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Changing Perspectives in Australian Archaeology, Part V

Karremarter—Mid to Late Holocene Stone Artefact Production and Use in the Lower Southeast of South Australia

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ABSTRACT. Karremarter is a small limestone shelter in the Lower South-East of South Australia that was used from the mid-Holocene onward. This paper presents a characterization of the typological and technological attributes of the chipped stone artefacts recovered from this shelter. This provides the basis for assessing the relationship between access to and selection of raw materials, tool-making strategies and the spatial and temporal availability of subsistence resources.

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The mid-late Holocene assemblage of chipped stone artefacts from Karremarter in the lower southeast of South Australia provides a springboard for discussing two of the recurring themes of Val Attenbrow's research: the meaning of variation and change in composition and characteristics of artefact assemblages, and the information that stone technology can contribute to an understanding of past land use patterns.

Assemblage variation can be investigated at different scales, ranging from the short-term and local to the long-term and widespread, and may involve explanations that refer to season and scale of occupation, through to patterns of mobility or broad responses to changes to the environment (cf. Frankel, 1991a: 144–145; Bird & Frankel, 2001, 2005: Bailey, 2007). Over the past 20-plus years researchers have striven for a better understanding of the factors contributing to assemblage variation in different circumstances, stimulating considerable interest in the strategies used to make and maintain tools and in the way these relate to the strategies employed to acquire other critical resources and to maintain social networks (e.g., Torrence, 1983; Shott, 1986; Kelly, 1988; Bamforth, 1991; Kuhn, 1992).

Kuhn (1994), for example, explored the relationship between the cost of transporting artefacts and their potential utility and found that if size did not constrain the effectiveness of a tool, the most economical strategy for a highly mobile forager would have been to carry many small tools with modest potential for reworking. However, if larger tools were required for effective performance of tasks, he suggests that it would have been more economical to carry tools with longer working edges and greater potential for re-working (Kuhn, 1994: 438). He also acknowledged a considerable body of evidence indicating that mobile foragers sometimes transported cores as part of their tool-kits, even though the mass of a core can never be converted in its entirety into tool blanks or tools.

Hiscock (2006) has built on these (and other) foundations to argue that in southeastern Australia changes in the relative abundance of backed artefacts and scrapers in Holocene artefact assemblages reflect different strategies for balancing the costs of tool manufacture and maintenance with the

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costs of acquiring food. He identifies scrapers as a strategy for extending the use life of larger, less-standardized tools, as their size and shape facilitated reworking. He postulates that scrapers would have been advantageous in situations in which resources were predictable and the cost of acquiring raw material for tool manufacture was greater than that of food procurement (Hiscock, 2006: 74–76, 83–85). On the other hand, he characterizes backed artefacts as a strategy for producing many small, standardized tools of known effectiveness from a unit of raw material. He argues that the greater cost of producing these more elaborate tools was outweighed by the benefit of being able to carry around reliable, maintainable and multi-purpose tools. It is postulated that these helped to reduce the risk of failing to acquire food resources in situations in which the distribution of resources was highly unpredictable (Hiscock, 2006: 78–80, 83–85).

A broad coincidence between the proliferation of backed artefacts and a shift in the circulation patterns, specifically, the mid-Holocene increase in the magnitude and frequency of ENSO driven climate cycles is noted (Hiscock, 2002, 2006: 88; Attenbrow *et al.*, 2009; Robertson *et al.*, 2009). These climatic shifts resulted in more marked seasonal variations and more variable rainfall, with consequent reduced predictability in the location and timing of resources. It is postulated that the proliferation of backed artefacts represents one technological solution to this adaptive problem. It is acknowledged that the timing and type of technological change triggered by these climate changes varied from one part of the continent to another, depending on the factors that influenced the relative costs and benefits of different technological and economic activities.

It should also be noted that changes in circulation patterns impacted differently in different areas, depending on topography and other localized factors. For example, during the mid-Holocene some parts of southeast Australia experienced reduced and more variable rainfall while other areas were buffered from such changes. The basalt plains of western Victoria experienced less rainfall, reduced lake levels and a reduction in woody taxa about 5000 to 4000 cal. BP (Cook, 2009: 220). During this time open woodlands and grasslands covered the plains, allowing red kangaroos, which prefer open plains, to re-colonize the area briefly. At the same time, wetlands expanded in the coastal hinterland, resulting in increased biological productivity (Head, 1987). These observations emphasize the importance of establishing the impact of regional and global climate changes on the distribution of critical resources at the local scale. This includes consideration of the extent of surface water, vegetation structure and the distribution of key plant and animal resources. Only then can the scale of environmental changes be related to the scale of human activity, allowing investigation of the relationship between resource exploitation and stone technology.

In this paper we consider this general problem through the stone artefact assemblage from Karremarter. We investigate what the characteristics of this small stone artefact assemblage indicates about the stone-working activities undertaken at the site and use these observations to discuss what this reveals about the relationship between stone technology, patterns of raw material use, duration of site occupation and the extent of people's mobility in this area during the mid-late Holocene. The Karremarter assemblage lends itself to this exercise because almost all of it derives from working two high quality raw materials with relatively low procurement costs, thus removing from consideration the powerful influence of the physical properties of stone on technology and recurring artefact forms.

The regional context

Karremarter is a small limestone shelter on the western edge of Discovery Bay, which stretches some 70 km from Cape Bridgewater in western Victoria to Port MacDonnell in the Lower South-East of South Australia (38°02'38"S 140°56'48"E; South Australian Heritage Unit Register No. 7021-2114, CEGSA Site L261; in a previous publication [Frankel, 1986] the site was referred to as Piccaninnie Ponds Cave) (Fig. 1). Most of Discovery Bay is characterized by extensive, exposed sandy beaches, which are backed by coastal flats and wetlands. However, to the west of the Glenelg River mouth, there are smaller embayments and beaches divided by low cliffs. Behind the coastal dunes, wetlands fill the depressions between a series of northwest trending ridges that parallel the modern coastline and mark the locations of ancient shorelines. These are the most conspicuous topographic feature on an otherwise low lying and undulating coastal plain comprising uplifted Tertiary limestone.

The plain is vegetated by heathland and coastal scrub, which inland gives way to dry forest woodland. Palaeoecological studies of lakes on the basalt plains of the western Victoria indicate that the modern vegetation communities were established 8000 to 7000 years cal. BP (D'Costa *et al.*, 1989; Kershaw *et al.*, 2004; Cook, 2009). A short period of reduced rainfall from 5000 to 4000 years ago resulted in a reduction in woody taxa in the western plains, but as Dodson *et al.* (1992**:** 140) point out, the coastal plain and its immediate hinterland were buffered from these changes. In fact, evidence has long pointed to an expansion of highly productive freshwater wetlands in coastal areas in this region during the mid-Holocene (Head, 1987).

