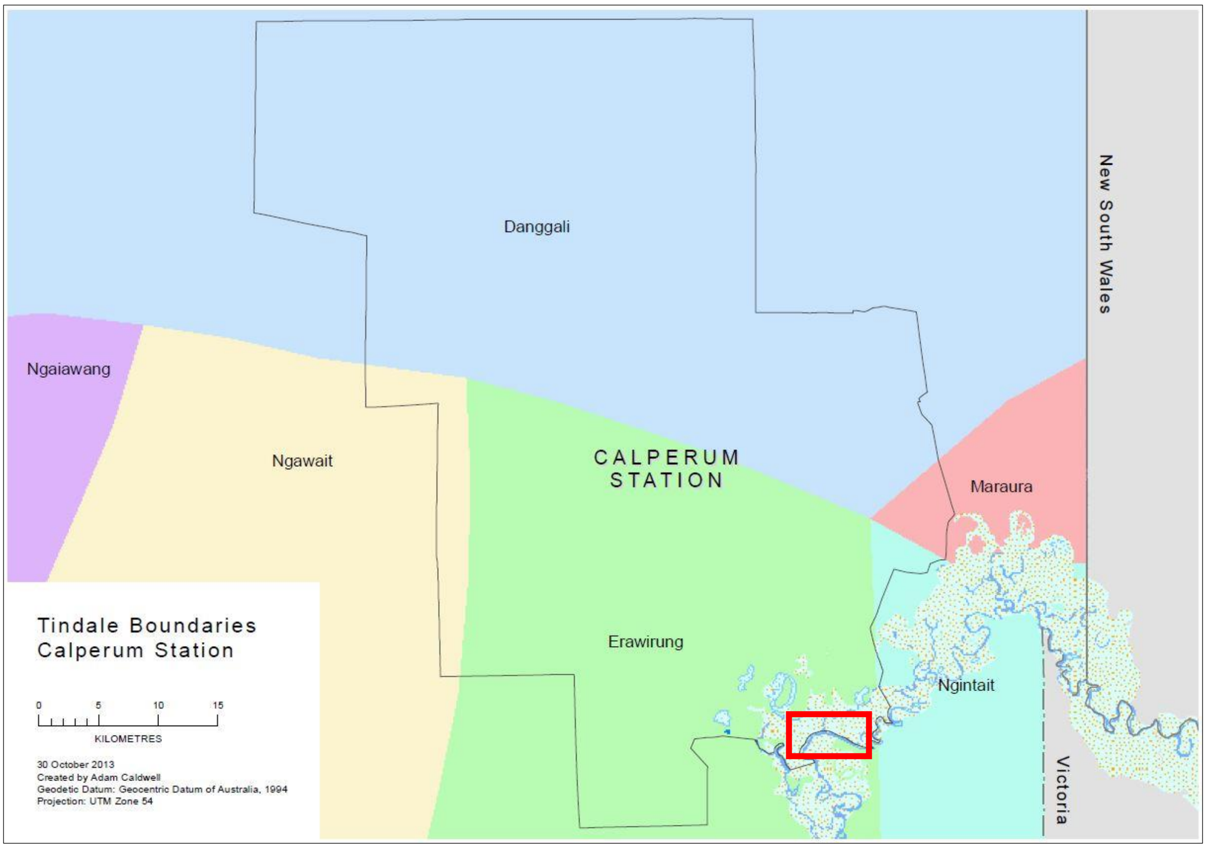

Figure 12: Tindale's (1974) Aboriginal tribal boundaries overlay map of Calperum Station and the surrounding areas (Caldwell 2014:4). The study area is marked with a red rectangle.

Pate and Owen (2014:91) also found evidence of sedentary lifeways and territorial social systems during the late Holocene. Stable carbon and nitrogen isotope analysis of human skeletal remains from the Coorong, Swanport and Roonka Flat archaeological sites in SA found different dietary patterns in different locations (Pate 1997:112-113; Pate 2006:240; Pate and Owen 2014:91–92). In the coastal Coorong area, the whole population was heavily dependent on marine food. At Swanport, adult males consumed more of the terrestrial animals and large fish than adult females and subadults, whose diets consisted more of shellfish and plant food. By contrast, at Roonka, roughly 100 kms to the north, subadults consumed larger amounts of terrestrial animals than both adult males and females, who had similar diets. Pate and Owen (2014) argued on this basis for discrete biogeographical zones indicating more sedentism and territoriality amongst the Murray River populations.

The Murray River, under a natural hydrological regime, would have been both a major resource and a significant determining factor of settlement patterns (Wood and Westell 2010:4). Wood et al. (2005, in Wood and Westell 2010:4) found that archaeological remains in the Chowilla anabranch, immediately upstream from the study area, indicated three major patterns: occupation focussed on areas adjacent to the river and more permanent water bodies during late summer to winter; occupation contracted to floodplain margins and elevated areas within the floodplain during summer floods; and areas of seasonal resources that were settled intensively whilst they were available. Similar trends were identified for the Katarapko[6]-Eckert Creek anabranch system, immediately downstream from Berri, SA, leading Wood and Westell (2010:7) to use these patterns as the basis of a predictive model of Aboriginal occupation of the Murray Valley in the Riverland region. They found that sites were clustered along landform boundaries or vegetation communities, and that the majority were located close to water with sites frequently located along the boundaries of regular high water levels (Wood and Westell 2010:20). In the neighbouring areas to the east, other

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[6] Katarapko is an Erawirung word meaning ‘home of rock crystal’ (Tindale c.1934-c.1991).

researchers have noted, similarly, that the densest concentrations of stone artefacts are generally found on elevated areas such as source-bordering dunes and lunettes (Garvey 2013:120; Grist 1995; Prendergast et al. 2009).

Historical records provide accounts of the kinds of subsistence activities being carried out along the Murray River. In the ethnographic period, men caught the majority of the large game, and women hunted small game and collected vegetables (Angas 1847a:54; Berndt and Berndt 1993:77; Eyre 1845 Vol.II:291). At times, men and women worked collaboratively to hunt (Angas 1847a:100; Eyre 1845 Vol II:277, 282) and whilst men were reported as consuming their catches immediately after catching them (Bellchambers 1931:141; Berndt and Berndt 1993:77), women usually shared their food and were responsible for preparing shared food (Berndt and Berndt 1993:77; Eyre 1845 Vol.II:291; but see Pate and Owen 2014 for regional variations). Women primarily, but not exclusively, made fibre and fibre-based products from a variety of reeds, but predominantly *Typha* spp. (Angas 1847a:55, 89–90; Berndt and Berndt 1993:101; Beveridge 1883:42–43; Browne 1897:72; Krefft 1865:361), including many different kinds of nets for ducks and fish, mats of all sizes, tassels, baskets, basket fish traps and necklaces (Eyre 1845:311–312a; Taplin 1879:18, 29, 52, 64a). The fibre for many of these products is likely to have been prepared in earth ovens (Beveridge 1883:42–44; Martin 2006). *Typha* spp. was both a permanently available food staple and the source of much of the equipment used to procure food (Beveridge 1883:42; Eyre 1845 Vol. II:269; Gott 1999:41; Krefft 1865:361).

The section of the Murray River that would later become Calperum Station became important to Europeans in 1838 as drovers from the eastern states began to use it as a campsite and watering place (Australian Landscape Trust 2016). In 1830 Charles Sturt was the first European to travel down the river, European settlers Joseph Hawdon and Charles Bonney found a route to drive cattle and sheep from NSW to SA, in part by following a broad Aboriginal road on the northern side of the Murray River in 1838 (Bonney nd:8). Many others followed, sparking conflict with the local Aboriginal populations which resulted in shootings and massacres (Burke et al. 2016; Foster et al. 2001:29–43; Foster and Nettelbeck 2012:32–39) which, combined with other effects of colonisation such as disease, resulted in significant population decline (Clarke 2009:142). Following the increase in drover numbers and frequency, and the greatly reduced local Aboriginal population, Chowilla[7] Station, later known as Chowilla-Bookmark[8] Station, became one of the first pastoral leases issued in 1851 (Australian Landscape Trust 2016).

In 1896 the property was split into Calperum and Chowilla Stations and Calperum was held by one family until its sale to the Federal Government in 1993 (Australian Landscape Trust 2016; Australian Government nd). Calperum Station covers an area of 242,800 hectares, mostly consisting of mallee bushland but also including a small section of Murray River floodplain (Australian Government nd). Since 1993 it has been part of the Riverland Biosphere Reserve, ending its time as a sheep and cattle station and instead providing a protected habitat for a number of endangered and vulnerable animal species and the endangered Mallee scrubland vegetation (Australian Government nd).

In the early 1970s a dam was proposed on Chowilla Station at a narrow section of the Murray River near the intersection of the NSW and Victorian border with the SA border. Had the plan gone ahead, an area of 2600 km² would have been inundated (Gill 1973:1). Environmental, geological and archaeological surveys were conducted in areas likely to be affected (see Gill 1973). The Aboriginal heritage sites identified in this large area included shell middens and stone artefact scatters, with samples of the latter being collected ahead of the anticipated inundation (Casey 1973:209). The retouched and ground artefacts were described in detail and are summarised below in Table 1. The unretouched flakes and flake fragments were not described in detail, except to mention the presence of two sites, both in the vicinity of the Berribee Quarries (which appear not to have been identified in this study), where large numbers of ‘notably small flakes’ were concentrated (Casey 1973:212).

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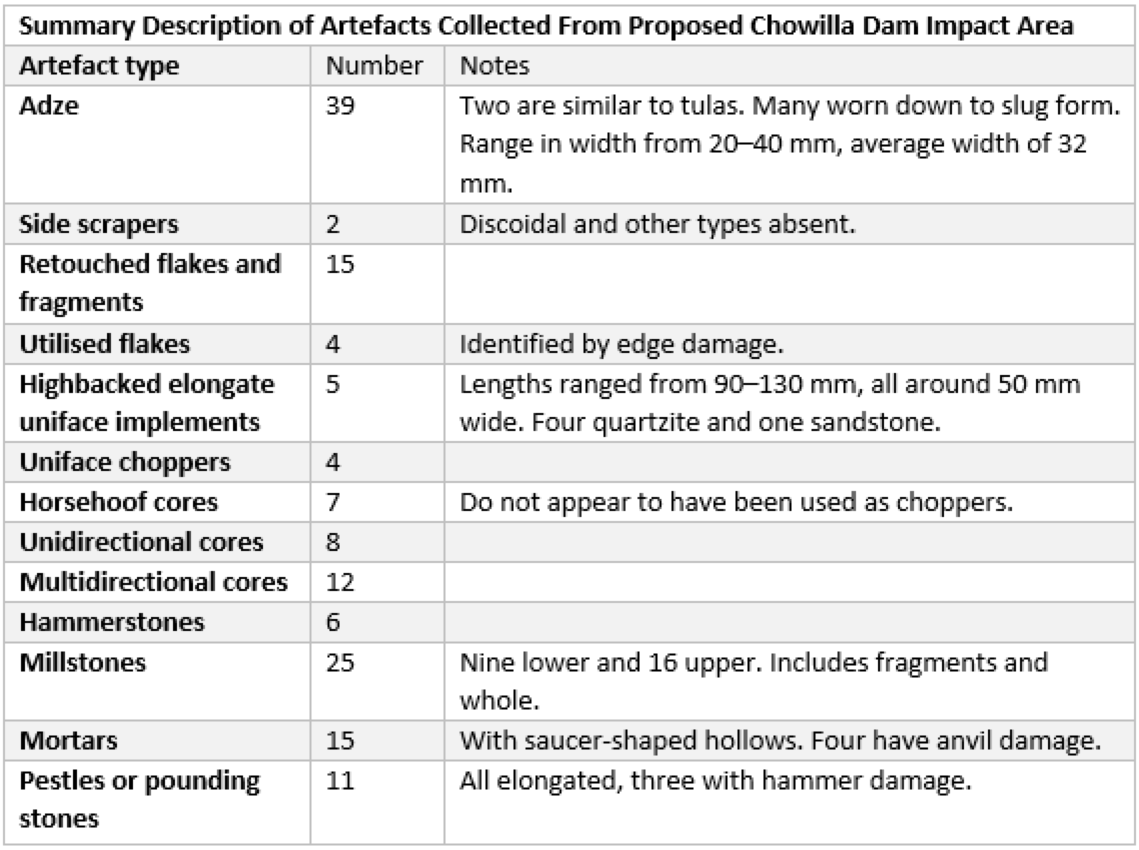
[7] ‘Chowillla’ is an anglicised version of the Erawirung word ‘Tjauwala’, meaning ‘place of ghosts and spirits’ (Tindale c.1934-c.1991).

[8] ‘Bookmark’ is an anglicised version of the Erawirung word ‘Buikmiko’, meaning ‘round hole’ (Tindale c.1934-c.1991).

Table 1: Summary description of artefacts collected from the proposed Chowilla Dam impact area (Casey 1973:209).



Summary Description of Artefacts Collected From Proposed Chowilla Dam Impact Area

Artefact type	Number	Notes
Adze	39	Two are similar to tulas. Many worn down to slug form. Range in width from 20–40 mm, average width of 32 mm.
Side scrapers	2	Discoidal and other types absent.
Retouched flakes and fragments	15	
Utilised flakes	4	Identified by edge damage.
Highbacked elongate uniface implements	5	Lengths ranged from 90–130 mm, all around 50 mm wide. Four quartzite and one sandstone.
Uniface choppers	4	
Horsehoof cores	7	Do not appear to have been used as choppers.
Unidirectional cores	8	
Multidirectional cores	12	
Hammerstones	6	
Millstones	25	Nine lower and 16 upper. Includes fragments and whole.
Mortars	15	With saucer-shaped hollows. Four have anvil damage.
Pestles or pounding stones	11	All elongated, three with hammer damage.

Gill (1973:89) noted a lack of recognisable tool types in the area—it was anticipated that ‘pirris’ and ‘tula adzes’ might be identified during their survey, but none were found. Edge-ground axes and cylcons were only rarely reported by European collectors and were understood in this context to be rare imports and not a part of the local material culture (Gill 1973:89). Beyond this there is little other publicly available commentary on the stone tools of the region.

2.3 Geomorphological Setting

The geological history of the Murray River and Mallee region is important in understanding the current landscape features, and is particularly relevant in understanding the sources of stone raw material in the study area. The Murray-Darling Basin (see Figure 13) is a depression that extends over the majority of inland southeastern Australia (Littleton and Allen 2007:285). Rain and snowmelt from the western slopes of the Great Dividing Range, which runs from north to south along the entire east coast of Australia, drains into the Murray River and its tributaries, flowing across the semi-arid plains of central and western NSW and northern Victoria and into SA. The river turns sharply to the south near the base of the Mt Lofty Ranges, travelling along a gorge at the edge of the basin, and continues to the Southern Ocean (Brown and Stephenson 1991:309).

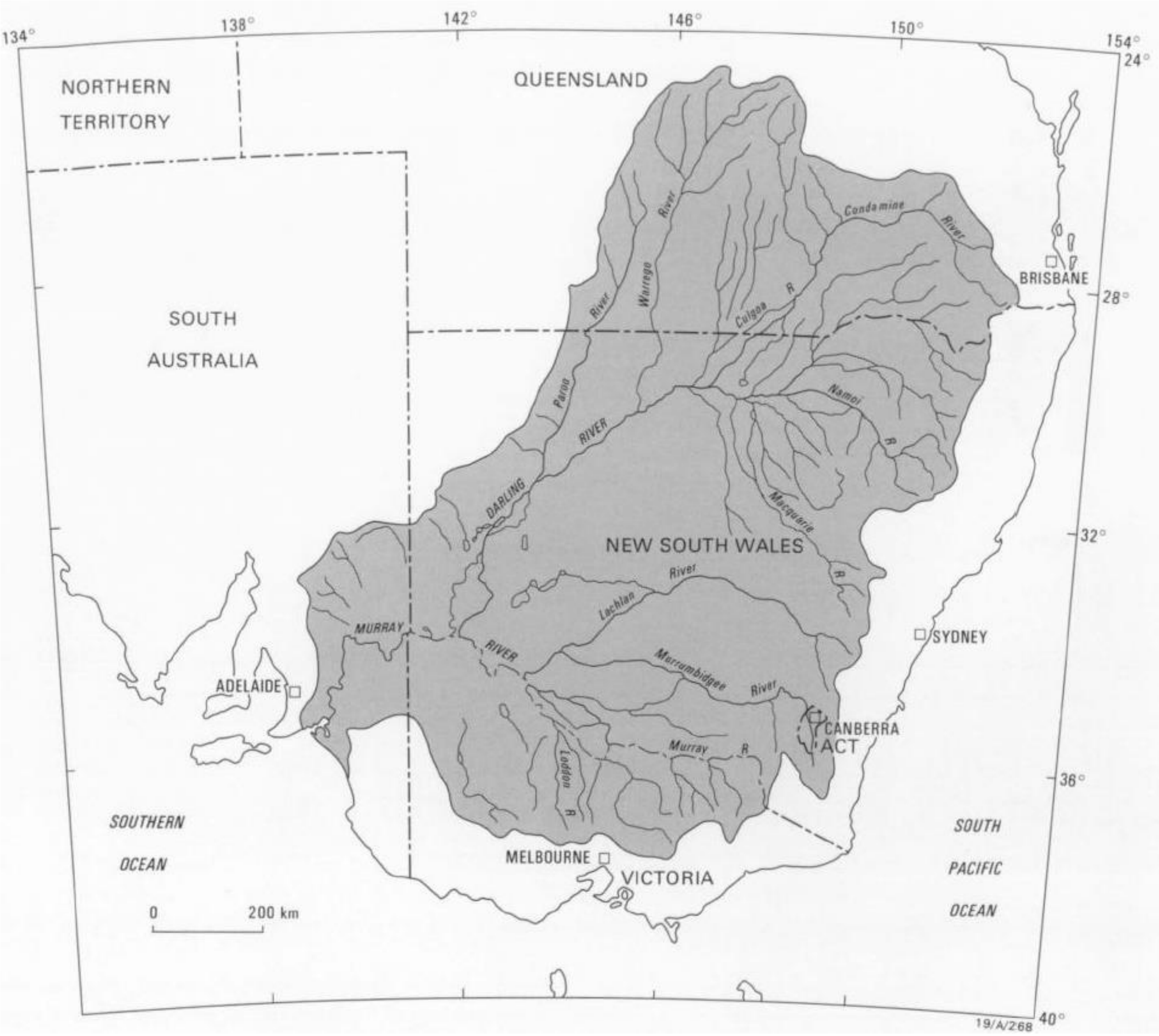


Figure 13: The Murray-Darling Basin and associated rivers (Brown and Stephenson 1991:22).

The geomorphology of the Murray channel is complex; very small units of a range of landforms undergoing different geomorphological processes are closely packed into the area (Evans 2013:9). Changing sea levels from the late Eocene until the middle Miocene drove cycles of ocean inundation and river valley incision in much of which is currently the Murray-Darling Basin (Brown and Stephenson 1991:315–318; Evans 2013:1), leading to the deposition of fossiliferous sands, marls and limestone (Twidale et al. 1977:31). Uplift of the Pinnaroo block around 3.2 million years ago created a depression in what is currently the Murray Mallee area, which the river then inundated, creating

Lake Bungunnia (Evans 2013:5). Marine inundation, the shallow mega-lake and sediment deposition from tributary rivers all contributed to the deposits of sand (Parilla Sands) and clay (Blanchetown Clay) in the basin that are now the dominant features of the Mallee landscape (Evans 2013:5–11), Because of these events the basin is dominated by unconsolidated and semi-consolidated sediments so there is very little stone suitable for knapping other than silcrete which is principally found in association with the Karoonda Surface of the Blanchetown Clay unit (Brown and Stephenson 1991:315; Gill 1973:33). Patches of silcrete from the Karoonda Surface would have been quarried from the Murray River cliffs, and as the Karoonda Surface lies close to the modern surface and is frequently exposed in the Chowilla area (Brown and Stephenson 1991:164), siliceous outcrops within this unit would have been exploited once encountered. Known outcrops that have been used as quarries by Aboriginal people are indicated in Figure 14 below.

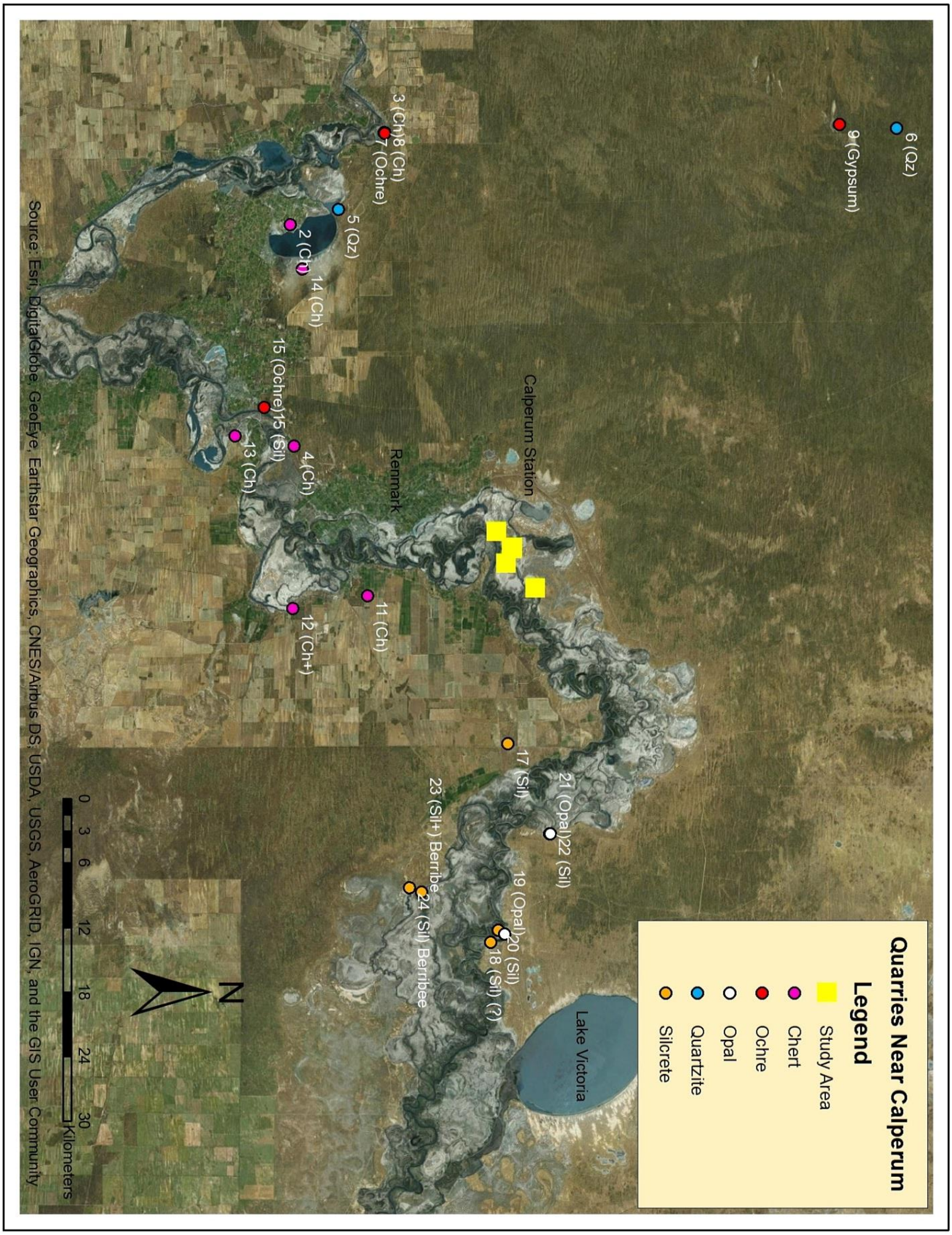


Figure 14: Known quarries near fieldwork locations, Riverland, South Australia. References for the quarries shown here, and for other quarries with no spatial information, are included in Appendix 1.The number on the map refers to the reference number. Map locations are all approximate. Map by Jarrad Kowlessar.

Figure 14 demonstrates that apart from three sources (Numbers 6, 9 and 17), the remainder are located on landform boundaries along the course of the Murray River, particularly the boundary between the grey floodplain areas and the surrounding red soils. This is possibly the boundary between the Neds Corner Land System and the Lindsay Land System (see Prendergast et al. 2009, Figure 15).

The Murray River at Calperum Station has been the route of the river in its last two phases; the ancestral river and the modern river (Brown and Stephenson 1991: 192; Gill 1973: 24–25, 49). The heavy flows and greater fall of the earlier phases of the river were much more active in creating landscape change, whereas the river in its modern phase is inactive even at peak flows (Brown and Stephenson 1991:194; Gill 1973:9). Fluvial scouring and sedimentation in the ancestral phase was much more active (Brown and Stephenson 1991: 192; Gill 1973:24–25, 49), leaving small islands of relict landforms interspersed with newer reworkings of the river sediments. In this section of the river it is sometimes difficult to determine whether a change in landform is a relict island of a former system or a reworking of a more modern land system. A detailed geomorphic study has been conducted for the Murray River just across the tristate border from Calperum Station (Prendergast et al. 2009; Figure 15). Due to both the lack of such a study for Calperum Station, and the proximity of Prendergast et al.'s (2009) study to Calperum Station, the Prendergast et al. (2009) system has been used as a preliminary framework to provide context for this study.

Figure 15: Prendergast et al.'s (2009:57) land systems map of the Murray River area from the South Australian border on the left margin. The vertical scale in the schematic cross section (B) is exaggerated. Figure removed due to copyright restrictions.

Borrowing the classificatory system of Prendergast el al. (2009), the landforms upon which the four survey areas were located are tentatively proposed to be the Mulcra Island System (see also Jones 2016:43). The Mulcra Island System (MIS) contains land units such as floodplains, paleomeander scrolls and billabongs (Prendergast et al. 2009:59–60). The dominant processes that have created this land system are fluvial, and the surface expression is a mildly undulating channel floodplain with medium grey gilgai clay (Prendergast et al. 2009:59–60). The vegetation is dominated by Black Box (E. largiflorens) with some lignum (M. florulenta) and grasses, and Red Gums (E. camaldulensis) are also found in association with billabongs (Prendergast et al. 2009:59–60).

This chapter has presented descriptions of the study areas that are the subject of this thesis, followed by descriptions of Aboriginal life and practices as described by European observers at the time. The final section described the geomorphological setting of the study area, identified regional sources of knappable stone raw materials, as well as describing and proposing a land system classification for the Calperum floodplain. The earth mounds that are a significant archaeological feature of the study area are introduced in the next chapter.

3. Earth Mounds and Lithics

This chapter reviews the literature on earth mounds from the Murray-Darling Basin, beginning with references to mounds in the ethnohistorical literature, followed by earth mounds studies from recent times with a particular focus on results of any lithic analyses that were conducted. Following this is a review of earth mounds studies from South Australia, and a discussion of the importance of earth mounds in intensification debates.

The final section examines recent research on usewear and residue analysis of stone artefacts from a variety of Australian locations, examining in particular the task associations of the artefacts, to better understand how stone artefacts were used and evaluate the likelihood that the stone artefacts around the mounds were used in food processing activities.

3.1 Earth Mounds in Australia

The earliest evidence of cooking processes using heat retainers in Australia comes from Lake Mungo, where an oven in the form of a shallow depression containing ash, charcoal and baked clay peds was dated to 30,780±520 BP (Barbetti and Allen 1972:48). By contrast, the development of mounds related to this kind of cooking technology proliferated only in the last 2500 years (Brockwell 2006:50; Martin 2006:96; Westell and Wood 2014:34; Williams 1988:216–218).

An oven (referred to as pit ovens, earth ovens) is dug into the ground, and clay and/or stone heat retainers are used to cook food or prepare reeds for fibre (Berndt and Berndt 1993:103–107; Coutts et al. 1979:5; Klaver 1998:32). An earth mound (or earthen mound, oven mound) is a place where the repeated use of ovens has left a mounded accumulation of remains such as ash, organic material and crumbled and/or intact clay balls (Klaver 1998:33). Mounds may be used repeatedly because they are located close to a resource associated with use of the mound such as water, *Typha* spp.[9] stands or clay deposits, and also because there are likely to be existing heat retainers within the mound that can be reused (Klaver 1998:34; Williams 1988:215). Other remains, such as mussel shell,[10] grass, bark, fish and animal bone, stone heat retainers, stone artefacts and human burials may also be included in the mound, adding to its volume (Klaver 1998:34; Littleton et al. 2013; MacPherson 1884:50–56). Mounds may be found in conjunction with pit ovens that have not been used to the extent that they become mounds (Coutts and Witter 1977:66–69; Williams 1988:47, 81, 90). In some instances, some mounds may have also been used as occupation sites (Beveridge 1883:39; Littleton et al. 2013; Williams 1988). Mound typologies vary on local and regional scales (Jones 2016; Klaver 1998:65; Westell and Wood 2014:30).

A number of factors appear to affect the distribution of earth mounds. Williams (1988:206, 214) found that in southwestern and central districts of Australia, mounds were formed on poorly draining soils. Earth mounds are also generally located near the resources associated with their use, as mentioned above, the combination of which is most likely to be found in wetland environments and seasonal floodplains (Klaver 1998:34; Westell and Wood 2014:30; Williams 1988:213–215).

3.2 Historical Observations of Earth Mounds from the Murray-Darling Basin

There are frequent references to earth oven cooking processes and earth mounds, particularly in the Murray-Darling Basin, by the early European travellers and settlers who speculated about or described their uses (see Beveridge 1869; Beveridge 1883; Eyre 1845 Vol.II; Kenyon 1912;

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[9] The two species of *Typha* found in Australia are *Typha orientalis*, and the more widely distributed *Typha domingensis*, the latter of which has been identified in the study area in modern times (Gott 1999:36).

[10] The two species of mussels found in archaeological deposits in the Murray-Darling Basin are the freshwater river mussel *Velesunio ambiguous* and the freshwater lake mussel *Alathyria jacksonii* (Garvey 2013:121). The freshwater snail *Notopala hanlei* may also have been consumed (Garvey 2013:121).

MacPherson 1884). The earliest description of the Aboriginal use of earth mounds for cooking comes from Mitchell's travels in NSW in 1839. Mitchell (1839:53) first observed Aboriginal people preparing *Typha* spp. as food during his travels along the Lachlan River. Later, travelling along the Murrumbidgee, he saw numbers of large earth mounds along the riverbanks which he described as being constructed of ash and clay, located in the same areas as the large *Typha* spp. stands (Mitchell 1839:81, 133). He observed that clay was being used due to the lack of stone in the area, instead of the stone heat retainers which he had seen in use along the Lachlan River (Mitchell 1839:81). Beveridge (1865:187–188; 1883) described the use of earth ovens and mounds by people living in the lower reaches of the Murrumbidgee, Lachlan and Darling Rivers where they join with the Murray River, just before the Murray crosses into SA. He described them as being used for camping and cooking animals, fish, birds' eggs and *Typha* spp. In a subsequent paper Beveridge (1883:37–38, 42–43) described the use of clay nodules in the ovens, as well as the use of *Typha* spp. both for food and for making string. Beveridge's (1883:37) account also indicated that the earth oven was located at a distance from the camp, and the same oven was reused for the duration of occupation at the camp.

Describing cooking practices in the Lower Murray region, Eyre (1845 vol.II:289–290) observed that the earth oven was used both for vegetables—various roots and a kind of cress—as well as the larger kinds of meat; however in this instance Eyre was describing a pit oven rather than an earth mound. Mounds were described later as places where burials might occur, and where shelters might be erected to protect the dead from the rain (Eyre 1845 vol.II:349). Eyre (1845 vol.II:349–350) did not specify the location of these practices, however he referred to an example of this practice at Lake Boga in northern central Victoria. Further to the south, at the mouth of the Murray River, Angas (1847a:54–55, 58, 74, 89–90) made numerous mentions of women and children collecting *Typha* spp. for food and fibre in the Coorong and Lower Lakes, SA. The use of *Typha* spp. for fibre in this district was extensive, as evidenced by string, nets and baskets recorded and collected by Europeans and housed at the South Australian Museum (see Angas 1847b:Plates 27, 30; Hemming et al. 1989:10, 12). Berndt and Berndt (1993) also discuss the use of *Typha* spp. for food and fibre making in the lower part of the Murray River in SA, noting that the majority of food in this region was cooked, much of it in pit ovens (Berndt and Berndt 1993:103). Despite the widespread consumption and use of *Typha* spp. earth mounds are not a feature of the lower Murray landscape (Westell and Wood 2014:32), even though earth ovens were commonly used (Berndt and Berndt 1993:103, Eyre 1845 Vol II:289–290). It is unclear why earth mounds are not found in the lower Murray regions despite sharing cultural links and exchange networks with middle and upper Murray regions, but it is possible that this is due to different geology and landform elements, the use of stone as heat retainers rather than clay, or the potential for mounds to grade into other kinds of site types such as middens (Klaver 1998:282–283; Martin 2006:10–11; Westell and Wood 1014:48–49; Williams 1988:214–215).

Material and technological cultural similarities with other Murray groups are suggested by Angas who stated that ‘although the weapons and utensils belonging to the various tribes are many of them similar in appearance, they are often designated by totally different names’ (Angas 1847a:93). There are no known ethnographic or historical accounts for the use of *Typha* spp. for either food or fibre specifically referring to Calperum Station or Renmark area, but there are for Aboriginal groups both up and downstream (for example to the southwest Eyre 1845 Vol II: 289–290, and to the east Mitchell 1839 Vol II:53, 81,133). Despite this, the number and concentration of earth mounds in this part of the Riverland (see Westell and Wood [2014:47] for a map of the mounds recorded so far), and their overlap with the distribution of *T. domingensis* (Gehrig and Nichol 2010:19; Gott 1999:36) suggest that the mounds in this part of the Riverland were used by Aboriginal people to prepare food and *Typha* spp. and other foods.

3.3 Earth Mound Studies and Associated Lithic Assemblages from the Murray-Darling Basin

Earth mounds have been a feature of archaeological interest in NSW and Victoria since the late 1970s (see Balme and Beck 1997; Coutts et al. 1976; Coutts et al. 1979; Johnston 2004; Martin 2006;

Williams 1988). Both regional and isolated studies have been conducted, and in some cases there have been excavations which obtained dates for mound development.

Coutts et al. (1976) undertook a large field survey and excavation of several mounds around Willaura, east of the Grampians National Park, south central Victoria. Burials and stone artefacts, including knapping floors and low numbers of retouched flakes, backed artefacts and scrapers, were common features of the mounds (Coutts and Witter 1977:62–66). Some mounds contained faunal remains such as emu egg and freshwater mussel shell, and burnt and unburnt bone (Coutts and Witter 1977:62–66). Dates were obtained from charcoal taken from both earlier and later phases of the mounds, returning an age range between approximately 600–2500 BP.[11] Other sites surveyed in the district included a large open site on the eastern edge of Lake Bolac and two rockshelters in the Grampians, as well as a quarried diorite outcrop on the Hopkins River, located alongside an open site with stone artefacts, knapping debris and a number of large fire pits containing hundreds of blocks of diorite and basalt (Coutts and Witter 1977:66–69). The authors suggested the fire pits were used to heat treat stone for axe production, or to process vegetable foods (Coutts and Witter 1977:68). Burnt rocks were also excavated within two mounds, which the authors interpreted as being part of fire places within the mounds (Coutts et al. 1976:21, 25; Coutts and Witter 1977:62–63).

Coutts et al. (1979) continued their study of earth mounds in northwest Victoria with a field survey and excavation of three mounds in the Nyah Forrest floodplain on the Murray River. Of the three excavations, only one mound contained stone artefacts (n=9) (Coutts et al. 1979:57). Coutts et al. (1979:1, 57, 85–87) suggested a semi sedentary settlement pattern that involved the use of the smaller mounds as cooking places and temporary campsites during dry periods, and the larger mounds as deliberately constructed camp sites for use during flood periods. This suggestion was

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[11] Dates are reported in maximum detail as provided by the authors of the research papers according to the norms at the date of publishing. Ideally, the laboratory number, genus and species of the material dated, ƺ13C, calibration method and any corrections used, and the 68% and 95% probability ranges for calibrated ages should be reported, but where this information was not provided by the original authors is it not reported here. As a result, dates are reported with varying amounts of supporting information in this thesis.

supported by small numbers of stone artefacts and other faunal and cultural material in the top layers of the large mounds (Coutts et al. 1979:85). The authors viewed the low number of artefacts as an indication that mound occupation was very intermittent and the mounds were not used as basecamps, in contrast to the central western districts mounds discussed above (Coutts et al. 1979:85). Four charcoal dates from within one mound indicated that occupation ranged from 960±80 BP (SUA-996) to 1375±130 BP (SUA-998) (Coutts et al. 1979:83).

Although Coutts et al. (1979:87) found many similar features in the large mounds of both the south central and northwestern districts of Victoria, such as hearths, heat retainers, faunal remains, occupation phases and burials, the primary difference was the absence of stone heat retainers and artefacts in the Nyah Forrest mounds (Coutts et al. 1979:87).

Williams (1988:2–3) built on Coutts et al.'s (1976) research with a study based on three locations with complex archaeological features. These features included large clusters of mounds close to eel farming sites near Mount William, presumed to have been associated with large gatherings; two village sites and mounds that had been used as hut foundations near another large gathering site at Caramut; and earth mounds fringing large swamps and stone hut villages near or on the edges of basalt flows with fish-trap complexes and a meeting place at Bessiebelle (Figure 16). Williams' (1988:4) goals were to explain when and why the mounds first appeared, how they were constructed, identify any associations with the stone villages, and examine the areas around mounds for evidence of occupation. She compared Coutts et al.'s (1976) observations of mound heights and diameters with early historical observations and found that the mounds were both lower and larger in diameter than in the nineteenth century, suggesting that rabbit warrens, bovid trampling, wind erosion and ploughing had contributed to ongoing mound deflation (Williams 1988:14).

Figure 16: Southwestern Victoria map showing areas featured in Williams' (1988:3) study (adapted from Williams 1988). Figure removed due to copyright restrictions.

Williams (1988:190) found that there were different occupation patterns in the three different areas, and that the mounds had been used in different ways both within one location as well as between locations. Williams (1988:214–215) concluded that the mounds had been constructed on poorly draining soils in order to raise occupation areas above damp soils, and provided additional benefit of being a place where a new oven pit could be easily constructed with stone heat retainers from previous ovens. Many mounds, but not all, had evidence of associated hearths and pit ovens, and Williams (1988) inferred their use as campsites due to the fairly consistent distribution of stone artefacts throughout all but one of the excavated mounds, but noted that not all of the pit ovens became mounds.

Excavations in the immediate vicinity of the mounds were conducted at Caramut and Mt William, revealing hearths and pit ovens from the historic period at Caramut and abundant stone artefacts at all levels in all four test pits at Mt William (Williams 1988:88, 184–189). Stone artefacts were also found below the mounds at Mt William, indicating that the area was occupied before the construction of the mounds (Williams 1998:190). Radiocarbon dates from charcoal deposits at the base of the mounds ranged from 2030±120 BP (ANU-3586) to 300±60 BP (ANU-4322) (Williams 1987:315–317). Due to the acidity of the soil no faunal remains were encountered during the excavations (Williams 1988:141). Stone artefacts were a common feature within, nearby and in the general vicinity of the mounds, as evidenced by the excavations and pedestrian surveys of the areas (Williams 1988). The stone artefacts were overwhelmingly made of quartz, manufactured using bipolar techniques and generally less than 20 mm in maximum length (Williams 1988:105,162,196). Williams' (1988:204) analysis of the stone artefacts from both the mound sites and the regional surveys indicated that a similar technology was consistently employed across all of the different sites, and did not vary with site type or function or over time.

In an extensive pedestrian survey of the cultural heritage of Barmah National Park, Victoria, stone artefacts were found in very small numbers and usually only in association with earth mounds (Bonhomme 1990:73). In total, 86 mounds were identified, but Bonhomme (1990:51) noted that a range of different kinds of activities were likely to have contributed to their formation, and the definition of 'mound' employed in the survey included earth ovens as well as mounded cultural deposits that could include shell and/or habitation debris. Bonhomme (1990:78) suggested that the mounds had different uses; the smaller mounds may have been single activity sites, but the larger mounds showed evidence of a variety of activities including knapping and food processing. Due to the proximity to the Murray River and the floodplain location, the area is regularly inundated and Bonhomme (1990:78) noted that any sites near mounds would have been affected by floods and possibly covered by alluvium.

Bonhomme (1990:51) found that mounds in the Barmah Forest were formed through both single activity (the use of ovens to process resources) and more commonly multiple activities (a combination of food processing, habitation, shell consumption and discard) in the one location. She proposed that the lack of stone in the area meant that stone would have to be traded in and flaked using conservative strategies (Bonhomme 1990:52). The lack of stone also meant that other raw materials would have been used instead of stone, such as shell, bone and wood, but she did not find evidence of this. Stone artefacts were usually found only in association with mounds (Bonhomme 1990:73).

Two stone artefact scatters were located in the vicinity of two large mounds (Bonhomme 1990:72). There did not appear to be any direct association between the two kinds of features apart from spatial proximity, but Bonhomme (1990:72) suggested that the scatters could have been occupation sites and the mounds used exclusively as cooking places. The dominant raw material in the survey area was quartz and bipolar flaking was the most common strategy employed (Bonhomme 1990:74). The majority of the artefacts were smaller than 15 mm and the single core was 30 mm in length (Bonhomme 1990:74). *Velesunio* sp. mussel shell was widely available in the area and frequently found in association with the earth mounds, campsites and small artefact scatters, along with smaller quantities of other kinds of shells (Bonhomme 1990:75). Stone artefacts which had been discovered and submitted by visitors to the interpretive centre in the park included basalt axe heads, grindstones and hammerstones, suggesting trade links with other groups (Bonhomme 1990:74). Cultural features such as burials, mounds, fish traps and scarred trees were identified during the survey, but no sources of stone raw material were known or encountered within the National Park (Bonhomme 1990:74).

Balme and Beck (1996) surveyed 63 mounds on the southern Macquarie Marshes region of central NSW. No excavations were conducted but stone artefacts were recorded on five mounds (Balme and Beck 1996:40). The number of stone artefacts was so low that they were not analysed or elaborated on (Balme and Beck 1996:40).

Klaver (1998) took up similar questions as Williams (1988) and Bonhomme (1990) about mound formation and distribution in the central Murrumbidgee riverine plain, NSW, examining the relationships between different kinds of sites and conducting excavations on four mounds, two smaller ovens, a shell midden and a rock shelter. Mound formation was found to be due to their primary function as ovens and mounds were only incidentally used as campsites or for other functions (Klaver 1998:281). Klaver (1998) did not see the mounds as part of a sedentary settlement system, rather, radiocarbon dates from the mound excavations indicated that their development had been intermittent.

Artefact densities in the survey areas were low overall, with maximums reaching 250 artefacts per km² (Klaver 1998:199). Raw stone availability was much higher in the eastern parts of the survey area and stone artefact discard rates, accordingly, were also much higher in the eastern than the western regions of the survey area (Klaver 1998:200). Small quartz pebbles were abundant in the southeastern survey areas, and the artefact assemblages reflected this availability, with the percentages of quartz steadily decreasing and supplanted by silcrete and quartzite pebbles to the west (Klaver 1998:201). With high amounts of cortex in all the assemblages, Klaver (1998:203) suggested that the local microblade industries were likely to have been a strategy developed in response to the small size of the local raw materials, and that the large amounts of debitage at many sites were also a result of this strategy rather than being an indicator of the intensity of site occupation (Klaver 1998:201–202).

Klaver (1998:247) noted that stone artefact scatters, hearths and small ovens were often found in the vicinity of earth mounds, and scarred trees were also often nearby when mounds were located in wooded areas. The majority of mounds did not appear to have surface stone artefacts, but visibility was low (Klaver 1998:217). Artefacts were encountered on just a few mounds, and the raw material trends matched the broader local patterns (Klaver 1998:217). Quartz was the dominant raw material, many artefacts had pebble cortex and there were few exhausted cores (Klaver 1998:206). Use-wear was common on 10–15 mm flakes regardless of the raw material type (Klaver 1998:213).

Mound surfaces also showed low densities of artefacts, mostly flakes with use-wear or retouch or broken fragments of larger artefacts such as grindstones and hammerstones. Klaver (1998:218) argued that the high percentages of retouch or use-wear supported the interpretation of ovens as resource processing areas within the context of, or as components of habitation campsites, rather than as secondary accumulations of waste and heat retainers, in which case they would be more likely to contain random debitage from the surrounding areas. The two excavated mound assemblages were also small both in number and size (n=42 and 31) with all artefacts including cores less than 20 mm in length (Klaver 1998:219–220).

Klaver (1998:221) concluded that a regional lack of stone raw material led to the production of multiple-use tools that were limited in size by the use of local raw materials. The diminishing numbers of artefacts from east to west in the survey area suggested an increase in reliance on non-stone raw materials such as bone, shell and wood (Klaver 1998:221). In addition, Klaver (1998:211) noted that the use of bipolar flaking techniques to reduce quartz pebbles in a context where the pebbles were easily procured resulted in large amounts of debitage in many of the eastern sites surveyed. Klaver (1998:221) suggested that discard rates may be influenced more by the kinds of raw materials used and the reduction techniques employed than by occupational intensity, and that these factors could also obscure typological changes over time.

In a detailed analysis of stone artefacts collected from the surface and excavations of a mound near Lake Boort, northwest Victoria, Johnston (2004:52–56) found that the surface artefacts were entirely bipolar cores and unmodified flakes, 70% broken and primarily manufactured from quartz (Johnston 2004:52). Johnston (2004:52) interpreted this assemblage as recent knapping at the mound, and argued that the presence of cores with large flake scars but without any flakes of the equivalent size in the assemblage suggested that flakes in this size range and any finished tools had been removed from the site. The excavated artefacts were mostly small broken, unmodified flakes and some small bipolar cores, all generally less than 30 mm. Johnston (2004:55–56) concluded that the artefacts were produced onsite and were largely knapping debris, with the dominance of broken flakes suggesting that complete flakes and finished tools had largely been removed. This suggested that the mound had sporadically been used as an occupation and workshop site, not solely as an oven, and this combination of activities at different times had contributed to the development of the mound (Johnston 2004:56–57).

In excavations of two earth mounds on the Hay Plain, Martin (2006:217–225) found that the stone artefact assemblages within the excavated mounds were dominated by bipolar microblade technology—both microblade cores and backed artefacts (also described as geometric microliths or microblades). This kind of technology was common in the area, and the artefacts reflected the general local trends (Martin 2006:222). Martin (2006:216) suggested that the presence of unfinished backed artefacts indicated that the artefacts were being produced on-site. The artefact assemblages were not linked by Martin (2006) to specific activities at the mounds.

Martin’s (2006:12–13, 306–308) research concluded that although mounds were used for different functions (including habitation platforms and burials), because they were spatially associated with dense and predictable carbohydrate crops that grew on floodplains, the primary process that created the mounds was vegetable cooking in heat retainer ovens. Martin (2006) also interpreted the mounds as having an important social context, as a landscape feature in a place otherwise devoid of features, an inscription on the landscape created primarily by women cooperating to produce nourishing food, and as an advertisement of specialised skills in plant food preservation and fibre making.

Martin (2006) found that the primary process that created the kind of mounds that are found in the Hay Plain region was the repeated use of earth ovens to cook food, inferring that vegetable processing, primarily the then abundant *Typha* spp., was the majority of that cooking. Earthen oven use was repeated over many years at the same location leaving deposits of ash, organic remains, clay, and stone fragments used as heat retainers, all of which accumulated over time to form an earth mound (Martin 2006:87). Historical accounts indicate that some mounds were ‘like hills’ in the past (Mitchell 1839:81); in modern times the mounded shape has often been lost due to extended dry periods causing them to settle and flatten, and also due to animal trampling (Coutts et al. 1976:11; Martin2006:12; 87).

In addition to excavations of earth mounds, in some instances excavations of the surrounding area were carried out. Frankel (1991:80) conducted off-mound excavations however no archaeological evidence was found. Coutts (1980:31) also found no cultural material in excavations around earth mounds during a search for earth ovens and hearths associated with mounds at Nyah Forrest. Williams (1988:88) opened a trench between two mounds at Caramut and found pits 80–100 mm below the surface which were filled with organic deposits and burnt basalt rocks and interpreted as pit ovens. Dates obtained from charcoal from two pits indicated they were modern (ANU 4324: 100.1±1.5%M and ANU 4324: 100.1±1.5%M) (Williams 1988:88). Johnston (2004:50) also excavated a square 30 m away from the mound that was the focus of excavations at Lake Boort, and found no cultural material.

In early earth mound research, stone artefacts were considered an indicator of intensity of occupation (Coutts et al 1979:81). This view of stone artefacts was challenged by Hiscock (1982; 1996), and later associated with workshop-style stone tool manufacture (Johnston 2004; Martin 2006). Connections between the primary activity associated with mounds—*Typha* spp. or other food processing—and stone artefacts were not proposed or discussed by the researchers. Johnston's (2004) assessment of the mound being used sporadically as an occupation site follows Coutts et al.'s (1976) arguments, along with historical accounts (Beveridge 1869; Beveridge 1883; Eyre 1845 and Kenyon 1912) that the mounds were used for multiple purposes, and, whilst they were largely created from the debris of earth oven activities, they were also added to by other activities.

Martin (2006) has argued that the primary function of the earth mounds in Australia was for cooking *Typha* spp. (and other root vegetables), and that the mounds are the result of repeated earth oven processes. However, the historical descriptions of earth oven/mound use in the Lower Murray region—being the section of the Murray River to the east of where the Darling River meets the

Murray, close to the edge of the SA border with Victoria and NSW, down to the Murray mouth in the Coorong—usually include descriptions of cooking places being used for meat as well as vegetables. The placement of earth ovens and roasting pits in relation to campsites are often not described, but some historical accounts describe them as being at a distance from the main camp (Beveridge 1883:37–38). This may have been the case for a number of reasons, such as the smell created by the accumulation of animal products (Beveridge 1869:187–188; Sutton 1993:44), or because they presented a fire hazard (O'Connell 1987:83). Klaver (1998:66) found that earth mounds occurred within and near to occupation sites, or close to mound-related resources such as heat retainer and/or vegetable sources.

3.4 Earth Mound Studies in South Australia

One of the few mounds in SA that has been excavated and dated is at Gillman, Adelaide. The Gillman mound was much larger than the earth mounds in the Riverland district, and was formed on top of a natural sand dune (Littleton et al. 2013:38). Although this mound was to some extent created by food processing activities, it was also occupied both before and after a period during which it was used for burials (Littleton et al. 2013:38–40). Dating of the burials and other material from the mound indicated that it had been used for burials from approximately 1120–630 BP (Littleton et al. 2013:40). All of the burnt soil and animal bone in the mound returned dates within the last 500 years, indicating a gap between burials and occupation of around 100 years (Littleton et al. 2013:40). Littleton et al. (2013:47–48) found that the mound was occupation prior to the burials, but no dates were obtained.

Westell and Wood (2014:48, 51) have conducted many regional surveys in relatively unmodified areas of the Riverland region and note that mound frequency declines rapidly downstream from Renmark. They suggest that the mound/midden distinction may be obscured due to the different landscape, specifically the lack of land available to perform separate subsistence activities such as in the gorge section of the lower Murray (Westell and Wood 2014:48). Unlike the mounds at Calperum

Station, cooking processes in the gorge are evidenced by midden deposits, charcoal-rich sediments and stone heat retainers (Westell and Wood 2014:49). However, as mentioned above, historical accounts and archaeological studies (Berndt and Berndt 1993:103–105; Eyre 1845 Vol. II:289–292) indicate that earth ovens were used in the Lower Lakes region near the mouth of the Murray.

Previous surveys of the mounds in the SA Riverland found that stone artefacts are a very minor component of the mound structure, and are only found on 57.3% of the surfaces of the mounds (Westell and Wood 2014:50, 53). Westell and Wood (2014:53) found that artefacts associated with the mounds were almost exclusively unretouched flakes. This thesis specifically expands and tests these observations.

3.5 Earth Mounds and Intensification

Mounds have been an important feature of debates about intensification in Australia (Bird and Frankel 1991; Lourandos 1980; Lourandos 1985; Lourandos and Ross 1994). Intensification is a theory that challenges the view of Australian ‘prehistory’ as culturally constant over time, suggesting instead change and social reorganisation with increases in population, productivity and production, evidenced by increasing rates of site usage and new site development, the increasing exploitation of marginal environments such as swamps and floodplains, and increased complexities of site economies and exchange systems (Lourandos 1985:385–391). These processes allowed the exploitation of the natural environment in ways that made it possible to support an increasing population on a static quantity of land (Lourandos 1980:259). Intensification also refers to increasing social complexity associated with more sedentary land occupation systems, more static boundaries with neighbours and increased flows of information between groups (Lourandos 1980:246; Lourandos 1985:386, 390, 404–411).

Earth mounds are an important element of discussions about intensification because they are the result of food preparation processes whose introduction has been dated to the early Holocene internationally (Wandsnider 1997:34), and the mid-Holocene in Australia (Brockwell 2006:50;

Lourandos 1985:400; Martin 2006:96; Westell and Wood 2014:34; Williams 1988:216–218). Mounds are an example of cooperative and large scale food processing (Martin 2006:289) that involves the kinds of social aspects that have been described by Lourandos (1985:404–411) as characterising this period. Mounds are important in this context because they appear to be a new site type that indicates exploitation of marginal environments and foodstuffs, and provides a habitation base in a marginal environment (Lourandos 1985:400). The interpretation of mounds as habitation bases has subsequently been found to be the case only at some mounds in some locations (Bonhomme 1990:82–83; Littleton et al. 2013; Martin 2006:244, 304; Westell and Wood 2014:56–57; Williams 1988:213), and others have argued that the evidence indicates that regional, short term adjustments as a result of changing internal and external circumstances are more likely to have driven mound development than a cumulative directional change such as that proposed by intensification (Bird and Frankel 1991:189–190; Hiscock 2008:188–189; Lourandos 1985:400).

3.6 Connections between Mounds and Lithics

Earth mounds are associated in the ethnohistorical and archaeological literature predominantly with food processing and the production of fibre (Beveridge 1889:32–33; Mitchell 1839:80–81, 134), and Martin (2006) has argued that *Typha* spp. processing contributes significantly to the development of mounds due to the large volumes used to produce the great variety of fibre products used and traded by the Aboriginal groups living along the river (Eyre 1845:218; Howitt 1904:717; Krefft 1865:361) (see also Beveridge [1883:43–44] regarding other kinds of reeds used for specific kinds of fibres in the western districts of Victoria). One of the questions explored in this thesis focuses on what the stone artefacts on and near earth mounds allows us to infer about the activities carried out at and in the vicinity of those mounds. This section reviews in detail the food processing activities that took place at the mounds and the tools that were used to carry out those activities, before turning to stone and glass artefact residue studies to examine the likelihood that the stone artefacts were part of the food processing activities at the mounds.

3.6.1 Tool Use and Earth Mounds

Bonhomme (1990:19) suggests that the tools associated with food gathering and processing were most likely to include wooden digging sticks, grindstones and pounders, and locally available shell which was used to cut and peel roots and stems and to scrape fibres for weaving into baskets, also used in food gathering. The few ethnohistorical references describing food and fibre processing activities along the Murray River suggest that both mussel shell and stone were important resources. In the riverine areas of western Victoria, shell or stone was used to cut reeds (Beveridge 1883:43–44). Near the Murray mouth, Berndt and Berndt (1993:103–105) describe the use of mussel shell, reed and flint to cut up meat prior to earth oven cooking, and mussel shell or flint to cut up large fish (Berndt and Berndt 1993:105). Angas (1847a:66–67, 92, 96) describes the use of mussel shells by both men and women as cutting implements in several instances when discussing the material culture of Aboriginal people living in the vicinity of the Coorong. Shell was also used as a scraper tool when preparing string made from *Typha* spp. (Angas 1847a:55; Beveridge 1883:42). In other parts of Australia, women used both shell and stone in food and fibre processing activities (Fullagar et al. 1992:15–18; Kamminga 1982:54; Lumholtz 1902:193–194; McCarthy 1967:86–88; O’Connell 1974:192; Roth 1904:21; Witter et al. 1993:84, 86). Furthermore, Coutts et al. (1979:57) noted during experiments using freshwater shell that the cutting edge was self-sharpening.

These accounts indicate that shell and stone were equally useful for food processing purposes in these regions. In a context where stone is a scarce resource and shell is abundant, it seems likely that shell rather than stone would have been more abundantly available for use at the mounds for food processing. Shell is frequently found on the surface of earth mounds and in mound excavations (Coutts et al. 1979:57; Jones 2016:98; Klaver 1998:122–135; Martin 2006:10; Westell and Wood 2014:46). However, stone was intentionally transported to the vicinity of the mounds, indicating that it is likely to have been used there (Dibble et al. 2016:9). Kamminga (1982:56) states that, in recent ‘prehistory’ at least, stone was overwhelmingly used to manufacture and repair wooden artefacts, which suggests that other activities were taking place in the vicinity of the mounds. However, flakes produced and discarded at one point in time can be picked up and reused later (Binford 1986:553; Dibble et al. 2016:15; Horne and Aiston 1924:101), and Gould et al. (1971:163) noted the expedient use of any suitable stone available to carry out required activities.

3.6.2 Residue Analyses of Stone Artefacts

Although it was not possible to perform use-wear and residue analysis as part of this project, a review of the results of these kinds of analyses from other studies around Australia can shed light on the range of functions that stone artefacts were likely or unlikely to have been used for at Calperum Station.

Backed artefacts from rockshelters Native Well 1 and 2 in the Central Highlands region of western Queensland (QLD) were analysed for use-wear and residues (Robertson 2009). The results indicated that the most common residues and use-wear were associated with general plant processing, followed by woodworking (Robertson 2009:245–247, 250–251). Starchy cooked plant processing and animal processing activities (such as boneworking) were both less common (Robertson 2009:245–247, 250–251). Many of the backed artefacts had use-wear and residues associated with only one of these activities (Robertson 2009). Continuing the focus on backed artefacts, Robertson (2011:84) analysed 50 artefacts from Lapstone Creek rockshelter on the western outskirts of Sydney, and two open sites, Deep Creek and Emu Tracks II in the Blue Mountains, to the north of Sydney. Boneworking, closely followed by woodworking, were both common inferred tasks, general plant and starchy plant processing was much less common (Robertson 2011:93). Multiple wear and residues on one artefact were also common (Robertson 2011:93).

Similar analyses were conducted on backed artefacts at Mangrove Creek, north of Sydney, NSW (Attenbrow et al. 2009:2766). The results indicated that the artefacts were used for a range of purposes, with wood working being the most common task (Attenbrow et al. 2009:2768). Plant processing was identified as a task for less than 5% of the artefacts, and 9.2% were used for more than one function, such as drilling and cutting, or scraping and cutting (Attenbrow et al. 2009:2768).

The authors concluded that the artefacts were used as domestic implements for making or repairing organic tools more frequently than food processing (Attenbrow et al. 2009:2768).

At Roof Fall Cave in central eastern QLD, residue analysis of all artefacts >15 mm from one excavation square yielded only plant fibres, resins and tissues (Eales et al. 1999:38). Statistical analysis indicated that the artefacts were used primarily for woodworking activities in the context of a short term campsite, most likely the repair and manufacture of organic tools (Eales et al. 1999:39). At Camooweal in western QLD near the border of the Northern Territory, 23 different kinds of artefacts, including flakes, cores and retouched flakes were analysed for residues and use-wear (Cooper and Nugent 2009:209). The results indicated that cores had been used for bone- and woodworking; blades for ritual activities, bone- and woodworking; hand axes for starchy plant processing or late stage butchery; and tulas for bone- and woodworking, starchy plant processing and grass processing (Cooper and Nugent 2009:210–211). Nine out of the ten surface and 13 subsurface artefacts had use-wear or contained residues that indicated multiple use or use with more than one subject material (Cooper and Nugent 2009:210–211). Further analysis of another 16 surface tulas indicated all of them had been used for woodworking, and some were used for one or more of the following activities: plant processing, boneworking, tuber processing, butchery and ceremonial activities (Cooper and Nugent 2009:222–223).

On the southern coast of QLD, use-wear and residue analysis indicated that Aboriginal glass artefacts at two sites from the historical period were used for plant processing and woodworking activities (Ulm et al. 2009). A pilot study of a sample of glass artefacts from three different contact sites, including one earth mound, in western Victoria, found use-wear and residues indicating woodworking and food processing activities (Wolski and Loy 1999). Interestingly, one glass artefact from the earth mound site had use-wear and residues consistent with starchy tuber processing (Wolski and Loy 1999:69).

Fullagar and David (1997:143) found a range of uses for stone artefacts excavated from Ngarrabullan Cave in northern QLD, including starchy plant processing, woodworking and animal processing. All 257 artefacts were examined, and use-wear and/or residues were identified on roughly 20% of the assemblage (Fullagar and David 1997:142). Where use-wear or residues were identified only one kind of residue or use was ascribed (Fullagar and David 1997:142).

The ethnohistorical literature indicates that whilst stone was an important cutting implement in food processing activities along the Murray River, it was not the only material available for these activities. Residue analysis indicates that the most common inferred use associations of stone artefacts, retouched or not, is with woodworking and general plant processing. Starchy plant or other food processing and boneworking were less frequent uses. However, multiple uses were also a common finding (Attenbrow et al. 2009:2768; Cooper and Nugent 2009; Robertson 2011:93; Ulm et al. 2009). These studies also indicate that usage patterns vary regionally, and whilst surface stone artefacts on or in the vicinity of earth mounds are most likely to have been used in the production and maintenance of organic tools, their use in food processing is also likely as a primary or secondary use.

This review of earth mound associated literature indicates that mounds are a common site type in the Murray-Darling Basin, one that has been an object of interest for both early European observers and archaeological researchers since the 1970’s. Mound studies have commonly found that the mounds were places formed in most cases by the repeated use of earth ovens, and in some cases places that could be used by Aboriginal people as logistical bases for exploiting riverine resources during flood periods.

Stone artefacts are generally a larger component of earth mounds that have been occupied than those that have not, although this is generally only observable in excavations (Johnson 2004; Littleton et al. 2012; Williams 1988). Usewear and residue studies from around Australia indicate that stone artefacts have a variety of task and material associations, regardless of the kind of site. Stone was not a necessary requirement for food processing activities at the mounds, as both historical sources and archaeological research indicate that mussel shell could also be used as cutting implements. This may be part of the reason why there are often few stone artefacts found in association with earth mounds. Alternatively, taphonomic processes may play a role in the low numbers, and these are explored in the next chapter.

4. Taphonomic Impacts

A variety of taphonomic processes are likely to have had an impact on the surface stone artefacts in the study area, and these impacts have the potential to influence the results obtained in this study. In order to understand the effect that the local taphonomic processes might have on the surface assemblage, these impacts are described in detail in this chapter. Two major kinds of impacts were considered; those related to water flows and the location of the study area on a floodplain, and those related to human and animal trampling, given the historic accounts of the Aboriginal populations living in the area and the recent use of the survey area as a pastoral property.

4.1 Taphonomy

Taphonomy is the study of the processes, both their nature and effects, which affect a place or an object over time, particularly the time that passes after an object was buried or discarded (Schiffer 1983:678–679). Taphonomic processes include the effects of water or wind on a landscape, possibly causing erosion or deflation that can move or obscure objects that have been deposited (Fanning and Holdaway 2001; Fanning et al. 2008; Schiffer 1983:679). The activity of humans, animals and insects can also move or obscure objects, damaging or destroying the relationship between the object and the original depositional context (Cameron et al. 1990; Cane 1982; Douglass and Wandsnider 2012; Eren et al. 2010; McBrearty et al. 1998; Pargeter and Bradfield 2013; Robins and Robins 2011; Solomon et al. 1986). Both of the aforementioned agents can also cause changes in the morphology of the object itself (McPherron et al. 2014). Understanding the taphonomic processes in play at a particular location facilitates a deeper understanding of both the artefacts at a specific location and the site in general (Hiscock 1985:83–84).

Surface scatters of stone artefacts are one of the most common archaeological sites in Australia, particularly in arid regions. As taphonomic processes play a large role in the visibility of surface stone artefacts (Cameron et al. 1990; Fanning and Holdaway 2001; Fanning et al. 2008), it is necessary to consider such processes when assessing the surface assemblages at Calperum Station. This section reviews the likelihood and impacts of a variety of potential sources of taphonomic disturbance to the stone artefacts in the study areas.

4.2 Water Impacts

The study areas are located on a floodplain and are regularly inundated with floodwaters, which may impact on the site. Twidale (2004:162) states that the meandering channels of the Murray River in general, and in the Calperum Station area specifically, have developed as a result of low bank erodibility combined with moderate flows and sediment load. However, the presence of clay in deposits can be an indicator of low velocity water flows (Petraglia and Potts 1994:229; Stein 1987:341), and the thin Quaternary units mantling most of the surface of the Murray-Darling Basin contain high proportions of clay, indicating long term low velocity flows (Brown and Stephenson 1991; Gill 1973:4; Prendergast et al. 2009:59; Schumm 1968:39). Sediments, particularly in the western parts of the Murray-Darling Basin, are generally very fine as a result of the low dynamics and grades of the Murray River, especially in its later phases (Brown and Stephenson 1991:86; Gill 1973:9). The sediment load in this section of the Murray is suspended silt and clay (Brown and Stephenson 1991:30; Schumm 1968:39), indicating that modern flows continue to be low energy, a context that is unlikely to disturb the spatial arrangement of artefacts (Petraglia and Potts 1994:229, but see also Taphonomy section below).

Experimental studies and research in areas formerly and/or currently affected by rivers and lakes have established a number of indicators of water disturbance. Artefact inclination can indicate water disturbance, producing inclinations ranging from 5–10˚ in slow flowing water and up to 30˚ in higher velocities (Schick 1986). Fanning and Holdaway (2001) found that whilst knapping produces more small artefacts than large ones, artefacts sized between 20–30 mm are generally removed from assemblages by water activity even on small slopes (such as the edges of a billabong or mound) (Fanning and Holdaway 2001:681–683). Even slow to moderate flows can remove smaller artefacts from stone assemblages (Petraglia and Potts 1994:231). The absence of artefacts with maximum dimensions less than 5 mm, complete or fragmented, can indicate that the assemblage has been affected by water flows, but can also indicate that knapping did not occur on-site (Petraglia and Potts 1994:233).

The movement of suspended sediments carried by the Murray River have been modelled by de Rose et al. (2004:248), indicating that the deposition of sediments in floodplain areas is higher in recent times than it was under the natural regime, despite changes in land management practices. This suggests that floodplain sediment accumulation and subsequent artefact burial may have occurred at higher rates since European occupation. Currently, between 0–1 kilotons of sediment are deposited in the study area per year (Moran et al. 2005:9). However, those same fine sediments are also highly susceptible to erosion during dry seasons (McTainsh et al. 2011:32). The loss of sediments from the study area due to aeolian erosion is difficult to assess due to the number of local variables and lack of local data (McTainsh et al. 2011:12–13; Newall et al. 2009:166–167), but as the Murray-Darling Basin is still one of the most actively eroding regions on the continent despite the many recent improvements in pastoral management (McTainsh et al. 2011:33), erosion of the study area and the possibility that the assemblage is a lag deposit must be considered. As part of Calperum Station, the Reny Island billabong (see later sections for site description) in particular is likely to have been trampled significantly by sheep and cattle seeking access to and milling around the waterbody, leading to wind erosion during dry periods. Former pastoral use has heavily reduced the vegetation from pre-European settlement levels, and whilst pest and weed control has been carried out, current soil salinity problems mean that plant regrowth could be limited in places, increasing the risk of erosion (Newall et al. 2009:167).

Sedimentation and infill rates, and the geomorphology of the floodplain area in general at Calperum Station are identified knowledge gaps (Newall et al. 2009:166–167), making it difficult to assess the impact that the local environment has on the visibility of stone artefact deposits. As the study material is a surface assemblage in a floodplain landscape, it is most likely that the artefacts were deposited in the late-Holocene up to the contact period, and ethnographic and historical accounts are considered to be relevant. Given the low energy flows of the floodwaters of the Murray River at Calperum Station it is unlikely that this would have been a factor in the movement of artefacts (Petraglia and Potts 1994:229), however it is still possible that artefacts less than 20 mm lying on sloping surfaces may have been displaced or removed from the assemblages through water movement (Fanning and Holdaway 2001:681–683). Overall, the spatial integrity of the study area is more likely to depend on the amount of time that it lay exposed on the surface, with integrity decreasing the longer the deposit is exposed to human and animal trampling (Petraglia and Potts 1994:230). Human and animal impacts are explored in the next section.

4.3 Human and Animal Impacts

In addition to the removal of small artefacts by water, small artefacts can also be consumed by birds. Both large and small birds collect stones, or swallow them to aid digestion, and this can include small stone artefacts (Cane 1982; Hiscock 1985; Solomon et al. 1986). The traditional use of digging sticks to uproot rhizomes may also have disturbed the context of artefacts deposited on the Reny Island billabong bed or moved there by water, and furthermore, it is also possible that *Typha* spp. roots, as they grow or decay, may displace stone artefacts (Tjelldén et al. 2015:376–377). Humans moving and removing artefacts can also contribute to site disturbance (Midgley et al. 1998), and there are several examples of this happening in the Riverland area (Casey 1973; Record of the National Estate Report). Despite these potential impacts, the evidence of high Aboriginal occupation densities in this area prior to the arrival of Europeans (Clarke 2009:147; Eyre 1845 Vol II; Mitchell 1839; Webb 1984) and the use of the study area predominantly for sheep grazing in the historic period suggests that trampling disturbances by humans and pastoral activities are likely to be more significant factors in the current visibility of any surface stone artefacts.

The effects of animal and human trampling on stone artefacts have been the focus of a number of studies. Gifford-Gonzalez et al. (1985:806–808) compared human trampling on two surfaces—a compact sandy loam from a river valley and an unconsolidated, medium fine sand dune, both in Santa Cruz—and found that artefacts subject to human trampling on a dry, compact loam surface, similar to non-beach margins of the Reny Island billabong, tended to disperse horizontally. In the loose sandy surface, almost all the artefacts were trampled below the surface, up to 11 cm below the surface, however the experimenters observed artefacts resurfacing during trampling, which they described as ‘churning’ (Gifford-Gonzalez et al. 1985:809). A moist layer of sand beneath the dry and loose surface acted as a barrier preventing any further downward migration (Gifford-Gonzalez et al. 1985:810), something that is likely to have been a factor at all of the study locations. Edge damage and artefact breakage was similar in both substrates except for pieces 20 mm and smaller, which were significantly more fragmented at the loam than the sand site (Gifford-Gonzalez et al. 1985:810). This study found that in sandy substrates, it was possible that the debris of successive periods of occupation could intermingle with the (previously ‘churned’) upper levels of the last period of occupation (Gifford-Gonzalez et al. 1985:816). It also suggests that over time, on more compacted substrates such as those around the Reny Island billabong and the creek margins, discarded artefacts would have been horizontally displaced along the margins and also into the water or billabong bed, and further away from the margin, effectively reducing their visibility on the surface (Gifford-Gonzalez et al. 1985:816).

Eren et al. (2010) in the Jurreru River Valley, South India, tested animal trampling effects on stone artefacts in wet and dry substrates using both goats and water buffalo to trample the artefacts for a short period in order to examine both displacement and damage. The authors found some surprising small upward movement of artefacts in dry soils, and some horizontal movement in the directions of the animal’s travel particularly in dry soils (Eren et al. 2010:3015). The majority of artefact movement in wet soil was down into the substrate, to maximum depths of 21 cm (Eren et al. 2010:3017). The test artefacts were excavated following trampling and the inclination recorded. Artefacts in dry substrates showed little change in inclination after trampling regardless of animal size, but significant change in inclination for both large and small animals in wet substrates (Eren et al. 2010:3019).

Although Eren et al.'s (2010) artefact inclination findings apply mostly to artefacts that have been trampled into the subsurface it is possible that surface artefacts can show some inclination due to trampling. As mentioned in the previous section, artefact inclination can also indicate water disturbance (Schick 1984; 1991). Eren et al.'s (2010:3017–3018) findings also demonstrate that some of the surface archaeological record is likely to have been displaced due to animal trampling.

Flake breakages or damage to edges were uncommon in Eren et al.'s (2010:3013–3014, 3018–3019) study. Despite this, experiments conducted on other soils indicate that loose, uncompacted soils yield more breakages than more compacted or indurated substrates (Douglass and Wandsnider 2012:356). In an experiment conducted in the Great Plains, USA, Douglass and Wandsnider (2012) examined the displacement and damage to stone artefacts in three dry substrates of varying degrees of compaction. The authors also found that artefacts in dry, loose soils were pushed below the ground surface by cattle trampling, and were susceptible to damage in all three substrates, but also that fragmentation did not increase over time (Douglass and Wandsnider 2012:358–359). High levels of damage caused to artefacts when human trampling pushed them onto gravel or other stone artefacts had been noted by McBrearty et al. (1998), and Douglass and Wandsnider (2012:358–359) proposed that these kinds of 'artefact on artefact' impacts, together with increasing compaction and cattle speeds over the course of the experiment, contributed to high levels of flake breakage.

This experiment also provided the opportunity to test whether extrapolating from complete flakes in order to overcome bias in estimates of artefact size in assemblages with high breakage levels skews towards larger class sizes (Douglass and Wandsnider 2012:362). The results suggest that assemblage size averages based on whole flakes are more accurate than those that include broken flakes, but the authors also recommend reporting the degree of assemblage completeness (Douglass and Wandsnider 2012:362). The same is true for flake thickness, and the accuracy of this measure further improved when the thickness of proximal flakes is also included (Douglass and Wandsnider 2012:363). This is useful to consider in the Calperum Station context—the loose silty and sandy soils combined with the lack of gravel and the superficially thin scatter of artefacts around the mounds may not yield many breakages, despite the high likelihood of animal trampling. A method that allows for a more accurate assessment of the average size and thickness of the assemblage will improve the accuracy of any results.

Pargeter and Bradfield (2012:24-244) studied the trampling effect of goats in a sandy-loam soil in dry conditions, looking for damage to blades and backed artefacts on the surface and at depths of up to 6 cm. Common outcomes included small scars, half-moon fractures and crushed notches, as well as vertical and horizontal displacement (Pargeter and Bradfield 2012:244–246). Snap fractures were more frequent on the blades and infrequent on the smaller artefacts (Pargeter and Bradfield 2012:244). Similar kinds of damage were described by Douglass and Wandsnider (2012:359), who also noted that this kind of damage was also found on the dorsal ridges of artefacts, and although the damage mimicked retouch, it was seldom continuous along the margin.

These studies cover some of the major kinds of taphonomic processes of that are likely to have been active in the study area, and they are indicative of the kinds of issues that require consideration when assessing the surface stone artefact assemblages. They also indicate diagnostic features that can be observed during survey. They indicate that both human and animal trampling, in particular hoofed but likely to also be applicable to animals such as kangaroos and emus, can cause edge damage in the form of small to medium-sized notches, artefact fragmentation, and most commonly, artefact displacement both horizontally and vertically, resulting in the redistribution and loss of surface artefacts. Environmental mechanisms such as water and wind displacement, and animal consumption also tend to remove artefacts < 20 mm from the surface assemblage in which they were deposited.

5. Relative Mobility and Technological Studies

Earlier sections of this study reviewed literature suggesting that there were high population densities with sedentary lifestyles living along the Murray River corridor (Pate and Owen 2014; Webb 1984). Sedentism is a concept related to mobility, which in an archaeological context refers to the settlement systems of a group, the extent to which a group or individuals from it move or travel in an area, the distances they travel, and the patterning or frequency or those movements (Binford 1980). These activities and patterns leave traces in the One of the aims of this study is to gain some indication of the level of mobility of the Aboriginal inhabitants from the surface assemblages at the earth mounds. This section reviews the concept of mobility and its expression in the archaeological record.

Mobility allows populations to exploit a range of resources within a certain area (Binford 1980:9; Mackay 2005:95). As people move around, they need certain equipment to carry out tasks that may be the motivation for the movement or coincidental to the purpose of travel, such as collecting food and preparing a meal along the way. Once they arrive at a resource patch, they may or may not carry out activities that require specialised equipment. They may manufacture any tools required when they arrive, or bring them with them, or the tools may already be at the place where they will be used. The greater the range of activities carried out at a location, the greater the diversity of the archaeological remains at that place (Binford 1980:12).

Surface assemblages that have been subjected to high levels of trampling (see Taphonomy section) and are subsequently fragmented can still yield technological information, but this may be limited (Clarkson and O'Connor 2014:187–188). However, cores are less susceptible to trampling damage and in some cases can be used to provide information about mobility. Many of the archaeological studies from southeastern Australia and the Murray-Darling Basin indicate that bipolar knapping was a strategy commonly used to maximise the stone raw materials available in a stone poor area, or to exploit small raw materials that could not be knapped by other techniques, such as the small quartz pebbles of the central Murrumbidgee riverine plain, NSW (Klaver 1998:201-202, 209; see also Bonhomme 1990:73; Johnston 2004:52; Martin 2006:127–130).

Hiscock (1996) has argued that bipolar knapping can be linked to low group mobility. Bipolar knapping usually occurs at the end of a reduction sequence, and this technique becomes more common as the distance from the raw stone material source increases (Hiscock 1996:152). Hiscock (1996:152–153) examined the surface artefacts at a number of sites in the Kakadu coastal wetlands of the Alligator Rivers, Northern Territory. The sites were all similar distances to raw material sources, half in woodlands and half close to billabongs, and all used by one Aboriginal group in the ethnographic period (Hiscock 1996:152). Hiscock (1996:153) found that the ratio of bipolar cores to other kinds of cores was higher at the billabong sites, regardless of the distance to the raw material source, even in the situation where the site was adjacent to a raw material source. Additionally, whilst the woodland sites had overall roughly even ratios of bipolar cores to other cores, that ratio increased slightly as the distance to the source increased (Hiscock 1996:153). Hiscock (1996:154) concluded that as there was no correlation between the frequency of bipolar cores and the distance to outcrops at the billabong sites, the billabong sites were occupied intensively, and the woodland sites were occupied for short times only. When this model was applied to other sites in the region, the model was supported (Hiscock 1996:154). One group employed different occupation and knapping strategies during different seasons.

A similar model was employed by Mackay (2005) to explore concepts of provisioning and mobility. Mackay (2005) employed Kuhn’s (1995) concept of provisioning. Kuhn (1995:22) uses the term ‘technological provisioning’ to summarise variations in planning strategies. Provisioning refers to planning artefact production, transport and maintenance, and other strategies that are employed to ensure potential needs are met, taking into account the relevant costs and benefits (Kuhn 1995:22). Kuhn (1995:22) describes these strategies as a continuum, with provisioning individuals at one end, and provisioning places at the other.

‘Provisioning individuals’ refers to the practice of ensuring that a person has on hand at least a limited toolkit that has been manufactured to be transportable, durable and maintainable, and that will meet anticipated needs in most circumstances (Kuhn 1995:22). The tools themselves may be specialised or multipurpose depending on the extent to which future activities may be anticipated (Kuhn 1995:22). At the other end of the spectrum is ‘place provisioning’, which is a strategy of supplying places where tools are likely to be required with the appropriate raw materials or tools that are anticipated to be useful (Kuhn 1995:22). These strategies are not exclusive, and it is expected that a group will make use of a combination of the two (Kuhn 1995:25–26).

Mackay (2005:97; following Kuhn 1995:27) suggests that where individual provisioning is the dominant strategy, there is likely to be a high percentage of local material, as local materials can be easily obtained and replaced, mitigating the risks of tool failure and in the short term supplement the toolkit to conserve the more difficult to replace items. The imported items will either be discarded tools or knapped on-site (Mackay 2005:97). As immediate utility and a lightweight toolkit is important in individual provisioning, cores will be uncommon (Kuhn 1995:23; Mackay 2005:97). Overall the discard rates will be low, with a high percentage of broken or exhausted items and a high percentage of small, thin flakes consistent with retouching on-site (Mackay 2005:97).

Alternatively, assemblages reflecting a high degree of place provisioning are likely to have the following characteristics: the ratio of cores to tools will increase because a core has more potential utility than a finished tool (Kuhn 1995:24; Mackay 2005:97). As the cost of tool failure is low where there is the potential to produce more tools, it is likely that there will be more flexibility in manufacturing and design, more variability in forms, and a greater range of artefact sizes generally (Mackay 2005:97). There is likely to be discard of items prior to exhaustion and little retouch, and a greater number of large and unused unretouched flakes (Mackay 2005:97). Place provisioning practices should result in assemblages where good quality materials dominate, as there is no requirement to supplement hard-to-replace high quality materials with expedient poorer quality materials (Mackay 2005:98). Using the concept of provisioning, and by identifying what kinds of assemblages different strategies are likely to produce, Mackay (2005) was able to examine a range of undated surface assemblages and dated stratified assemblages on a sandstone plateau, and identify changes in occupation patterns over time from a combination of individual and place provisioning to an increasing tendency towards individual provisioning.