Two larger shelters on either side of the Bay, Bridgewater Cave South in the east (Lourandos, 1980) and Koongine Cave in the west (Bird & Frankel, 2001) were used intermittently from the late Pleistocene onward as the post-glacial sea level rise altered their position on the landscape. The most famous of the open, inland sites in the region is Wyrie Swamp, where excavations yielded collections of both stone tools and wooden artefacts dating to the terminal Pleistocene (Luebbers, 1978). Middens provide evidence for continuous use of coastal resources from the time the sea approached its present level during the early Holocene (Godfrey, 1989, 1994; Frankel, 1991b, 1993; Fresløv & Frankel, 1999; see also Luebbers, 1978). Karremarter is one of a number of smaller limestone shelters in the region and is only a few hundred metres from Narcurrer, which was excavated by Lourandos in 1985 (Barker, 1987; Cooke, 1994). Debris started to accumulate in these small shelters once the sea level reached its present position and wetland and littoral resources were brought into close proximity. However, both coastal and hinterland campsites were generally established in the open (Bird & Frankel, 2001: 77). A corollary of this is that the smaller rock shelters were infrequently and opportunistically occupied and were brief stopping-over places for people moving along the coast or from the coast to the forested hinterland.

The karst formations of the Lower South-East of South Australia (Twidale *et al.*, 1983) provide evidence for varied inland activities. Bednarik has recorded wall markings in a number of caves (Aslin *et al.*, 1985; Bednarik, 1986a), although their age is uncertain. Flint nodules were quarried from the formations in which the caves developed (Bednarik, 1986b, 1992**;** Bird & Frankel, 2001). These are generally fine-grained and dark grey to black in colour. Flint nodules are also washed up from submarine beds offshore, resulting

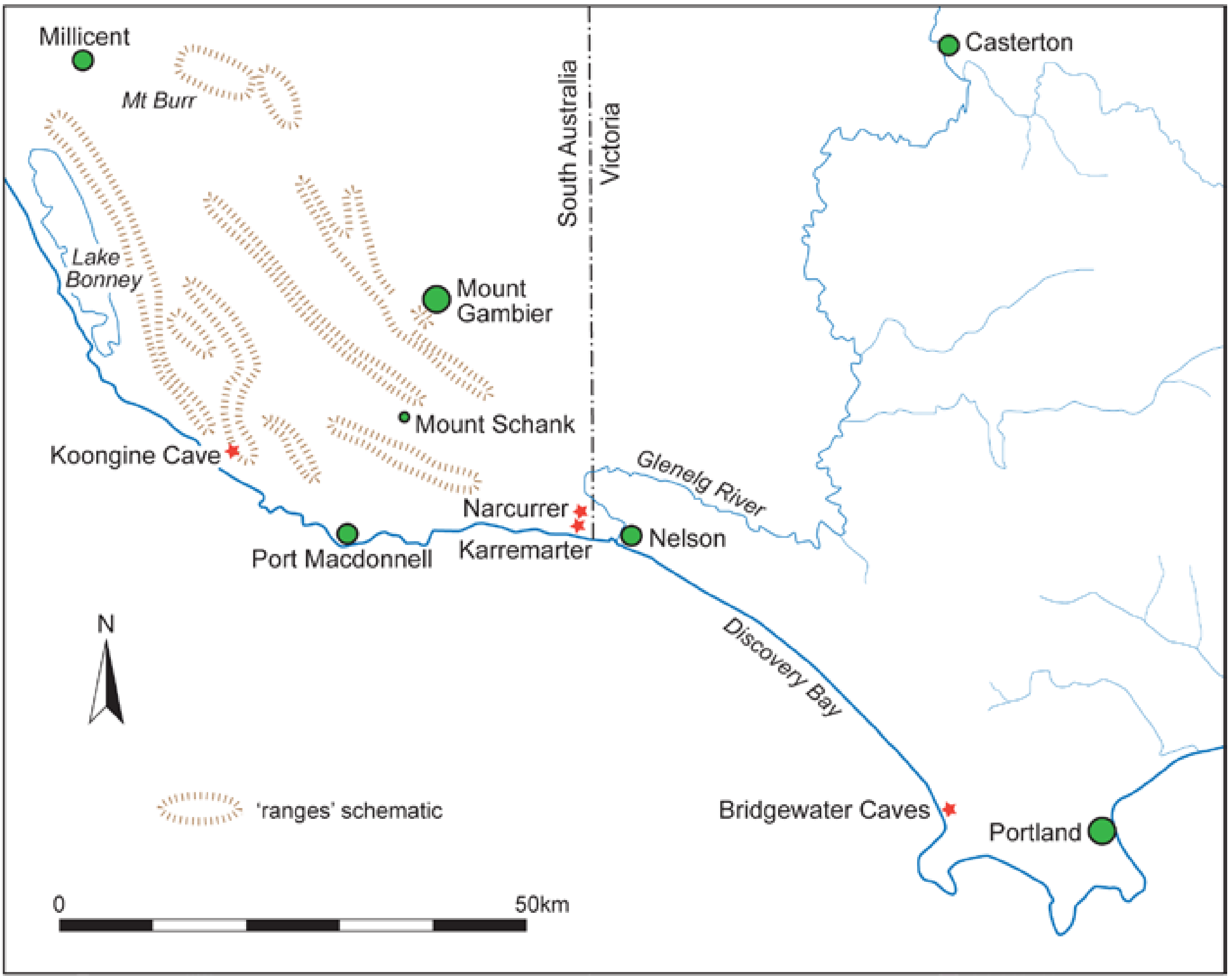

Figure 1. Map of southwestern Victoria and the Lower Southeast of South Australia showing the location of Karremarter and other relevant sites.

in the formation of extensive flint cobble-beds on many of the beaches along this coastline (Campbell & Edwards, 1966: 166–167, figs 2, 3; Scott-Virtue, 1982).

Lighter coloured flint nodules (mostly grey, but also brown) dominate the cobble beaches, but a small proportion of those cobbles are dark like the nodules quarried from the inland caves. The lighter coloured flint is harder and less brittle than the dark flint (i.e. it has a higher fracture toughness), and is less predictable in the way it flakes. However, it produces flakes with highly durable working edges. In contrast, the dark flint is more brittle, fractures more predictably and requires less force to work; as a result, longer, thinner flakes are more readily produced from the dark flint (John Duggan, personal communication, 2008). Both types of flint are found in the Karremarter assemblage.

Karremarter

Karremarter, *"the banks of the lakes"* (Smith, 1880: 132), is an appropriate name for this small limestone shelter, which is set high on a ridge overlooking the coastal flats that surround the Piccaninnie Ponds sinkholes (Figs 2, 3). The modern entrance is about 9 m wide and only 80 cm high, but there would, of course, have been greater headroom before the sediment build up of the last few thousand years (Figs 4, 5). Low clearance prevented documentation of the full extent of the shelter. At some time in the recent past chicken wire had been strung across the entrance to restrict access by rabbits, whose burrows have adversely affected so many inland archaeological sites in this part of southeastern Australia (Bird & Frankel, 2001: 51–52).

An initial test excavation was carried out in 1985 under the supervision of Wendy Beck, concurrently with Frankel's excavations at Malangine and Koongine caves (Frankel, 1986). At this time, a 1 × 1 m square (K12), which straddles the drip line near the centre of the entrance, was excavated to a depth of about 70 cm to a rocky base. During this, and all subsequent excavations, particular care was taken to remove material from identifiable rabbit burrows separately from the undisturbed sediments. A sample from the lowest deposits provided a radiocarbon determination of 7155–6030 cal. BP (Beta-14083, Table 1, Fig. 5).