Implicit in Mackay's (2005) model is the idea that some raw stone material is local and some is imported. There is an assumption that raw materials are not distributed evenly in the landscape, and that higher quality raw materials have a limited distribution and poorer quality raw materials are more common (Kuhn 2005:27) which in reality may or may not be the case. Kuhn (2005:27) notes that 'local' can be a very flexible term, related largely to the distances that individuals or a group is able to travel, the foraging radius of the group, and the extent of residential mobility. For this reason, raw materials that are worked in place to produce artefacts that are infrequently retouched prior to discard are termed 'local' (Kuhn 1995:27). It is difficult to apply the term 'local' in the Calperum Station context as there are numerous flakeable stone sources near the study area (see Figure 14) and probably others that have not been recorded, but very little stone is available away from the course of the Murray River. For the purposes of this study, fine-grained siliceous stone is presumed to be of limited availability, in high demand and the supply regulated (see Tindale 1974:211), and larger grained, unevenly or poorly silicified stone is likely to have been more widely available and less regulated, and for this reason, following Kuhn (1995:27), fine grained materials will be considered 'exotic' and coarse grained materials will be considered 'local'.

Mackay's (2005) model only requires analysis of the surface assemblage. At this stage of the research at Calperum Station, only the surface artefacts are available for examination. This limits the extent to which it is possible to understand what is happening at the earth mounds in this area for two reasons. First, there are likely to be subsurface archaeological deposits both within and around at least some of the earth mounds in addition to what is visible on the surface. Secondly, both the surface and subsurface deposits are likely to have been disturbed by a variety of activities such as human and animal trampling, water inundation, fire, erosion, plant growth and root disturbance that might move the stone artefacts from where they were first deposited. Whilst this kind of analysis does not depend on the spatial integrity of a site, visibility and an accurate assessment of all the site components are necessary. Understanding and taking these processes into account can help to form a more accurate understanding of the site.

6. Field Methods at Calperum Station

This chapter describes the field methods that were employed for the Calperum Station survey. It outlines the approvals process and selection of the study areas. It provides a description of the raw materials that were encountered during survey, the recording form categories and the rationale behind them.

6.1 Field Methods

6.1.1 Community and Ethics Approval

Ethics approval for this project, including an amended approval to conduct this research as a part of the overall project was obtained from both RMMAC and the Social and Behavioural Research Ethics Committee of Flinders University (Ethics Approval Project Number 6618). RMMAC representatives were present for the 2015 fieldwork season and the subsequent field visit in April 2016, and regular progress reports were presented at RMMAC Directors' Meetings. All fieldwork adhered to the cultural protocols requested by RMMAC.

6.1.2 Survey Procedures

The study area for this survey was described in Chapter 2. The field work for this project was conducted during two field trips, the first as part of the Finders University 2015 Archaeology Field School in September 2015 and a second field trip in April 2016. The entire margin of the Reny Island billabong was surveyed and all artefacts recorded in situ as per the recording attributes below. Following the identification of a second mound complex on the northern bank of Hunchee Creek north, four of eleven mounds were surveyed and the artefacts recorded. Finally, three isolated mounds were also surveyed and the associated artefacts recorded. Gemma Incerti assisted with field survey and measurement on all days except the second day of the April 2016 visit.

The Reny Island billabong was targeted for both mound and stone artefact analyses on the basis that there were six mounds or mound-type structures around a single landscape feature. As the mounds were distributed around the billabong perimeter, all of the surface stone artefacts around the perimeter of the billabong were measured in situ, from the edge of the water in the billabong at the time to approximately 15 m back from the water's edge, depending on surface visibility and vegetation. Duckweed (*S. polyrhiza*) growing in the shallow water was deposited on the ground surface as the water evaporated, which dried to form a dark organic mat that further obscured artefact visibility. Subsequent mounds were surveyed following their identification during Jones (2016) survey. A second mound complex at Hunchee Creek was selected as a comparison for the Reny Island billabong complex. As the surface stone artefacts densities had been higher than expected at Reny Island billabong, and the visibility at Hunchee Creek was much more variable, the decision was made to survey only in the vicinity of the mounds. The remaining time was spent on two areas with fewer mounds as a further basis for comparison.

This study focused on heat retainer earth mounds because they were one of the main Aboriginal site types in this landform, and also because recent research by Westell and Wood (2014) had highlighted the extensiveness of this site type along with associated preservation issues, and the lack of research in this area compared to further east along the Murray River.

6.2 Raw Material Types

Sources of flakeable stone in the Calperum Station region were identified (see Figure 14). The kinds of stone that were identified during the survey are described here in detail.

6.2.1 Silcrete

Silcrete is a siliceous rock which is strongly indurated as a result of low temperature surface or near-surface silicification of unconsolidated sediments, regolith or weathered bedrock (Webb and Domanski 2008:557). Silcretes are formed by the cementing of sand grains in a duricrust, such as the

Karoonda Surface, in arid and semi-arid environments (Gill 1973; Rapp 2009:57). Silcretes are generally composed of 85–95% silica and host rock grains which variably in size, depending on the grain size of the host material (Webb and Domanski 2008:557). Silcrete is both hard and brittle, and fractures conchoidally, making it a suitable raw material for stone tool production. Silcrete is available in the study area in the Karoonda Surface (Gill 1973:33). Samples of silcrete flakes from the study area are featured in Figure 17.

Figure 17: Examples of silcrete from the study area.

Visits to potential source quarries were not possible during the fieldwork due to time constraints. The nature of the cliff face along the Murray River near Calperum Station, and the continual possibility of exposure and/or loss of flakeable material due to cliff erosion means that some past sources are unlikely to be located. Linking artefacts to specific quarries is often a difficult prospect, but more so when the raw material is not homogenous (Shackley 2008:195–197). Despite having examined the Berribee silcrete quarries in detail, Grist (1995) found it difficult to identify raw material from those quarries in the field based on colours and grain sizes alone.

Many of the heat shattered rocks were sandstone (Figure 18). Sandstone is formed from both quartz grains and rock fragments that have been silicified to varying degrees, but are less cemented than silcrete (Rapp 2009:56–57). The sandstone in the study area was friable and often poorly cemented, and contained grains of varying sizes. Conchoidal fracture surfaces were not observed during survey, instead crenated fractures with uneven surfaces were common. Grist (1995:42) found sandstone in association with silcrete at the Berribee Quarries, and it is likely that this material is available at other locations along the Murray River Cliffs.

Figure 18: Coarse-grained and friable sandstone pieces from the survey area.

6.2.2 Chert

Chert is a sedimentary rock that consists of micro- or cryptocrystalline quartz that consists of roughly equidimensional crystals (Rapp 2009:76) (Figure 19). It is hard, brittle and fractures conchoidally, and is one of the most common rocks to be used for stone tools around the world (Rapp 2009:76). It precipitates from, and occurs as nodules in limestone, and is likely to have been obtained from the Murray River cliffs (Grist 1995:36; Shackley 2008:197; Tindale 1974:211; Rapp 2009:78).

Figure 19: Chert flakes from the study area. The centre flake was manufactured from oolitic chert.

6.2.3 Quartz

Quartz may occur in many colours and shapes, but the most common forms that have been used for artefact production are clear or opaque quartz pebbles, and ‘milky’ vein quartz. There are no known quartz sources in the district, although Tindale (c1934–c1991) records the meaning of Katarapko as

‘Home for rock crystal’, suggesting this may have been a source of quartz, but this has not been confirmed. Quartz flakes are rare in the district, and most likely to have been traded in (Grist 1995).

6.3 Calperum Station Stone Artefact Field Recording Scheme

The artefact characteristics were recorded in the field on a Microsoft Excel spreadsheet which was loaded onto an LG Nexus X5 tablet. The measurements taken with a Mitutoyo Absolute Digimatic Caliper, and the weights were measured with a CE Professional-Mini Digital Pocket Scale. The maximum weight on this scale was 500 g, so any heavier artefacts were measured with a bucket scale in a thin calico bag. For this reason, weights over 500 g are approximate. A loss of accuracy in the weight of large artefacts was considered acceptable in light of the relative rarity of these items. The locations of artefacts were recorded with a Garmin GNSS handheld GPS. On the 2015 field season, photos were taken with a Nikon D3100 camera. On the 2016 field season, photos were taken with a Canon EOS 350D camera with a Sigma 20-700 lens. The Nexus X5 tablet was set to back up the recorded data to Google Docs at regular intervals during the day. This was reviewed for errors at the end of the day, and all other field recordings were backed up to the project computer every evening.

The recording scheme used in this analysis is based on a technological approach, which allows for artefacts to be recorded based on their observable attributes (Andrefsky 2005; Clarkson and O’Connor 2006; Hiscock 2007:202–203). This approach was selected primarily because earth mound research in the Riverland and other parts of the Murray-Darling Basin had indicated that stone artefacts found on the surface of mounds were frequently unretouched flakes, and retouched or formal types of artefacts were uncommon in mound assemblages or in the study area in general (Balme and Beck 1996:40; Bonhomme 1990:73; Coutts and Witter 1977:62–66; Coutts et al. 1979:57; Gill 1973:89; Klaver 1998:217; Westell and Wood 2014:53). Some aspects of a typological approach were also included, however, as Australian stone artefacts studies frequently recognise several artefact types, particularly those for which ethnographic studies or use-wear analyses have established use associations (e.g. Attenbrow et al.2009; Clarkson 2007; Cooper and Nugent 2009). It includes measurements and attributes to meet three goals: to answer the questions posed in this study; to be general and informative enough to provide a comparative basis for future studies at Calperum Station; and to facilitate some degree of comparative analysis with research associated with the Murray River (e.g. Bland 2012; Grist 1995) and other mound locations (e.g. Bonhomme 1990; Coutts et al. 1979; Klaver 1998; Martin 2006; Williams 1988). Many of the measurements are drawn from Andrefsky (2005), Clarkson (2007), Hiscock (1989), Holdaway and Stern (2004) and Macgregor and Hiscock (2014). The basic flake orientation is with the dorsal surface facing the observer and the platform at the top.

6.3.1 Stage 1 All Artefacts

Measurement: **Field ID**: Recording day and time, e.g. 28=1422.

Rationale: The equals sign prevents Excel from seeing the ID as a date. Links the measurements with the spatial location and photograph, allows for simple representation on a site drawing or any other spatial representation of the site.

Measurement: **Date**: Date of the recording, day/month/year.

Measurement: **Artefact location**: GPS waypoint number.

Rationale: As low densities were anticipated, mapping the location gives a rough (minimum 3 m error range) indication of the spatial distribution of artefacts in relation to the mound.

Measurement: **Artefact orientation**: (A_ORIENT) Flat; angled; vertical, indeterminate.

Rationale: Identifies whether the artefact is lying flat on the ground or has been disturbed to the extent that the artefact is angled more than 30˚ on any axis into the ground, indicating an artefact has been trampled. Eren et al. (2010:3019) found that trampling resulted in artefact inclination to a small degree in dry soils and to a large degree in wet soils.

Measurement: **Artefact type**: (A_TYPE) Unretouched flake (URTF); retouched flake (RTF); core; grindstone; hammer; anvil; non-diagnostic shatter (NDS); heat shatter (HS), flaked piece (FP) (unclear whether the item is a flake, core or a retouched flake—see Hiscock [1989:26]); ochre, other non-artefactual stone (ONA).

Rationale: Simple typological classifications aid description of the assemblage by reducing variability into manageable units. Where typologies are clearly defined, they aid comparability with other studies (Andrefsky 2005:61). Different kinds of artefacts can indicate specific activities, for example grindstones can indicate seed processing activities (Fullagar and Field 1997), hammerstones indicate knapping, as do anvils, but these items can also be used in food processing and fibre manufacturing (Fullagar et al. 1992:16). Categories are not exclusive as artefacts can have multiple uses. Alternative uses are recorded in the general notes. For ochre, only weight and colour are recorded. For NDS and HS, only weight, raw material and raw material colour are recorded. ONA indicates that the stone does not show evidence of having been culturally modified, but as stone is not naturally occurring in the study area, it has most likely been transported to the site by human agency.

Measurement: **Artefact completeness**: (COMPLETENESS) Complete or broken. If broken and a flaked artefact: margin missing (MarMiss), marginal fragment (MarFrag), longitudinal cone split right or left piece (LCSR or LCSL), proximal (ProxFrag), medial (MedFrag) or distal fragment (DistFrag).

Rationale: Identifying flake completeness creates categories of flakes that can then be included or excluded to provide different measures of site density (Andrefsky 2005: 83). Counting complete, LCS and proximal flakes allows for a more accurate assessment of the artefact density, one which controls for artefact breakage either in the course of use or due to post depositional factors such as trampling (Andrefsky 2005:83). LCS fractures indicate too much force has been exerted during knapping (Clarkson 2007:30). Low levels of artefact completeness in an assemblage can be an important indicator of animal trampling (Douglass and Wandsnider 2012:353). Split fragments are coded as left or right on the basis of the presence of the left or right lateral margin.

Measurement: **Artefact raw material**: (RAW_MAT) Quartzite, quartz, silcrete, chert, sandstone.

Rationale: Raw material has an impact on the kinds of artefacts that can be manufactured from it and the techniques used in the manufacture process (Andrefsky 2005:24, 224); if the raw material sources in the vicinity are known, identifying the type of raw material can determine whether it is likely to be locally available or not (Andrefsky 2005:42). Attempts to conserve certain raw materials can be identified through measures such as dorsal scar direction, platform preparation and artefact thickness (Andrefsky 2005:42; Pelcin 1997:749,755). As lithic raw material is an important part of subsistence strategies, understanding the sources as well as the usage can assist in reconstructing patterned activities in the landscape (Clarkson 2007:9; Binford 1979:251).

Measurement: **Material comments**: (RAW_MAT_COMMENTS) Observations about the raw material, particularly raw material quality and grain size.

Rationale: As there is potentially a range of raw materials in the vicinity, this category allows for notes to be recorded that may assist raw material identification during the course of the survey. Raw material quality can vary in grain size and consistency, and this has an influence on knapping techniques (Clarkson 2007:37). Fine-grained raw materials can be knapped to produce smaller and thinner flakes than is possible, using the same techniques, with coarse-grained materials, and fine-grained material is also likely to be exploited more conservatively and intensively than coarse-grained material (Clarkson 2007:37; Pelcin 1997:755). It has also been suggested that raw material quality, rather than type, can be used as an indicator of flaking properties (Bradbury et al. 2008:249).

Measurement: **Raw material colour**: (RAW_MAT_COLOUR) Colour.

Rationale: Colour can sometimes be useful in indicating heat treatment, raw material source, or in identifying clusters of raw material where one core has been used to produce a number of artefacts at a site. However, raw material can also vary significantly in colour, both at the source and within a single nodule (see Grist 1995:35).

Measurement: **Artefact weight**: (A_WEIGHT) (500 g to 0.1 g).

Rationale: Weight is correlated strongly with the stage of reduction (Andrefsky 2005:98) and mobility (Kuhn 1995:23, 25, 32, 36). Weight over 500 g exceeded the maximum weight of the balance, and a hanging scale was used to give an approximate weight.

Measurement: **Artefact size**: Length (LENGTH_MM); width (WIDTH_MM); thickness (THICK_MM) (LWT). For flakes, percussion LWT is used. Percussion length is measured from the ring crack along the percussion axis to the artefact termination (Hiscock 1989:31). Percussion width is measured at the midpoint of percussion length, along the same axis, and percussion thickness is measured at the intersection of these two points. Measuring the flake along the axis of percussion is an effective measure of flake elongation as a result of knapping actions (as opposed to the uncertainties of a fracture travelling through raw material of internally variable resistance to that fracture), and can be compared to the length of negative scars on cores (Hiscock 1989:31). For broken flakes that can still be oriented, the same measurements apply. For retouched or broken flakes that cannot be oriented (e.g. backed artefacts), maximum length, width and thickness will be recorded. Cores will be oriented with the main flaking surface towards the observer and the main flaking platform at the top, and LWT will be measured from that position. For all other artefacts, maximum LWT will be taken.

Rationale: Artefact size has frequently been correlated with the stage of reduction, with larger artefacts being produced earlier in the reduction sequence and smaller and thinner artefacts being produced in later stages (Andrefsky 2005:98), but this is also dependent on the original dimensions of the core. Martin (2006:215) recorded the percussion length rather than the maximum length, and to enhance the comparability of this study with that one, the same measurement has been chosen. Andrefsky (2005:98) suggests measuring only the complete flakes, but if broken flakes are being used to make composite tools, then standardisation is still likely to be evident, and maximum measurements (together with weight) should reveal clustering. Conversely, if flake breakages are due to trampling, broken flake sizes are more likely to be random. See Clarkson (2007:18) for a discussion on the advantages of standardisation.

Measurement: **General comments**: (G_COMMENTS) Any unusual or notable features.

Rationale: Unusual features observed for which there is no category for recording can be included here, in particular, heat damage to flakes, such as potlids, crazing or crenated fracture surfaces (see Hiscock 1990:40–41). Comments do not need to be made for all artefacts.

Measurement: **Cortex Coverage:** (DORSAL_CORTEX_PCT) Recorded as a percentage of coverage of the dorsal surface of flakes or as a percentage of the entire surface of cores—0%; 1–50%; 51–99%; 100%. Cortex on flake platforms is not recorded here, it is indicated at **Flake platform surface** above. This recording style allows for the data to be broken down in several ways—the flakes with all or no cortex coverage can be identified, and the degree of cortex coverage in the middle range is separated into larger or smaller amounts (Holdaway and Stern 2004:144).

Rationale: The presence of cortex is related to early stages of reduction (Andrefsky 2005:103—based on the assumption that as cortical material fractures unpredictably, cortex will be removed in the initial stages of flaking), however the degrees of cortex present on the original cores is important contextual information (e.g. small river cobbles will have large amounts of cortex present on flakes, large outcrops or raw materials may allow for nodules free of cortex to be extracted). Measuring for presence or absence rather than percentages of cortex decreases inter-observer errors and increases the replicability of the measurement (see Andrefsky [2005:103–106 and 115–118] for a discussion on the problems associated with this measurement and a summary of studies). Cortex, together with flake size, can also be used as indicators of the distance a core has travelled from its source, or to help identify sources (Doelman et al. 2001:24; 26; Grist 1995:2; Holdaway and Stern. 2004:49–50).

6.3.2 Stage 2 Flaked Artefacts

Measurement: **Platform size**: Width (PLAT_WIDTH_MM) and thickness (PLAT_THICK_MM) (mm).

Rationale: Frequently used in association with other variables such as platform type to determine the stage of production (Pelcin 1997:749;) and can assist in identifying conservation strategies (Andrefsky 2005:90; Pelcin 1997:749).

Measurement: **Flake initiation**: (INITIATION) Hertzian; wedging; bending; none.

Rationale: Hertzian initiations are the most common result of hard hammer percussion (Cotterell and Kamminga 1987:679) and are evidenced by a bulb of percussion even when the platform has shattered. Wedging initiations do not produce a bulb of percussion and are frequently associated with bipolar flaking (Cotterell and Kamminga 1987:685, Andrefsky 2005:26, 125) and will help to identify the use of this flaking strategy. Bending initiations are the result of flake detachment from a flaw or crack near the point of percussion, and do not have a bulb of percussion (Holdaway and Stern 2004:34) (Figure 20). They have also been associated with the use of soft hammers such as wood or antler (Cotterell and Kamminga 1987:683). Flakes with no initiation indicate the proximal part of the flake is missing.

Figure 20: Three common kinds of flake initiation. Adapted from Clarkson (2007:28). Figure removed due to copyright descriptions.

Measurement: **Flake platform surface**: (FLAKE_PLAT_SUR) Cortical; shattered; single; multiple; faceted; focalised; none. Cortical indicates that the platform employed was cortex; shattered platforms are missing most or all of the platform information and cannot be recorded; single indicates that the platform was created by the removal of a single flake; multiple indicates that multiple negative flake scars have created the platform surface; facetted indicates that multiple small negative flake scars were initiated from the dorsal surface across the platform surface to create a ridged surface from which the flake is struck; focalised indicates that the only part of the platform that is present is the point where hammer impacted the platform surface and the remainder of the platform is left on the core (Clarkson and O'Connor 2014:160-161; Holdaway and Stern 2004:119-122; Whittaker 1994:101).

Rationale: Platform surface and shape is frequently linked to manufacturing strategies, the skill of the knapper, the stage of reduction, and the reduction strategy being employed (Andrefsky 2005:90). Flakes with flat platforms (single fracture in this study) are usually removed from unidirectional cores (Andrefsky 2005:95). Small flakes with single fracture platforms not associated with knapping debris can be associated with removal from larger flakes (Andrefsky 2005:95), indicating resharpening on-site. Wedging initiations are associated with bipolar flaking (Andrefsky 2005:26, 125) and small artefact size measurements. Shattered platforms are also associated with too much force exerted during knapping (Clarkson 2007:30). Faceting a platform can improve high platform angles and improve the chance of removing a flake from a small core, but this strategy also reduces the amount of control a knapper has over the shape of the flake (Clarkson and O'Connor 2014:160–161) (see Figure 22 below).

Measurement: **Artefact termination**: (FLAKE_TERM) Feather; step; hinge; outrepasse; none (for a broken or retouched flake) (see Figure 21). Feather termination results when a fracture travels through to the free face of the core in the direction of percussion, turning slightly to meet the free face at a very acute angle (Cotterell and Kamminga 1987:699). Step terminations occur when the fracture changes direction abruptly and turns to meet the free face of the core at roughly right angles (Cotterell and Kamminga 1987:699–700). A hinge termination is also a change in direction towards the free face, but at a more acute angle that results in a curved or lipped edge (Cotterell and Kamminga 1987:700–701). Outrepasse or plunging terminations are similar to hinge terminations except that the fracture turns to the opposite direction and instead of travelling towards the free face of the core, curves back into the centre and out the opposite side, removing what is at that point the base of the core (Cotterell and Kamminga 1987:701). Cotterell and Kamminga (1987:699–700) also discuss axial terminations, similar to feather terminations, where the fracture travels directly through the core to the bottom instead of travelling towards the free face. This kind of termination is associated with wedging initiations and bipolar flaking, and for recording purposes was not differentiated from feather terminations.

Rationale: As with platform measurements, flake terminations reveal information about the kind of force that was applied to detach the flake, and also indicate the potential useability of a flake (Andrefsky 2005:87). They can also indicate the ability of the knapper to manage the core geometry and the forces required to detach suitable flakes (Clarkson 2007:32; Amick and Mauldin 1997:25). Step terminations are difficult to differentiate from broken flakes, and in some research designs are counted as broken flakes. In this study it was important to differentiate between step-terminated flakes formed during knapping as opposed to complete flakes broken through taphonomic processes, but unfortunately this was not always possible. Where it was clear that the flake was not broken during knapping (e.g. other parts of the distal edge away from the axis of percussion showed hinge or feather terminations), the flake was classified as step terminated. Where it was not possible to make this distinction, the flake was classified as broken. Coarser raw materials are more prone to step terminations (and LCS fractures) than finer raw materials (Amick and Mauldin 1997:20–21).

Figure 21: Flake terminations. From Clarkson (2007:28). Figure removed due to copyright restrictions.

Measurement: **Overhang removal**: (OHANG_REMOVAL) Yes; no.

Rationale: Platform morphology is important in determining the size and shape of the resulting flake, and eliminating excess platform material left behind by previous flake removals has the effect of increasing low platform angles and thereby increasing flake sizes (Clarkson and O'Connor 2014:160–161; Holdaway and Stern 2004:143–144) (see Figure 22). Overhang removal indicates conservation practices and careful control of flaking procedures (Holdaway and Stern 2004:143–144). Deliberate overhang removal is not easily distinguished from small flakes accidentally removed during knapping, and is recorded only when confidently identified as not being platform shattering associated with flake removal (Holdaway and Stern 2004:144).

Figure 22: Two platform preparation techniques recorded in this study: faceting and overhang removal. From Clarkson and O'Connor (2014:165). Figure removed due to copyright restrictions.

Measurement: **Dorsal scar count**: (DORSAL_SCAR_COUNT) 0; 1; 2; 3. Flakes with only cortex or unclear negative scars on the dorsal surface will be recorded as 0. Where negative flake landmarks (such as a negative bulb, margins, ripples or striations indicating the negative flake percussion axis) are absent then the dorsal surface is unclear. Partial scars where the percussion axis could be established were recorded. Flakes with three or more scars were recorded as 3. Small flake scars that relate to platform preparation, or overhang removal were not counted (Andrefsky 2005:109).

Rationale: Dorsal scars can be associated with the stage of reduction (Andrefsky [2005:106–109], although this is complex). As replicability can be an issue with this measurement, the simple measurement suggested by Andrefsky (2005:109) was adopted.

Measurement: **Dorsal scar direction**: (DORSAL_SCAR_DIRECTION) None; indeterminate; same; opposite; oblique; same and opposite; same and oblique; opposite and oblique; same, opposite and oblique. Scars oriented within 30˚ of the percussion axis of the ventral surface are classified as same; scars oriented within 30˚of the percussion axis from the opposite direction are opposite; scars oriented more than 30˚ from the percussion axis in either direction are oblique (Macgregor and Hiscock 2014:124).

Rationale: Dorsal ridges or the lack thereof affect flake length and shape, and overall morphology (Pelcin 1997). The direction of dorsal scars can be associated with the stage of reduction and reduction strategies, and also with core rotation practices which are linked to raw material conservation and may vary across raw materials (Holdaway and Stern 2004:148).

Measurement: **Edge damage**: (EDGE_DAMAGE) Yes; no; unknown.

Rationale: Edge damage in the form of very small negative scars, too small to be created by a hammer, can indicate damage incurred due to flake use and/or damage due to trampling (Holdaway and Stern 2004:167), but distinguishing between the two causes is difficult—edge damage that is randomly distributed, occurs on the dorsal ridges as well as the flake edges, and that occurs as crescent-shaped scars is more likely to be attributable to trampling damage (Douglass and Wandsnider 2012:358; McBrearty et al. 1998: 123–124).

6.3.3 Stage 3 Retouched Flakes and Cores

Stage 3: Retouched flakes only

Measurement: **Retouched artefact type**: (RTFTYPE) Backed Artefact (BA); scraper; point; burin; tula; amorphous retouch.

Rationale: The kinds of artefacts found in the study area, or the kinds of retouch on artefacts, may relate to activities that have been performed in the area. The ‘types’ listed in this measurement describe functional attributes of artefacts derived from use-wear and ethnographic studies, allowing artefacts that have similar characteristics that have been proposed or demonstrated to relate to particular functions, to be grouped together (Holdaway and Stern 2004:101).

Backed artefacts (BA), also known as geometric microliths, are identified by shape (woakwine, which retains the platform and bulb, as well as triangle, trapeze and crescent) and also by the removal of very small flakes from the margins opposite the working edge—the margin of the flake—either at one or both ends, and possibly the opposite margin to create a blocky, 90˚ angle between the ventral and edge, or dorsal and edge of the flake (Holdaway and Stern 2004:262–263). There is little direct evidence for the use of these artefacts, but it is possibler that they were replaceable parts of composite tools (Holdaway and Stern 2004:262–263).

Scrapers are flaked artefacts that have continuous retouch along one or more margins (Holdaway and Stern 2004:227). Points are flakes that have been retouched, usually from the ventral onto the dorsal and less frequently bifacially, both on the margins and the distal end to form a point at the distal end with sharp, acute working edges along the margins (Holdaway and Stern 2004:266–267). Burins are manufactured to produce a sharp and strong chisel edge at the distal end of a flake (Holdaway and Stern 2004:241–243), either by alternately flaking the margins of one end, or by creating a platform on the flake and removing a margin with successive flakes.

Tula adzes are retouched flakes with a broad platform for hafting and pronounced bulb, that have been steeply retouched onto the dorsal side predominantly from the distal end until only the bulb and platform remains (Clarkson 2007:116; Holdaway and Stern 2004:253–255). Tula adzes were hafted and used mainly for woodworking, especially hardwood (Holdaway and Stern 2004:252–253). As a tula became blunt, it was retouched repeatedly until the working edge was close to the platform, at which point it became too thin for continued resharpening and the slug was discarded

(Holdaway and Stern 2004:253). Tula adzes are not generally associated with earth mounds, and Calperum Station is on the edge of the distribution of tulas in Australia (Doelman and Cochrane 2012:255).

Amorphous retouch includes flakes that show evidence of retouching but that do not fit into any of the other retouched flake categories, including utilised flakes (Holdaway and Stern 2004:233), discontinuously retouched flakes, notched and serrated flakes (Holdaway and Stern 2004:236–239). Detail about the kind of retouch observed can be entered into the General Comments section.

Measurement: **Retouch location**: (RT_QUAD) 1; 2; 3; 4; a; b; c; d. Retouched artefacts were divided into four segments, and the location of the retouch in each segment was recorded for both the ventral and dorsal surfaces by noting the quadrant in which it occurs (Holdaway and Stern 2004:145–147). On the dorsal side, the presence of retouch was recorded as being in quadrants 1, 2, 3, 4 where 1 is the platform, and numbering continues clockwise around the flake margins. On the ventral side, the same arrangement of segments were labelled *a, b, c, d*, also in a clockwise direction, where *a* is the platform (Seg 1=a, 2=d etc.).

Rationale: The location of retouch, as with the type of artefact produced, may suggest the kinds of activities the artefacts are being used for. Additionally, it can also indicate the raw material resource pressures, or lack thereof, that the people producing artefacts were under. Retouch in order to resharpen a working edge (where possible) suggests a shortage of resources, as this practice is more conservative and time consuming than replacing the artefact with a new one because a resharpened (less acute) edge will blunt more quickly than a new edge (Ugan et al. 2003).

Stage 3 Cores Only

Measurement: **Core type**: (CORE_TYPE) Unidirectional; multidirectional; bifacial; bipolar. Categories are not entirely exclusive—bipolar can be unidirectional or multidirectional. Directionality of bipolar cores can be recorded in the general comments field.

Rationale: Core type indicates the kind of reduction methods being used, and goes towards establishing a reduction sequence (Holdaway and Stern 2004:180). For example, if cores found at a site are all multidirectional, but the many of the large flakes have unidirectional dorsal scars, this suggests multidirectional reduction in the later stages of reduction but not the early stages. Westell and Wood (2014:53) did not observe any cores at the Riverland mound sites they surveyed. Martin (2006:216) found small, mainly bipolar cores and flakes, usually smaller than 20 mm, at the Hay Plains sites, as did Klaver (1998:203), who suggested that this was typical of the stone-poor Hay Plain. The core measurements here and below are intended to illuminate the state of the core to establish why it was not reduced further, the reduction methods employed and still visible on the core, and any technological problems that the knapper may have been encountering and trying to overcome.

Measurement: **Number of platforms**: (CORE_PLATNO) This includes the number of visible platforms, as well as those whose orientation can be reconstructed from a portion of a negative scar.

Rationale: Indicates the minimum number of core rotations (Holdaway and Stern 2004:193). Together with the core length, the relationship between the two can suggest that there were technological problems with the core, such as voids, high platform angles or an accumulation of hinge or step terminations, that the knapper was trying to overcome by rotating it (Clarkson and O'Connor 2014:160–161).

Measurement: **Complete scar length 1 and 2**: (CORE_SC1_LENG / CORE_SC2_LENG) Percussion length of the longest, intact negative scar.

Rationale: Only taken where possible. Indicates the maximum length of one of the last flakes removed from this core. Where the scar does not run the entire length of the core, it can indicate that the knapper was having problems reducing the core, which may be the reason why the core was discarded (Holdaway and Stern 2004:188). Complete negative scars on cores are measured along the axis of percussion, as the flakes were, and can be examined in light of the length of flakes that remain in the local assemblage (Hiscock 1989:31). For example, if negative scars on cores are consistently longer than the flakes in the assemblage, it can indicate that larger flakes are being removed from the assemblage.

Measurement: **Complete scar platform 1 and 2**: (CORE_PLAT_SC1 / CORE_PLAT_SC2) Cortex; Negative scar; Single surface; Multiple surfaces; Crushed; Indeterminate.

Rationale: Only taken where possible. As with the measurement above, the platform characteristics on cores also hold information about reduction techniques and the amount of preparation that has been put into producing flakes (Holdaway and Stern 2004:191).

Measurement: **Core Problems**: (CORE_PROBS) Cracks; Voids; Uneven texture; Crushing.

Rationale: Crushing is an indication that the core has been rested on an anvil and can assist with identifying bipolar cores (Clarkson and O’Connor 2014:158). The other categories indicate obstacles that must be overcome by the knapper, or that may have been the reason the core was abandoned (Clarkson and O’Connor 2014:160–161).

7. Results

This chapter presents the results from the stone artefact survey of a selection of mounds from Calperum Station floodplain. These results are presented in three sections, the first section reviews the overall trends of the artefacts that were measured, the second section focusses on results relating to taphonomic disturbances and the final section compares the mound associated and between mound assemblages.

A total of 14 mounds were surveyed: small numbers of artefacts were found on three mounds (one of which was a natural levee mound with only a small number of scattered, burnt clay nodules); 11 mounds had artefacts within 10 m of the outer boundaries. Apart from the areas surveyed for this study, other sites were recorded on the floodplain during the 2015 and 2016 Field School surveys, including earth mounds, scar trees, shell middens and lenses, hearths, artefact scatters and isolated artefacts. In some cases different kinds of sites were in close proximity or clustered around a landscape feature.

7.1 Stone Artefact Assemblage Summaries

7.1.1 Reny Island Billabong Precinct

The entire margin of the Reny Island billabong were surveyed and stone artefacts around the margin recorded. The tables of mound associated/not associated artefacts presented here are based on the outer mound dimensions (Jones 2016) plus a 10 m margin; all artefacts in Tables 2–6 are within this margin are associated with the earth mounds. The remainder are described in Table 7. Surface visibility varied at each mound and around the margins. Alluvium covered the surface of RIBB2, RIBB7 (also noted by Jones 2016:68), diminishing the visibility of artefacts. The majority of artefacts recorded at the Reny Island billabong were not associated with the earth mounds.

Table 2: Reny Island Billabong earth mounds with no associated artefacts.

RIBB2:	**Above ground hearth/oven**	17x5m	40% visibility
RIBB3:	**Oven Mound**	20x20m	<40% visibiity

Table 3: Reny Island billabong earth mound 4 associated artefacts.

RIBB4:	**Oven Mound**		11x11m	<40% visibility
Artefact Type	Chert	Silcrete	Total	Heat Affected
URTF	2	1	3	1
RTF			0	
FP			0	
Core			0	
NDS			0	
HS			0	
ONA			0	

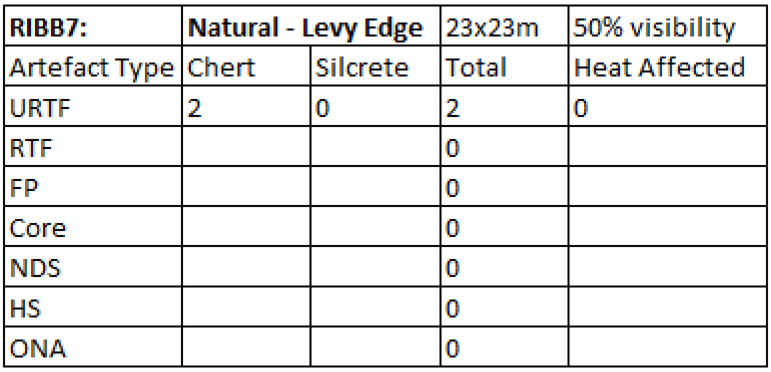
Table 4: Reny Island billabong earth mound 5 associated artefact summary.

RIBB5:	**Oven Mound**		9x9m	<40% visibility
Artefact Type	Chert	Silcrete	Total	Heat Affected
URTF	2	0	2	1
RTF			0	
FP			0	
Core			0	
NDS			0	
HS			0	
ONA			0	

Table 5: Reny Island billabong earth mound 6 associated artefact summary.

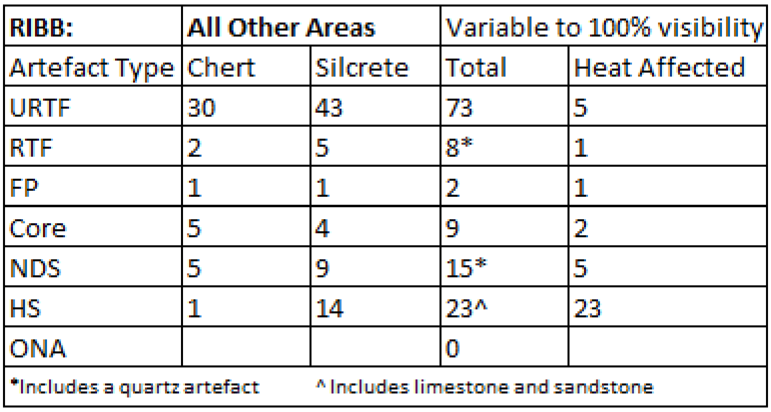
RIBB6:	**Oven Mound**		10x7m	<40% visibility
Artefact Type	Chert	Silcrete	Total	Heat Affected
URTF			0	
RTF	1	0	1	0
FP			0	
Core	0	1	1	0
NDS			0	
HS			0	
ONA			0	

Table 6: Reny Island billabong natural Levy edge occupation area associated artefact summary.



RIBB7:	**Natural - Levy Edge**		23x23m	50% visibility
Artefact Type	Chert	Silcrete	Total	Heat Affected
URTF	2	0	2	0
RTF			0	
FP			0	
Core			0	
NDS			0	
HS			0	
ONA			0	

Table 7: Reny Island billabong margins—all other artefact summary.



RIBB:	**All Other Areas**		Variable to 100% visibility	
Artefact Type	Chert	Silcrete	Total	Heat Affected
URTF	30	43	73	5
RTF	2	5	8*	1
FP	1	1	2	1
Core	5	4	9	2
NDS	5	9	15*	5
HS	1	14	23^	23
ONA			0	
*Includes a quartz artefact		^ Includes limestone and sandstone		

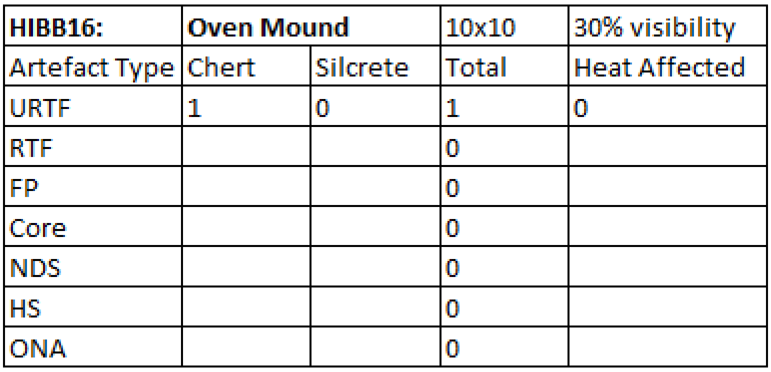
7.1.2 Hunchee Island Billabong Precinct

Four mounds were recorded by Jones (2016) at the Hunchee Island billabong, two on the northern side of the billabong were surveyed for stone artefacts. The whole northern margin of the sandy rise where the mounds were located was surveyed, and the stone artefacts are summarised in Tables 8–10 as per the Reny Island billabong margins. Both mounds had been disturbed by rabbit activity. Visibility was low and few artefacts were identified.

Table 8: Hunchee Island billabong earth mound 15 with no associated artefact summary.

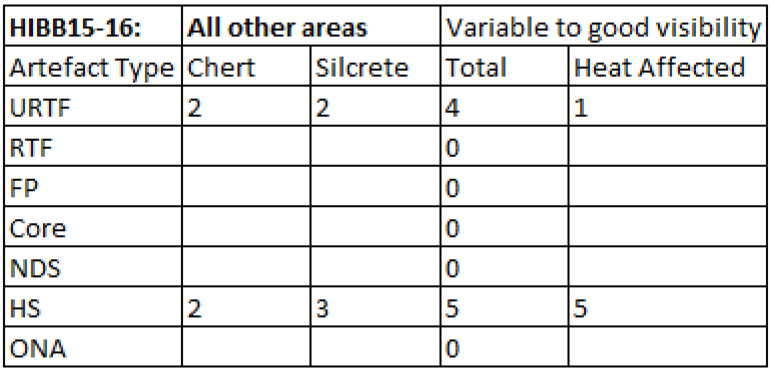
HIBB15:	**Oven Mound**	21x20	<20% visibility

Table 9: Hunchee Island billabong earth mound with associated artefact summary.



HIBB16:	**Oven Mound**		10x10	30% visibility
Artefact Type	Chert	Silcrete	Total	Heat Affected
URTF	1	0	1	0
RTF			0	
FP			0	
Core			0	
NDS			0	
HS			0	
ONA			0	

Table 10: Hunchee Island billabong margin—all other artefact summary.



HIBB15-16:	**All other areas**		Variable to good visibility	
Artefact Type	Chert	Silcrete	Total	Heat Affected
URTF	2	2	4	1
RTF			0	
FP			0	
Core			0	
NDS			0	
HS	2	3	5	5
ONA			0	

7.1.3 Hunchee Creek Precinct

Eleven mounds were recorded by Jones (2016) along this section of Hunchee Creek, only four were surveyed for artefacts. The mound surfaces and immediate vicinities were surveyed and all artefacts recorded. The areas between the mounds were not surveyed due to time constraints, and due to this, the results are presented with all the artefacts in the vicinity of the mounds as well as all the artefacts within the 10 m buffer (Tables 11–14). Table 15 summarises the artefacts recorded along the margins of the track beside the creek (as shown in Figure 9), from HCN23 to HCN22. The tables below show all of the artefacts recorded in the mound vicinity, and artefacts that fell within the 10 m buffer around the outer extent of the mound are shown in an extra column 'MoundAss'.