The association of backed artefacts with this relatively early date prompted a second, smaller excavation at Karremarter. In 1987, Square J11D was excavated from a 25 × 25 cm square adjacent to Square K12 to check the

Table 1. Radiocarbon determinations from Karremarter.

sample	lab code	context	age BP	cal. BP (2 sigma)
1	Beta 25006	J12D/5	210±70	356–433
2	Beta 2505	J12D/15	1880±80	1614–1994
3	Beta 25007	J12D/24	3550±90	3614–4088
4	Beta 14083	K12/16	5750±200	6030–7155

Figure 2. Karremarter set near the top a limestone ridge overlooking the coastal plain.

Figure 3. View south from Karremarter across Piccaninnie Ponds to Discovery Bay.

stratigraphy and to obtain an additional series of radiocarbon samples. In this area deposits went down beside the rocks in Square K12, excavated to a depth of 155 cm. Three radiocarbon samples (Table 1, Fig. 5) provide a sequence from 4088–2394 cal. BP (Beta-25007) at about 75 cm below the surface, to 433–356 cal. BP at about 20 cm below the surface. The discrepancy between the basal dates from the two squares probably results from the uneven depth of sediment in the two areas, with the earliest date coming from material that was trapped between the basal rocks in Square K12 before the major build up of sediment in J12D.

The stratigraphic sections show that the deposits in both squares are similar and field observations suggest that there were no changes in sediment source or mode of deposition that could be used to identify assemblages of artefacts that might have accumulated at the same time (for instance, during a single occupation). Features like hearths and pits are not preserved and organics are a minor constituent of the sediments. Consequently, excavation spits were grouped into four analytical units, A to D (from youngest to oldest), each representing approximately the same thickness of sediment. These are arbitrary divisions of the deposit and the artefact assemblages contained within each should be treated as a time-averaged agglomeration (Stern, 2008). They provide a basis for assessing changes in assemblage composition through time (Fig. 5).

Table 2. Number of pieces of artefactual stone from each analytical unit at Karremarter.

square	analytical unit				unstratified	total
	A	B	C	D		
J12D	323	288	185	280	20	1096
K12	928	249	276	—	17	1470
Total	1251	537	461	280	37	2566

Artefacts are not distributed evenly through the analytical units: 50% of the assemblage comes from unit A, 10% from unit D, with the remaining 40% derived more or less evenly from the middle units (Table 2). However, the quantity of accumulated debris cannot be related directly to intensity of site use without an understanding of either the stone-working activities that took place there, or detailed information about net rates of sediment accumulation.

The surfaces of the artefacts are not pristine, reflecting both cultural and non-cultural post-depositional modification. Mobilization of carbonate through the deposit produced thin coatings of calcium carbonate on many of the artefacts, making it difficult to identify features on some and requiring the use of lower power magnification to study most. Many of the artefacts, especially in the upper units, have crazed surfaces and/or pot-lid fractures resulting from direct exposure to fire (Table 3), so it appears that fires were lit directly on top of the debris of previous occupations. There is no evidence for heat treatment of any of the raw materials.

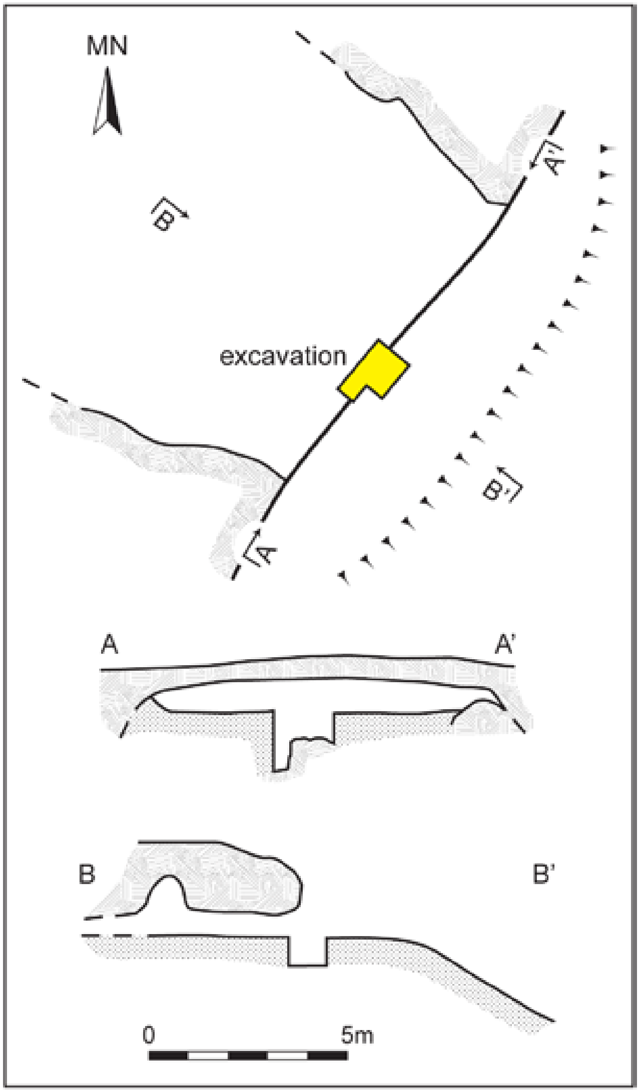

Figure 4. Karremarter, showing the location of the excavations.

Faunal remains

The vertebrate and invertebrate faunal remains recovered from Karremarter were analysed by Dingli (1995: 60–81). The terrestrial vertebrate fauna includes the remains of 15 taxa from wetland and woodland settings. The taxa present, together with the degree of bone fragmentation and distribution of tooth marks, indicates that the two marsupial carnivores whose bones are found in the assemblage, the Tasmanian devil (*Sarcophilus harrisii*) and tiger cat (*Dasyurus maculatus*), contributed to the accumulation of all the small- and some of the medium-sized taxa present. However, humans were responsible for all the larger and some of the medium sized mammals, including grey kangaroo, wombat, swamp wallaby, pademelon and brushtail possum, an inference supported by the taxonomic distribution of calcined bone and the representation of body parts and element portions (Dingli, 1995: 64–72). The range of human prey species at Karremarter is similar though not identical to that recorded at nearby Narcurrer and all the taxa identified as human prey at both sites are mentioned in the ethno-historical literature as having been part of the diet of the area's nineteenth century inhabitants (Barker, 1987).