Overall artefact densities were still low in this area, but despite poor to average surface visibility there were more artefacts associated with the mounds than in other areas.

Table 11: Hunchee Creek North earth mound 23 artefact summary.

HCN23:	**Oven Mound**		22x22	<30% visibility	
Artefact Type	Chert	Silcrete	Total	MoundAss	HeatAff
URTF	7	1	8	0	2
RTF			0		
FP	1	0	1	0	0
Core	1	0	1	0	1
NDS			0		
HS	2	3	5	1	5
ONA			0		

Table 12: Hunchee Creek North earth mound 22 artefact summary.

HCN22:	**Oven Mound**		25x25	<30% visibility	
Artefact Type	Chert	Silcrete	Total	MoundAss	HeatAff
URTF	0	2	2	0	0
RTF			0		
FP			0		
Core	1	0	1	0	0
NDS			0		
HS	0	5	5	2	5
ONA			0		

Table 13: Hunchee Creek North earth mound 21 artefact summary.

HCN21:	**Oven Mound**		40x23	<50% visibility	
Artefact Type	Chert	Silcrete	Total	MoundAss	HeatAff
URTF			0		
RTF			0		
FP			0		
Core			0		
NDS	0	2	2	2	2
HS	1	2	3	3	3
ONA					

Table 14: Hunchee Creek North earth mound 20 artefact summary.

HCN20:	**Oven Mound**		20x14	<50% visibility	
Artefact Type	Chert	Silcrete	Total	MoundAss	HeatAff
URTF	3	0	3	3	0
RTF			0		
FP			0		
Core			0		
NDS			0		
HS	0	3	3	2	3
ONA			0		

Table 15: Hunchee Creek North track between HCN23 and HCN22 artefact summary.

HCN:	**All Other Areas**		Variable to good visibility	
Artefact Type	Chert	Silcrete	Total	Heat Affected
URTF	2	0	2	1
RTF	1	0	1	0
FP			0	
Core			0	
NDS			0	
HS	0	1	1	1
ONA	0	1	1	0

7.1.4 Ral Ral Creek East Mounds

Three mounds were recorded by Jones (2016) in this area, two were surveyed for stone artefacts. Survey extended beyond the mound boundaries, but all artefacts identified were either on the mound or within the 10 m buffer zone (Tables 16 and 17).

Table 16: Ral Ral Creek earth mound 12 artefact summary.

RRCE12:	**Oven Mound**		15x15	70% visibility	
Artefact Type	Chert	Silcrete	Total	MoundAss	HeatAff
URTF	1	2	3	3	0
RTF			0		
FP			0		
Core			0		
NDS			0		
HS	1	0	1	1	1
ONA			0		

Table 17: Ral Ral Creek earth mound 14 artefact summary.

RRCE14:	**Oven Mound**		20x20	<30% visibility	
Artefact Type	Chert	Silcrete	Total	MoundAss	HeatAff
URTF	1	0	1	1	0
RTF			0		
FP			0		
Core			0		
NDS			0		
HS	0	4	4	4	4
ONA			0		

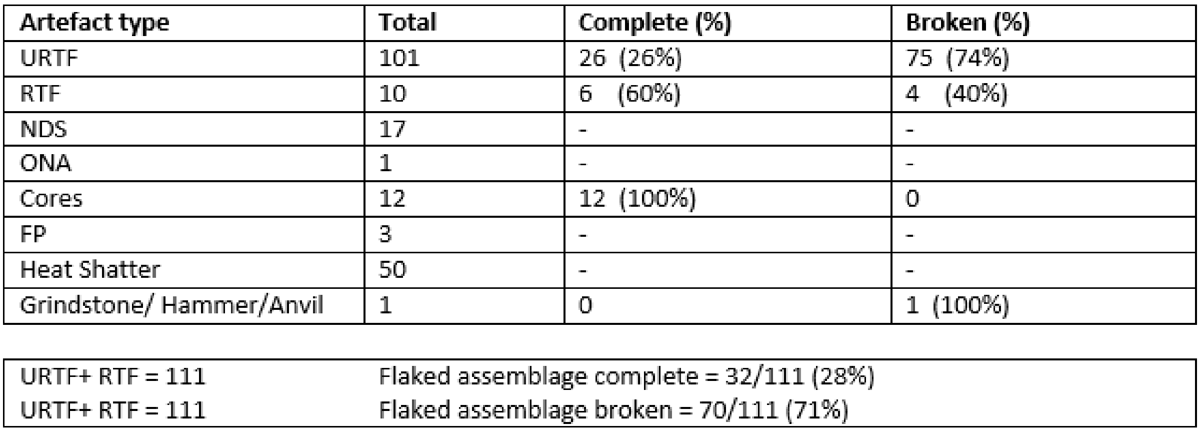
7.2 Raw Material Quantification and Measures of Reduction

The results of the analysis of the surface stone artefacts from Calperum Station are presented in this chapter, which begins with an overview of the different study areas and the land systems they were associated with, before describing the general characteristics of the stone artefact assemblage. The following section presents results related to taphonomic impacts, followed by analyses relating to mobility and technological questions.

7.2.1 Measures of Raw Material Abundance

Results of the overall numbers and types of stone artefacts are presented in Table 18. The majority of artefacts in the study area were unretouched flakes (URTF), most of which were broken. Non-diagnostic shatter was not included in the fragmentation percentages as it was not clear whether those pieces were broken or complete.

Table 18: Whole assemblage totals of artefact types and numbers.



Artefact type	Total	Complete (%)	Broken (%)
URTF	101	26 (26%)	75 (74%)
RTF	10	6 (60%)	4 (40%)
NDS	17	-	-
ONA	1	-	-
Cores	12	12 (100%)	0
FP	3	-	-
Heat Shatter	50	-	-
Grindstone/ Hammer/Anvil	1	0	1 (100%)

URTF+ RTF = 111	Flaked assemblage complete = 32/111 (28%)
URTF+ RTF = 111	Flaked assemblage broken = 70/111 (71%)

Figures 23 and 24 show that the dominant raw material for the entire assemblage, excluding heat shattered stone and non-artefactual manuports, is silcrete. The assemblage is 54.4% silcrete, 47.6% chert and 1.3% quartz by number, but 90.6% silcrete, 9.3% chert and 0.1% quartz by weight.

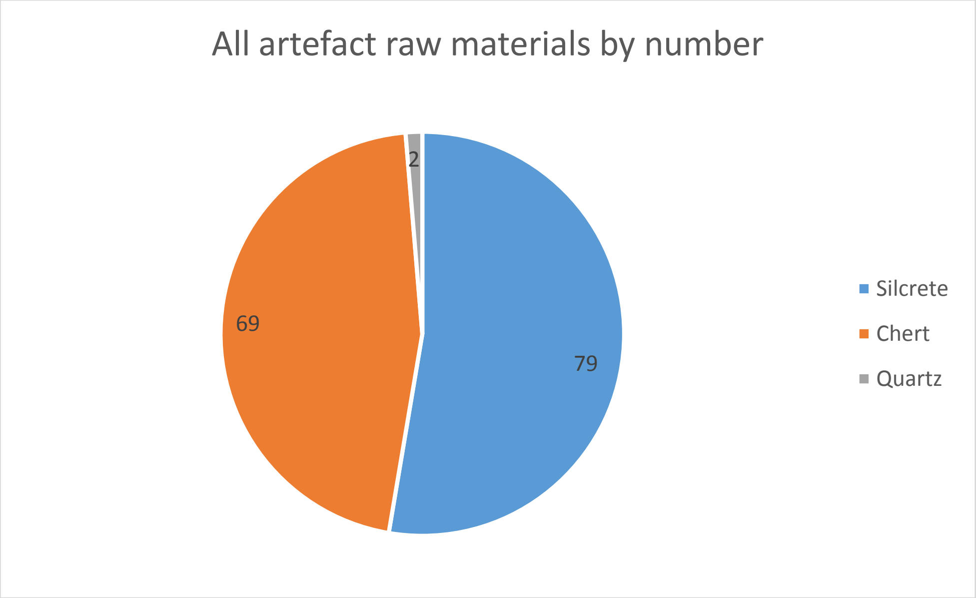


Figure 23: All artefact raw materials by number.

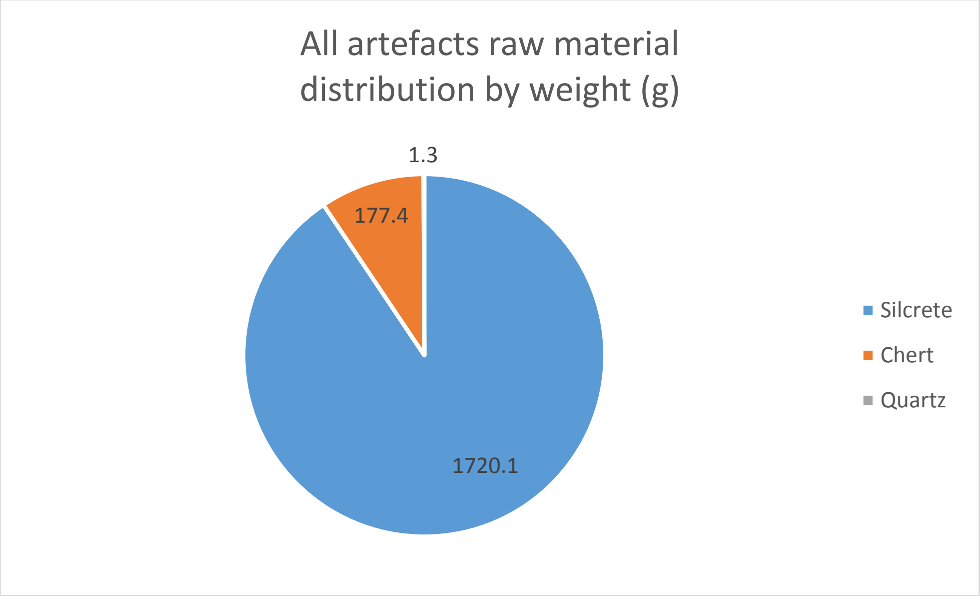


Figure 24: All artefact raw material distribution by weight.

Excluding cores and one hammer fragment reduces the size of the assemblage to 130 flaked artefacts. Figures 25 and 26 show the same calculations performed with only the flaked artefacts (URTF, RTF, FP and NDS), indicating similar results.

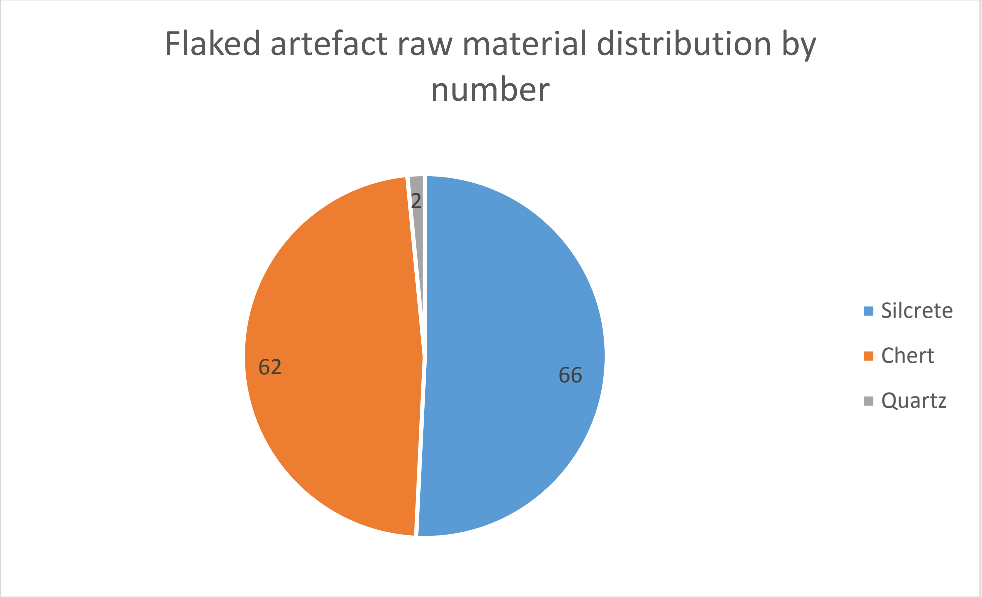


Figure 25: Flaked artefact raw material numbers.

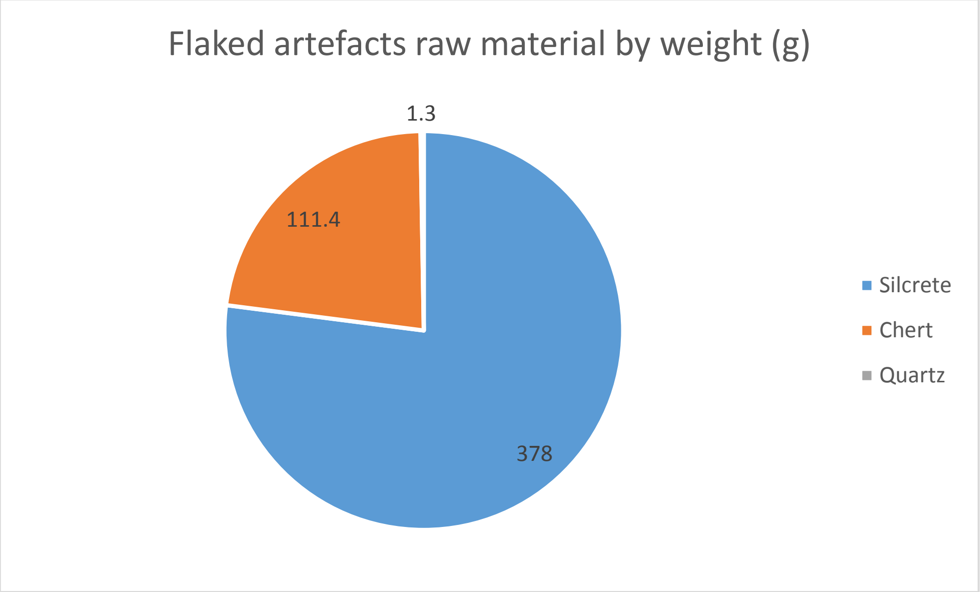


Figure 26: Flaked artefacts only, by raw material and weight.

Raw material quality varied across the flaked assemblage, as demonstrated in Figure 27. URTF, RTF, FP and NDS combined totalled 131 flakes. The raw material comments were edited to either fine, medium or coarse, and then the distributions plotted. Fine quality raw materials dominated the assemblage.

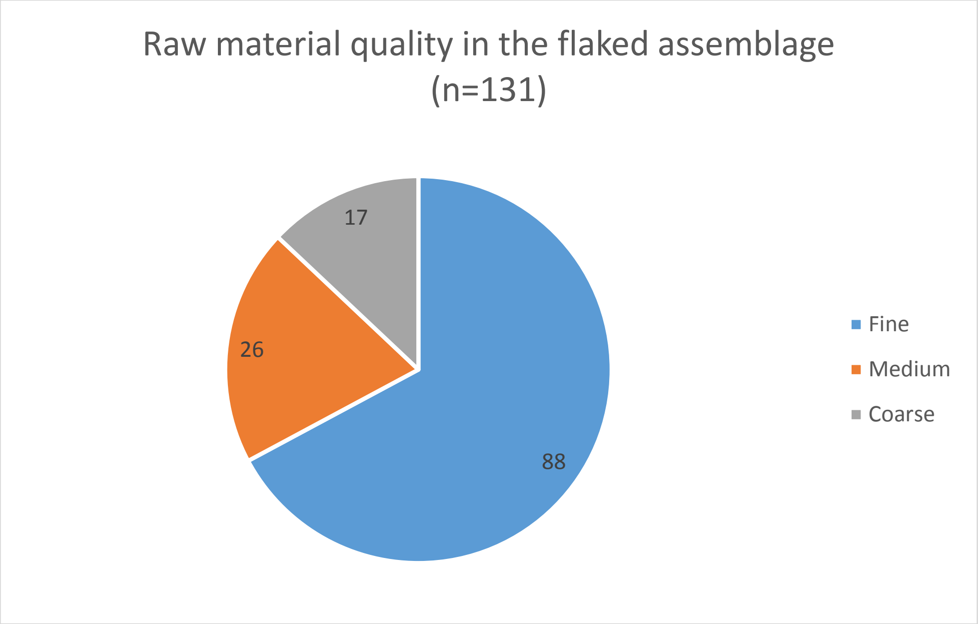


Figure 27: Quality of raw materials in the flaked assemblage.

7.2.2 Complete and Broken Flake Distributions

Flake breakage ratio and percentages for the assemblage were calculated in order to identify differences in raw material breakage rates. The results are shown in Table 19. ONA and heat shatter were not included in the number of artefacts; flaked pieces, cores and the grindstone were not included in flake counts; non-diagnostic shatter was not included in broken flakes. Flake breakage levels were similarly high for the two raw materials.

Table 19: Complete and broken flakes in the assemblage.

Raw material type	Number of artefacts	Number of complete flakes	Number of broken flakes	Ratio of broken: complete flakes	Percentage of broken flakes in assemblage
All materials	144	32	79	2.5:1	55.2%
Silcrete	55	17	38	2.2:1	69%
Chert	55	15	40	2.6:1	72.7%

Figure 28 shows the dimensions for all URTFs (n=101), both broken and complete. NDS was not included in this set. Flake sizes were generally less than 20 mm and the average length was 17 mm.

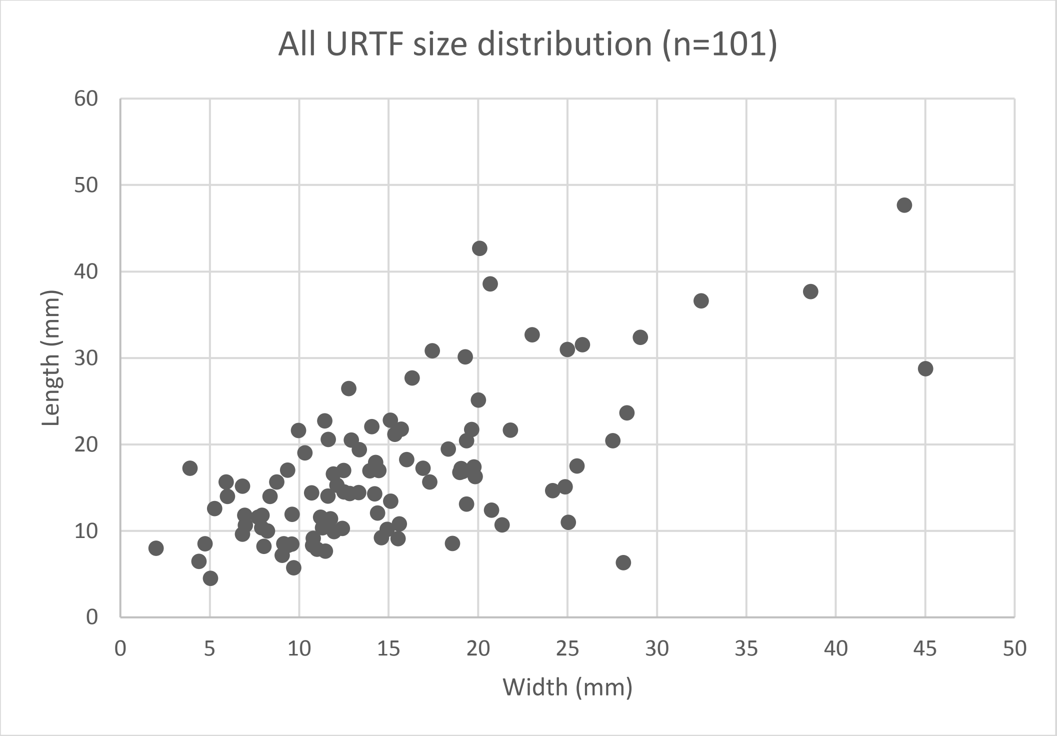


Figure 28: Unretouched flake size distributions.

In order to examine the effect of broken flakes on the size distribution, complete and broken flakes are broken down into separate categories in Figures 29 and 30 below. Complete flake sizes were also generally less than 20 mm, with an average length of 18 mm.

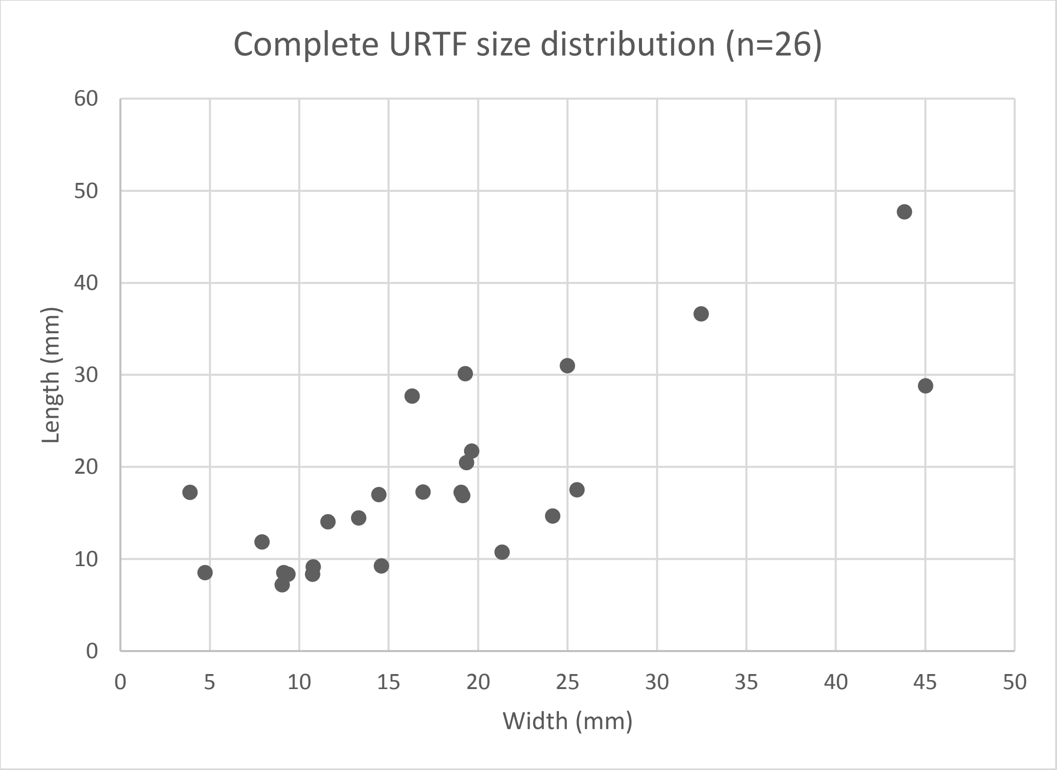


Figure 29: Complete unretouched flake size distribution.

Broken flakes, shown in Figure 30, were largely clustered below 20 mm and the average length was 16 mm. Broken flakes were only slightly smaller than complete flakes overall.

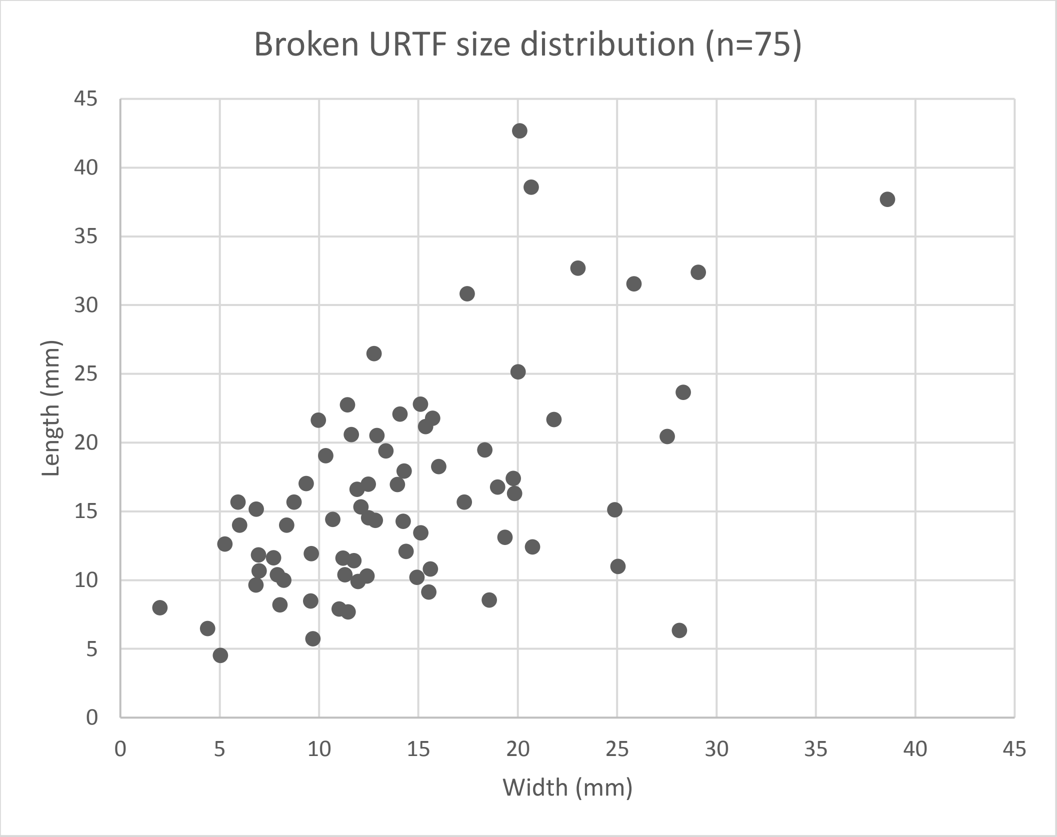


Figure 30: Broken unretouched flake size distribution.

As unbroken flakes constitute only 34% of the flaked assemblage, it is difficult to use them to describe the entire assemblage. The following statistics are only intended to describe the trends in stone artefact reduction at the sites surveyed in this study, and will benefit from comparisons with future assemblages. Figures 31 and 32 summarise the length distributions of silcrete and chert flakes. Figure 31 demonstrates the length ranges of chert (n=12) and silcrete (n=14) complete flakes. Although there are similar numbers of flakes in each category, the range of silcrete lengths is much larger than that of chert.

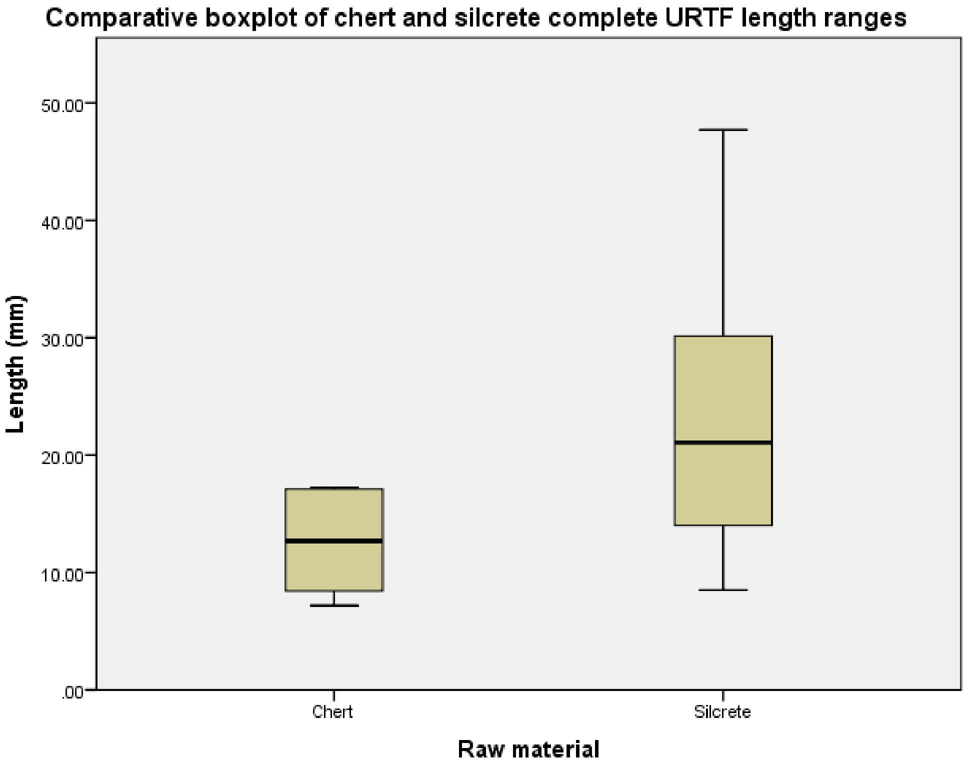


Figure 31: Comparative boxplot of chert and silcrete complete unretouched flake length ranges.

This process was repeated to include some of the fragmented flakes. Figure 32 also shows the length ranges of chert and silcrete complete URTF flakes, but also includes the margin missing (MM) flakes. The median length increased for chert (n=22) but decreased for silcrete (n=21).

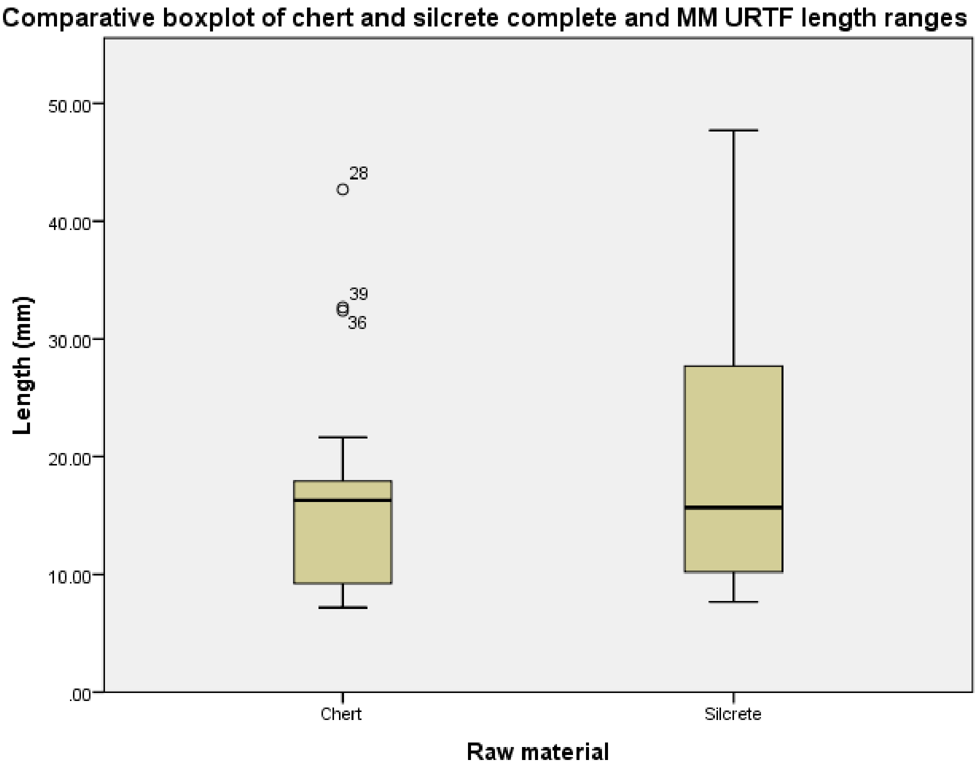


Figure 32: Comparative boxplot of chert and silcrete complete and margin missing unretouched flake length ranges.

The range of flake thicknesses was also plotted in a similar fashion. Figure 33 demonstrates the complete chert (n=12) and silcrete thickness ranges (n=14) with similar results. Again, there is considerably more variability in the thickness of silcrete flakes than chert flakes.

Figure 33: Comparative boxplot of chert and silcrete complete unretouched flake thickness ranges.

Figure 34 shows this measurement repeated for the complete, margin missing, proximal and medial fragments of flakes for chert (n=42) and silcrete (n=33). Including proximal and margin missing flakes (following Douglass and Wandsnider 2012:364; Mackay 2005:103) brought the two measurements closer together in range and median. Overall, silcrete flakes were still slightly thicker than chert. Increasing the range of flake fragments included in the thickness measurement as suggested by Mackay (2005) and Douglass and Wandsnider (2012) should yield more accurate results for this measurement.

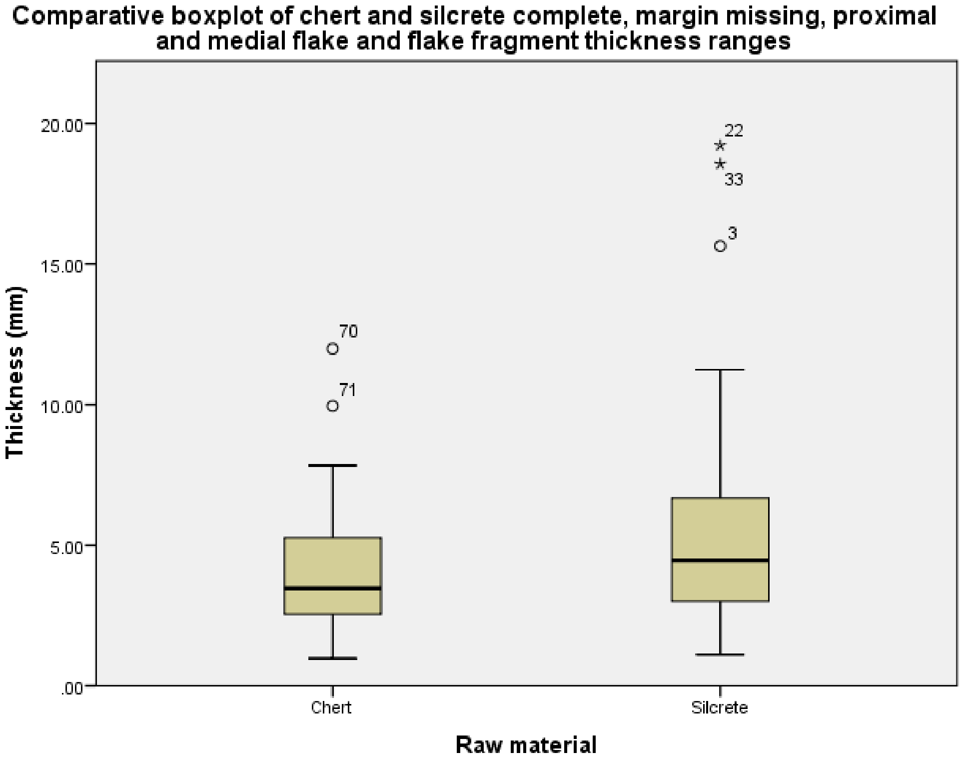


Figure 34: Comparative boxplot of chert and silcrete complete, margin missing, proximal and medial flake fragment thickness ranges.

7.2.3 Cores and Negative Core Scars

Figure 35 shows the core weights. The total number of cores was 12, and the total weight was 1381.5 g. No quartz cores were found during the survey, reinforcing the scarcity of this material. Only one knapping floor was identified, approximately 50 m away from the Reny Island billabong margins. Knapping debris was also generally absent. There were seven chert cores weighing 66 g, and five silcrete cores weighing 1315.5 g in total.

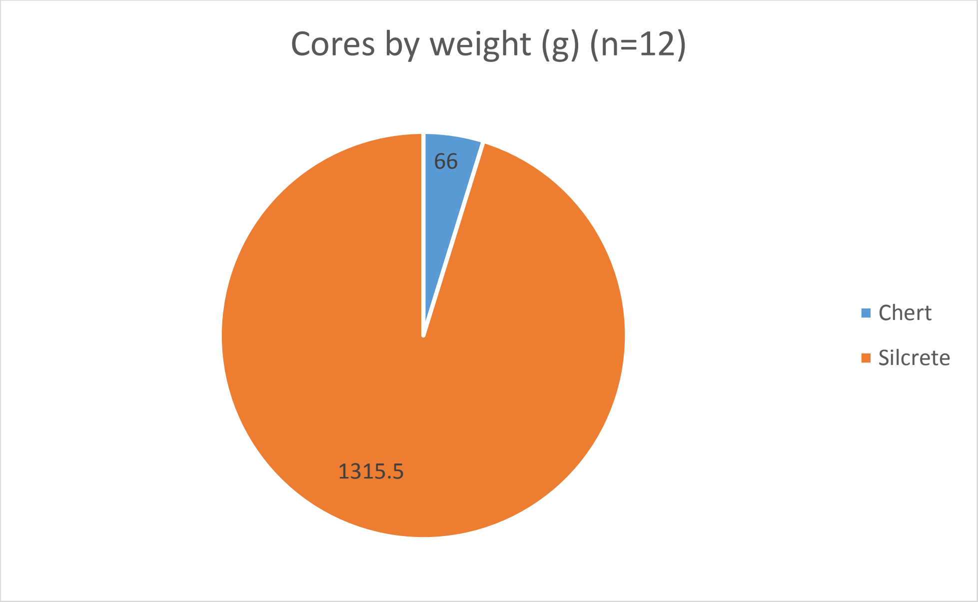


Figure 35: All cores displayed by weight.

Figure 36 shows the core weights again excluding one outlier weighing approximately 1000 g from the silcrete core group. The average weights with this outlier removed are 78.9 g for silcrete (85% of the assemblage) and 9.4 g for chert (15%). Even with the 1000g silcrete core outlier removed, chert cores still comprises less than 25% of the assemblage by weight.

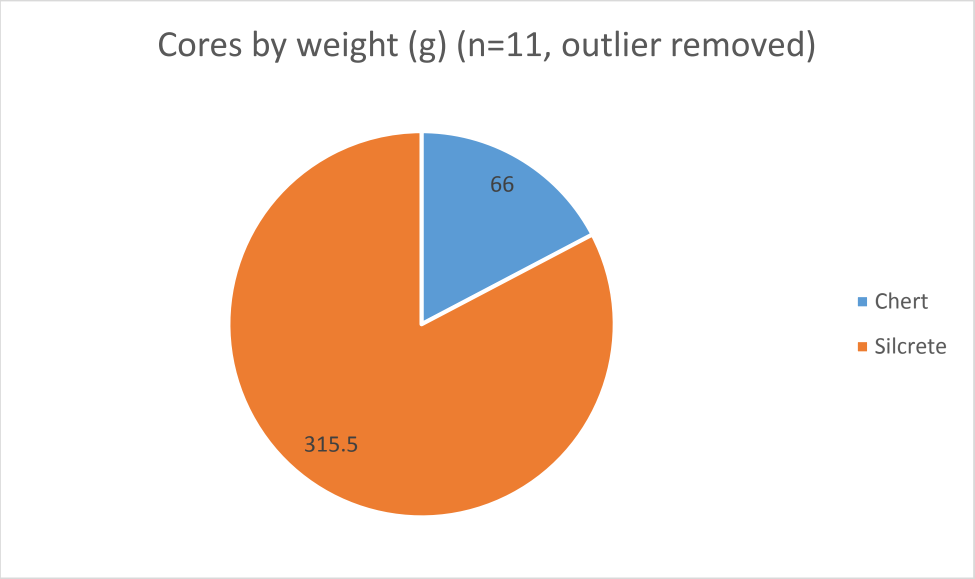


Figure 36: Cores, less one outlier, displayed by weight.

Silcrete was the dominant raw material both by a small lead by number and a large lead by weight. This may be related to the flaking properties of the raw materials, and/or to the nature of the parent rock. It may be that chert parent rock sizes are small, resulting in proportionally smaller cores and flakes.

Core lengths are plotted against widths in Figure 37. Cores were mostly less than 40 mm with an average length of 34 mm.

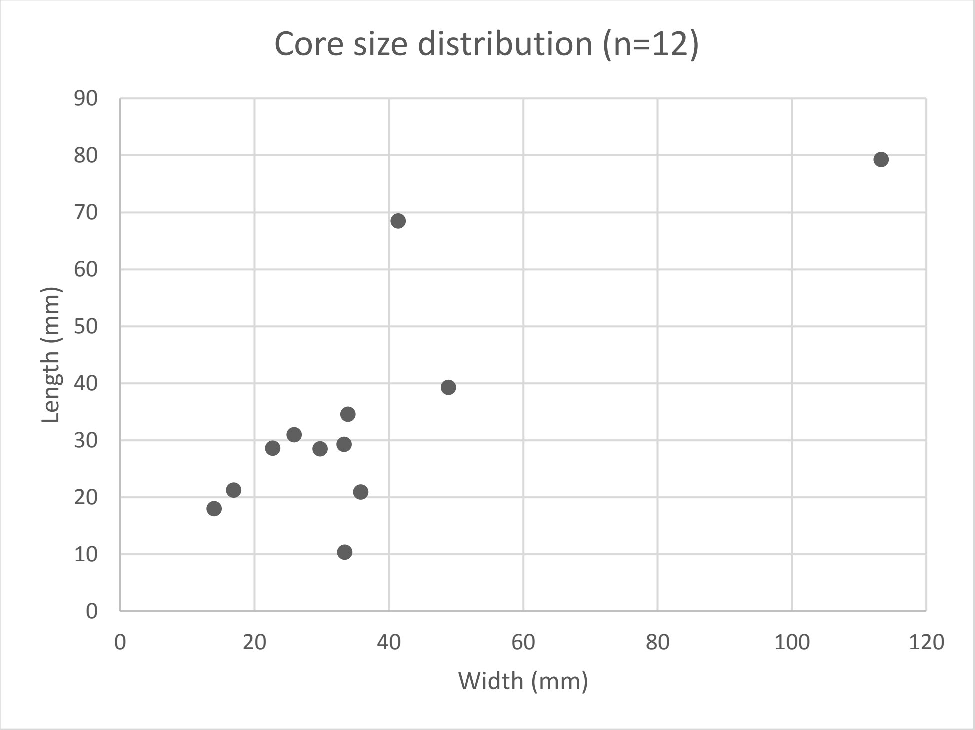


Figure 37: Core size distribution.