The invertebrate assemblage is made up entirely of marine molluscs, two-thirds of which are wedge shell (*Paphies angusta*) collected from sandy shores. Elsewhere in the area, pipi (*Donax deltoides*) tends to be the preferred sandy shore species. The remainder of the molluscs are rock platform species, the most common of which is Turbo (*Turbo undulatus*). Emu eggshell was also recovered in all analytical units and was undoubtedly a persistent component of the winter diet. The faunal assemblages from both

Table 3. Percentage of each form of surface modification in each analytical unit at Karremarter. Sample size = 2562.

surface	analytical unit				unstratified	total
	A	B	C	D		
none	48.5	3.5	11.1	0.6	5.4	27.1
calcium carbonate	26.5	36.0	52.9	4.5	32.4	35.3
calcium carbonate and potlidding	6.3	20.7	13.4	1.6	21.6	11.9
calcium carbonate and crazing	3.4	23.5	12.8	1.4	13.5	10.7
potlidding	10.7	5.8	3.3	1.2	13.5	8.5
crazing	3.6	9.9	5.2	0.6	13.5	5.7
discolouration	0.6	0.4	1.1	—	—	0.6
weathering crack	0.2	0.2	0.2	—	—	0.2

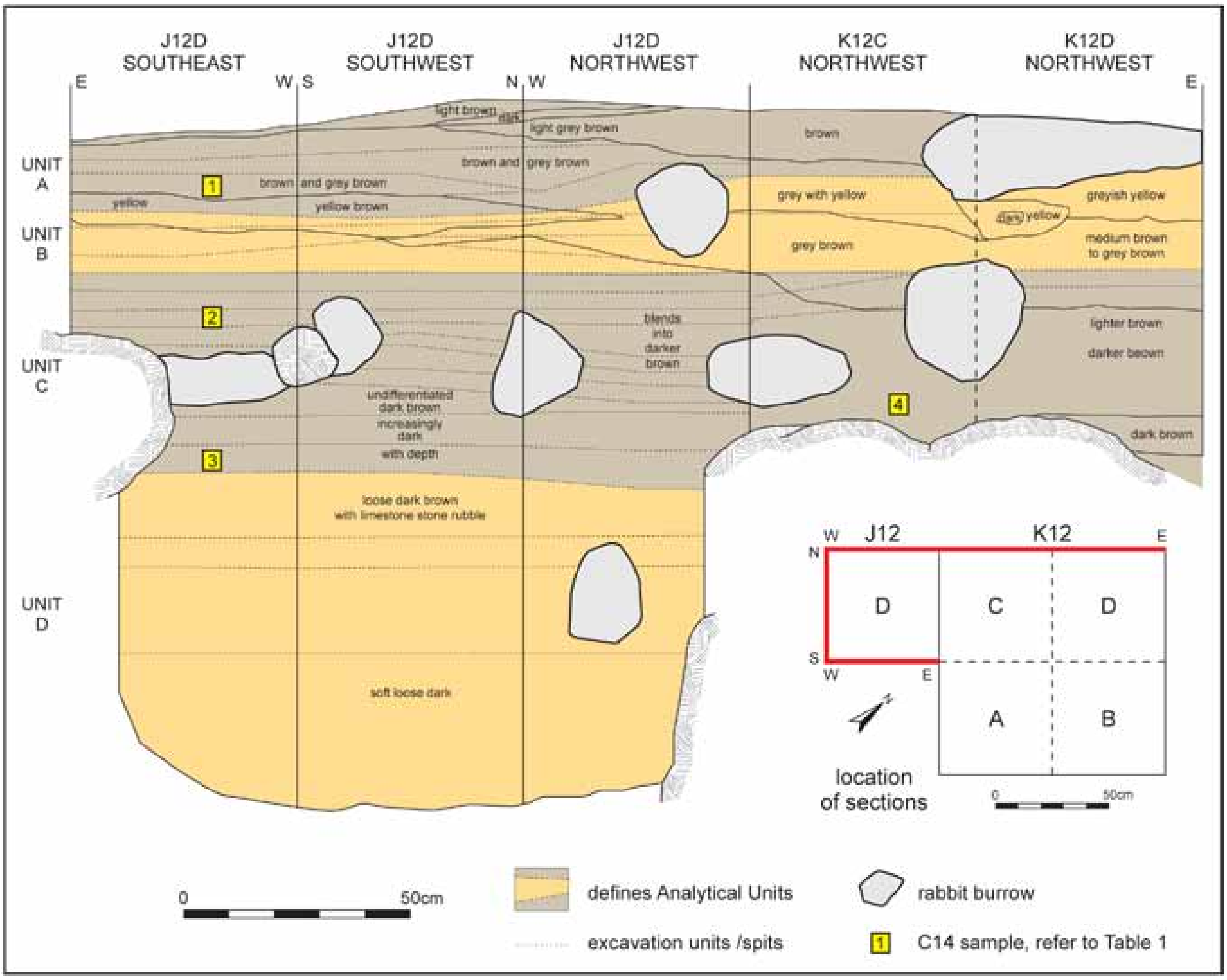

Figure 5. Sections and spit diagram of Karremarter, showing the location of radiocarbon samples.

Narcurrer (Barker, 1987) and Karremarter (Dingli, 1995) suggest that terrestrial and wetland resources were more important components of the diet than the marine molluscs (cf. Luebbers, 1978; Godfrey, 1989).

The Karremarter Stone Artefact Assemblage

Between 96% and 99% of the artefacts recovered from all analytical units in both squares are made of flint, with 79–88% of these made from the less brittle but more durable grey flint nodules that dominate the cobble beds on the nearby beach (Table 4). Small numbers of chert, quartz and limestone artefacts are also present, but the numbers of the chert and quartz artefacts, together with their limited stratigraphic distributions, suggests that they may represent single knapping events. The predominance of flint reflects both its flaking and edge-holding properties and the fact that it was readily available on the beach that lies within a kilometre of the cave.

The better quality dark flint could have been picked up from the local cobble beach but could also have been carried in from the inland karst formations where nodules were quarried (Bednarik, 1986b, 1992**;** Bird & Frankel, 2001). However, the proportion of the assemblage made up of dark flint artefacts (up to 20%) is far greater than the proportion of dark flint cobbles in the cobble beaches and while this may result from systematic scouring of the cobble beds for dark flint nodules, it also suggests that most of the dark flint was probably brought in from the hinterland caves. The costs of procuring material from either flint source would not have been high, as both sources lie well within the foraging range of the Holocene inhabitants of the area. Given the accessibility of these materials, and their co-occurrence with other resources, their acquisition is likely to have been

Table 4. Percentage of raw materials in each analytical unit at Karremarter. Sample size = 2562.

raw material	analytical unit				unstratified	total
	A	B	C	D		
grey flint	83.7	86.6	79.0	87.5	86.5	84.2
dark flint	13.7	12.3	17.6	11.4	13.5	13.9
chert	0.8	0.4	0.7	—	—	0.6
limestone	0.7	0.2	2.2	0.7	—	0.9
quartz	0.2	—	0.4	—	—	0.2
other	1.0	0.6	0.2	0.4	—	0.7

Table 5. Percentages of technological types in each analytical unit at Karremarter. Sample size = 2560.

technological	analytical unit				unstratified	total
type	A	B	C	D		
tool	5.8	6.7	6.9	4.3	13.5	6.1
core	0.8	0.9	2.0	0.7	—	1.0
whole flake	19.9	21.4	33.0	35.0	16.2	24.2
whole blade	1.0	2.0	3.0	2.1	2.7	1.7
broken flake	5.7	4.5	10.2	12.9	8.1	9.2
broken blade	0.3	2.0	0.9	0.4	—	0.8
angular fragment	65.9	51.8	42.5	44.3	56.8	56.4
rejuvenation flake	0.4	0.4	1.1	0.4	2.7	0.5

embedded in other activities and acquired as people moved around their usual foraging range. Of course, relatively more effort would have been involved acquiring the darker and more brittle flint from the hinterland caves (and/or in locating nodules of this material on the beaches), and this suggests that its flaking qualities may have been preferred for some purposes.