The average sizes of core scar lengths were measured and are presented in Figure 37. The average size of the first complete negative scar length was 21 mm, and the second was 18 mm. Cores were overall generally longer than the negative scars removed from them, but the silcrete cores show much smaller scars for the length of the cores. The small size of the negative scars on the largest core is a reflection of the knappers attempts to remove the finer quality material and avoid the coarse.

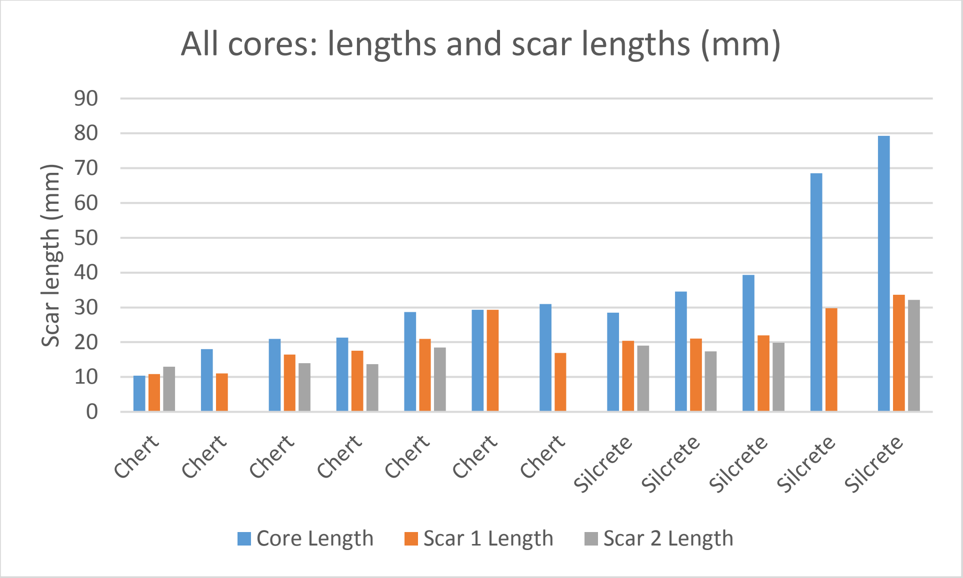


Figure 38: Core and negative core scar lengths for chert and silcrete.

Figure 39 shows boxplots for chert and silcrete complete and MM URTFs lengths in relation to the first and second scar lengths chert and silcrete cores. Chert flakes were overall similar in length but slightly smaller than the negative scars on the cores, whereas the majority of the silcrete flakes were smaller than the negative scars on the silcrete cores in the survey area.

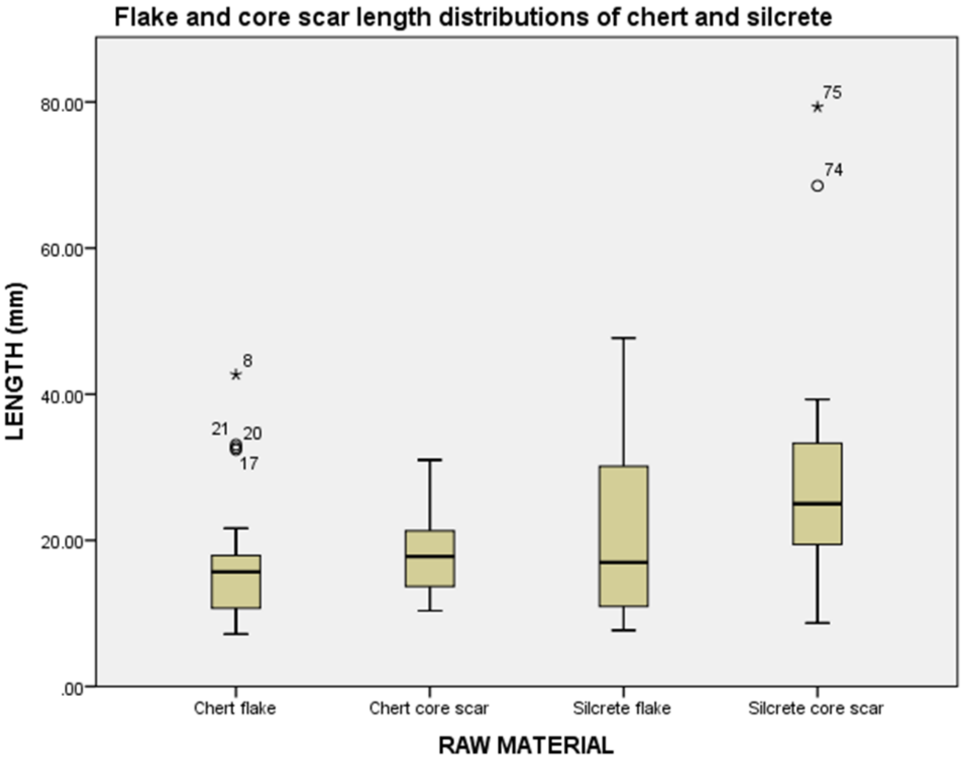


Figure 39: Complete and margin missing flake lengths compared to negative flake scars on chert and silcrete cores.

Cortex coverage on cores, described in Table 20, was also low. Only the smallest and two largest cores had less than 50% cortex coverage. The low rates of cortex in the assemblage made it difficult to identify the size, shape and nature of the parent rocks. Voids were a common core problem, as was uneven raw material quality. Table 20 also shows that the ratio of bipolar cores to other kinds of cores was 1:1. The majority of bipolar cores were 12 g or less—the only non-bipolar core less than 12 g was exhausted. The second largest core was also flaked using bipolar methods and featured extensive battering on the base suggesting bipolar reduction for an extended period.

Table 20: Raw material, percentage coverage, weight and problems for all cores.

Raw Material	Quality	Weight (g)	% Cortex	Type	Problems
Chert	fine	0.3	1-50	bipolar uni	voids
Chert	fine	4.1	0	bipolar multi	
Chert	fine	7	0	bipolar multi	voids/cortex
Chert	opal/fine	11.9	0	multidirectional	voids/uneven
Chert	fine	12	0	bipolar uni	crush/uneven
Chert	fine	12.2	0	bipolar uni	all
Chert	fine	18.5	0	multidirectional	
Silcrete	medium	25.2	0	multidirectional	small voids
Silcrete	variable	38.5	0	multidirectional	uneven
Silcrete	medium	74.6	0	multidirectional	uneven
Silcrete	medium	177.2	1-50	bipolar uni	
Silcrete	medium to coarse	1000	1-50	bifacial	voids/uneven

Core types are also described in Figure 40. Multidirectional flaking was the most common strategy for the final stages of both bipolar and unidirectional cores.

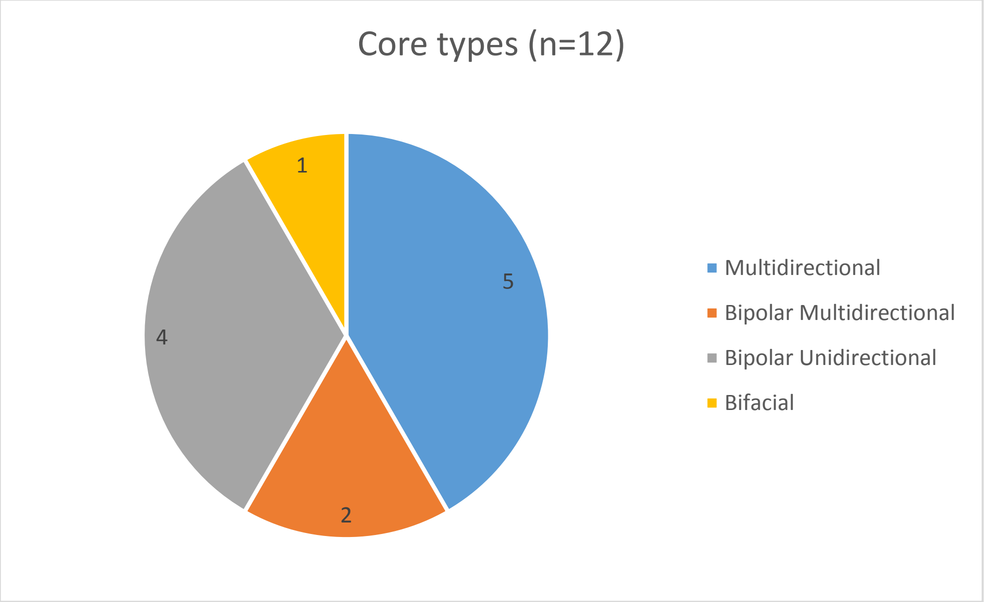


Figure 40: Types of cores in the survey area.

7.2.4 Flaking Strategies: Platform Preparation and Dorsal Scars

RTF and URTF platform measurements were obtained for 2 RTF and 23 URTFs, and these are summarised in Figure 41. Neither of the quartz pieces had intact platforms, and are not included in these calculations. Silcrete artefacts overall had larger platforms than chert artefacts, and the range was larger despite similar medians. The small sizes of chert platforms reflect the overall smaller width of chert flakes.

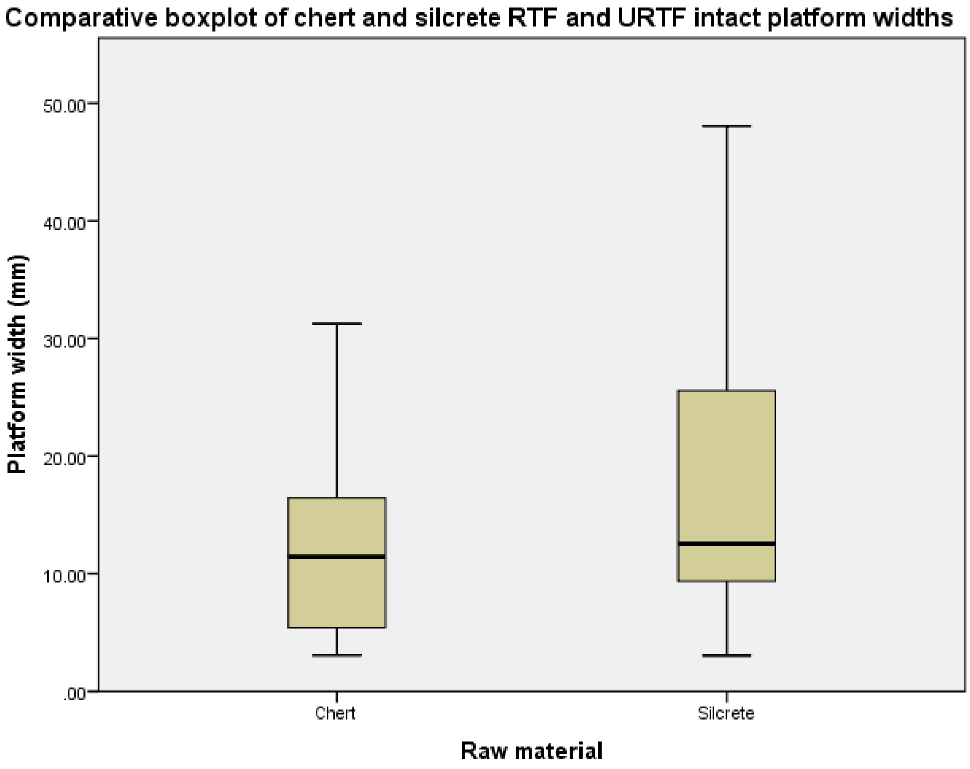


Figure 41: Comparative boxplot of chert and silcrete retouched and unretouched flakes with intact platform widths.

A boxplot was calculated for the same artefacts comparing the thicknesses of the platforms (Figure 42). The majority of chert and silcrete platform thicknesses were the same but chert platforms had a slightly larger range of thicknesses than silcrete platforms.

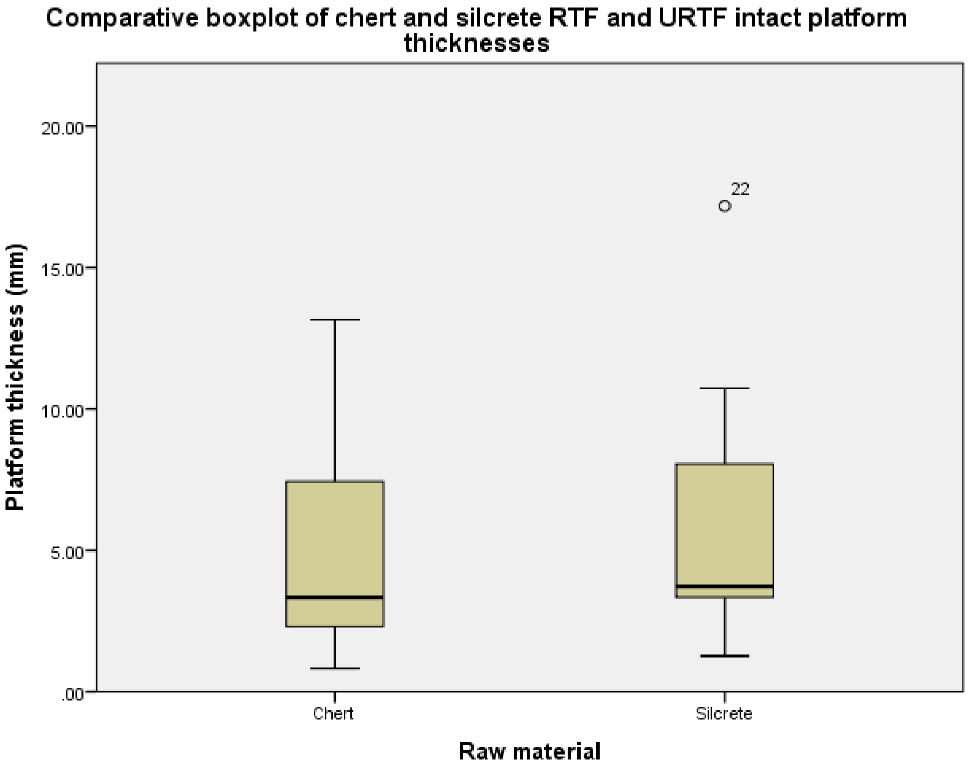


Figure 42: Comparative boxplot of chert and silcrete retouched and unretouched intact platform thicknesses.

The platform surfaces for URTF and RTF chert flakes are presented in Figure 43. The majority (n-13) of platforms were comprised of a single surface, closely followed by shattered platforms (n=12). Multiple surface platforms (n=7) were less common and the only focalised platform identified during the survey was also a cortical surface.

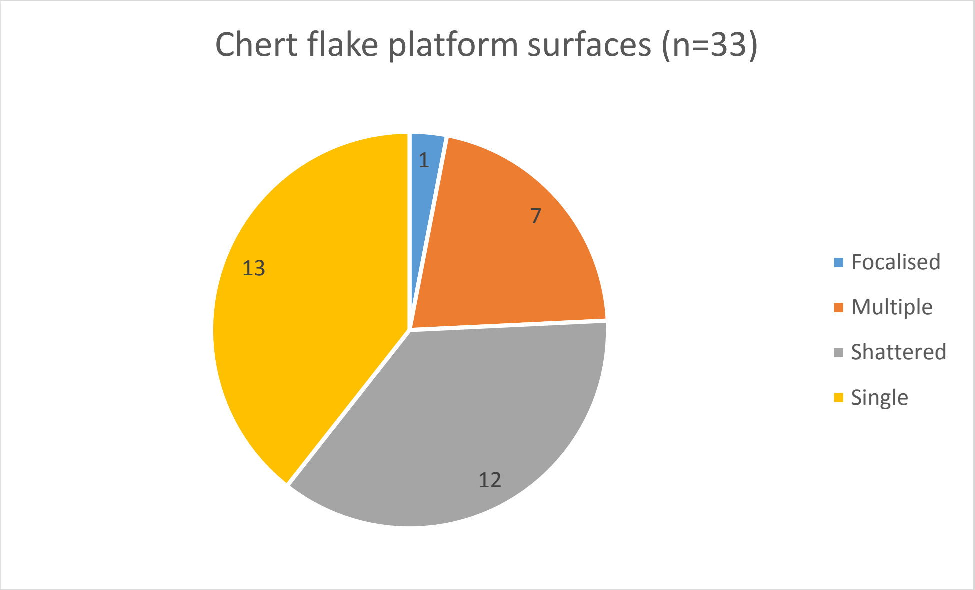


Figure 43: Chert flake platform surface types.

The platform surfaces of 26 silcrete flakes were recorded for the same categories of flakes and are presented in Figure 44. Half (n=13) were shattered, of those that had intact platforms, single surface platforms (n=9) were the next most common. Silcrete flakes showed less diversity in platform surfaces than chert flakes.

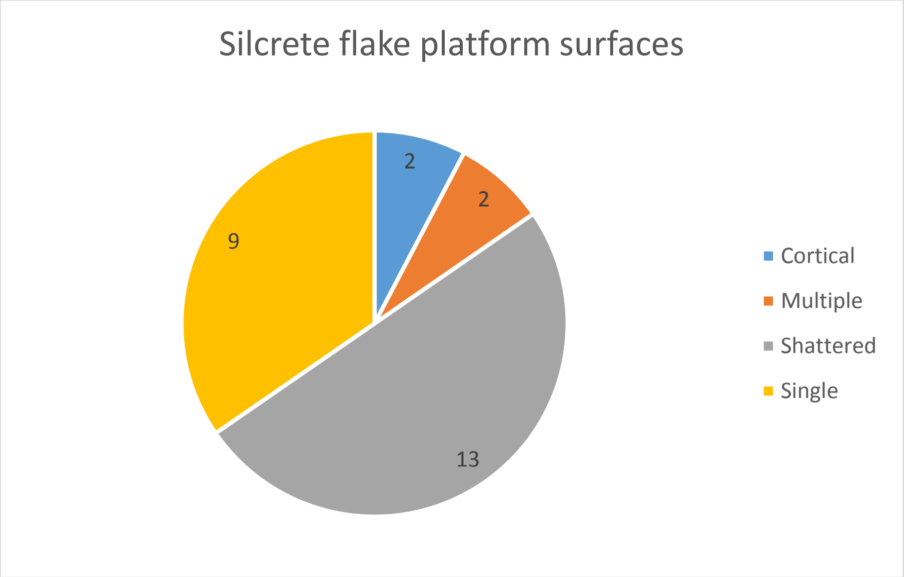


Figure 44: Silcrete flake platform surface types.

The combined results are presented in Figure 45. Overall, shattered platforms are the most common platform surfaces, followed by single surface platforms.

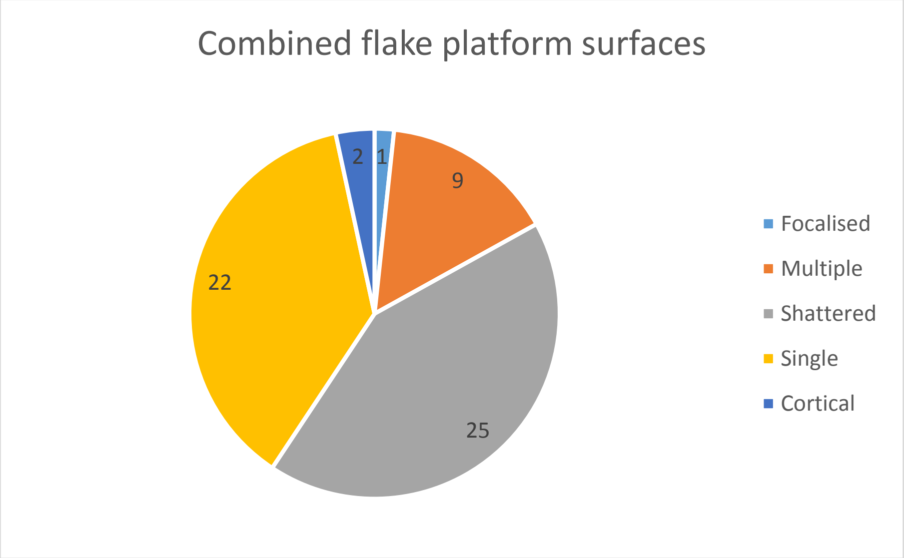


Figure 45: Combined chert and silcrete flake platform surfaces.

Another kind of platform preparation recorded in this study was overhang removal. Of the 43 URTF and 3 RTF (equal numbers of chert and silcrete) that had information about this feature recorded, overhang removal was identified on only six flakes, all of which were chert. Three of these flakes, including a RTF, had multiple platform surfaces.

7.2.5 Cortex in the Assemblage

To calculate the amount of cortex in the assemblage, the heat shatter, non-artefactual and the single grindstone (and one flake recorded as 'unclear') were eliminated from the assemblage, leaving 142 flaked and core artefacts. The percentages of cortex in the flaked assemblage are presented below.

Table 21 summarises the amount of cortex present in the assemblage. The majority of artefacts had no cortex or less than 50% dorsal surface coverage (93%), and only 7% had more than 50% cortex.

Table 21: Rates of dorsal cortex coverage in the flaked and core assemblage.

Dorsal Cortex Rates		
% cortex	**Frequency**	**% of assemblage**
0%	111	78.2
1-50%	21	14.8
51-99%	5	3.5
100%	5	3.5
Total	142	100%

Cortex was also present on the platform surface of seven flakes. The flake type and amount of dorsal coverage is summarised in Table 22. Cortex was also present on the dorsal surface of the majority of flakes (n=5) that also had cortical platforms.

Table 22: Artefact type, completeness, raw material and percentage of cortex for all artefacts with cortical platforms.

Artefact type	Completeness	Raw Material	Platform Surface	% Cortex
URTF	LCSR	Silcrete	cortical/focalised	51-99
URTF	LCSL	Silcrete	cortical	0
URTF	LCSR	Silcrete	cortical	51-99
URTF	LCSL	Silcrete	cortical	100
URTF	LCSR	Silcrete	cortical	100
URTF	Complete	Silcrete	cortical	100
URTF	MarMiss	Silcrete	cortical	0

7.2.6 Dorsal Scars

The dorsal scar results are summarised in Figure 46. There were 51 RTF and URTF complete and partial flakes with dorsal scar information. Of 19 chert flakes, ten showed some core rotation and nine had dorsal scars travelling only in the same direction as the flake.

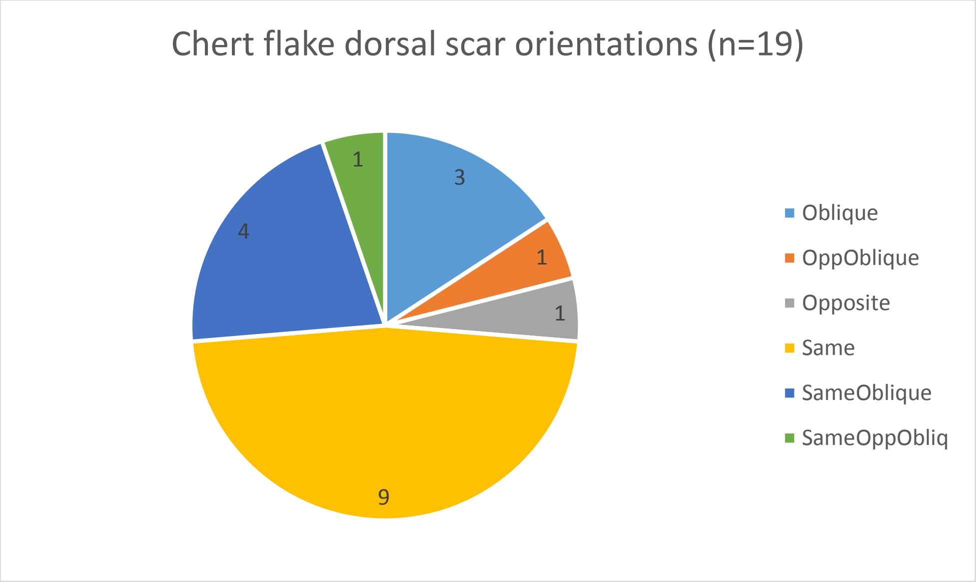


Figure 46: Chert flake dorsal scar orientations.

Figure 47 shows the results for silcrete. Of 32 silcrete flakes, 28 had dorsal scars travelling in the same direction, and only four flakes showed evidence of core rotation.

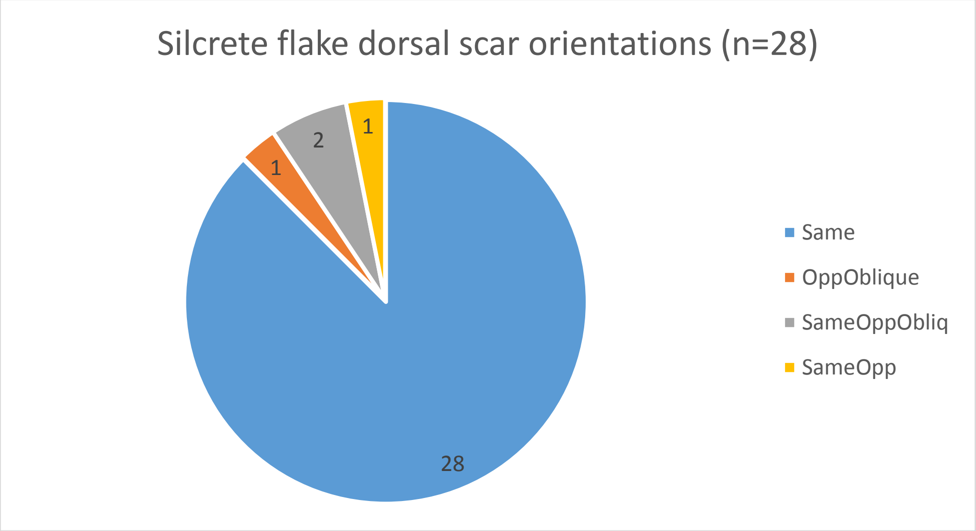


Figure 47: Silcrete flake dorsal scar orientations.

As the quality of raw materials can have an influence on the knapping strategies employed (Andrefsky 2005:24, 224), the same flakes were all reclassified into fine, medium or coarse material, regardless of their raw material, based on the field entries relating to the raw material comments. The same analysis was then repeated for the fine and medium grained raw materials, demonstrated in Figures 48 and 49. Only six flakes classified as coarse had dorsal scar directions recorded and in all cases the direction of percussion was the same as the flake. The majority of flakes exhibited dorsal scars travelling in the same direction as the flake, but there was more diversity in dorsal scar orientations in fine-grained materials than medium- and coarse-grained materials.

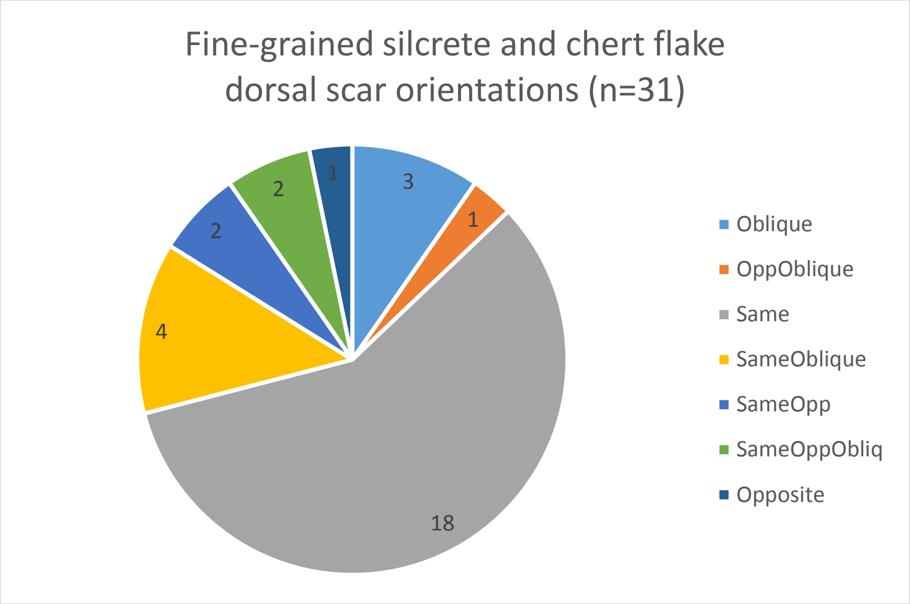


Figure 48: Fine-grained silcrete and chert flake dorsal scar orientations.

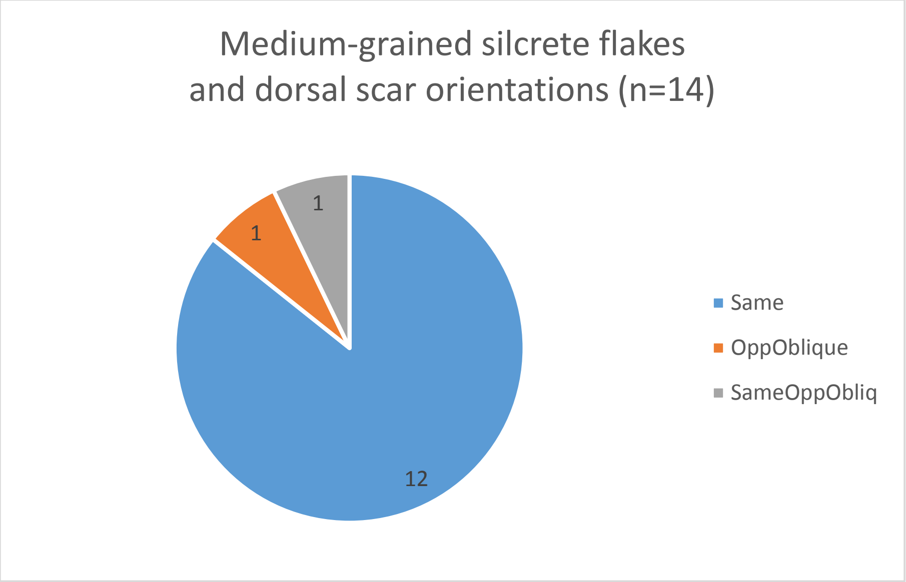


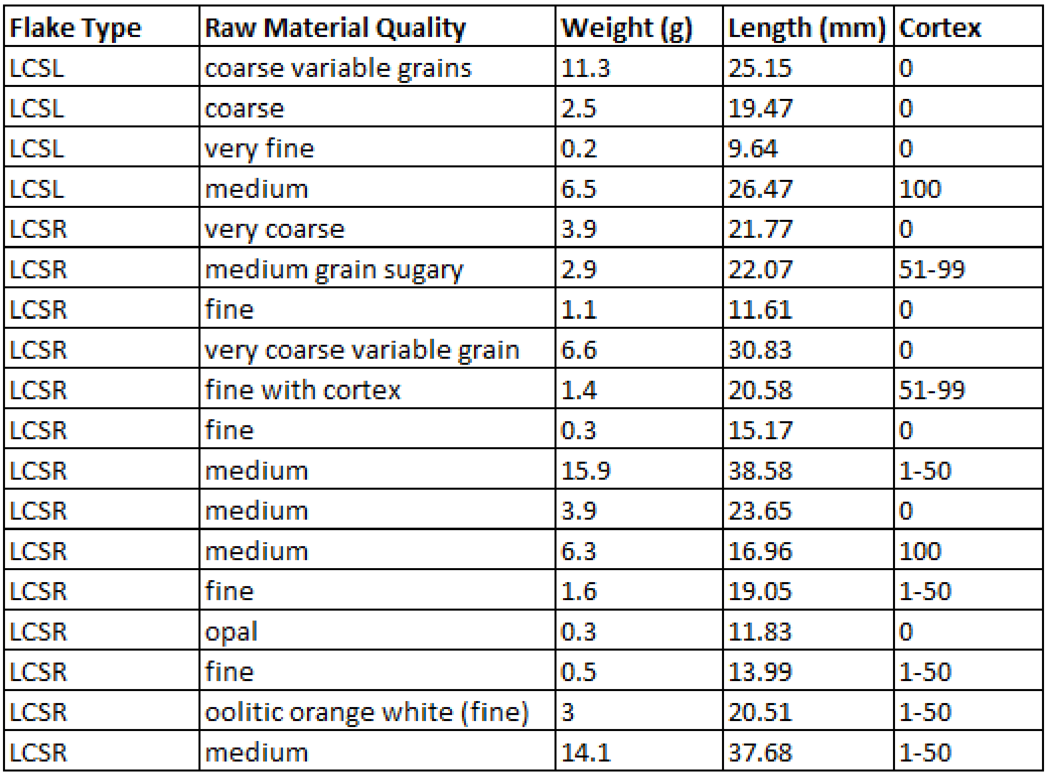
Figure 49: Medium-grained silcrete flakes and dorsal scar orientations.

Combining platform surfaces and dorsal scar information, only seven RTF and URTF flakes that had complex platform surfaces also had dorsal scar information. Of these seven, three also had complex dorsal surfaces.

7.2.7 Cone Split Flakes

Table 23 shows information about the cone split flakes, including which side of the flake was present, raw material quality, weight, length and the amount of cortex present. This table shows that an unusually large proportion of the cone split flakes were right flakes. There was also a relatively high proportion of cortex (50%) present in this subset.

Table 23: Longitudinal cone split flakes raw material quality, length and amount of cortex.



Flake Type	Raw Material Quality	Weight (g)	Length (mm)	Cortex
LCSL	coarse variable grains	11.3	25.15	0
LCSL	coarse	2.5	19.47	0
LCSL	very fine	0.2	9.64	0
LCSL	medium	6.5	26.47	100
LCSR	very coarse	3.9	21.77	0
LCSR	medium grain sugary	2.9	22.07	51-99
LCSR	fine	1.1	11.61	0
LCSR	very coarse variable grain	6.6	30.83	0
LCSR	fine with cortex	1.4	20.58	51-99
LCSR	fine	0.3	15.17	0
LCSR	medium	15.9	38.58	1-50
LCSR	medium	3.9	23.65	0
LCSR	medium	6.3	16.96	100
LCSR	fine	1.6	19.05	1-50
LCSR	opal	0.3	11.83	0
LCSR	fine	0.5	13.99	1-50
LCSR	oolitic orange white (fine)	3	20.51	1-50
LCSR	medium	14.1	37.68	1-50

7.2.8 Retouched Flakes and Grindstone

Ten retouched flakes were identified during the survey. Retouched flake lengths were mostly smaller than 20 mm, and the average retouched flake was 21 mm. Of the ten retouched flakes six were complete and averaged 23 mm in length. The four fragmented RTF averaged 17 mm in length. Seven retouched flakes had amorphous retouch on one or two margins, only three had consistent retouch around all three margins (including the RTF described in Figure 43), and only one of these featured the steep retouch commonly associated with scraping activities.

Figure 50 shows an adze flake which has been reduced to the edge of one platform with steep retouch at 90˚ to the ventral and dorsal surfaces, initiated from the dorsal surface due to a large inclusion on the ventral surface. The bulb on the ventral surface was interrupted by the inclusion. The dorsal surface does not appear to have any dorsal scars. The platform was formed from two broad surfaces meeting at an obtuse angle.


Figure 50: Adze flake, from left to right: dorsal, ventral (with inclusion) and retouched edge. All photos J. Thredgold 2015.

Figure 51 shows a silcrete grindstone fragment, which exhibited two ground surfaces indicating seed grinding activities. The grindstone fragment measured 35 mm by 33 mm, and also had evidence of use as a hammer (in the form of pitting and crushing on the corner) and an anvil (in the form of pitting, crushing and incipient cones on the flatter areas and ground surfaces), pointing to multiple uses for the one tool. Although the un-fragmented stone would still have been relatively small, it is unclear where a cobble of this size would have originally come from. Both of the fracture surfaces have subtle indications of Hertzian initiations, one negative scar on the broad surface and one positive on the narrow surface, but the bulbs are unclear, suggesting these fractures formed primarily as a result of cracks in the raw material or incipient fractures incurred during use.


Figure 51: Grindstone/hammer/anvil fragment. All photos J. Thredgold 2016.

7.3 Evidence of Taphonomic Processes at the Mounds

7.3.1 Surface Disturbances

No artefacts were found on the billabong bed. There are several reasons why this might be the case. Figure 52 shows that there were numerous animal (predominantly emu and kangaroo) footprints pressed deep into the bed when it was soft. If artefacts were present, they may have been trampled below the surface during periods when it was soft.

Figure 52: Emu footprint in the Reny Island billabong bed. Photograph J. Thredgold, September 2015..

Figure 53 also shows multiple animal footprints visible in a clay area of the Reny Island billabong margin, indicating the intensity of animal visitation to the billabong margin each time the billabong holds water. No artefacts were identified in the section of margin indicated in this photo.

Figure 53: Animal trampling of the Reny Island billabong margin. Photograph J. Thredgold, April 2016.

Additionally, the bed of the Reny Island billabong was formed of grey gilgai clay that formed wide and deep cracks during dry periods which would allow any artefacts on the surface to fall below the surface if disturbed. It is also possible that there are no artefacts in the billabong bed because none were deposited there. Although this seems somewhat unlikely, it is also possible that the billabong was filled with *Typha* spp. stands which would have made it difficult to access. It is also possible that sedimentation from flood events has covered any discarded artefacts. Two observations from the survey support this possibility; alluvium was noted covering several mound areas during the survey; and artefact pedestalling was not observed during the survey, indicating that wind erosion has not removed surface sediments.

Artefacts were identified only on the verges of the flat base of the billabong bed. These artefacts may have been deposited at that location, or they may have been disturbed by human or animal activity and knocked from the bank down onto the edges of the billabong (Petraglia and Potts 1994:230), or moved there by water (Fanning and Holdaway 2001:681–683).

7.3.2 Artefact Inclination

The inclination of artefacts was measured for all artefacts, following Eren et al. (2010). Three categories of inclination were included on the form: flat, angled and vertical. In all instances, the artefact was found flat on the ground. As some of the study areas, particularly around the Reny Island billabong, were also surveyed by field school participants, it is possible that the surface orientation was disturbed by the participants. However, the majority of artefacts measured were not identified by other participants, and were all flat.

7.3.3 Flake Fragmentation

Given Amick and Mauldin's (1997) findings that, during knapping, there will be more proximal or step terminating flakes made from coarser raw materials, and that finer raw materials will have fewer proximal and step terminating flakes, these categories of flakes were analysed. As described previously, the URTF, RTF, NDS and FP flakes were all reclassified into fine, medium or coarse material based on the field entries relating to the raw material comments. There were 85 fine, 27 medium and 18 coarse quality flakes. All URTF flakes that did not have feather or hinge terminations were selected. This produced a set of 45 fragmented flakes such as LCS, proximal and medial fragments. Figure 54 demonstrates the distribution of the raw material quality for all broken flakes and flake fragments, and shows that the majority of fragmented flakes were manufactured from finer quality material.

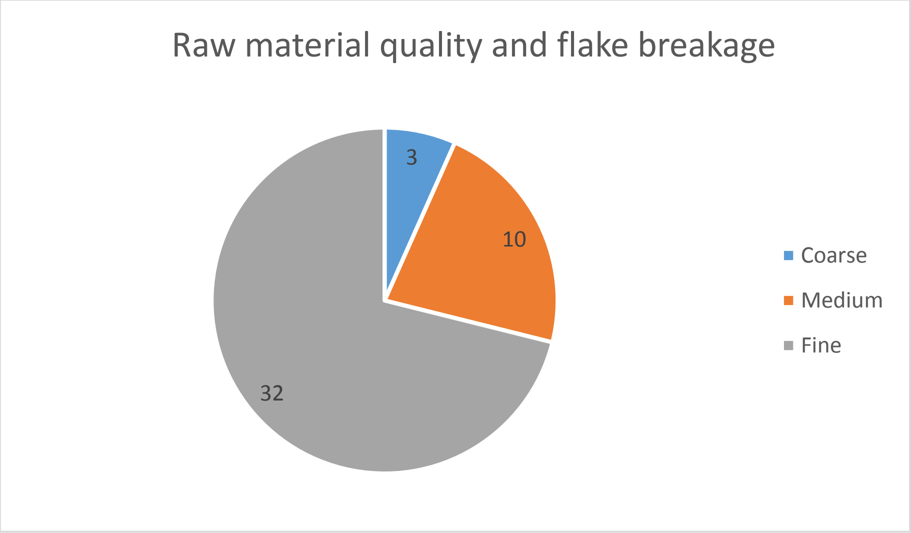


Figure 54: Raw material quality of broken flakes.