The size distribution of artefacts and the range of artefact types making up an assemblage, together provide an indication of whether it accumulated through *in situ* working of cores, whilst the amount of cortex preserved on the artefacts provides a general indication of how intensively the cores were reduced (e.g., Holdaway, 2004: 17–18, Clarkson & O'Connor, 2006: 187–188). The relative abundance of technological types in the Karremarter assemblage (for definitions, see Holdaway & Stern, 2004) (Table 5), together with size distributions (Fig. 6), and the proportion of artefacts preserving cortex (Table 7), indicates that the very small number of chert artefacts was probably brought into the cave as tool-blanks and/or finished tools: neither cores nor any quantity of flaking debris is present and most are devoid of cortex. However, the presence of angular fragments with an average maximum dimension of 16 mm does suggest some on site modification of tool-blanks or tool edges. Quartz is represented in the assemblage by a few un-worked pebbles and angular fragments, but there are no cores and neither is there any evidence for bipolar flaking. This may indicate that at least on one occasion quartz pebbles were brought to the site to assess their suitability for flaking.

In contrast, in all units, both the size distributions of the dark and light flint assemblages, and the proportions of each made up of tools, cores, core rejuvenation flakes, flakes, and angular fragments, suggest that they were worked on-site (Table 6, Fig. 6). However, the small proportion of each assemblage made up of artefacts <2 cm in maximum dimension and the ratio of angular fragments to whole flakes, suggests that neither assemblage contains all the debris from the reduction of entire nodules of raw material. Some knapping of both materials took place off-site, and it appears that the dark flint was knapped off site to a greater extent than the light flint. Nevertheless, the knapping of flint nodules was clearly the main focus of stone-working activities at Karremarter.

The relative proportion of dark to light flint remains more or less the same throughout the sequence and although there is some variation in the relative abundance

Table 6. Relationship between raw material and technological types at Karremarter. Sample size = 2560. *(a)* Percentage of raw materials that are of each technological type; *(b)* percentage of each technological type that are of each raw material.

	technological type	raw material						total
		grey flint	dark flint	limestone	chert	quartz	other	
a	tool	6.0	6.5	4.8	33.3	—	—	6.1
	core	1.1	0.8	—	—	—	—	1.0
	whole flake	23.1	30.4	28.6	40.0	—	17.4	24.2
	whole blade	1.3	4.5	—	—	—	—	1.7
	broken flake	9.1	9.9	9.5	6.7	—	4.3	9.2
	broken blade	0.7	1.1	—	—	—	—	0.8
	angular fragment	58.3	45.6	57.1	20.0	100.0	78.3	56.4
	rejuvenation flake	0.5	1.1	—	—	—	—	0.5

	technological type	raw material					
		grey flint	dark flint	limestone	chert	quartz	other
b	tool	81.5	14.6	0.6	3.2	—	—
	core	88.5	11.5	—	—	—	—
	whole flake	80.0	17.4	1.0	1.0	—	0.6
	whole blade	63.6	36.4	—	—	—	—
	broken flake	83.4	14.9	0.9	0.4	—	0.4
	broken blade	80.0	20.0	—	—	—	—
	angular fragment	86.8	11.2	0.8	0.2	0.1	1.2
	rejuvenation flake	71.4	28.6	—	—	—	—
	total	84.0	13.9	0.8	0.6	0.1	0.9

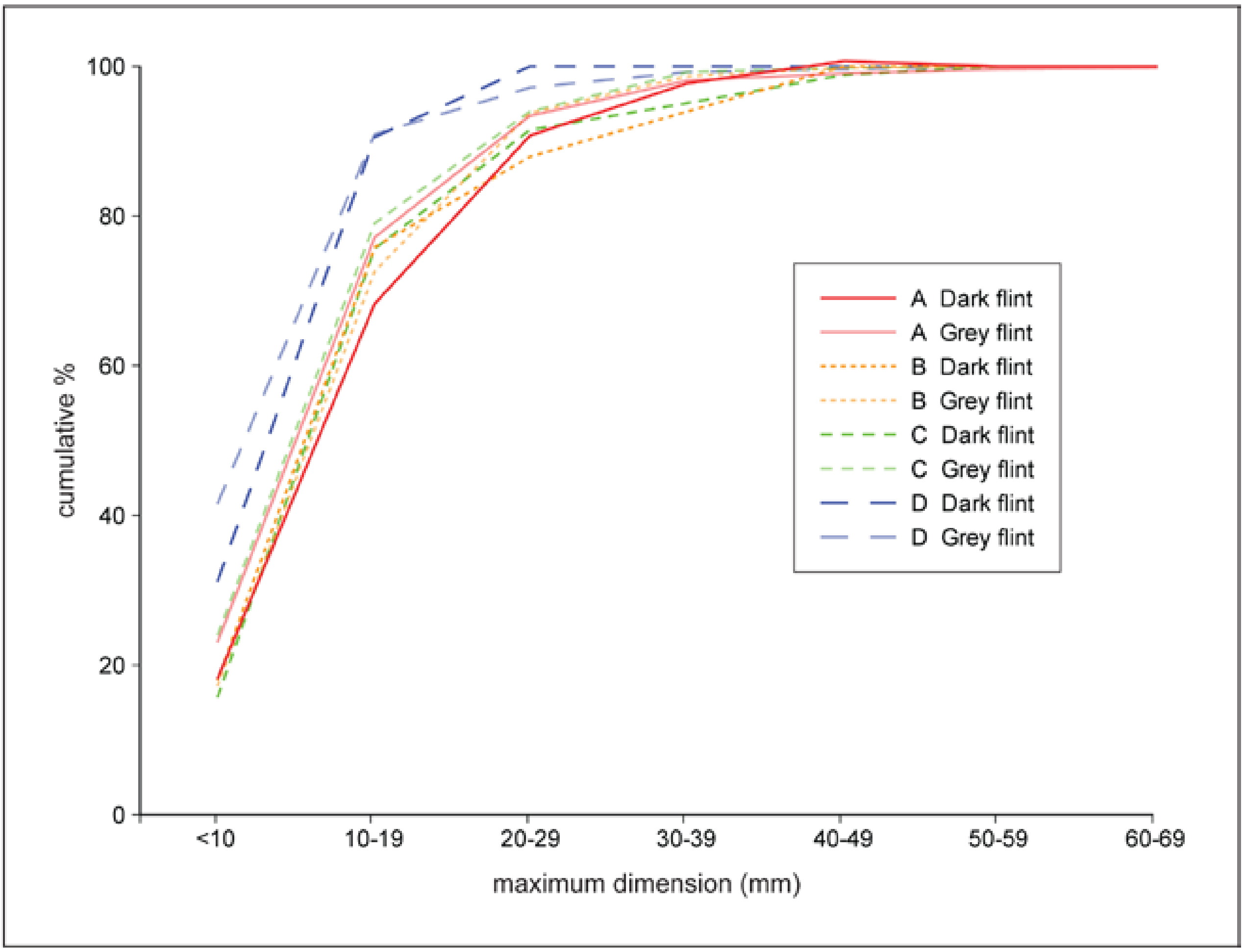

Figure 6. Cumulative percentage curves of proportions of size classes of types of flint in each analytical unit.

of some technological types and the proportion of artefacts retaining cortex, these do not show any strong patterning. It is reasonable, therefore, to build a more detailed picture of stone-working activities by examining the dark and light flint artefacts from the site as a whole. Although each analytical unit contains the debris of many different episodes of core reduction, tool-manufacture and repair, analysing each arbitrary unit separately does not necessarily enhance the quality of information that can be generated from these assemblages. In fact, the longer the time-span of accumulation, the more likely that the assemblage being investigated will contain debris from less frequently occurring tasks (Stern 2008) and so provide a more complete picture of past stone-working activities at Karremarter.