Figure 55 presents similar information for the proportions of broken and complete flakes manufactured from fine raw materials. This is repeated for both medium and coarse quality raw materials in Figures 56 and 57.

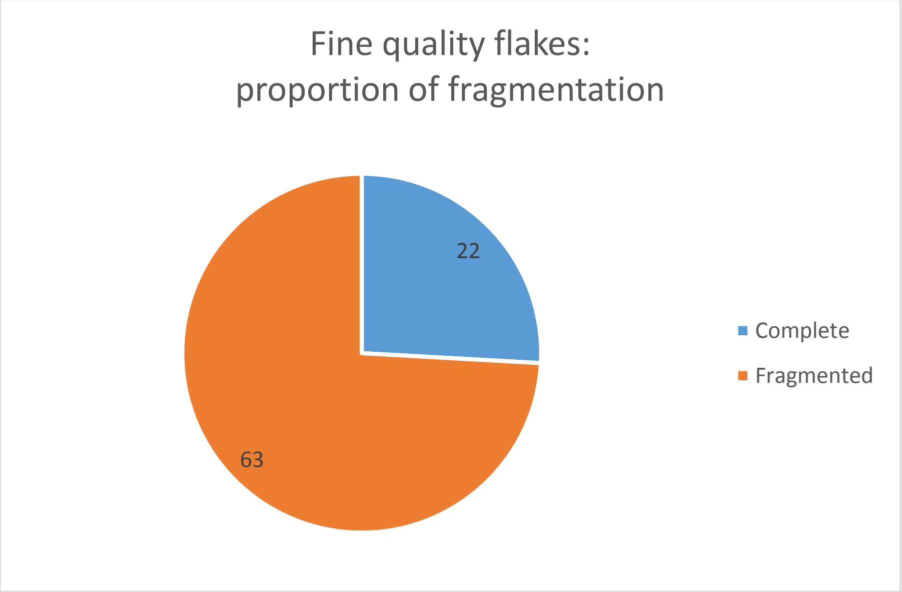


Figure 55: Proportion of fine quality broken and complete flakes.

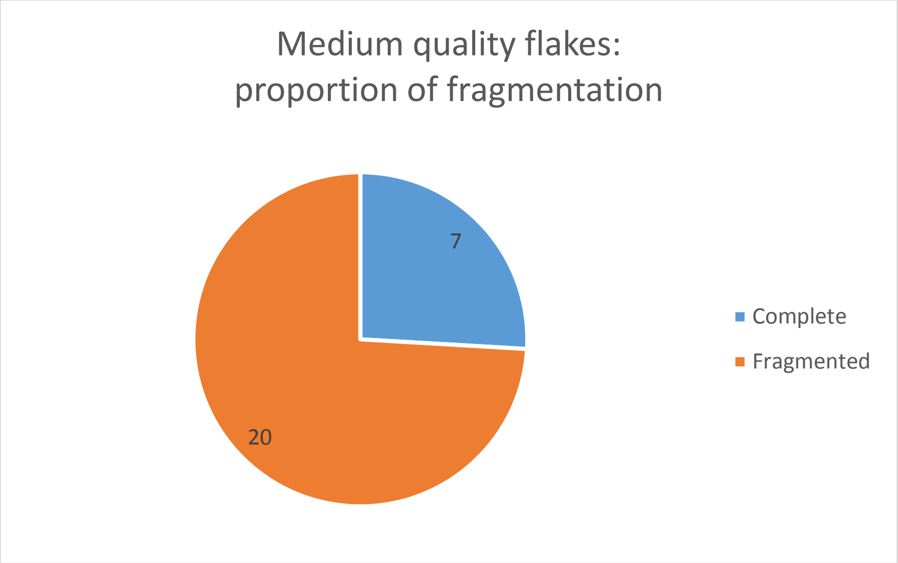


Figure 56: Proportion of medium quality broken and complete flakes.

The level of fragmentation was roughly one quarter of the assemblage regardless of the level of quality of the raw material, however coarse raw materials had proportionally slightly lower levels of breakage, as shown in Figure 57.

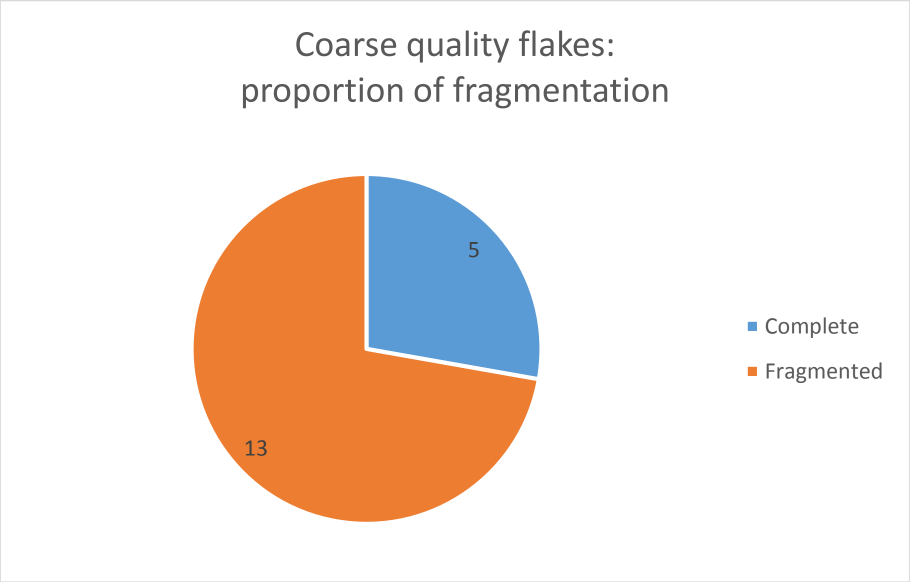


Figure 57: Proportion of coarse quality complete and broken flakes.

Figures 58 demonstrates flake breakage patterns found in the assemblage. Flakes can fracture transversely or longitudinally, and both kinds of fracture can be present on one flake. There were similar levels of transverse and longitudinal fracture, with a smaller amount of combined fractures.

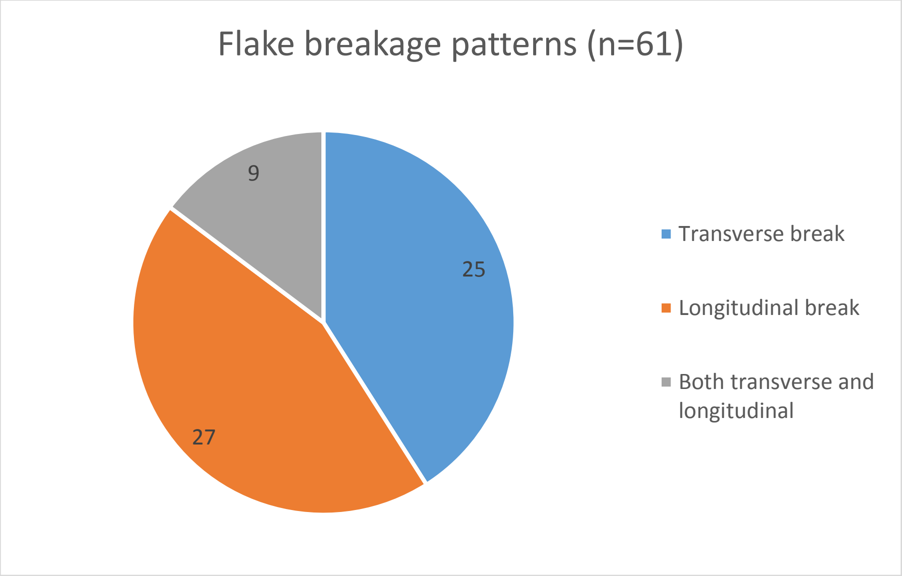


Figure 58: Breakage patterns of flakes.

Edge damage was recorded on 30 URTF, RTF, FP and NDS. The proportions of complete and broken flakes with edge damage, broken down by raw material, are demonstrated in Figure 59. The total number of flaked artefacts in this assemblage was 131, 23% of this assemblage displayed edge damage. Edge damage was noted only on flake margins and not on the dorsal ridges of artefacts, as may sometimes occur (Douglass and Wandsnider 2012:359; McBrearty et al. 1998:124).

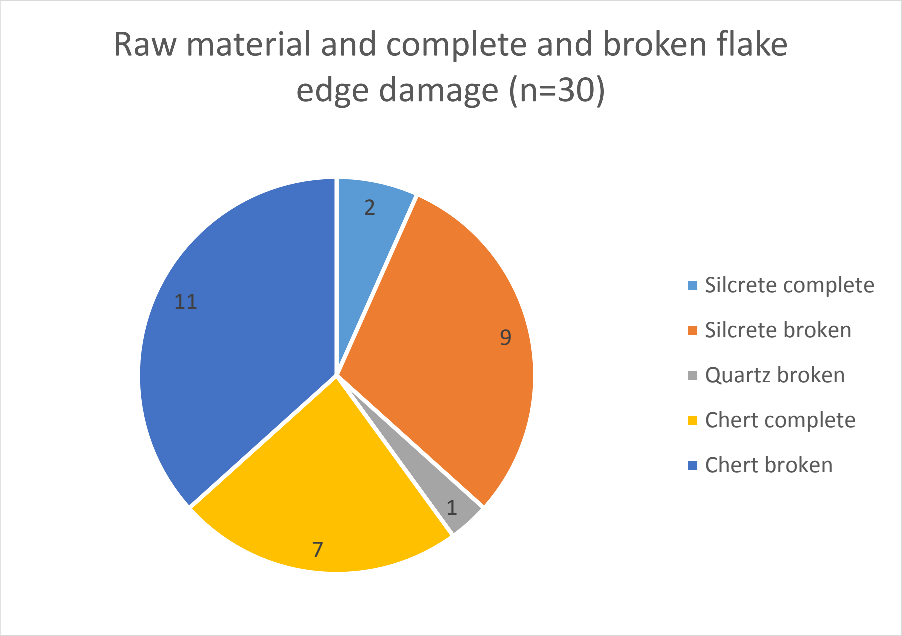


Figure 59: Raw material complete and broken flake edge damage rates.

7.3.4 Other Taphonomic Processes

Artefacts smaller than 20 mm are most likely to be subject to taphonomic processes that remove them from assemblages (Cane 1982; Hiscock 1985; Fanning and Holdaway 2001:681–683; Petraglia and Potts 1994:231 Solomon et al. 1986). The number of artefacts, flaked or otherwise, that had lengths and widths recorded was 127. 76 artefacts, or 60% of this subset, had both lengths and widths measuring less than 20 mm. As artefacts < 20 mm are such a large percentage of the assemblage, they are not lacking in this size category. There were no artefacts recorded in the survey areas smaller than 5 mm in both length and width. The absence of artefacts with maximum dimensions less than 5 mm, complete or fragmented, can indicate that the assemblage has been affected by water flows, but can also indicate that knapping did not occur on-site (Petraglia and Potts 1994:233).

7.3.5 Heat Shattered Stones and Heat Affected Artefacts

Heat treatment was not recorded in the field and was not examined in this study as it was not possible to assess the local raw material stone sources as part of this study, a necessary step in determining whether artefacts have undergone heat treatment prior to flaking (Gregg and Grybush 1976:191–192; Purdy and Brooks 1971:324).

Prior to conducting the survey, research had indicated that stone would be relatively uncommon in the vicinity and that clay would have been used as heat retainers instead of stone (Westell and Wood 2014). For this reason, heat damaged stone was not anticipated. During the survey, many heat shattered fragments of very coarse silcrete and resilicified sandstone were identified, in addition to heat affected fragments of stone that appeared, based on raw material quality and thinness, to have once been artefacts. The decision was made to stop measuring heat shattered rock with no other diagnostic information in preference to artefacts containing more information. This decision was made due to time constraints after the second field day, when close to one third of the stones recorded were heat shattered stone with no other diagnostic features. Heat shattered stone recording was resumed regardless of diagnostic features in the 2016 field season. Heat shattered rock and heat affected artefacts were distributed all around the edges of the Reny Island billabong and some of the mounds, and were not exclusively associated with the earth mounds.

The heat shattered, friable, very coarse silcrete or resilicified sandstone, as shown in Figure 60, was blue, purple and red, with variable grain sizes. There was no evidence of conchoidal fractures on any fracture surfaces, which all appeared to be crenated fractures created by heating and/or cooling the stone too rapidly (Purdy 1975:138).

Figure 60: Examples of heat shattered stone from the survey areas.

Heat damage to artefacts was noted in the general comments**.** Figure 61 shows examples of heat affected artefacts. Crazing, potlidding (or spalling) and crenated fractures were all identifying features of heat damage to the artefacts. These kinds of heat damage mean that the internal structure of the stone has been altered such that the stone will no longer fracture conchoidally, indicating that the heat damage occurred after the artefacts were knapped (Purdy 1975:135–136).

Figure 61: Examples of heat affected artefacts from the survey areas.

The whole assemblage numbered 195 artefacts, of these 69, or 35% of the assemblage, were heat shattered stone and heat affected cores and flakes (although some of the heat shattered stones were not recorded). Of these, 20 (10%) were cores or flakes and 49 (25%) were heat affected rock. The total number of cores was 12, four of which were heat affected. No complete flakes showed signs of heat damage; correspondingly all 16 of the heat affected RTF and URTF were also flake fragments.

7.4 Comparisons of the 'Mound Associated' and 'Between Mounds' Assemblages

Table 24 shows the number and condition of artefacts that were found on or within ten metres of the outer extent of the earth mounds. The total number of artefacts, and the number of artefacts that were heat affected is also shown. The highlighted entries contain heat affected artefacts also associated with an earth mound. In order to examine overall patterns of association between heat affected stones/artefacts and earth mounds, the mound locations and dimensions, as recorded by Jones (2016) were entered into ArcGIS, and buffers around the external mound dimensions were created at five and ten metre intervals. The fine to medium quality raw material artefacts numbered 28, of which five (17.9%) were heat affected. Unfortunately, due to the cessation of heat shatter recording in the early stages, the number of heat shattered stones is incomplete, making it difficult to draw conclusions about this set. However, during the periods when heat shatter was being recorded, four mounds out of ten did not have associated heat shatter, indicating that the heat shatter was not a consistent feature on mounds. Furthermore, of a total 41 pieces of heat shatter were recorded (not including fine-grained materials for which there were no identifying features) but only 11 pieces were associated with mounds. It is also worth noting that Reny Island billabong 6 was associated with a chert retouched implement and a small silcrete core, and was in the vicinity of the only scar tree at the billabong.

Table 24: Distribution of artefacts and heat shattered rock associated with mounds. Highlighted entries indicate heat affected artefacts associated with mounds. Mound descriptions

Mound ID	**Description**	**Total Number of Artefacts (HS not included)**	**Number of Heat Affected Artefacts**	**Number of Heat Shatter**	**Notes**
RIBB2	Above ground hearth/oven	0	-	0	
RIBB3	Oven mound	0	-	0	
RIBB4	Oven mound	3	1	0	Ceased recording HS
RIBB5	Oven mound	2	1	0	
RIBB6	Oven mound	2	2	0	RTF and core
RIBB7	Natural - Levy edge	2	0	0	
HCN23	Oven mound	0	-	1	Resumed recording HS
HCN22	Oven mound	1	0	2	Core
HCN21	Oven mound	3	0	2	
HCN20	Oven mound	3	0	2	
HIBB15	Oven mound	0	-	0	
HIBB16	Oven mound	1	0	0	
RRCE12	Oven mound	4	1	0	
RRCE14	Oven mound	1	0	4	

Table 25 shows the distribution of raw material types at the mounds. Mounds had higher percentages of associated chert flakes than non-mound areas.

Table 25: Dominant raw materials for mound associated and not associated assemblages.

Mound Associated			**n=33**				
All artefacts		**%**	**Excluding HS**		**%**	**Total heat affected/HS**	
Chert	16	49%	Chert	12	36%	Number	% of total
Silcrete	17	51%	Silcrete	6	18%	n=15	45%

Mound Not Associated			**n=162**				
All artefacts		**%**	**Excluding HS**		**%**	**Total heat affected/HS**	
Chert	61	38%	Chert	55	34%	Number	% of total
Silcrete	91	56%	Silcrete	68	42%	n=54	33%
Other	10	6%	Other	2	1%		

8. Discussion

This chapter discusses and contextualises the results that were presented in Chapter 7. It evaluates the results in light of the studies discussed earlier regarding taphonomic disturbances and indications of residential mobility. The final sections describe the relationships between the mounds and the artefacts, and the limitations of this study.

8.1 Raw Material Quantification and Measures of Reduction

A total of 195 stone artefacts were recorded in the study area. Of these, 144 were flaked artefacts. The greater majority of the stone artefacts were unretouched flakes, confirming Westell and Wood (2014:53) finding that artefacts associated with the mounds were almost exclusively unretouched flakes.

Silcrete was the dominant raw material in the assemblage, only slightly by number but overwhelmingly by weight both for the entire assemblage and for the flaked assemblage. Chert flakes, whilst almost matching silcrete in number, were both thinner and shorter than silcrete flakes (Figures 25, 32 and 34), and chert cores were also much smaller than silcrete cores (Figure 32). It is likely that this is due parent core sizes, although this would need to be confirmed by a survey of the raw material sources. Both the length and thickness boxplots (Figures 26 and 28) indicate that the silcrete artefacts were larger and thicker overall than the chert artefacts. This is also supported by the thickness measurements, suggesting that the parent silcrete cores were larger than the parent chert cores.

Two pieces of milky quartz were recorded, one was an amorphously retouched flake and the other had no diagnostic features. Quartz sources have not been identified in the Riverland region, and given that quartz was nonetheless an important raw material in the region, used for ceremonial purposes and in composite tools or weapons, it is likely to have been imported into the area (Angas 1847:93; Eyre 1845:306, 309; Grist 1995:10, 57).

All but three cores in the study area were smaller than 40 mm in both length and width (Figure 37), and correspondingly, the same was true for the negative flake scars (Figure 38). Chert cores outnumbered silcrete cores 7:5, and the three largest chert cores were similar in size to the smallest silcrete core. There could be a number of reasons why this might be the case—chert cores were possibly flaked more intensively than silcrete cores, or chert occurred in smaller parent nodules than silcrete, or the flaking properties of chert allowed it to be flaked to smaller cores than silcrete.

The chert and silcrete flake lengths were compared to the negative core scar lengths in Figure 39, indicating that the negative scars were slightly larger than the complete flakes. This suggests that cores were generally subject to more intensive reduction than the cores found on site. The lengths of the negative scars on the chert cores was generally the same or close to the core lengths, whereas the silcrete cores were considerably longer than the flakes that were removed, suggesting that the chert cores were flaked to exhaustion in most cases, or close to it, whereas silcrete cores were not. This suggests that is possible that the chert cores were part of a personal provisioning system and were discarded in the final stages of reduction, whereas the silcrete cores were part of a site provisioning system and left on site to provide expedient flakes when required. Furthermore, despite the small sizes of the cores, Figure. 39 shows that for chert, the size of the negative scars is roughly equivalent to the size of the flakes. This is not the case for the silcrete flakes, where the majority of flakes are smaller than the scars on the cores, which also indicates that the silcrete cores in the survey area were in the early stages of reduction.

8.1.1 Cortex in the Assemblage

The form in which rock was introduced to the study area was difficult to determine, however the cortex that was present in the assemblage indicates some patterns. The chert assemblage had a white or grey chalky cortex that also lined voids in the raw material. The silcrete in the assemblage appears to grade from sand to sandstone to silcrete. Grist’s (1995) description of Berribee Quarry 1 indicates that chert outcropped in thin bands up to approximately 60 mm thick (Grist 1995:36, 44). The silcrete band was estimated to be around 7500 mm, variable in quality, ranging from coarse sandstone to patches of good quality silcrete that had been targeted for quarrying, and also ranging in colour, including dark purple, yellow, red, brown, orange and grey (Grist 1995:35–36, 44). This is consistent with the raw material found at Calperum Station.

The low rates of cortex in the assemblage (Table 20) suggest two possibilities. Following the source to discard model proposed by Doelman et al. (2001), it suggests that the raw materials were obtained at some distance from the study area, which would have accounted for the small size of the artefacts and the low levels of cortex (Doelman et al 2001:29; Hiscock 1988:81-82, 113). Alternatively, the raw material occurred in medium to small sizes and did not exhibit much cortex. Grist (1995) does not discuss the kinds of cortex or nodule sizes found at the Berribee quarries, but it is worth noting that there were no consistent patterns of distance decay in the cores found on either the inland or the up-river transects that were carried out from the Berribee Quarries, and Grist (1995:65–67) proposed that locally available sources may have contributed to this result.

It has already been established that small flakes and cores are common in the Murray-Darling Basin and are frequently the product of small raw material nodules (Johnston 2004:55; Klaver 1998:203; Martin 2006:130). Johnston (2004:55–56) found that the use of small cores that rarely had identifiable cortex meant that there were low levels of cortex overall. Klaver (1998:203) found that the use of small quartz pebbles meant that only small artefacts could be produced and that there were large amounts of cortex in the assemblages. Martin (2006:130) found variable rates of cortex in surface and excavated assemblages, but also found extensive use of pebbles and small nodules as stone raw materials. This led Martin (2006:130, 218) to argue that the large numbers of small cores and artefacts, and overall low levels of cortex were not the result of distance decay but directly the result of small, imported raw materials.

Given the findings of other researchers, it is clear from the lack of cortex that the stone artefacts in the study area were not manufactured from small pebbles. Beyond that, it would be necessary to have a more detailed understanding of the sources and nature of the stone raw materials used at Calperum Station, and the forms in which they outcrop, before these results can be properly assessed. However, given the relatively small core and flake sizes described by Grist (1995:75-76), the closest stone artefact analysis in the region, the proximity of his study to a large quarry, and the frequency of quarries along the Murray River valley, the results tentatively suggest that small parent rocks with little cortex, rather than a distance decay model, led to small flakes and low levels of cortical coverage in the study area.

8.1.2 Flaking Strategies: Platform Preparation and Dorsal Scars

Platform widths (Figure 41) and thicknesses (Figure 42) were plotted for the two raw materials. Overall the results were very similar, but as the silcrete flakes were generally larger than the chert flakes, larger platform thicknesses were anticipated for silcrete. As the thickness of the platform is generally also associated with the size of the flake, where an increase in the thickness of the platform generally results in a longer flake (Pelcin 1997:752), the slightly larger range of chert platform thicknesses and overall similarity in this measurement was surprising. It is possible that the core surface morphology was a factor in the platform thicknesses, as Pelcin notes that in order to maximise the length of a flake being removed from a broad core face (as opposed to a blade core), it is necessary to increase the platform thickness (Pelcin 1997:752), however it is difficult to reconcile the overall similar flake thicknesses with the overall larger dimensions of the silcrete flakes.

Platform preparation does not appear to have been common in the study area. The majority of flakes that had intact platforms were flaked from single surface platforms, most likely to have been the negative surface of a previous flake removal. Although more complex platforms were rare (Fig. 45), they were more common on chert flakes than silcrete (Figures 43 and 44), suggesting more intensive reduction of chert cores than silcrete. More complex forms of platform preparation such as faceting or abrasion were not employed in the study area.

A different kind of platform preparation technique, in the form of overhang removal, was also identified in the study area, although only six flakes featured evidence of this strategy, all of which were chert. Three of these six flakes also had multiple platforms, including one RTF, suggesting that this strategy was not commonly employed in the study area, and was used only on the finer-grained raw materials.

Dorsal scars can also provide information about the kinds of knapping strategies that have been employed during core reduction. Chert and silcrete cores appear to have been treated differently, with roughly half the chert flakes showing evidence of core rotation (Figure 46), compared to very few of the silcrete flakes (Figure 47). An alternative way of approaching this measure is to examine whether there were any differences in the way that fine- and medium-grained materials were treated. The dorsal scars indicated that core rotation of fine quality raw material was more common than core rotation of medium-grained materials, but overall unidirectional flaking was the most common strategy employed. Generally, cores of fine-grained materials were subjected to more rotations that poorer quality materials (Figures 48 and 49).

8.1.3 Cone Split Flakes

In total, 18 longitudinally cone split flakes (LCS) were identified, 15 of which were in the vicinity of Reny Island billabong (Table 23). Cone split flakes are generally regarded as knapping debitage related to the early stages of core reduction (Doelman 2005:56) and are unlikely to occur as a result of taphonomic processes (Hiscock 1989a:365-366), which suggests that knapping was occurring around the billabong. If this were the case, it would be expected that both halves of the flakes would appear in the assemblage, i.e. that there would be roughly equal numbers of left and right cone split flakes. 14 out of the 18 cone split flakes were LCSR pieces, only four were LCSL. Only one LCSR flake was found in association with other flake debitage and the parent core. The LCSL half was not present. This was the only knapping floor identified in this study, and it was located roughly 50 m away from RIBB7 and the billabong margin in a nearby scald. If trampling were the cause of the surface absence of these flakes, again, it would be expected that there would be roughly equal numbers of both left and right LCS flakes. Five of the seven artefacts with cortical platforms were also LCS flakes. This is consistent with Doelman's (2005:56) finding that cone split flakes were knapping debitage associated with the early stages of knapping, however, the majority of LCS flakes did not have cortical platforms or dorsal surfaces.

The uneven ratio of left to right LCS flakes is unexpected and difficult to contextualise in light of the assemblage size. It is possible that there was knapping at the billabong and LCSL were preferentially removed and transported elsewhere. This hypothesis is supported by small amounts of evidence of knapping at the billabong, such as several exhausted cores and a chert knapping floor 50 m from the billabong. However, evidence for knapping is also absent in that much of the small knapping debris is either missing or was too small to be identified during the survey; despite the number of cores there was only one knapping floor, and there was a very diffuse distribution of artefacts which may be explained by site cleaning activities (Binford 1986:553; O'Connell 1987:81–82). Alternatively, the flakes may have been made elsewhere and LCSR flakes were preferentially brought in to the billabong, or were lost by chance through trampling in greater numbers.

8.1.4 Retouched and Ground Artefacts

Several artefacts have typological classifications and corresponding functional descriptions. Although they are low in number, the retouched and ground artefacts can provide insight into the kinds of activities being carried out at and around the earth mounds. The majority of artefacts identified as having been retouched during the survey did not resemble any formal types and exhibited irregular retouch. Only one RTF resembled a formal implement, and was classified as an adze flake on the basis of invasive and steep, 90˚ retouch across the distal and left margins (Fig. 50) (Holdaway and Stern 2004:258–9). Adzes are associated with woodworking (Holdaway and Stern 2004:252;

Kamminga 1982; McCarthy 1967:27–28) and as it was found in the vicinity of the billabong, it suggests woodworking activity at that location. If woodworking using an adze was an activity commonly carried out at the billabong, it is likely that there would be more evidence of this, in the form of more discarded adze flakes. The adze was manufactured from high quality chert and did not show any signs of heat damage.

The grindstone fragment was formed from a rounded silcrete cobble, and showed evidence of grinding on two surfaces as well as use as a hammer and anvil (Figure 51). Grindstones are associated primarily with seed processing, but also ethnographically and through residue studies with a variety of food processing activities such as bone and cartilage pulverising, meat pulping, seed husk removal, fibrous root and vegetable processing, fruit paste preparation, and bone cracking to obtain marrow (Fullagar et al. 1999:15–16; Gorecki et al. 1997:142; Smith 1985:23–24). They were also used in some activities unrelated to food processing, such as ochre grinding, sharpening or smoothing wooden tools, stone axe sharpening, and resin and bush tobacco preparation (Gorecki et al. 1997:142; Smith 1985:24). Hammerstones and anvils, primarily used for knapping stone (Holdaway and Stern 2004:11–12), have the same food processing task associations as described for grindstones (Fullagar et al. 1999:16, 21). The presence of a multipurpose tool such as a grindstone/hammer/anvil at the billabong suggests both knapping and food processing activities may have taken place in the vicinity, consistent with both the presence of cores and the earth mounds. As with the adze, if grindstones/hammers/anvils were being used in the vicinity of the billabong or other food processing areas, why is there only one fragment present? Given the rarity of stone in the study area, it is likely that an object such as a grindstone/hammer/anvil would be highly curated, if observations from other areas also apply to the Riverland region (Horne and Aiston 1924:53–55), and furthermore as a large artefact, they are more visible in the landscape and likely to have been collected by Europeans (see Casey 1973; Midgley et al. 1998).

The absence of backed artefacts is not surprising given that they have not been identified in other regional studies (Casey 1973; Gill 1973:89) and are more commonly found in archaeological contexts dating between 4500–1500 BP (Attenbrow et al. 2009:2765; Frankel 1991:24; Hiscock and Attenbrow 1998:59), suggesting they are unlikely to be found in surface assemblages, particularly on the Calperum Station floodplain. The absence of other kinds of formal types is not unusual generally for sites in the Murray-Darling Basin (Balme and Beck 1996:40; Bonhomme 1990:73; Coutts and Witter 1977:62–66; Coutts et al. 1979:57; Gill 1973:89; Klaver 1998:217; Westell and Wood 2014:53) and supports Westell and Wood's (2014:49) suggestion that in the Riverland, earth mounds were single activity sites.

8.1.5 Comparisons with Stone Artefact Findings from other Mound Surveys:

The results of this survey are summarised and compared with results from other mound studies reviewed in Chapter 3, and presented in Table 26. The comparisons indicate that small flakes sizes are a common feature of earth mounds in the Murray-Darling Basin, even when there are sources of raw material available nearby. Bipolar flaking strategies were also common, as was occupation of the earth mounds. Table 26 also shows that where stone was available in the area, it was also used as heat retainers.

Table 26: Comparisons with stone artefacts findings from other Murray-Darling Basin mound surveys. Ticks indicate instances where the results matched the statement. Dashes indicate that the statement does not apply.

Comparisons with Stone Artefact Findings from other Mound Surveys:

Study authors:	Bonhomme 1990	Balme and Beck 1996	Coutts et al. 1976	Coutts et al. 1979	Johnston 2004	Klaver 1998	Littleton et al. 2013	Martin 2006	Williams 1988	Westell and Wood 2014	This study
Location: *Yellow highlights indicate studies where excavations were conducted.	Barmah Forrest, Vic.	Macquarie Marshes, central NSW.	Hopkins River, south central Vic.	Nyah Forest, northwest Vic.	Lake Boort, northwest Vic.	Murrum-bidgee riverine plain, south central NSW.	Northern Adelaide plains, SA.	Hay Plain, south central NSW.	Caramut and Mt. William, south western Vic.	Riverland, SA.	Calperum Station, Riverland SA.
Lack of stone raw material in the vicinity	✓	✓				variable	-	✓		✓	✓
Very small flakes, tools and cores	✓	-		✓	✓	✓	-	✓	✓	✓	✓
Bipolar flaking dominant strategy	✓	-			✓	✓	-	✓	✓		✓
Many flakes in the excavation	-	-	✓		✓	few	-		✓	-	-
Few flakes in the excavation	-	-		✓		majority	-			-	-
Very few flakes on mound surface	✓	✓				✓	-			✓	✓
Many flakes on the surface					✓		-		✓		
Majority of flakes <20 mm in length	✓	-	✓	✓	✓	✓	-	✓	✓	-	✓
Excavated in the vicinity of mounds and found:	-	-	-	Nothing	Nothing	-	-	Many flakes	Many flakes	-	-
Use of stone heat retainers		-	✓								✓?
Use of clay heat retainers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mounds used for multiple purposes	Some	-	✓	Some	✓	Some	✓	✓	✓		
Mounds used only for food and fibre	Some	-		Some		Most				✓	✓

8.2 Taphonomic Impacts in the Study Area

8.2.1 Inclination of artefacts

Following Eren et al. (2010) and Schick (1986), it was hypothesised that the inclination of the artefacts could help identify whether artefacts had been trampled or affected by water movement. The study area experiences the same kind of periodic wetting and drying as Eren et al.'s (2010) test location, therefore both the test cases described in Eren et al.'s (2010) study apply. It was hypothesised, following Eren et al. (2010), that surface artefacts that had been disturbed in wet periods and might show some surface inclination. The artefact inclination was recorded for all surface artefacts encountered in the field. All of the artefacts measured lay parallel to the ground surface. This suggests that water flows have not affected the surface artefacts (Schick 1986). It also suggests that the high rates of artefact breakage may not be related to trampling, or that the artefacts on the surface have not been trampled (Eren et al. 2010). The latter seems particularly unlikely given the evidence of animal activity around the billabong margins (see Figures 46 and 47). Given the abundance of both large and small animals in the vicinity of the watercourses in the survey areas, and the sandy and loam substrates, this result suggests that trampling is likely to push the artefacts below the surface, and what is currently on the surface has either not been subjected to animal disturbance, or subjected only to horizontal disturbance.

Inclination in the artefacts could also have indicated trampling in wet periods followed by exposure by erosion, but as all the artefacts were uniformly flat on the surface, this was not the case. Artefact displacement is not possible to measure from the surface, all it can do is indicate that some artefacts are lost. Eren et al. (2010) and Gifford-Gonzalez et al. (1985) found that artefact inclination remained flat or slightly inclined in dry substrates, meaning that even if artefacts have been trampled, they may still remain on the surface and they may still be flat.

8.2.2 Flake Fragmentation

Amick and Mauldin's (1997:20–21) study on the rates of flake breakage during knapping processes was correlated with the quality of the raw material, and in particular they found that coarse raw materials tend to fracture more frequently during knapping than finer quality raw materials. As the majority of fragmented flakes were manufactured from fine quality raw materials, and the rates of breakage across the fine, medium and coarse categories were very similar but slightly lower for coarse raw materials, the high fragmentation rates are unlikely to have resulted as part of the knapping process and more likely to have resulted from other mechanisms (Amick and Mauldin 1997) (Figures 55–57).

Following experimental research on the effect of different substrates on flake fracture rates (Douglass and Wandsnider 2012; Eren et al. 2010; Gifford-Gonzales et al. 1985), it appeared that there may be differences in the fragmentation rates of artefacts 20 mm or smaller on loam vs sandy substrates. Unfortunately, there were very few artefacts identified on the more consolidated loam substrates during this study due to vegetation and leaf litter coverage, making it impossible to compare assemblages between the sandy and loam substrates.

As the majority of artefacts were found in low densities on sandy substrates, it appears that the most comparable study is that conducted by Eren et al. (2010). In this study, artefacts were trampled on a sandy substrate in both wet and dry conditions by goats, resulting in low levels of damage to the assemblage (Eren et al. 2010). Overall, the authors found low rates of flake fracturing and minimal edge damage (Eren et al. 2010:3018). Eren et al. (2010:3019–3020) argued that the low rates of damage were due to the absence of gravels or other rock or hard surfaces, as well as the low density of artefacts on the sandy substrate, which meant that there were few 'rock on rock' or 'artefact on artefact' interactions, leading to a lower rate of damage (Douglass and Wandsnider 2012:358–359; Eren et al. 2010:3019; Gifford-Gonzales 1985:814; McBrearty et al. 1998:123). It is worth noting that other taphonomic impacts that occur on this kind of context are that the sand traps the artefacts and makes them less susceptible to horizontal displacement (Gifford-Gonzales 1985:810–811), and also that as the sandy ‘beach’ areas are inclined around the edges of the billabong, it is possible that subsurface artefacts may gradually migrate downslope in sandy substrates as a result of trampling (Gifford-Gonzales 1985:809–810), suggesting that the margins of the billabong bed might contain higher densities of subsurface artefacts than the sloping margins due to trampling-mediated artefact migration.

Overall, as flake breakage proportions were similar for the two raw materials, it is unlikely that the broken flakes were a result of knapping activities (Amick and Mauldin 1997). Animal and human trampling is the most likely cause of the high numbers of flake breakages (Douglass and Wandsnider 2012; Eren et al. 2010; McBrearty et al. 1998), and also potentially for the loss of artefacts from the surface to the subsurface (Eren et al. 2010). It is possible that there were more artefacts visible in the two beach areas of the Reny Island billabong as a result of the sand trapping artefacts and arresting horizontal displacement in those areas, and also due to churning which could circulate artefacts back up to the surface during trampling, rather than them simply being pushed beneath the surface and staying there as is likely in more clayey substrates (Eren et al. 2010; Gifford-Gonzales 1985).

8.2.3 Other Taphonomic Processes

It is not possible to identify whether water or other animals might have preferentially removed artefacts < 20 mm from the study area, as studies by Cane (1982), Fanning and Holdaway (2001), Petraglia and Potts (1994) and Solomon et al. (1986) suggested might occur. Flakes < 20 mm were common in the study area, and the lack of any baseline studies indicating their frequencies on sites of this type and others means that there is no basis for comparison.

By contrast, artefacts < 5 mm were entirely absent, which can indicate water disturbance in the area, or the absence of knapping on the site (Hiscock and Mitchell 1993:30; Petraglia and Potts 1994:233). One further possibility is that artefacts this small were not identified during the survey due to their size and visibility issues.

8.2.4 Heat Affected Artefacts

Two kinds of heat affected artefacts were recorded during the survey; heat shattered stone and heat affected artefacts. The heat shattered stone appeared to be non-artefactual apart from having been transported to the site. The heat affected non-artefactual silcrete and resilicified sandstone found around the billabong and at several other mounds, and the heat affected limestone found at Ral Ral Creek are difficult to account for, as the majority of this material was found away from the mounds, which is the most obvious heat source. It is possible that these fragments may have been used as heat retainers in the earth mounds, subsequently eroded out of the mounds and displaced around the margins of the billabong and creeks through human and animal activities (Gifford-Gonzalez et al. 1985:816; Pargeter and Bradfield 2012:244–246). It is also possible that they were not used in the mounds, and may instead have been used as heat retainers for other kinds of non-mound fires, cooking or otherwise.

Despite visible signs of heat damage to fine to medium-quality chert and silcrete artefacts, the majority of these artefacts (23/28) were located more than 10 m away from the outer boundaries of earth mounds. As described above, this may be a result of horizontal displacement. Alternatively, these artefacts could have been damaged by non-mound related fires such as ephemeral hearth fires or natural bushfires, but there is no way to determine this. As only a small proportion of the stone was heat affected, and the majority of these artefacts were located on bare sandy patches, it is unlikely that a natural fire would have the duration and intensity to affect artefacts in the open with no immediate vegetation, or that a natural fire would affect some surface artefacts and not others (Buenger 2003). An exception to this is where artefacts were associated with trees burnt in natural fires, whether clustered around burning roots, immediately adjacent to a standing burning tree, or immediately beneath a fallen burning tree could experience temperatures high enough and of a sufficient intensity to alter the stone and create a spatially discrete cluster of heat-affected artefact (Buenger 2003:69–77). Additionally, experiments conducted in riparian zones indicate that the high moisture content of the soil leads to a lower impact on stone artefacts even at high temperatures, except where the artefacts are located immediately adjacent to large, burning trees (Buenger 2003:77–84).

Ultimately, the results of this study do not show a relationship between the earth mounds and heat affected artefacts in the study area. Furthermore, as there is no way to distinguish between heat damage caused by natural versus cultural post-depositional fires, it is not possible at this stage to say how the artefacts became heat affected, although at the billabong, it is more likely that the artefacts became heat affected through cultural processes than as a result of bushfires. Alternatively, whilst the heat shattered stones have been used as heat retainers, some of these stones were associated with earth mounds but the majority were not, suggesting that whilst they may have been used in mounds, they may also have been used in other kinds of features such as hearths. As heat shatter was not recorded consistently this is a tentative conclusion. Whilst the use of stone heat retainers is uncommon in the Murray-Darling Basin, it is more common in the lower reaches of the Murray River, where stone is readily available and used as heat retainers in the Murray River Gorge (Westell and Wood 2014:49) and in the Lower Lakes region (Wiltshire 2006:69, 73).

8.2.5 Mobility and Technological Studies

Discerning mobility patterns for Calperum Station from the artefacts at one large complex, and low numbers of artefacts at several others, is not straightforward as analyses are usually based on comparisons between a number of sites from a region. Despite this, a number of points can be made for the Reny Island billabong in particular.

Overall, the assemblage does not meet many of the criteria for individual provisioning, as described by Kuhn (1995) and Mackay (2005). Supporting points include the equal numbers of bipolar and non-bipolar cores, which are more likely to reflect mobile occupation patterns than sedentary ones (Hiscock 1996), and the good quality cores and retouched flakes were either extensively flaked or exhausted. However, in many cases, these criteria are based on comparisons of sites, and as the relative distributions of cores and flakes have not been established for the area, it is difficult to comment on the relative proportions of local versus imported raw materials, or relative frequencies of cores on sites. It is also unclear whether knapping was occurring on-site, but the presence of heavily reduced and exhausted chert cores, large silcrete cores and cone split flakes suggests that it was, despite the absence of knapping floors or debitage at the mound locations. For this reason, it is not possible to comment on aspects of individual provisioning practices such as a comparative lack of cores, or whether the discard rates are high or low.

There is also little support for criteria associated with place provisioning practices. The assemblage shows little retouch and high levels of good quality raw materials (Figure 21), in addition to large numbers of unretouched flakes, all of which are associated with place provisioning. However, the variability of knapping strategies, artefact forms and artefact sizes is low, and the ratio of cores to tools is roughly equivalent.

These results do not compare easily with the models of individual provisioning versus site provisioning as described by Kuhn (1995) and Mackay (2005), and it appears that a combination of strategies may be in place at the Reny Island billabong. However, there are other indications of mobility patterns. Klaver (1998:276) noted that site clustering was related to sedentary settlement patterns, and clustering is exhibited at both Reny Island billabong and the Hunchee Creek north. The larger silcrete cores could possibly have been part of the site furniture/site utility, ready to provide an expedient flake if required for the activities at that place (see Binford 1978:339, Binford 1979:278; Gould 1977:164; Webb 1993:108). The overall lack of fit with both of these models provides support for Westell and Wood's (2014) finding that the mounds were not habitation sites but 'special-purpose sites', as described by Binford (1978:357; 1980:10), and were used primarily for food processing purposes.

8.3 Connecting the Artefacts to the Mounds

Whilst the adze is associated with woodworking activities, and the numerous scarred trees on the floodplain also indicate that woodworking was being carried out at Calperum Station, the lack of any other formal retouched implements associated with woodworking indicates that this was not a common activity carried out at earth mound sites. The grindstone/hammerstone/anvil fragment, together with the cores found on site, suggests both knapping activity in the vicinity of the billabong. Multiple use of larger pieces of stone is a common conservation strategy, and multiple uses for grindstones, hammers and anvils were common (Casey 1973:209; Smith et al. 2015:72). Grindstones, anvils and hammerstones were also used in food processing activities such as crushing bones to extract marrow, and crushing or pounding plant food (Fullagar et al 1992:17; McCarthy 1967:51; Smith et al. 2015:72). The lack of any other grindstone or hammers in the area could be related to human collecting practices over the years (Casey 1973:209; Midgley et al. 1998:229–230), or alternatively, these items could have been transported to other locations following their use at the mounds.

The lack of stone artefacts in the immediate vicinity and on the surface of the mounds indicates that the mounds were not being used as occupation sites (Table 24). Mounds that have been used as occupation sites frequently have larger numbers of artefacts associated with them (Johnston 2006; Littleton et al. 2013; Williams 1988). The relative abundance of stone artefacts on the beach areas of the Reny Island billabong suggests either that the artefacts are more visible in this context due to 'churning' (Gifford-Gonzales et al. 1985:816) or that food processing activities took place close to, but away from the mounds themselves. Stone tools were not necessary prerequisites for food or fibre processing, the locally abundant mussel shell could be used for knives in an effective manner (Bonhomme 1990). This may explain why stone is not more common at the mounds, or in their vicinity, given the number of mounds at the Reny Island billabong.

Overall the assemblage is largely composed of small and mostly broken unretouched flakes. This is consistent with food processing activities such as butchering (Binford and O'Connell 1984; Kamminga 1982; Tainter 1979, Walker 1978). Experiments indicate that unretouched flake edges were more effective for butchering than retouched edges (Walker 1978:713), and as butchering tools quickly became blunt, they were replaced frequently (Brose 1975:93; Schoville et al. 2016:17; Walker

1987:714), leading to high rates of unretouched flake discard at sites where butchering is being carried out (Tainter 1979:465). Kamminga (1982:32–34, 117–119) also conducted butchering experiments with a variety of raw materials, with similar results. The majority of tools did not blunt as quickly as in Walker's (1978) experiments, although granular materials (such as silcrete and quartzite) generally were much less effective than more siliceous raw materials overall (Kamminga 1982:117–119), suggesting that chert flakes would be effective for longer than silcrete flakes, providing a possible explanation for the high levels of good quality raw materials at the mounds.

In conclusion, the low levels of inter- and intrasite variability observed at and in the vicinity of the mounds at the four study locations examined in this thesis provides support for the suggestion that the mounds are functionally specific sites where food processing activities associated with the mounds were carried out (Binford 1980:10, 12; Westell and Wood 2014:48). The assemblage is largely composed of unretouched flakes less than 20 mm in length, manufactured from good quality raw materials. The taphonomic impacts in the study area are significant, and trampling by humans and animals is likely to have led to high levels of flake fragmentation and displacement of artefacts both horizontally around the mounds as well as vertically down into the subsurface sediments. Conclusions from this chapter are elaborated on in Chapter 9.

8.4 Limitations of this Study and Future Directions

At this stage there are no other areas of Calperum Station with which to compare this assemblage. In many instances, the lack of local studies with which to compare these results, combined with the small and fractured nature of the assemblage that these conclusions are based on, means that even though many of the conclusions presented are tentative, they may be overstated. The broader patterns of occupation and distribution of activities will become clearer as more research is undertaken at Calperum Station in the future.

The inconsistent recording of heat shattered rock meant that it was difficult to draw conclusions about the use of this material in the study area. Despite this, the possibility of stone being used as heat retainers has been raised and can be examined in future studies in the region.

Although the billabong’s edge was a focus of taphonomic disturbances, the loss and extent of trampling damage to artefacts would be clearer if excavations were possible. Excavations at the billabong would indicate the extent to which the surface material has been lost to the subsurface through trampling or flooding, and would provide more information about artefact densities, knapping activities and taphonomic processes in the study areas.

The lack of information about the nature of the raw material sources also presents difficulties in understanding the local assemblages, particularly when discussing cortex in the assemblage and parent rock sizes. A survey of the areas at and in the vicinity of Calperum Station that are likely to have outcrops of flakeable raw material, as well as known quarries in the region, would help to inform future lithic studies in this region.

9. Conclusions

The discussion presented in Chapter 8 is summarised here together with the questions that were posed at the beginning of this thesis. The subsidiary questions are presented initially, and summarised to answer the primary question.

- *What taphonomic processes affect the stone artefacts in the vicinities of the mounds in the Calperum Station study area, and what impact do such processes have on interpreting the archaeological record in this region?*

As the stone artefacts were mostly less than 20 mm in length, it is not possible to identify a proportional absence of artefacts in this size category that might have been removed from the assemblage due to animal consumption or water movement (Cane 1982; Fanning and Holdaway 2001; Petraglia and Potts 1994; Solomon et al. 1986). However, no artefacts smaller than five mm were recorded, suggesting either water disturbance or an absence of knapping at the site (Petraglia and Potts 1994:23).

The surface stone artefacts did not show evidence of surface inclination, suggesting that they have not been disturbed by water flows during flood periods (Eren et al. 2010; Schick 1986). Surface inclination could also have indicated animal and/or human trampling. (Eren et al. 2010; Gifford-Gonzales et al. 1985; McBrearty et al. 1998). High rates of flake fragmentation were observed during the survey. This is more likely to be as a result of animal and human trampling than of raw material quality and knapping processes. For the majority of the Reny Island billabong margins and the mounds in other locations, it is likely that trampling has pushed artefacts below the surface during wet periods, and the remainder of the surface artefacts have been subject to horizontal displacement and fracturing on the surface. In the sandy beach areas of the billabong, it is likely that artefacts on the surface of earth mounds or in the vicinity of them have not been trampled, or have been churned by human and animal activity (Gifford-Gonzales 1985). It is also possible that surface artefacts have been buried by flood-borne alluvium.

A variety of taphonomic processes have been, and continue to be, at work in the study area. Overall, these processes lead to a loss of artefacts from the surface to the subsurface, and obscure the full extent of human activity in these areas. It is likely, given both the pastoral history of Calperum Station and its current use as a Regional Reserve, that animal trampling has contributed to the loss of large amounts of the surface artefacts. Excavations would demonstrate the extent of this loss, which is likely to vary in different substrates.

- *Are there differences between stone artefacts on and very close to the mounds in comparison to the artefacts away from the mounds?*

Very few artefacts were found on the surface or within 10 m of the external boundaries of the mounds. This is consistent with Westell and Wood's (2014:50, 53) finding that stone artefacts are a minor component of earth mounds in the Riverland. Westell and Wood (2014:53) found stone artefacts on the surface of 57.3% of mounds surveyed, whereas this study found stone on 78.6% of the mounds surveyed. However, this variability between findings could be a function of survey intensity and artefact visibility due to ground cover, as for this research there were frequently only one to five artefacts identified on or within 10 m of the external mound boundaries.

The mound associated and non-mound associated assemblages showed similar raw material preferences and rates of raw material usage, similar flake sizes and knapping strategies, and there was little inter- and intrasite variability. These results lend support to Westell and Wood's (2014:48) finding that the mounds were locations where task specific activities were carried out.

- *What inferences can be drawn about mobility, raw material selection and distribution, knapping strategies, tool manufacture and use from the surface lithics?*

Silcrete was the dominant raw material in the study area, only slightly by raw numbers, but more than three quarters of the assemblage overall by weight. Good quality raw materials dominated the flaked assemblage. Chert cores were small, between 10–30 mm and mostly exhausted at discard. Silcrete cores were both less common and larger, and not exhausted.

These trends were reflected in the overall flake lengths. Chert flake lengths mostly ranged from 10–20 mm, and silcrete from 12–30 mm. Cortex was uncommon and largely associated with flakes in the early stages of core reduction. It is more likely that this is a reflection of the parent raw material sizes than as a result of the distance to raw material sources. Basic flaking strategies such as single surface platforms and unidirectional flaking were applied to half of the assemblage, multidirectional flaking was more common for the finer raw materials—particularly chert but also occasionally for finer quality silcrete. In the later stages of knapping, bipolar and multidirectional flaking strategies were common. Platform preparation and retouch were rare, and formal tool types even rarer.

An unexpected finding of this study was the large numbers of very coarse silcrete, resilicified sandstone and smaller amounts of limestone that had been used as heat retainers. As heat shattered rock was not consistently recorded, the distribution of heat shatter cannot be linked to the mounds, but where was recorded, it is not clearly linked to the mounds. It is possible that taphonomic processes such as horizontal displacement have moved the stone away from the mounds, or that these stones were used in hearths in the vicinity of the mounds. The distribution of heat affected artefacts is also not clearly associated with the mounds. Whilst it is possible that the artefacts were affected by heat caused by bushfires, specifically, large burning trees (Buenger 2003), the heat shattered stone has no other artefactual features other than having been transported to the earth mound areas, and is thus most likely to have been used mound or hearth fires.

Assessing provisioning strategies related to mobility proved inconclusive, partially due to a lack of sites with which to make comparisons, but also because of the uniformity of the assemblage. Individual provisioning strategies associated with high mobility were tentatively suggested from the equal numbers of bipolar to non-bipolar cores and the employment of good quality raw materials to exhaustion (Mackay 2005:97–98). Place provisioning strategies associated with sedentary settlement practices were suggested by the lack of retouched flakes, the proportion of broken and exhausted artefacts, and the generally high levels of good quality raw materials employed (Mackay 2005:97–98).

Overall, these trends point to the use of simple flaking strategies to manufacture expedient flakes from small parent cores, combined with the use of more complex strategies in order to maximise the number of flakes obtained from good quality raw materials and very small cores. The lack of retouched and formal tool types indicates a narrow range of activities, most likely food processing, occurring in the vicinity of the mounds.

The answers to the subsidiary questions can now be summarised to answer the primary question for this thesis:

- *What can the surface stone artefacts on and near earth mounds at Calperum Station allow us to infer about the activities carried out at and near earth mound sites in the Calperum Station region? And how do such inferences correspond to previous conclusions about the actions of Aboriginal people around such features?*

Both the heat affected stone artefacts and the heat shattered stone indicate the use of fire in the vicinity of the mounds, consistent with the use of earth mounds. The uniform sizes of the flakes reflect the parent raw material sizes. Flakes were generally knapped without the use of complex knapping strategies, except to maximise the use of good quality raw materials, leaving behind an assemblage that indicates food processing activities being undertaken in the vicinity of the mounds.

The results of this study are generally consistent in many aspects with the findings of many other earth mound studies from the Murray-Darling Basin. Stone is generally difficult to obtain in the Basin (Bonhomme 1990; Balme and Beck 1996; Coutts et al. 1979; Martin 2006) and where it is available, it is often flaked using bipolar methods to maximise the small parent material, resulting in many small flakes (Bonhomme 1990; Coutts et al. 1979, Johnston 2004; Klaver 1998; Martin 2006; Williams 1988). In several respects, however, these results differed from other studies. The use of stone as heat retainers in excavations of earth ovens was recorded only at the Hopkins River, south central Victoria by Coutts et al. (1976: 21–22, 25). The coarse stone used as heat retainers at Calperum Station is easily obtainable from the Murray River cliffs nearby, something not available in the floodplain areas of the Murray-Darling Basin. The use of stone in hearths was common in the lower reaches of the Murray, where stone is also easily accessible, particularly in the gorge section of the Murray River.

The separation of activities indicated in this study, where the mounds were used only for food and fibre processing, was also uncommon. Again, it is likely that the geography of the Murray River valley at Calperum Station is the major factor in these differences. At Calperum Station, the Murray Valley terraces provide the opportunity to access the aquatic resources and retreat to higher ground to carry out other activities (Wood and Westell 2010:7). In other parts of the Basin, raised mounds on the Murray River floodplains offered access to aquatic resources available whilst the river was in flood, resources that would otherwise be difficult to access due to the flat landscape.

As such this thesis provides additional fine-grained data and analysis supporting Westell and Wood’s (2014) conclusions that; the Riverland earth mounds were single activity sites related to food and fibre processing, such as large game and *Typha* spp. roots, and were not formed as a result of or used for occupation; that only a small number of artefacts are present on the surface of mounds and where present, the artefacts are predominantly unretouched flakes with occasional instances of grindstones and retouched flakes.

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11. Appendices

Appendix 1: Quarries and Other Raw Material Sources in the Calperum Station Region.

Quarries and Other Raw Material Sources in the Calperum Station Region

Map ID	Location Name	Closest Location	Type of Resource	Raw Material	Raw Material Notes	Direction Notes	General Notes	References
1		Sugarloaf Hill, Cobdogla		Chert	Poor quality.	SugarLoaf Hill, Cobdogla.	Record of the National Estate (RNE) Report: Commercial mining takes place here, but on the opposite side of the hill to the Aboriginal mining.	RNE; Woolmer 1974:21.
2	Stony Ridge	West Lake Bonney	Scarp exposure?	Chert	Poor quality.	Stony Ridge, West Lake Bonney.		Woolmer 1974:21.
3	Overland Corner	Overland Corner	Scarp exposure	Chert	Poor quality.	Overland Corner.		Woolmer 1974:21.
4	Memdelbuik	Spring Cart Gully	Quarry	Chert	Woolmer: Region's best quality. RNE: opaline chert, also light to dark brown and white to grey.	Spring Cart Gully. RNE: 7km east of Berri.	Woolmer and the RNE refer to this as Memdelbuik. RNE suggests the site preservation is not good and regularly fossicked. Tindale also refers to chert mines to the south of Renmark.	Lenehan 1996:19, 22; RNE; Tindale 1974:211; Woolmer 1974:21
5		North West Lake Bonney	Quarry	Quartzite		Half a mile east of North West Lake Bonney.		Woolmer 1974:21.
6		Overland Corner	Outcrop	Quartzite		Thirty miles north of Overland Corner.		Woolmer 1974:21.
7	Overland Corner	Overland Corner Hotel	Scarp exposure	Ochre	Red and white ochre.	Scarp above the Overland Corner Hotel.	RNE suggests site is in good condition, important ochre mine including pits and a small cave.	RNE; Woolmer 1974:21.
8	Overland Corner	Overland Corner Hotel	Scarp exposure	Chert		Scarp above the Overland Corner Hotel.	Delcared a historic reserve. Possibly the same as No. 3.	Woolmer 1974:21.
9		Overland Corner	Small dry lake	Gypsum		In a small dry lake about thirty miles north of Overland Corner.		Woolmer 1974:21.
10	Quarry 13	Barmera	Quarry	Chert?	Hard flinty rock.	Near Barmera.	Used as a quarry by Europeans, may have been an Aboriginal quarry prior to that.	Woolmer 1974:21.
11		Paringa	Quarry	Chert		Location as per Lenehan's map.		Lenehan 1996:20 (refers to Tindale 1940-1956:637-641).

Quarries and Other Raw Material Sources in the Calperum Station Region (continued)

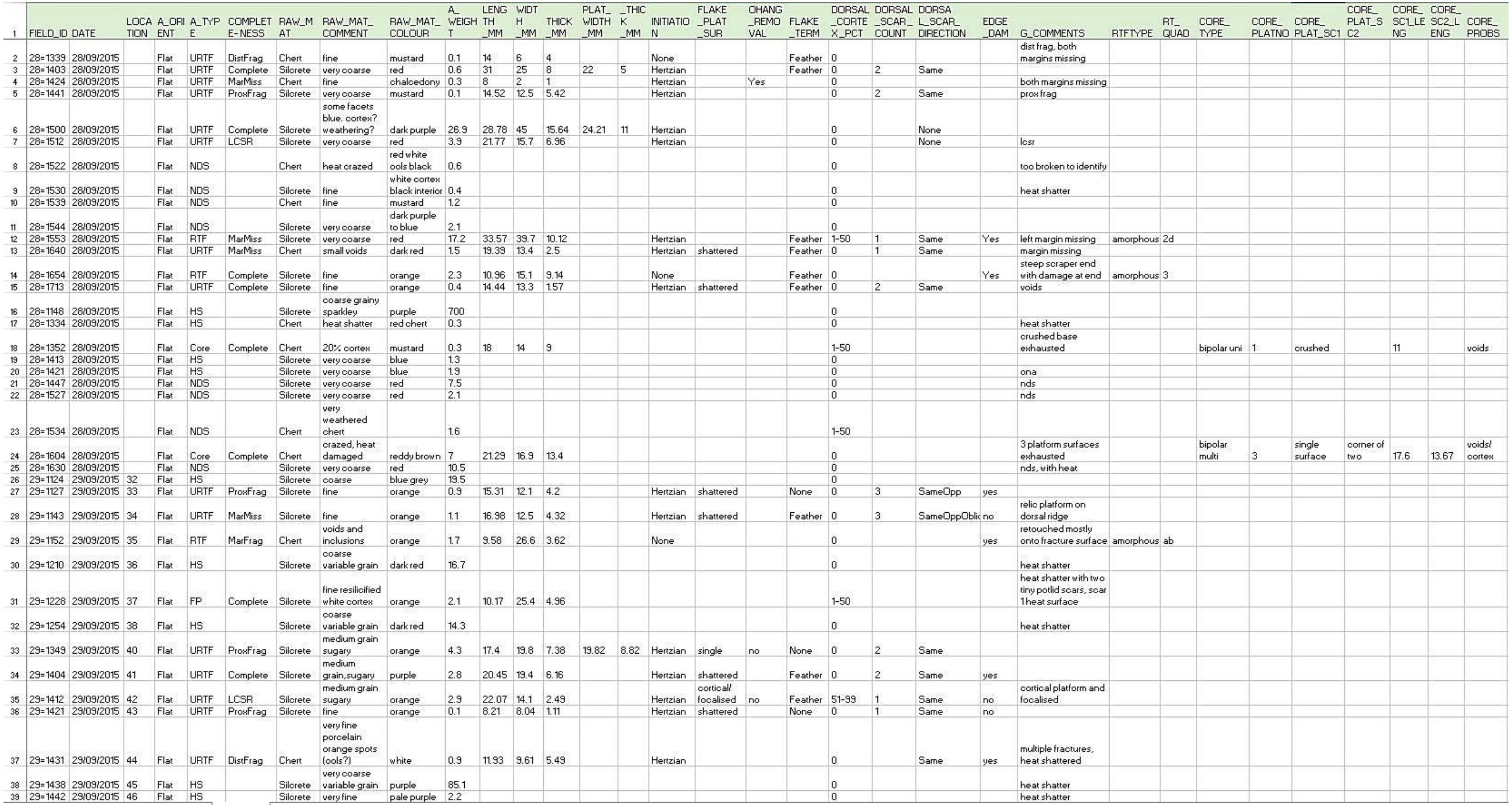
Map ID	Location Name	Closest Location	Type of Resource	Raw Material	Raw Material Notes	Direction Notes	General Notes	References
12		Pike River	Quarry	Chert, silcrete, opalite, porcelainite, sandstone and limestone	Chert according to Lenehan 1996, but Pretty (in Grist 1995:47) advises that the same raw material selection as was available at Berribee: chert, silcrete, opalite, porcelainite, sandstone and limestone.	Location as per Lenehan's map.	Lenehan 1996 identified this as a chert quarry, however Grist 1995:47 discussed this quarry with Pretty who confirmed that the raw materials available here were the same as those available from the Berribee Quarry.	Grist 1995:47 (quoting Pretty pers. comm. 1995); Lenehan 1996:19, 22.
13		Lyrup	Quarry	Chert	Red chert thought to have been from here (Lenehan 1996:22).		Not confirmed and no reference.	Lenehan 1996:19; 22.
14		East central Lake Bonney	Quarry	Chert			Lenehan incorrectly refers to this location as Memdelbuik (Dowling 1990:6-19)	Lenehan 1996:19; 22 (refers to Dowling 1990:6-19).
15	Wilabalangaloo Quarry	Wilabalangaloo Reserve, Lyrup	Cliff outcrop	Silcrete			This may be the same as No. 13. Grist (1995:62) lists known quarries from the SA Museum collections and this is described as a silcrete quarry. However, there is a quote from P. Brown pers. comm. 1994 stating that the Lyrup quarry contained glassy red chert, as described by Lenehan 1996 above. Conflicting information.	Grist 1995:62.
16				Chert	Red chert.		RNE: 'red flint deposits can be seen in the cliffs of the Murray River in the Chowilla Reserve'.	RNE: Murray Malley Bookmark Block entry, p.5.
17		Weila Station	Outcrop	Silcrete		Weila Station.	Only known outcrop of silcrete along upper Murray in SA.	RNE (Calperum and Taylorville Stations entry): p.7 refs to Edmonds (1995). Also refers to the red flint of the previous entry.
18		Nampoo Station (Murray Cliffs)	Cliff outcrop	Silcrete		Nampoo Station, east of the station on the west side of a track down the cliff to river level.	Part of Karoonda Surface between Blanchetown Clay above and Chowilla Sand below. Gill (1973) says it has been quarried but not by whom.	Gill 1973:33.
19	Sharp Point	Nampoo Station (Murray Cliffs)	Cliff outcrop	Opal	Highly vitreous, translucent, (clear, brownish, bluish, pinkish) and opaque (mostly brown).	Sharp Point, north bank of the river at Nampoo Station.	Outcrop thickness is max 1-2m band, associated with the dolomite layer.	Gill 1973:35-36.

Quarries and Other Raw Material Sources in the Calperum Station Region (continued)

Map ID	Location Name	Closest Location	Type of Resource	Raw Material	Raw Material Notes	Direction Notes	General Notes	References
20	Sharp Point	Nampoo Station (Murray Cliffs)	Cliff outcrop	Silcrete		Sharp Point, north bank of the river at Nampoo Station.	Silcrete associated with the sandy dolomite layer.	Gill 1973:35.
21		Salt Creek, Kulcurna Station, Cal Lal	Cliff outcrop	Opal				Gill 1973:36-37.
22		Salt Creek, Kulcurna Station, Cal Lal	Cliff outcrop	Silcrete		10 m away from the opal.		Gill 1973:36-37.
22		Salt Creek, Kulcurna Station, Cal Lal	Cliff outcrop	Silcrete		10 m away from the opal.		Gill 1973:36-37.
23	Lindsay Point	Between Lindsay Point and Lake Wallawalla.	Hillside outcrop, extensively quarried.	Silcrete, quartzite, chert, opalite, porcelanite, sandstone and limestone (Grist 1995:35-40).	Highly silicified golden brown silcrete (Grist 1995:2), with some variability in the colour ranging from 'neutral silcrete through to a dark purple. Yellow, Brown and red silcretes exist within the colour range.' (Grist 1995:22).	Between Lindsay Point and Lake Wallawalla.	Known as Berribee Silcrete, subject of Grist 1995. Pardoe 1995:708 - fine grained silcrete (indurated siliceous sandstone).	Grist 1995:2, 29; Pardoe 1995:708 (Map only); Prendergast et al. 2009:63 (outcrop of Karoonda Surface).
24	Lindsay Point	Between Lindsay Point and Lake Wallawalla.	Hillside outcrop, extensively quarried but damaged by subsequent European quarrying.	Silcrete	Highly silicified golden brown silcrete (Grist 1995:2), with some variability in the colour ranging from 'neutral silcrete through to a dark purple. Yellow, Brown and red silcretes exist within the colour range.' (Grist 1995:22).	Between Lindsay Point and Lake Wallawalla, ~700m upstream of Berribee Quarry 1.	Known as Berribee Silcrete, subject of Mark Grist's Hons thesis. Pardoe 1995:708 - fine grained silcrete (indurated siliceous sandstone).	Grist 1995:3.

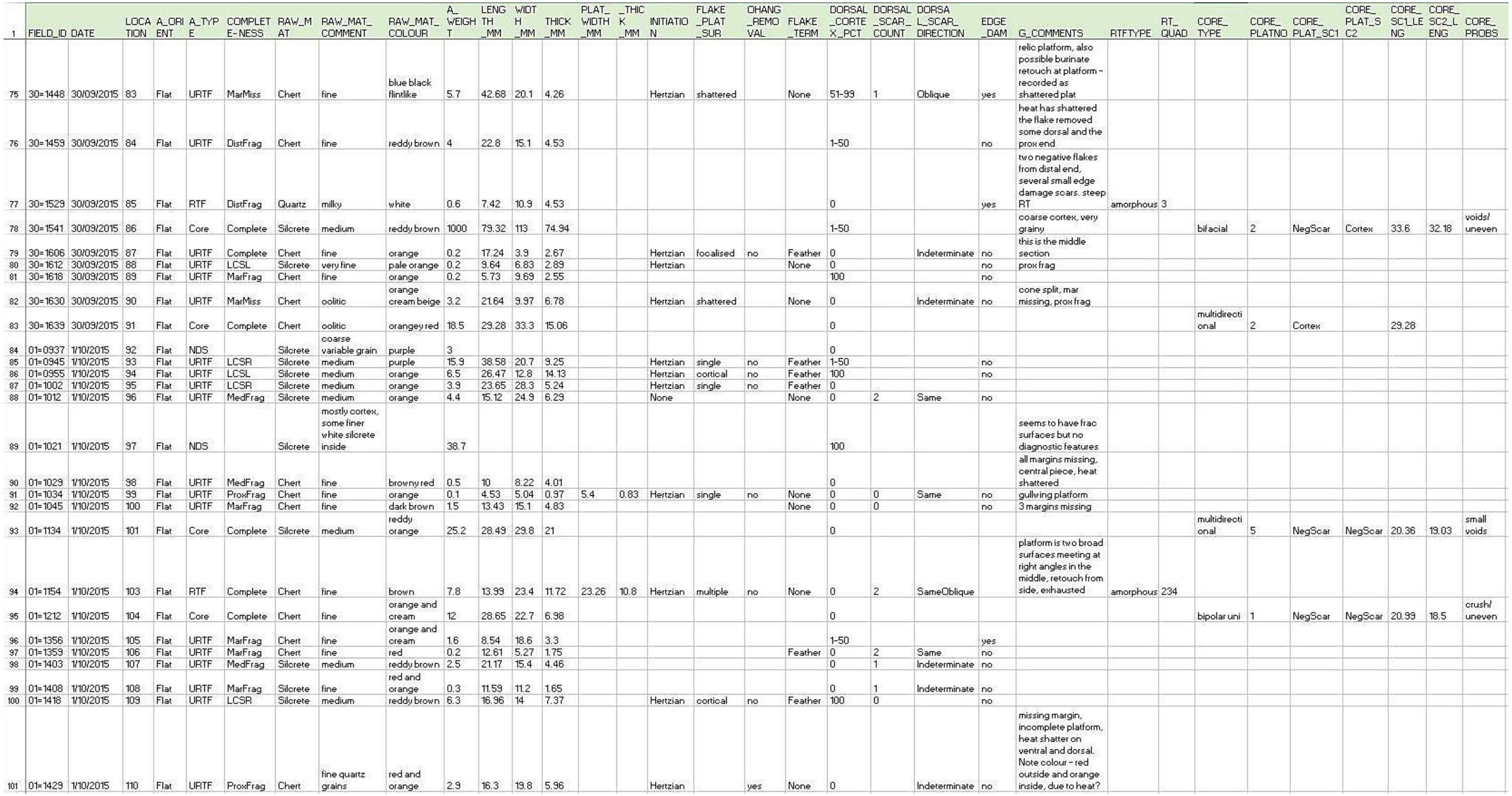
Appendix 2: Raw Data

The raw data from the survey is provided in this Appendix. Abbreviations used in the recording form are described in full in Chapter 6.

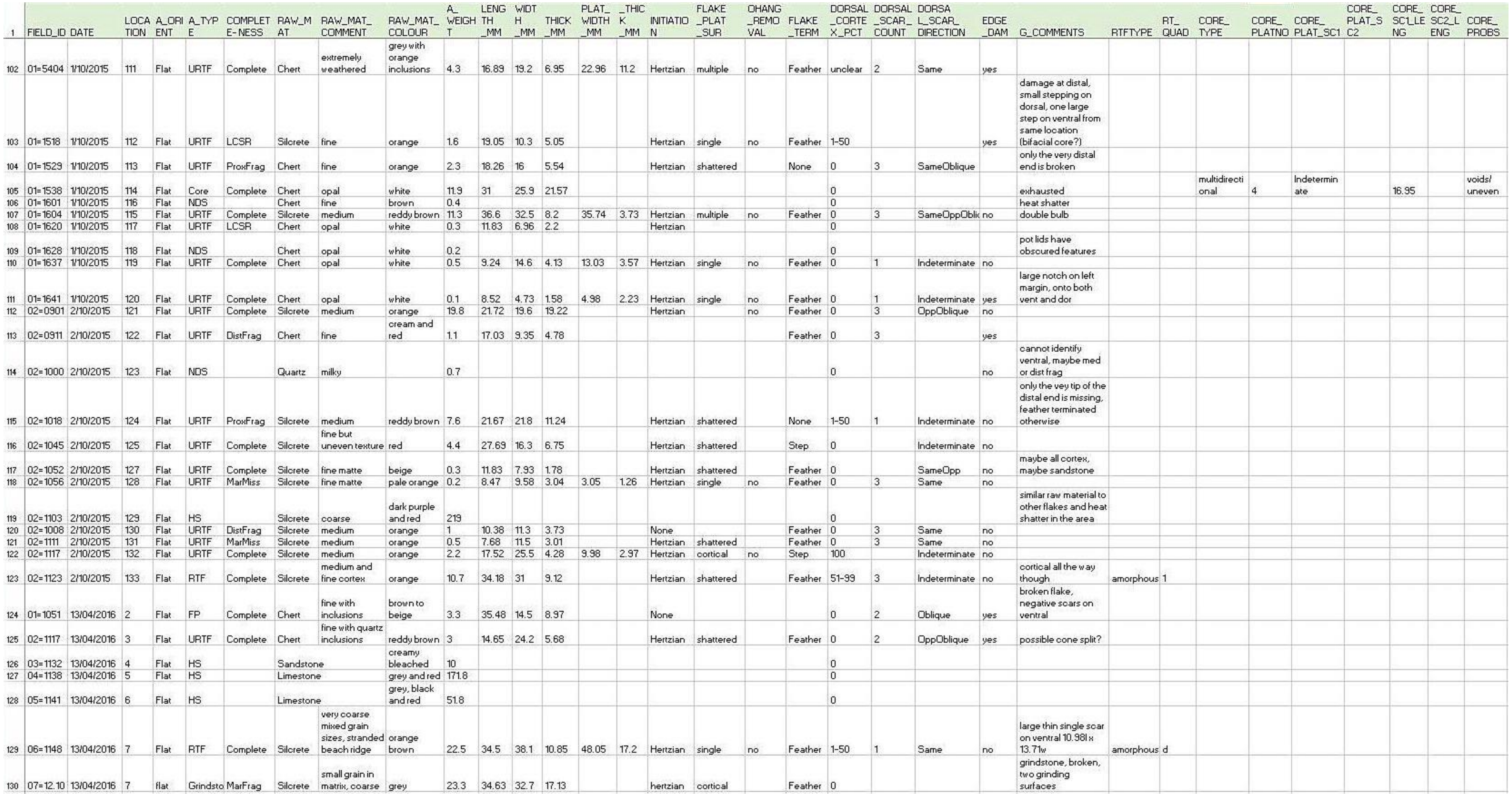


1	FIELD_ID	DATE	LOCATION	A_ORIENT	A_TYPE	COMPLETE-NESS	RAW_MAT	RAW_MAT_COMMENT	RAW_MAT_COLOUR	A_WEIGHT	LENGTH_MM	WIDTH_MM	THICK_MM	PLAT_WIDTH_MM	_THICK_MM	INITIATION	FLAKE_PLAT_SUR	OHANG_REMOVAL	FLAKE_TERM	DORSAL_CORTEX_PCT	DORSAL_SCAR_COUNT	DORSAL_SCAR_DIRECTION	EDGE_DAM	G_COMMENTS	RTFTYPE	RT_QUAD	CORE_TYPE	CORE_PLATNO	CORE_PLAT_SC1	CORE_PLAT_SC2	CORE_SC1_LENG	CORE_SC2_LENG	CORE_PROBS
2	28=1339	28/09/2015		Flat	URTF	DistFrag	Chert	fine	mustard	0.1	14	6	4			None			Feather	0				dist frag, both margins missing									
3	28=1403	28/09/2015		Flat	URTF	Complete	Silcrete	very coarse	red	0.6	31	25	8	22	5	Hertzian			Feather	0	2	Same											
4	28=1424	28/09/2015		Flat	URTF	MarMiss	Chert	fine	chalcedony	0.3	8	2	1			Hertzian		Yes		0				both margins missing									
5	28=1441	28/09/2015		Flat	URTF	ProxFrag	Silcrete	very coarse	mustard	0.1	14.52	12.5	5.42			Hertzian				0	2	Same		prox frag									
6	28=1500	28/09/2015		Flat	URTF	Complete	Silcrete	some facets blue. cortex? weathering?	dark purple	26.9	28.78	45	15.64	24.21	11	Hertzian				0		None											
7	28=1512	28/09/2015		Flat	URTF	LCSR	Silcrete	very coarse	red	3.9	21.77	15.7	6.96			Hertzian				0		None		lcsr									
8	28=1522	28/09/2015		Flat	NDS		Chert	heat crazed	red white ools black	0.6										0				too broken to identify									
9	28=1530	28/09/2015		Flat	NDS		Silcrete	fine	white cortex black interior	0.4										0				heat shatter									
10	28=1539	28/09/2015		Flat	NDS		Chert	fine	mustard	1.2										0													
11	28=1544	28/09/2015		Flat	NDS		Silcrete	very coarse	dark purple to blue	2.1										0													
12	28=1553	28/09/2015		Flat	RTF	MarMiss	Silcrete	very coarse	red	17.2	33.57	39.7	10.12			Hertzian			Feather	1-50	1	Same	Yes	left margin missing	amorphous	2d							
13	28=1640	28/09/2015		Flat	URTF	MarMiss	Chert	small voids	dark red	1.5	19.39	13.4	2.5			Hertzian	shattered		Feather	0	1	Same		margin missing									
14	28=1654	28/09/2015		Flat	RTF	Complete	Silcrete	fine	orange	2.3	10.96	15.1	9.14			None			Feather	0			Yes	steep scraper end with damage at end	amorphous	3							
15	28=1713	28/09/2015		Flat	URTF	Complete	Silcrete	fine	orange	0.4	14.44	13.3	1.57			Hertzian	shattered		Feather	0	2	Same		voids									
16	28=1148	28/09/2015		Flat	HS		Silcrete	coarse grainy sparkley	purple	700										0													
17	28=1334	28/09/2015		Flat	HS		Chert	heat shatter	red chert	0.3										0				heat shatter									
18	28=1352	28/09/2015		Flat	Core	Complete	Chert	20% cortex	mustard	0.3	18	14	9							1-50				crushed base exhausted			bipolar uni	1	crushed		11		voids
19	28=1413	28/09/2015		Flat	HS		Silcrete	very coarse	blue	1.3										0													
20	28=1421	28/09/2015		Flat	HS		Silcrete	very coarse	blue	1.9										0				ona									
21	28=1447	28/09/2015		Flat	NDS		Silcrete	very coarse	red	7.5										0				nds									
22	28=1527	28/09/2015		Flat	NDS		Silcrete	very coarse	red	2.1										0				nds									
23	28=1534	28/09/2015		Flat	NDS		Chert	very weathered chert		1.6										1-50													
24	28=1604	28/09/2015		Flat	Core	Complete	Chert	crazed, heat damaged	reddy brown	7	21.29	16.9	13.4							0				3 platform surfaces exhausted			bipolar multi	3	single surface	corner of two	17.6	13.67	voids/ cortex
25	28=1630	28/09/2015		Flat	NDS		Silcrete	very coarse	red	10.5										0				nds, with heat									
26	29=1124	29/09/2015	32	Flat	HS		Silcrete	coarse	blue grey	19.5										0													
27	29=1127	29/09/2015	33	Flat	URTF	ProxFrag	Silcrete	fine	orange	0.9	15.31	12.1	4.2			Hertzian	shattered		None	0	3	SameOpp	yes										
28	29=1143	29/09/2015	34	Flat	URTF	MarMiss	Silcrete	fine	orange	1.1	16.98	12.5	4.32			Hertzian	shattered		Feather	0	3	SameOppOblic	no	relic platform on dorsal ridge									
29	29=1152	29/09/2015	35	Flat	RTF	MarFrag	Chert	voids and inclusions	orange	1.7	9.58	26.6	3.62			None				0			yes	retouched mostly onto fracture surface	amorphous	ab							
30	29=1210	29/09/2015	36	Flat	HS		Silcrete	coarse variable grain	dark red	16.7										0				heat shatter									
31	29=1228	29/09/2015	37	Flat	FP	Complete	Silcrete	fine resilicified white cortex	orange	2.1	10.17	25.4	4.96							1-50				heat shatter with two tiny potlid scars, scar 1 heat surface									
32	29=1254	29/09/2015	38	Flat	HS		Silcrete	coarse variable grain	dark red	14.3										0				heat shatter									
33	29=1349	29/09/2015	40	Flat	URTF	ProxFrag	Silcrete	medium grain sugary	orange	4.3	17.4	19.8	7.38	19.82	8.82	Hertzian	single	no	None	0	2	Same											
34	29=1404	29/09/2015	41	Flat	URTF	Complete	Silcrete	medium grain,sugary	purple	2.8	20.45	19.4	6.16			Hertzian	shattered		Feather	0	2	Same	yes										
35	29=1412	29/09/2015	42	Flat	URTF	LCSR	Silcrete	medium grain sugary	orange	2.9	22.07	14.1	2.49			Hertzian	cortical/ focalised	no	Feather	51-99	1	Same	no	cortical platform and focalised									
36	29=1421	29/09/2015	43	Flat	URTF	ProxFrag	Silcrete	fine	orange	0.1	8.21	8.04	1.11			Hertzian	shattered		None	0	1	Same	no										
37	29=1431	29/09/2015	44	Flat	URTF	DistFrag	Chert	very fine porcelain orange spots (ools?)	white	0.9	11.93	9.61	5.49			Hertzian				0		Same	yes	multiple fractures, heat shattered									
38	29=1438	29/09/2015	45	Flat	HS		Silcrete	very coarse variable grain	purple	85.1										0				heat shatter									
39	29=1442	29/09/2015	46	Flat	HS		Silcrete	very fine	pale purple	2.2										0				heat shatter									