Stone-working activities: core reduction/blank production

Both dark and light flint nodules were knapped at Karremarter, but not all stages of core reduction took place there and there appear to have been some differences in the way in which and extent to which the dark and light flint cores were reduced. The small number of cores, especially of dark flint, constrains the way in which information about the reduction these materials can be generated. Consequently, analysis focused on determining whether both early and late stages of reduction are represented in the two flint assemblages, on identifying the tool-blanks that were being produced, and on establishing whether any effort was being made to conserve the use-life of the cores.

The flint nodules on the beaches of the Lower South-East of South Australia have a silicified and/or chalky weathering rind that has to be removed before the workable portion of the nodule can be accessed, and the longer the nodules have lain exposed on the beach, the thicker and chalkier the cortex. However, less than 30% of the flint artefacts preserve any cortex and most of these preserve only small amounts (1–32%). Only 10% of the light and 3% of the dark flint flaking debris is entirely cortical (Table 7). This suggests that initial stages of reduction were undertaken before the cores were brought to the shelter. In the case of the grey flint this probably means that cortex was removed on the beach and in the case of the dark flint it suggests that cores were prepared close to procurement sites so that only potentially usable material was carried across the landscape. As a consequence, differences between the two assemblages in

Table 7. Percentage of artefacts with different amounts of cortex at Karremarter. Sample size = 2491.

raw material	no cortex	1–32%	33–66%	67–99%	100%
dark flint	70.1	15.4	5.7	5.7	3.1
grey flint	71.1	10.9	4.0	3.6	10.4
total	71.0	11.5	4.3	3.9	9.4

Table 8. Number of cores and blades of each raw material at Karremarter.

raw material	cores	blades	ratio blades:cores
dark flint	3	20	6.7
grey flint	23	37	1.6

the ratios of flakes and blades: cores (Table 8) must reflect either a difference in the extent to which each material was reduced and/or the removal of some partially worked cores (discussed further below).

Although the assemblage contains relatively few cores, it is worth noting that a significant proportion of the dark and light flint flakes are longer than the mean oriented length of the longest flake scar on the cores of the same materials, which suggests that later stages of core reduction were also undertaken in the shelter (Table 9). Although the small number of dark flint cores limits explanation, both their smaller mean dimensions (Fig. 7), and the higher proportion of the dark flint flakes that are longer than the mean oriented length of the flake scars on the associated cores (Fig. 8), suggests that dark flint may have been reduced more heavily than the light flint. The alternative interpretation, that most of the cores were taken away and that the smaller flakes struck from the cores were discarded elsewhere, is not favoured because larger flakes are usually preferred for tool use (e.g., Holdaway, 2004), and this appears to have been the case at Karremarter (see below, Fig. 9).

A relatively high proportion of the light flint cores were flaked only in a single direction (Table 10), but the small sample of dark flint cores means that other information is needed in order to compare the extent to which the two materials were reduced. A higher proportion of dark flint artefacts are core rejuvenation flakes than is the case with grey flint, suggesting that more efforts were made to extend the utility of the dark than the light flint cores. This inference is supported by experimental observations which show that when dark and light flint cores are reduced in the same way and to the same extent, the resulting light flint assemblage contains a higher proportion of rejuvenation flakes than does the dark flint assemblage (John Duggan, personal communication). More intensive reduction of the dark flint cores would also explain the higher ratio of tool-blanks to cores exhibited by the dark flint, although removal of some still-usable dark flint cores may also have contributed to this pattern.

Table 9. Comparison of the mean length of flakes and blades and the longest flake scars on cores at Karremarter.

	dark flint	grey flint
mean flake and blade length (mm)	17.1	17.0
mean longest flake scar on cores (mm)	14.0	19.0

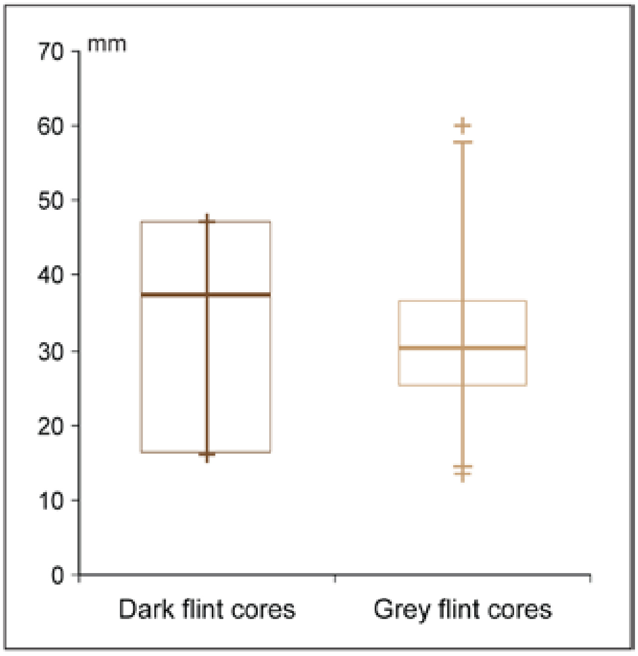

Figure 7. Box and whisker plot of the maximum dimensions of cores.

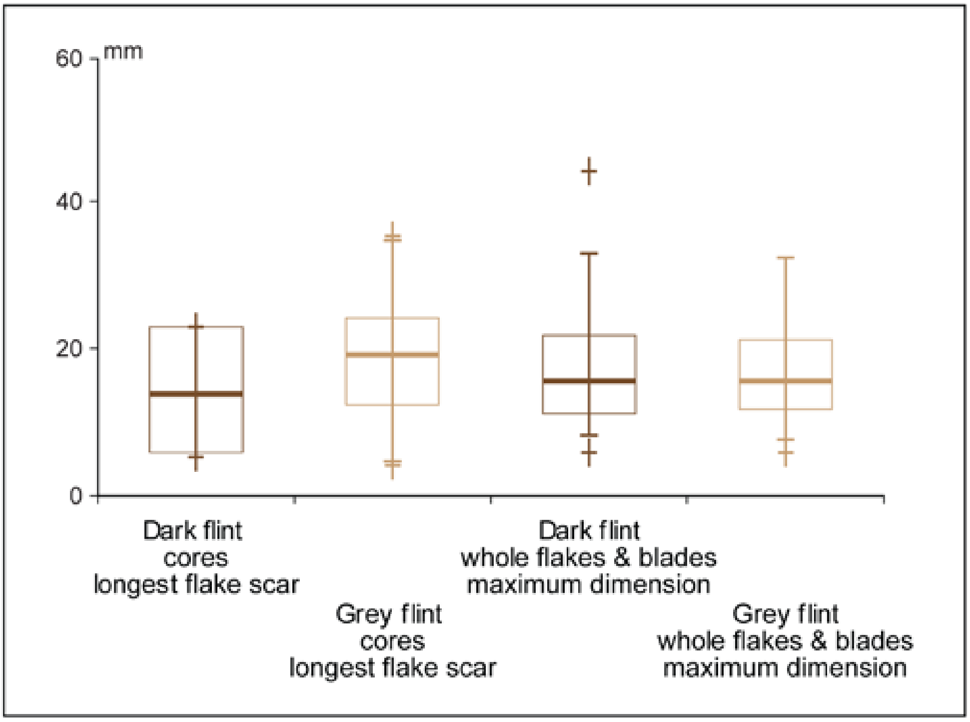

Figure 8. Box and whisker plot of mean length of blades, flakes and scars on cores.

Table 10. Percentage of cores with different number of flaking directions at Karremarter.

raw material	uni-directional	bi-directional	multi-directional	sample size
dark flint	33.3	33.3	33.3	3
grey flint	43.5	34.8	21.7	23

Both flakes and blades were produced from both light and dark flint cores, but the proportion of blades made from dark flint (30.8%) exceeds that of dark flint in the assemblage as a whole (18.1%), suggesting a preference for striking blades from the more brittle material. Furthermore, the mean oriented length of the dark flint flakes and blades (17.3 mm) is greater than it is for those made from the lighter flint (15.8 mm). These observations accord with experimental studies indicating that the dark flint is more brittle, making it easier to control detachment and produce longer flakes (John Duggan, personal communication). A higher percentage of the blades have hinge terminations whereas most of the flakes have feather terminations, which may reflect the more intensive reduction of the dark flint cores used to produce blades, as hinge terminations tend to be produced more frequently during the later stages of reduction.

There is only one micro-blade core in the assemblage, made of dark flint, and the oriented length of its longest flake scar is greater than that of any of the un-retouched blades in the assemblage (Table 11). However, there are some retouched blades of comparable oriented length, suggesting that longer blades were selected as blanks for tools. The absence of un-retouched blades of comparable length indicates that dark flint blades were taken away from Karremarter, either as tool-blanks or as finished tools.

Table 11. Dimensions of dark flint blades and core at Karremarter.

Mean max dimension of 16 dark flint whole blades	19
Maximum dimension of 1 dark flint backed blade	7.54
Dark flint microblade core—longest flake scar	23.3

Stone-working Activities: Transformation of Blanks into Tools

Six percent of the artefacts in the Karremarter assemblage have macroscopic edge damage or exhibit retouch undertaken to modify or rejuvenate their edges and thus, can be identified as tools. The relative abundance of dark and light flint tools mirrors the relative abundance of these materials in the assemblage as a whole. That is, despite its superior flaking qualities, dark flint was not preferentially transformed into tools, perhaps because the light flint produced working edges that were just as effective as well as more durable. More than 80% of the tools in the Karremarter assemblage are scrapers and utilized pieces, the remainder are backed artefacts (Table 12). Those tools were made on a wide range of technological types, including a cobble fragment, angular fragments and broken flakes and blades. It would, however, be fair to argue that whole flakes were the preferred blank for scrapers, while blades and broken blades were the preferred for the backed artefacts (Table 12).

Although dark flint was preferred for blade production and blades were the preferred blank for backing, only two of the backed artefacts in the assemblage were made from dark flint; one was fashioned from a broken flake, the other from a whole flake. This lends weight to the suggestion made earlier that the larger blades struck from the higher quality flint cores were taken away from the site, either as tool-blanks or as finished tools. In contrast, most (92%) of the backed artefacts discarded at the shelter were made from the locally abundant grey flint and most of these were fashioned from broken or whole blades (70%).

The proportion of utilized artefacts and scrapers made from dark and light flint also mirrors the proportion of each

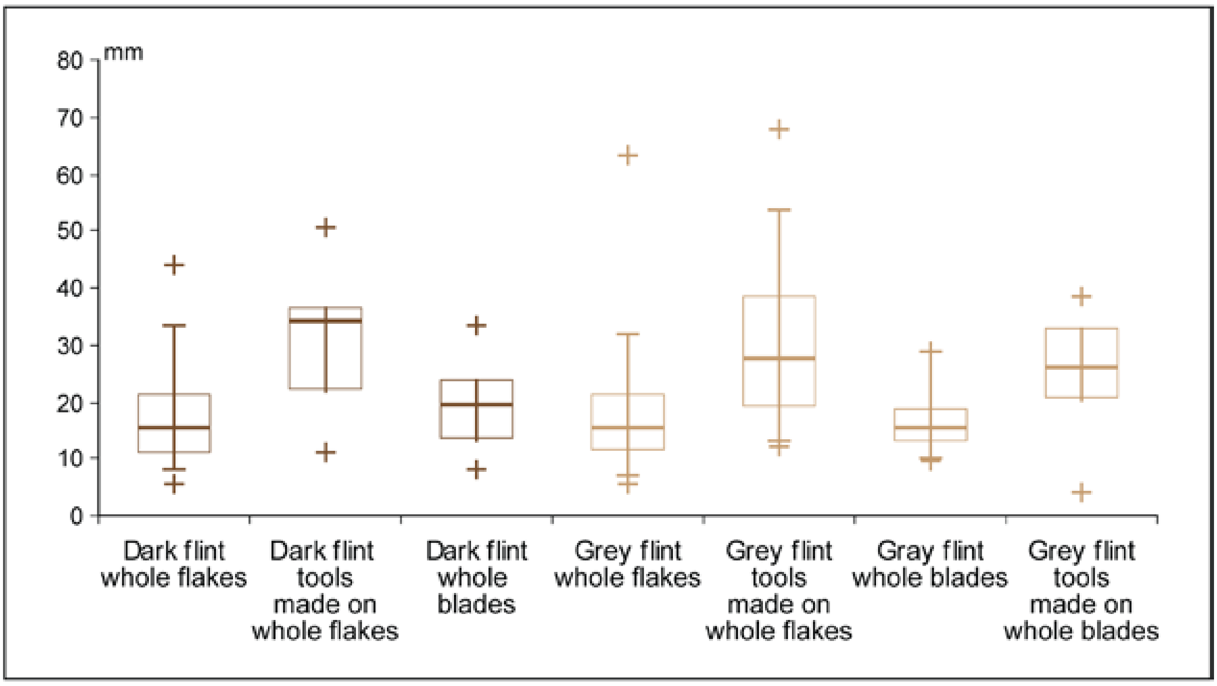

Figure 9. Box and whisker plot of maximum dimensions of flakes and blades.