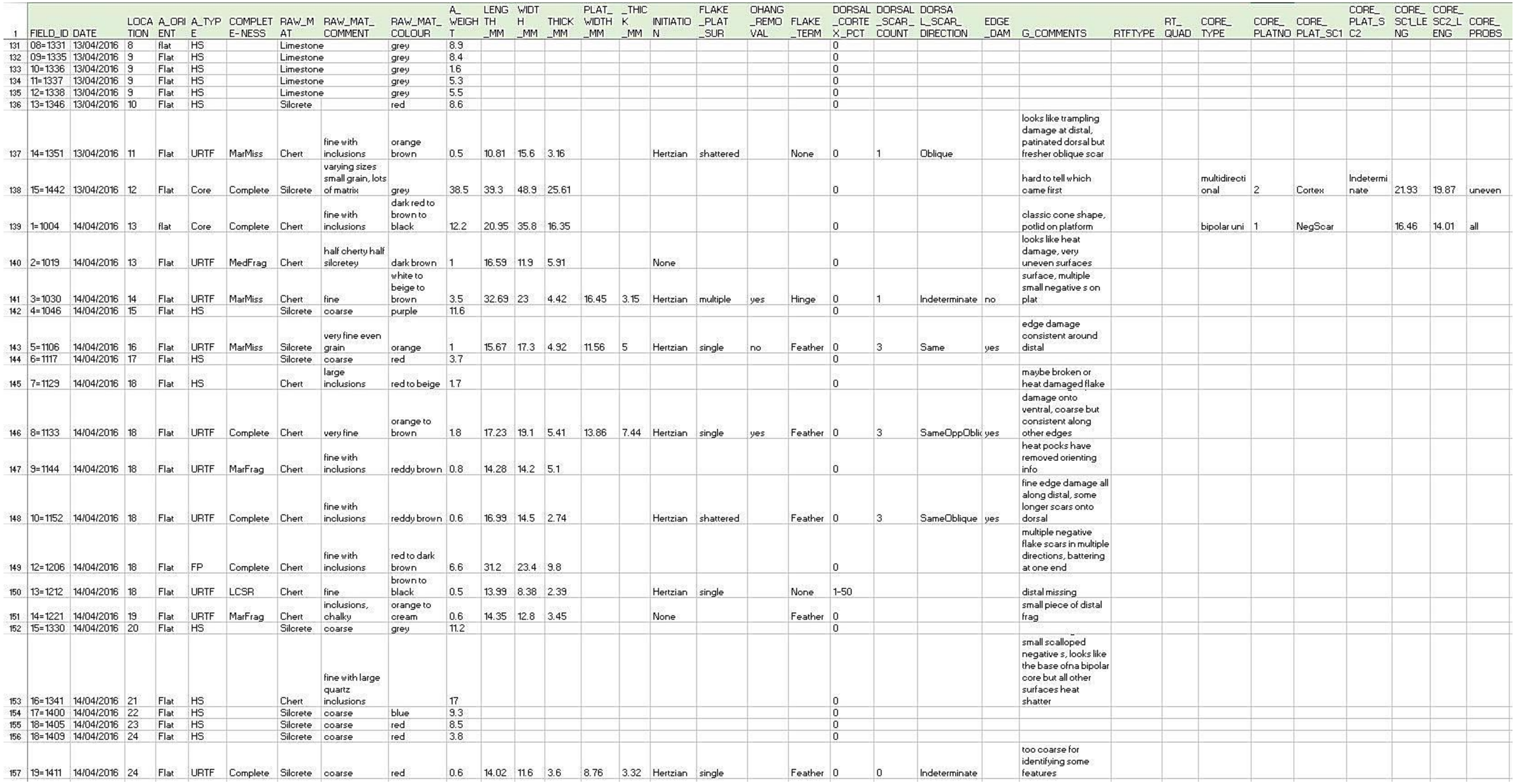
1	FIELD_ID	DATE	LOCATION	A_ORIENT	A_TYPE	COMPLETE-NESS	RAW_MAT	RAW_MAT_COMMENT	RAW_MAT_COLOUR	A_WEIGHT	LENGTH_MM	WIDTH_MM	THICK_MM	PLAT_WIDTH_MM	_THICK_MM	INITIATION	FLAKE_PLAT_SUR	OHANG_REMOVAL	FLAKE_TERM	DORSAL_CORTEX_PCT	DORSAL_SCAR_COUNT	DORSAL_SCAR_DIRECTION	EDGE_DAM	G_COMMENTS	RTFTYPE	RT_QUAD	CORE_TYPE	CORE_PLATNO	CORE_PLAT_SC1	CORE_PLAT_SC2	CORE_SC1_LENG	CORE_SC2_LENG	CORE_PROBS
40	29=1445	29/09/2015	47	Flat	URTF	ProxFrag	Chert	fine	orange	0.2	10.39	7.9	1.74	4.58	1.17	Hertzian	single	no	none	0	2	same	no	distal and margin missing									
41	29=1458	29/09/2015	49	Flat	HS		Silcrete	coarse variable grain	purple	7.6										0				heat shatter									
42	29=1504	29/09/2015	50	Flat	URTF	MarMiss	Silcrete	fine silty	pale orange	0.4	10.2	14.9	3.43			Hertzian	shattered		Hinge	0	2	Same	no										
43	29=1513	29/09/2015	51	Flat	NDS		Silcrete	fine	orange and red	2.8										0			yes	damage on the only sharp edge									
44	29=1518	29/09/2015	52	Flat	URTF	MarFrag	Silcrete	fine	orange and red	2	22.75	11.4	5.68							0			yes	edge damage on fracture surfaces									
45	29=1523	29/09/2015	53	Flat	URTF	DistFrag	Silcrete	medium	orange brown	0.9	12.09	14.4	3.32							0			yes	edge damage all along distal end									
46	29=1533	29/09/2015	54	Flat	URTF	LCSL	Silcrete	coarse variable grains	orange	11.3	25.15	20	10.15			Hertzian	cortical	no	None	0	2	Same	yes	all margins missing									
47	29=1542	29/09/2015	55	Flat	URTF	ProxFrag	Chert	fine	orange	0.9	15.66	5.92	3.18			Hertzian	shattered		None	0	2	Same	yes										
48	29=1550	29/09/2015	56	Flat	URTF	MarMiss	Chert	fine	dark red	1.6	17.92	14.3	5.26			Hertzian	single	no	Feather	0		Indeterminate	yes	edge damage on ventral and dorsal all natural margins not fracture edge									
49	29=1601	29/09/2015	57	Flat	URTF	MarFrag	Chert	fine	dark red	1.7	10.99	25.1	4.72							0			no	heat damage									
50	29=1606	29/09/2015	58	Flat	HS		Silcrete	fine	red	1.6										0				heat shatter									
51	29=1609	29/09/2015	59	Flat	URTF	Complete	Silcrete	fine	orange	2.8	30.13	19.3	4.75			Hertzian	shattered		Feather	0	2	Same	no										
52	29=1617	29/09/2015	60	Flat	URTF	Complete	Silcrete	medium	orange	0.3	9.15	10.8	2.6			Hertzian	shattered		Feather	0	2	Same	no										
53	29=1627	29/09/2015	61	Flat	Core	Complete	Silcrete	medium coarse	red	177.2	68.53	41.4	49.67							1-50				battering and crushing at distal end, heat shatter on many surfaces			bipolar uni	1	Indeterminate		29.8		
54	30=1020	30/09/2015	62	Flat	RTF	DistFrag	Silcrete	very fine with large grain inclusions	dark red	1.9	18.52	17.9	3.91						Hinge	0	2	Same	yes	ventral surface, edge damage on right margin onto dorsal, left margin onto ventral	amorphous	2							
55	30=1036	30/09/2015	63	Flat	URTF	ProxFrag	Chert	fine	orange	0.1	6.47	4.4	1.63			Hertzian	single	no	None	1-50	2	Same		margin missing									
56	30=1046	30/09/2015	64	Flat	Core	Complete	Silcrete	medium	orange	74.6	34.57	33.9	31.55							0							multidirectional	3	NegScar	Indeterminate	21.07	17.33	uneven
57	30=1058	30/09/2015	65	Flat	HS		Silcrete	coarse	purple	4.6										0													
58	30=1100	30/09/2015	66	Flat	NDS		Silcrete	medium	red to orange	6.9										0				edges, very weathered									
59	30=1104	30/09/2015	67	Flat	URTF	ProxFrag	Silcrete	medium	red to	2.8	13.12	19.4	6.52			Hertzian	single	no	None	0	2	Same		margin missing									
60	30=1114	30/09/2015	68	Flat	URTF	Complete	Chert	fine	brown	1.4	17.25	16.9	4.23	3.06	2.31	Hertzian	single	no	Feather	0	3	SameOblique	no										
61	30=1125	30/09/2015	69	Flat	URTF	LCSR	Chert	fine	orange	1.1	11.61	7.71	2.51			Hertzian	single	no	Feather	0	2	Same	yes	edge damage on the split only									
62	30=1136	30/09/2015	70	Flat	HS		Silcrete	coarse	purple	16.1										0													
63	30=1140	30/09/2015	71	Flat	URTF	MarFrag	Chert	fine	orange	0.8	9.12	15.5	2.44							1-50													
64	30=1144	30/09/2015	72	Flat	URTF	MarMiss	Silcrete	medium	purple	1.2	12.42	20.8	3.19	12.56	3.36	Hertzian	single	no	None	0	1	Same	no										
65	30=1152	30/09/2015	73	Flat	URTF	Complete	Chert	fine	orange and cream	1.3	10.72	21.3	4.6	9.89	2.43	Hertzian	single	no	Feather	51-99	1	Indeterminate	no										
66	30=1158	30/09/2015	74	Flat	URTF	LCSR	Silcrete	very coarse variable grain	purple	6.6	30.83	17.5	10.08			Hertzian	single		None	0	1	Same		margins missing									
67	30=1204	30/09/2015	75	Flat	URTF	LCSR	Silcrete	fine with cortex	pale orange	1.4	20.58	11.6	3.83			Hertzian	cortical	no	Feather	51-99	1	Same	no										
68	30=1208	30/09/2015	76	Flat	URTF	ProxFrag	Silcrete	medium	purple	3	16.77	19	6.67	17.57	7.29	Hertzian	multiple	no	none	0	2	Same	no	very rounded and weathered									
69	30=1215	30/09/2015	77	Flat	URTF	MarMiss	Chert	fine	orange and red	0.5	15.67	8.74	3.23			Hertzian	multiple	no	Feather	0	0	Indeterminate		multiple margins missing									
70	30=1223	30/09/2015	78	Flat	URTF	LCSL	Silcrete	coarse	grey pale brown	2.5	19.47	18.3	5.33			Hertzian	single	no	None	0	0		no	multi mar miss, maybe feather term or weathered break?									
71	30=1310	30/09/2015	79	Flat	URTF	DistFrag	Chert	opal	white	0.3	10.66	6.99	3.78			None			Feather	0			yes	distal end, heat affected									
72	30=1318	30/09/2015	80	Flat	URTF	LCSR	Silcrete	fine	orange	0.3	15.17	6.84	3.17			Hertzian	faceted	no	None	0	2	Same		distal missing									
73	30=1332	30/09/2015	81	Flat	URTF	Complete	Silcrete	medium	brown	0.5	8.51	9.15	2.88	4.64	3.43	Hertzian	single	no	Feather	0	3	Same	no										
74	30=1354	30/09/2015	82	Flat	RTF	Complete	Chert	fine	brown	5.7	13.26	18.9	10.99			Hertzian	multiple	yes	None	0	ind	Indeterminate		removed part of platform	scraper	234							



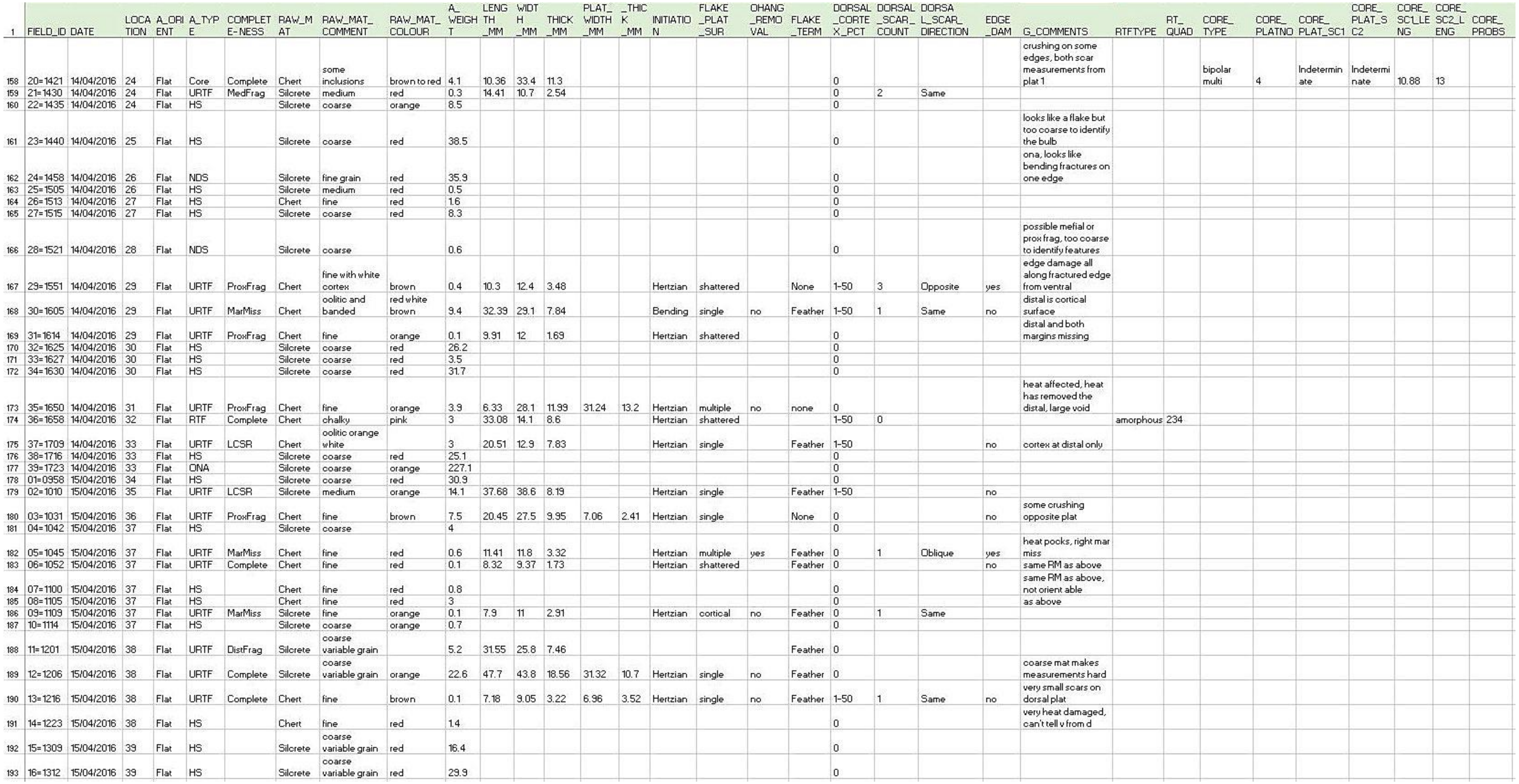
1	FIELD_ID	DATE	LOCATION	A_ORIENT	A_TYPE	COMPLETE-NESS	RAW_MAT	RAW_MAT_COMMENT	RAW_MAT_COLOUR	A_WEIGHT	LENGTH_MM	WIDTH_MM	THICK_MM	PLAT_WIDTH_MM	_THICK_MM	INITIATION	FLAKE_PLAT_SUR	OHANG_REMOVAL	FLAKE_TERM	DORSAL_CORTEX_PCT	DORSAL_SCAR_COUNT	DORSAL_SCAR_DIRECTION	EDGE_DAM	G_COMMENTS	RTFTYPE	RT_QUAD	CORE_TYPE	CORE_PLATNO	CORE_PLAT_SC1	CORE_PLAT_SC2	CORE_SC1_LENG	CORE_SC2_LENG	CORE_PROBS
75	30=1448	30/09/2015	83	Flat	URTF	MarMiss	Chert	fine	blue black flintlike	5.7	42.68	20.1	4.26			Hertzian	shattered		None	51-99	1	Oblique	yes	relic platform, also possible burinate retouch at platform - recorded as shattered plat									
76	30=1459	30/09/2015	84	Flat	URTF	DistFrag	Chert	fine	reddy brown	4	22.8	15.1	4.53							1-50			no	heat has shattered the flake removed some dorsal and the prox end									
77	30=1529	30/09/2015	85	Flat	RTF	DistFrag	Quartz	milky	white	0.6	7.42	10.9	4.53							0			yes	two negative flakes from distal end, several small edge damage scars. steep RT	amorphous	3							
78	30=1541	30/09/2015	86	Flat	Core	Complete	Silcrete	medium	reddy brown	1000	79.32	113	74.94							1-50				coarse cortex, very grainy			bifacial	2	NegScar	Cortex	33.6	32.18	voids/ uneven
79	30=1606	30/09/2015	87	Flat	URTF	Complete	Chert	fine	orange	0.2	17.24	3.9	2.67			Hertzian	focalised	no	Feather	0		Indeterminate	no	this is the middle section									
80	30=1612	30/09/2015	88	Flat	URTF	LCSL	Silcrete	very fine	pale orange	0.2	9.64	6.83	2.89			Hertzian			None	0			no	prox frag									
81	30=1618	30/09/2015	89	Flat	URTF	MarFrag	Chert	fine	orange	0.2	5.73	9.69	2.55							100			no										
82	30=1630	30/09/2015	90	Flat	URTF	MarMiss	Chert	oolitic	orange cream beige	3.2	21.64	9.97	6.78			Hertzian	shattered		None	0		Indeterminate	no	cone split, mar missing, prox frag									
83	30=1639	30/09/2015	91	Flat	Core	Complete	Chert	oolitic	orangey red	18.5	29.28	33.3	15.06							0							multidirectional	2	Cortex		29.28		
84	01=0937	1/10/2015	92	Flat	NDS		Silcrete	coarse variable grain	purple	3										0													
85	01=0945	1/10/2015	93	Flat	URTF	LCSR	Silcrete	medium	purple	15.9	38.58	20.7	9.25			Hertzian	single	no	Feather	1-50			no										
86	01=0955	1/10/2015	94	Flat	URTF	LCSL	Silcrete	medium	orange	6.5	26.47	12.8	14.13			Hertzian	cortical	no	Feather	100			no										
87	01=1002	1/10/2015	95	Flat	URTF	LCSR	Silcrete	medium	orange	3.9	23.65	28.3	5.24			Hertzian	single	no	Feather	0													
88	01=1012	1/10/2015	96	Flat	URTF	MedFrag	Silcrete	medium	orange	4.4	15.12	24.9	6.29			None			None	0	2	Same	no										
89	01=1021	1/10/2015	97	Flat	NDS		Silcrete	mostly cortex, some finer white silcrete inside		38.7										100				seems to have frac surfaces but no diagnostic features									
90	01=1029	1/10/2015	98	Flat	URTF	MedFrag	Chert	fine	browny red	0.5	10	8.22	4.01							0				all margins missing, central piece, heat shattered									
91	01=1034	1/10/2015	99	Flat	URTF	ProxFrag	Chert	fine	orange	0.1	4.53	5.04	0.97	5.4	0.83	Hertzian	single	no	None	0	0	Same	no	gullwing platform									
92	01=1045	1/10/2015	100	Flat	URTF	MarFrag	Chert	fine	dark brown	1.5	13.43	15.1	4.83						None	0	0		no	3 margins missing									
93	01=1134	1/10/2015	101	Flat	Core	Complete	Silcrete	medium	reddy orange	25.2	28.49	29.8	21							0							multidirectional	5	NegScar	NegScar	20.36	19.03	small voids
94	01=1154	1/10/2015	103	Flat	RTF	Complete	Chert	fine	brown	7.8	13.99	23.4	11.72	23.26	10.8	Hertzian	multiple	no	None	0	2	SameOblique		platform is two broad surfaces meeting at right angles in the middle, retouch from side, exhausted	amorphous	234							
95	01=1212	1/10/2015	104	Flat	Core	Complete	Chert	fine	orange and cream	12	28.65	22.7	6.98							0							bipolar uni	1	NegScar	NegScar	20.99	18.5	crush/ uneven
96	01=1356	1/10/2015	105	Flat	URTF	MarFrag	Chert	fine	orange and cream	1.6	8.54	18.6	3.3							1-50			yes										
97	01=1359	1/10/2015	106	Flat	URTF	MarFrag	Chert	fine	red	0.2	12.61	5.27	1.75						Feather	0	2	Same	no										
98	01=1403	1/10/2015	107	Flat	URTF	MedFrag	Silcrete	medium	reddy brown	2.5	21.17	15.4	4.46							0	1	Indeterminate	no										
99	01=1408	1/10/2015	108	Flat	URTF	MarFrag	Silcrete	fine	red and orange	0.3	11.59	11.2	1.65							0	1	Indeterminate	no										
100	01=1418	1/10/2015	109	Flat	URTF	LCSR	Silcrete	medium	reddy brown	6.3	16.96	14	7.37			Hertzian	cortical	no	Feather	100	0		no										
101	01=1429	1/10/2015	110	Flat	URTF	ProxFrag	Chert	fine quartz grains	red and orange	2.9	16.3	19.8	5.96			Hertzian		yes	None	0		Indeterminate	no	missing margin, incomplete platform, heat shatter on ventral and dorsal. Note colour - red outside and orange inside, due to heat?									



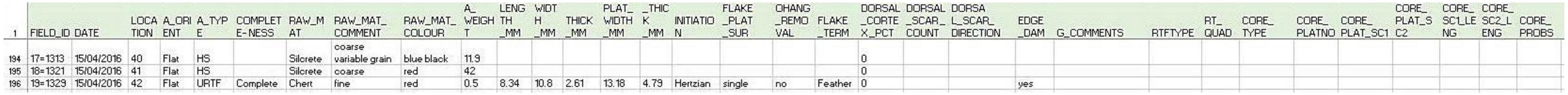
1	FIELD_ID	DATE	LOCATION	A_ORIENT	A_TYPE	COMPLETE-NESS	RAW_MAT	RAW_MAT_COMMENT	RAW_MAT_COLOUR	A_WEIGHT	LENGTH_MM	WIDTH_MM	THICK_MM	PLAT_WIDTH_MM	_THICK_MM	INITIATION	FLAKE_PLAT_SUR	OHANG_REMOVAL	FLAKE_TERM	DORSAL_CORTEX_PCT	DORSAL_SCAR_COUNT	DORSAL_SCAR_DIRECTION	EDGE_DAM	G_COMMENTS	RTFTYPE	RT_QUAD	CORE_TYPE	CORE_PLATNO	CORE_PLAT_SC1	CORE_PLAT_SC2	CORE_SC1_LENG	CORE_SC2_LENG	CORE_PROBS
102	01=5404	1/10/2015	111	Flat	URTF	Complete	Chert	extremely weathered	grey with orange inclusions	4.3	16.89	19.2	6.95	22.96	11.2	Hertzian	multiple	no	Feather	unclear	2	Same	yes										
103	01=1518	1/10/2015	112	Flat	URTF	LCSR	Silcrete	fine	orange	1.6	19.05	10.3	5.05			Hertzian	single	no	Feather	1-50			yes	damage at distal, small stepping on dorsal, one large step on ventral from same location (bifacial core?)									
104	01=1529	1/10/2015	113	Flat	URTF	ProxFrag	Chert	fine	orange	2.3	18.26	16	5.54			Hertzian	shattered		None	0	3	SameOblique		only the very distal end is broken									
105	01=1538	1/10/2015	114	Flat	Core	Complete	Chert	opal	white	11.9	31	25.9	21.57							0				exhausted			multidirectional	4	Indeterminate		16.95		voids/ uneven
106	01=1601	1/10/2015	116	Flat	NDS		Chert	fine	brown	0.4										0				heat shatter									
107	01=1604	1/10/2015	115	Flat	URTF	Complete	Silcrete	medium	reddy brown	11.3	36.6	32.5	8.2	35.74	3.73	Hertzian	multiple	no	Feather	0	3	SameOppOblic	no	double bulb									
108	01=1620	1/10/2015	117	Flat	URTF	LCSR	Chert	opal	white	0.3	11.83	6.96	2.2			Hertzian				0													
109	01=1628	1/10/2015	118	Flat	NDS		Chert	opal	white	0.2										0				pot lids have obscured features									
110	01=1637	1/10/2015	119	Flat	URTF	Complete	Chert	opal	white	0.5	9.24	14.6	4.13	13.03	3.57	Hertzian	single	no	Feather	0	1	Indeterminate	no										
111	01=1641	1/10/2015	120	Flat	URTF	Complete	Chert	opal	white	0.1	8.52	4.73	1.58	4.98	2.23	Hertzian	single	no	Feather	0	1	Indeterminate	yes	large notch on left margin, onto both vent and dor									
112	02=0901	2/10/2015	121	Flat	URTF	Complete	Silcrete	medium	orange	19.8	21.72	19.6	19.22			Hertzian		no	Feather	0	3	OppOblique	no										
113	02=0911	2/10/2015	122	Flat	URTF	DistFrag	Chert	fine	cream and red	1.1	17.03	9.35	4.78						Feather	0	3		yes										
114	02=1000	2/10/2015	123	Flat	NDS		Quartz	milky		0.7										0			no	cannot identify ventral, maybe med or dist frag									
115	02=1018	2/10/2015	124	Flat	URTF	ProxFrag	Silcrete	medium	reddy brown	7.6	21.67	21.8	11.24			Hertzian	shattered		None	1-50	1	Indeterminate	no	only the vey tip of the distal end is missing, feather terminated otherwise									
116	02=1045	2/10/2015	125	Flat	URTF	Complete	Silcrete	fine but uneven texture	red	4.4	27.69	16.3	6.75			Hertzian	shattered		Step	0		Indeterminate	no										
117	02=1052	2/10/2015	127	Flat	URTF	Complete	Silcrete	fine matte	beige	0.3	11.83	7.93	1.78			Hertzian	shattered		Feather	0		SameOpp	no	maybe all cortex, maybe sandstone									
118	02=1056	2/10/2015	128	Flat	URTF	MarMiss	Silcrete	fine matte	pale orange	0.2	8.47	9.58	3.04	3.05	1.26	Hertzian	single	no	Feather	0	3	Same	no										
119	02=1103	2/10/2015	129	Flat	HS		Silcrete	coarse	dark purple and red	219										0				similar raw material to other flakes and heat shatter in the area									
120	02=1008	2/10/2015	130	Flat	URTF	DistFrag	Silcrete	medium	orange	1	10.38	11.3	3.73			None			Feather	0	3	Same	no										
121	02=1111	2/10/2015	131	Flat	URTF	MarMiss	Silcrete	medium	orange	0.5	7.68	11.5	3.01			Hertzian	shattered		Feather	0	3	Same	no										
122	02=1117	2/10/2015	132	Flat	URTF	Complete	Silcrete	medium	orange	2.2	17.52	25.5	4.28	9.98	2.97	Hertzian	cortical	no	Step	100		Indeterminate	no										
123	02=1123	2/10/2015	133	Flat	RTF	Complete	Silcrete	medium and fine cortex	orange	10.7	34.18	31	9.12			Hertzian	shattered		Feather	51-99	3	Indeterminate	no	cortical all the w ay though	amorphous	1							
124	01=1051	13/04/2016	2	Flat	FP	Complete	Chert	fine with inclusions	brown to beige	3.3	35.48	14.5	8.97			None				0	2	Oblique	yes	broken flake, negative scars on ventral									
125	02=1117	13/04/2016	3	Flat	URTF	Complete	Chert	fine with quartz inclusions	reddy brown	3	14.65	24.2	5.68			Hertzian	shattered		Feather	0	2	OppOblique	yes	possible cone split?									
126	03=1132	13/04/2016	4	Flat	HS		Sandstone		creamy bleached	10										0													
127	04=1138	13/04/2016	5	Flat	HS		Limestone		grey and red	171.8										0													
128	05=1141	13/04/2016	6	Flat	HS		Limestone		grey, black and red	51.8										0													
129	06=1148	13/04/2016	7	Flat	RTF	Complete	Silcrete	very coarse mixed grain sizes, stranded beach ridge	orange brown	22.5	34.5	38.1	10.85	48.05	17.2	Hertzian	single	no	Feather	1-50	1	Same	no	large thin single scar on ventral 10.98l x 13.71w	amorphous	d							
130	07=12.10	13/04/2016	7	flat	Grindsto	MarFrag	Silcrete	small grain in matrix, coarse	grey	23.3	34.63	32.7	17.13			hertzian	cortical		Feather	0				grindstone, broken, two grinding surfaces									



1	FIELD_ID	DATE	LOCATION	A_ORIENT	A_TYPE	COMPLETE-NESS	RAW_MAT	RAW_MAT_COMMENT	RAW_MAT_COLOUR	A_WEIGHT	LENGTH_MM	WIDTH_MM	THICK_MM	PLAT_WIDTH_MM	_THICK_MM	INITIATION	FLAKE_PLAT_SUR	OHANG_REMOVAL	FLAKE_TERM	DORSAL_CORTEX_PCT	DORSAL_SCAR_COUNT	DORSAL_SCAR_DIRECTION	EDGE_DAM	G_COMMENTS	RTFTYPE	RT_QUAD	CORE_TYPE	CORE_PLATNO	CORE_PLAT_SC1	CORE_PLAT_SC2	CORE_SC1_LENG	CORE_SC2_LENG	CORE_PROBS
131	08=1331	13/04/2016	8	flat	HS		Limestone		grey	8.9										0													
132	09=1335	13/04/2016	9	Flat	HS		Limestone		grey	8.4										0													
133	10=1336	13/04/2016	9	Flat	HS		Limestone		grey	1.6										0													
134	11=1337	13/04/2016	9	Flat	HS		Limestone		grey	5.3										0													
135	12=1338	13/04/2016	9	Flat	HS		Limestone		grey	5.5										0													
136	13=1346	13/04/2016	10	Flat	HS		Silcrete		red	8.6										0													
137	14=1351	13/04/2016	11	Flat	URTF	MarMiss	Chert	fine with inclusions	orange brown	0.5	10.81	15.6	3.16			Hertzian	shattered		None	0	1	Oblique		looks like trampling damage at distal, patinated dorsal but fresher oblique scar									
138	15=1442	13/04/2016	12	Flat	Core	Complete	Silcrete	varying sizes small grain, lots of matrix	grey	38.5	39.3	48.9	25.61							0				hard to tell which came first			multidirectional	2	Cortex	Indeterminate	21.93	19.87	uneven
139	1=1004	14/04/2016	13	flat	Core	Complete	Chert	fine with inclusions	dark red to brown to black	12.2	20.95	35.8	16.35							0				classic cone shape, potlid on platform			bipolar uni	1	NegScar		16.46	14.01	all
140	2=1019	14/04/2016	13	Flat	URTF	MedFrag	Chert	half cherty half silcretey	dark brown	1	16.59	11.9	5.91			None				0				looks like heat damage, very uneven surfaces									
141	3=1030	14/04/2016	14	Flat	URTF	MarMiss	Chert	fine	white to beige to brown	3.5	32.69	23	4.42	16.45	3.15	Hertzian	multiple	yes	Hinge	0	1	Indeterminate	no	surface, multiple small negative s on plat									
142	4=1046	14/04/2016	15	Flat	HS		Silcrete	coarse	purple	11.6										0													
143	5=1106	14/04/2016	16	Flat	URTF	MarMiss	Silcrete	very fine even grain	orange	1	15.67	17.3	4.92	11.56	5	Hertzian	single	no	Feather	0	3	Same	yes	edge damage consistent around distal									
144	6=1117	14/04/2016	17	Flat	HS		Silcrete	coarse	red	3.7										0													
145	7=1129	14/04/2016	18	Flat	HS		Chert	large inclusions	red to beige	1.7										0				maybe broken or heat damaged flake									
146	8=1133	14/04/2016	18	Flat	URTF	Complete	Chert	very fine	orange to brown	1.8	17.23	19.1	5.41	13.86	7.44	Hertzian	single	yes	Feather	0	3	SameOppOblic	yes	damage onto ventral, coarse but consistent along other edges									
147	9=1144	14/04/2016	18	Flat	URTF	MarFrag	Chert	fine with inclusions	reddy brown	0.8	14.28	14.2	5.1							0				heat pocks have removed orienting info									
148	10=1152	14/04/2016	18	Flat	URTF	Complete	Chert	fine with inclusions	reddy brown	0.6	16.99	14.5	2.74			Hertzian	shattered		Feather	0	3	SameOblique	yes	fine edge damage all along distal, some longer scars onto dorsal									
149	12=1206	14/04/2016	18	Flat	FP	Complete	Chert	fine with inclusions	red to dark brown	6.6	31.2	23.4	9.8							0				multiple negative flake scars in multiple directions, battering at one end									
150	13=1212	14/04/2016	18	Flat	URTF	LCSR	Chert	fine	brown to black	0.5	13.99	8.38	2.39			Hertzian	single		None	1-50				distal missing									
151	14=1221	14/04/2016	19	Flat	URTF	MarFrag	Chert	inclusions, chalky	orange to cream	0.6	14.35	12.8	3.45			None			Feather	0				small piece of distal frag									
152	15=1330	14/04/2016	20	Flat	HS		Silcrete	coarse	grey	11.2										0													
153	16=1341	14/04/2016	21	Flat	HS		Chert	fine with large quartz inclusions		17										0				small scalloped negative s, looks like the base ofna bipolar core but all other surfaces heat shatter									
154	17=1400	14/04/2016	22	Flat	HS		Silcrete	coarse	blue	9.3										0													
155	18=1405	14/04/2016	23	Flat	HS		Silcrete	coarse	red	8.5										0													
156	18=1409	14/04/2016	24	Flat	HS		Silcrete	coarse	red	3.8										0													
157	19=1411	14/04/2016	24	Flat	URTF	Complete	Silcrete	coarse	red	0.6	14.02	11.6	3.6	8.76	3.32	Hertzian	single		Feather	0	0	Indeterminate		too coarse for identifying some features									



1	FIELD_ID	DATE	LOCATION	A_ORIENT	A_TYPE	COMPLETE-NESS	RAW_MAT	RAW_MAT_COMMENT	RAW_MAT_COLOUR	A_WEIGHT	LENGTH_MM	WIDTH_MM	THICK_MM	PLAT_WIDTH_MM	_THICK_MM	INITIATION	FLAKE_PLAT_SUR	OHANG_REMOVAL	FLAKE_TERM	DORSAL_CORTEX_PCT	DORSAL_SCAR_COUNT	DORSAL_SCAR_DIRECTION	EDGE_DAM	G_COMMENTS	RTFTYPE	RT_QUAD	CORE_TYPE	CORE_PLATNO	CORE_PLAT_SC1	CORE_PLAT_SC2	CORE_SC1_LENG	CORE_SC2_LENG	CORE_PROBS
158	20=1421	14/04/2016	24	Flat	Core	Complete	Chert	some inclusions	brown to red	4.1	10.36	33.4	11.3							0				crushing on some edges, both scar measurements from plat 1			bipolar multi	4	Indeterminate	Indeterminate	10.88	13	
159	21=1430	14/04/2016	24	Flat	URTF	MedFrag	Silcrete	medium	red	0.3	14.41	10.7	2.54							0	2	Same											
160	22=1435	14/04/2016	24	Flat	HS		Silcrete	coarse	orange	8.5										0													
161	23=1440	14/04/2016	25	Flat	HS		Silcrete	coarse	red	38.5										0				looks like a flake but too coarse to identify the bulb									
162	24=1458	14/04/2016	26	Flat	NDS		Silcrete	fine grain	red	35.9										0				ona, looks like bending fractures on one edge									
163	25=1505	14/04/2016	26	Flat	HS		Silcrete	medium	red	0.5										0													
164	26=1513	14/04/2016	27	Flat	HS		Chert	fine	red	1.6										0													
165	27=1515	14/04/2016	27	Flat	HS		Silcrete	coarse	red	8.3										0													
166	28=1521	14/04/2016	28	Flat	NDS		Silcrete	coarse		0.6										0				possible mefial or prox frag, too coarse to identify features									
167	29=1551	14/04/2016	29	Flat	URTF	ProxFrag	Chert	fine with white cortex	brown	0.4	10.3	12.4	3.48			Hertzian	shattered		None	1-50	3	Opposite	yes	edge damage all along fractured edge from ventral									
168	30=1605	14/04/2016	29	Flat	URTF	MarMiss	Chert	oolitic and banded	red white brown	9.4	32.39	29.1	7.84			Bending	single	no	Feather	1-50	1	Same	no	distal is cortical surface									
169	31=1614	14/04/2016	29	Flat	URTF	ProxFrag	Chert	fine	orange	0.1	9.91	12	1.69			Hertzian	shattered			0				distal and both margins missing									
170	32=1625	14/04/2016	30	Flat	HS		Silcrete	coarse	red	26.2										0													
171	33=1627	14/04/2016	30	Flat	HS		Silcrete	coarse	red	3.5										0													
172	34=1630	14/04/2016	30	Flat	HS		Silcrete	coarse	red	31.7										0													
173	35=1650	14/04/2016	31	Flat	URTF	ProxFrag	Chert	fine	orange	3.9	6.33	28.1	11.99	31.24	13.2	Hertzian	multiple	no	none	0				heat affected, heat has removed the distal, large void									
174	36=1658	14/04/2016	32	Flat	RTF	Complete	Chert	chalky	pink	3	33.08	14.1	8.6			Hertzian	shattered			1-50	0				amorphous	234							
175	37=1709	14/04/2016	33	Flat	URTF	LCSR	Chert	oolitic orange white		3	20.51	12.9	7.83			Hertzian	single		Feather	1-50			no	cortex at distal only									
176	38=1716	14/04/2016	33	Flat	HS		Silcrete	coarse	red	25.1										0													
177	39=1723	14/04/2016	33	Flat	ONA		Silcrete	coarse	orange	227.1										0													
178	01=0958	15/04/2016	34	Flat	HS		Silcrete	coarse	red	30.9										0													
179	02=1010	15/04/2016	35	Flat	URTF	LCSR	Silcrete	medium	orange	14.1	37.68	38.6	8.19			Hertzian	single		Feather	1-50			no										
180	03=1031	15/04/2016	36	Flat	URTF	ProxFrag	Chert	fine	brown	7.5	20.45	27.5	9.95	7.06	2.41	Hertzian	single		None	0			no	some crushing opposite plat									
181	04=1042	15/04/2016	37	Flat	HS		Silcrete	coarse		4										0													
182	05=1045	15/04/2016	37	Flat	URTF	MarMiss	Chert	fine	red	0.6	11.41	11.8	3.32			Hertzian	multiple	yes	Feather	0	1	Oblique	yes	heat pocks, right mar miss									
183	06=1052	15/04/2016	37	Flat	URTF	Complete	Chert	fine	red	0.1	8.32	9.37	1.73			Hertzian	shattered		Feather	0			no	same RM as above									
184	07=1100	15/04/2016	37	Flat	HS		Chert	fine	red	0.8										0				same RM as above, not orient able									
185	08=1105	15/04/2016	37	Flat	HS		Chert	fine	red	3										0				as above									
186	09=1109	15/04/2016	37	Flat	URTF	MarMiss	Silcrete	fine	orange	0.1	7.9	11	2.91			Hertzian	cortical	no	Feather	0	1	Same											
187	10=1114	15/04/2016	37	Flat	HS		Silcrete	coarse	orange	0.7										0													
188	11=1201	15/04/2016	38	Flat	URTF	DistFrag	Silcrete	coarse variable grain		5.2	31.55	25.8	7.46						Feather	0													
189	12=1206	15/04/2016	38	Flat	URTF	Complete	Silcrete	coarse variable grain	orange	22.6	47.7	43.8	18.56	31.32	10.7	Hertzian	single	no	Feather	0				coarse mat makes measurements hard									
190	13=1216	15/04/2016	38	Flat	URTF	Complete	Chert	fine	brown	0.1	7.18	9.05	3.22	6.96	3.52	Hertzian	single	no	Feather	1-50	1	Same	no	very small scars on dorsal plat									
191	14=1223	15/04/2016	38	Flat	HS		Chert	fine	red	1.4										0				very heat damaged, can't tell v from d									
192	15=1309	15/04/2016	39	Flat	HS		Silcrete	coarse variable grain	red	16.4										0													
193	16=1312	15/04/2016	39	Flat	HS		Silcrete	coarse variable grain	red	29.9										0													



1	FIELD_ID	DATE	LOCATION	A_ORIENT	A_TYPE	COMPLETE-NESS	RAW_MAT	RAW_MAT_COMMENT	RAW_MAT_COLOUR	A_WEIGHT	LENGTH_MM	WIDTH_MM	THICK_MM	PLAT_WIDTH_MM	_THICK_MM	INITIATION	FLAKE_PLAT_SUR	OHANG_REMOVAL	FLAKE_TERM	DORSAL_CORTEX_PCT	DORSAL_SCAR_COUNT	DORSAL_SCAR_DIRECTION	EDGE_DAM	G_COMMENTS	RTFTYPE	RT_QUAD	CORE_TYPE	CORE_PLATNO	CORE_PLAT_SC1	CORE_PLAT_SC2	CORE_SC1_LENG	CORE_SC2_LENG	CORE_PROBS
194	17=1313	15/04/2016	40	Flat	HS		Silcrete	coarse variable grain	blue black	11.9										0													
195	18=1321	15/04/2016	41	Flat	HS		Silcrete	coarse	red	42										0													
196	19=1329	15/04/2016	42	Flat	URTF	Complete	Chert	fine	red	0.5	8.34	10.8	2.61	13.18	4.79	Hertzian	single	no	Feather	0			yes										