Table 12. Incidence of tool types and preferred blanks at Karremarter.

	dark flint				grey flint				
	backed blade	geometric	scraper	utilized	backed blade	geometric	scraper	thumbnail	utilized
whole blade	—	—	—	—	8	—	1	—	3
distal blade	—	—	—	—	4	—	—	—	—
medial blade	1	—	—	—	4	—	—	—	1
proximal blade	—	—	—	—	2	—	—	—	—
whole flake	—	1	8	4	2	—	28	1	23
distal flake	—	—	1	—	1	—	4	—	3
medial flake	—	—	—	—	—	1	1	—	1
proximal flake	—	—	—	—	—	—	1	—	—
split flake	—	—	—	1	—	—	10	1	1
angular fragment	—	—	1	4	—	—	10	—	12
cobble fragment	—	—	—	—	—	—	1	—	—
indeterminate	—	—	1	1	2	—	2	—	—
total	1	1	11	10	23	1	58	2	44

raw material in the assemblage as a whole. These tools were undoubtedly used in a range of tasks on a range of materials. There was considerable latitude in the size, shape and angle of the retouched edge that could perform those tasks effectively; their final shape was, of course, partly affected by the degree of damage, retouch and resharpening as well as by the morphology of the original blank (cf. Clarkson, 2002; Hiscock & Attenbrow, 2004; Holdaway & Stern, 2004) (Table 13).

Table 13. Percentage of artefact type of each raw material with different numbers of retouched edges/quadrants at Karremarter.

	scraper			utilized piece		
	1	2	3	1	2	3
grey flint	60.9	31.9	7.2	81.8	15.9	2.3
dark flint	54.5	45.5	—	100.0	—	—

There are subtle, but significant differences in the way in which the light and dark flint was acquired, worked and transformed into tools and these have implications for understanding Holocene stone technology in this area. Although individual visits to Karremarter are thought to have been brief, the overwhelming majority of artefacts were made from the light flint nodules collected from the beach that lies within a kilometre of the shelter. The chalky cortex was removed before the cores were carried up to the ridge where the shelter lies. The cores that were worked inside the shelter produced mostly flakes, but also some blades. Most of these have plain platforms and feather terminations characteristic of earlier stages of core reduction. The cores were sometimes rotated but not much effort was made to extend their use-lives. Scrapers were made primarily from flake blanks whilst blades and broken blades were used to produce the backed artefacts.

Most of the dark flint was carried in from the hinterland caves, though a few nodules may have been picked up on the cobble beach near the shelter. Not surprisingly, cortex was removed from the cores before they were introduced to the shelter. The brittleness of the dark flint meant that it was easier to detach long, thin flakes from those cores than from the light flint. Some cores were worked down fairly extensively and efforts were made to extend the life of usable cores. Larger blades, and/or finished tools made on larger blades, were taken away, but many whole flakes, as well as angular fragments, were modified through use and/or retouch and then discarded at the shelter.

Discussion

The Karremarter assemblage contains two components: individual tool-kits made from high quality flint that was carried around the landscape and tools made from material collected from a nearby beach that were used and then discarded locally. The mobile tool kit included cores stripped of unusable cortex, tool-blanks and/or finished tools. Although cores are not the most efficient way of transporting potential tools, carrying them meant that tool-blanks could have been made when they were needed and in the quantity required. It was also a way of ensuring that the edges of finished tools were not damaged before use (Kuhn, 1994). The ease with which elongate, thin flakes can be detached from the more brittle dark flint cores explains why it was used to produce most of the blades in the assemblage. However, it was not used exclusively or systematically in the manufacture of backed artefacts, especially as backed artefacts were not made exclusively on blades. In fact, both the local and the transported stone were used to make flake and blade tool blanks and to produce backed artefacts and scrapers. Thus, the differences between the mobile tool-kit and the tools made for immediate use and discard, are quite subtle.

Artefact assemblages that accrued through ephemeral visits to a site are often characterized by an abundance of non-local raw materials (e.g., Kuhn, 1994). However, the Karremarter assemblage contains an abundance of local material, undoubtedly because of its proximity to a relatively high quality raw material that also produces durable working edges, thus enabling conservation of the higher quality flint that was carried in from other parts of the foraging range. This is consistent with the expectation that local raw materials will be used whenever feasible because it is "cheap and easy to do so" (Bamforth, 1986; Kuhn, 1992: 188). Thus assemblage composition is influenced not only by the frequency and duration of occupations but also by the distribution and quality of raw materials and the frequency with which and distance over which people moved (cf. Shiner *et al*., 2005).

The Karremarter assemblage, like other Holocene assemblages across southeast Australia, is dominated by scrapers and backed artefacts and the debris resulting from their manufacture and reworking. However, there is considerable variation in the relative abundance of these two tool categories, with backed artefacts making up anywhere between 96 and 4% of a tool assemblage (Brooke, 2006: 81). As discussed earlier, Hiscock (2006) has identified backed artefacts and scrapers as representing contrasting strategies for balancing the relative costs of making tools and acquiring food. As small, standardized components of multi-component and multi-purpose tools that were easily carried and easily maintained, backed artefacts are interpreted as a technological solution to the problem of acquiring resources when their timing and location became less predictable (e.g., Robertson *et al.*, 2009). Thus, according to this model, the relative abundance of backed artefacts and scrapers in Holocene artefact assemblages should vary in relation to foraging risk.

Unfortunately, current understanding of the chain of inference linking tool categories to foraging risk is limited. It is therefore worth highlighting some of the links in this chain of inference that require further investigation. The first of these is the concept of risk itself, which is usually determined on the basis of both predictability and abundance of critical resources (e.g., Cashden, 1992). Quite detailed knowledge of the critical resources utilized by a group of foragers, and the techniques and technologies to acquire those resources, is needed to make assessments about the risks they faced in any particular habitat. This knowledge depends on having quite detailed information about local palaeoenvironments, as well as about diet and subsistence activities.

The strategies developed in response to reduced resource abundance and increased uncertainty about their location and timing might have included changes in the ranking and/or range of the resources that were utilized, changes in the habitats exploited (e.g., Stevens & Krebs, 1986: 137–140), changes in the way in which those resources were acquired (e.g., Klein, 1979) or stored, as well as shifts in technology and mobility (e.g., Hiscock, 2002, 2006). As a result, more detailed investigations are needed of the circumstances in which technological solutions were more likely to be brought into play.

The cost of procuring raw materials for tool manufacture would have depended on a myriad of factors including the location, abundance and quality of the raw materials in question and their proximity to food resources, campsites and pathways. During the mid-late Holocene, Karremarter, for example, was located in an environment in which staple plant and animal foods were abundant and spatially and temporally predictable (Barker, 1987). High quality raw materials were readily available near the shelter and within people's foraging territory, so that the cost of acquiring them was relatively low. Despite this, backed artefacts are a conspicuous component of the Karremarter tool assemblage. Here, at least, the links between climatic change, resource abundance and predictability, and technology, are not clear.

Small and unprepossessing though it may be, the Karremarter assemblage exhorts us to explore, in much more detail, the chain of inference connecting the proliferation of backed artefacts to reduced predictability and abundance of critical resources, and both, to the impact of mid-Holocene shifts in the frequency and magnitude of ENSO driven climate cycles. We need to develop much more nuanced explanations of the various changes in stone technology that took place in many parts of Australia during the Holocene. As Val Attenbrow's meticulous work in the Mangrove Creek catchment north of Sydney demonstrated so many years ago, those explanations need to be grounded in a thorough understanding of local landscapes, archaeological evidence for foraging activities and for the stone working activities undertaken at different locations across that landscape.

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