TECHNOLOGICAL CHANGE AT BUSHRANGERS CAVE (LA:A11), SOUTHEAST QUEENSLAND

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INTRODUCTION

Bushrangers Cave is the oldest mainland archaeological site so far discovered in the Moreton Region of southeast Queensland. Occupation began approximately 6000 years ago, at a time when the rising seas flooded Moreton Bay and reached their present levels. Several researchers have suggested that after the infilling of the Bay food resources were more plentiful, and that during the last 6000 years there was population growth and a restructuring of Aboriginal society (Hall 1982, 1986; Morwood 1986). At least some of these changes should be visible at Bushrangers Cave and Hall (1986:101) has argued that economic and social reorganization may be reflected in the procurement of stone material by the knappers who left stone artefacts in the cave. Indications that stone from the vicinity of the cave may have been transported some distance during the late Holocene raise similar possibilities (Bird et al 1987). Exploratory excavations and preliminary analysis of the recovered artefacts was reported by Hall (1986), who demonstrated that changes in artefact frequency and raw material type did occur. Further radiocarbon dates and more detailed investigations of the artefactual assemblage are presented in this paper. While a more complete understanding of the site will require the excavation of a larger area, the data described below enable some preliminary conclusions to be drawn about chronological change in stone procurement, stoneworking technology and the nature and intensity of occupation.

THE SITE

Bushrangers Cave is located on the eastern edge of the Lamington Plateau, in the extreme southeast corner of Queensland (Figure 1). Situated at the base of a cliff and at the top of a steep scree slope, the rockshelter looks over the Numinbah Valley and the Nerang River.

The cave is formed by the weathering of an outcrop of Binna Burra rhyolite which comprises one component of the Lamington Group of basalt formations, conglomerates and rhyolites (Stevens 1973:55). The shelter is approximately 60m in length and has a maximum width of 8.5m (Figure 2). Facing northeast, the shelter forms a shallow arc about an ephemeral waterfall and spring fed streamlet, one of many comprising the headwaters of the Nerang River. After heavy rain, water cascades over the escarpment in front of the shelter. The southeast end of the shelter contains a spring which supplies drinkable water throughout the year. The floor of the rockshelter is fairly even and dips from both ends towards the central waterfall area. The topmost sediments have a fine silty and ashy texture which grades to sand and gravel outside the dripline where water has removed the finer grades. Numerous large angular boulders testify to past episodes of roof collapse due to weathering of the rhyolite cliff above. Today, the sediments appear very dry within the dripline except in the vicinity of the spring. Three hearth areas indicate recent campfires but a few stone artefacts scattered about the surface point to Aboriginal occupation.

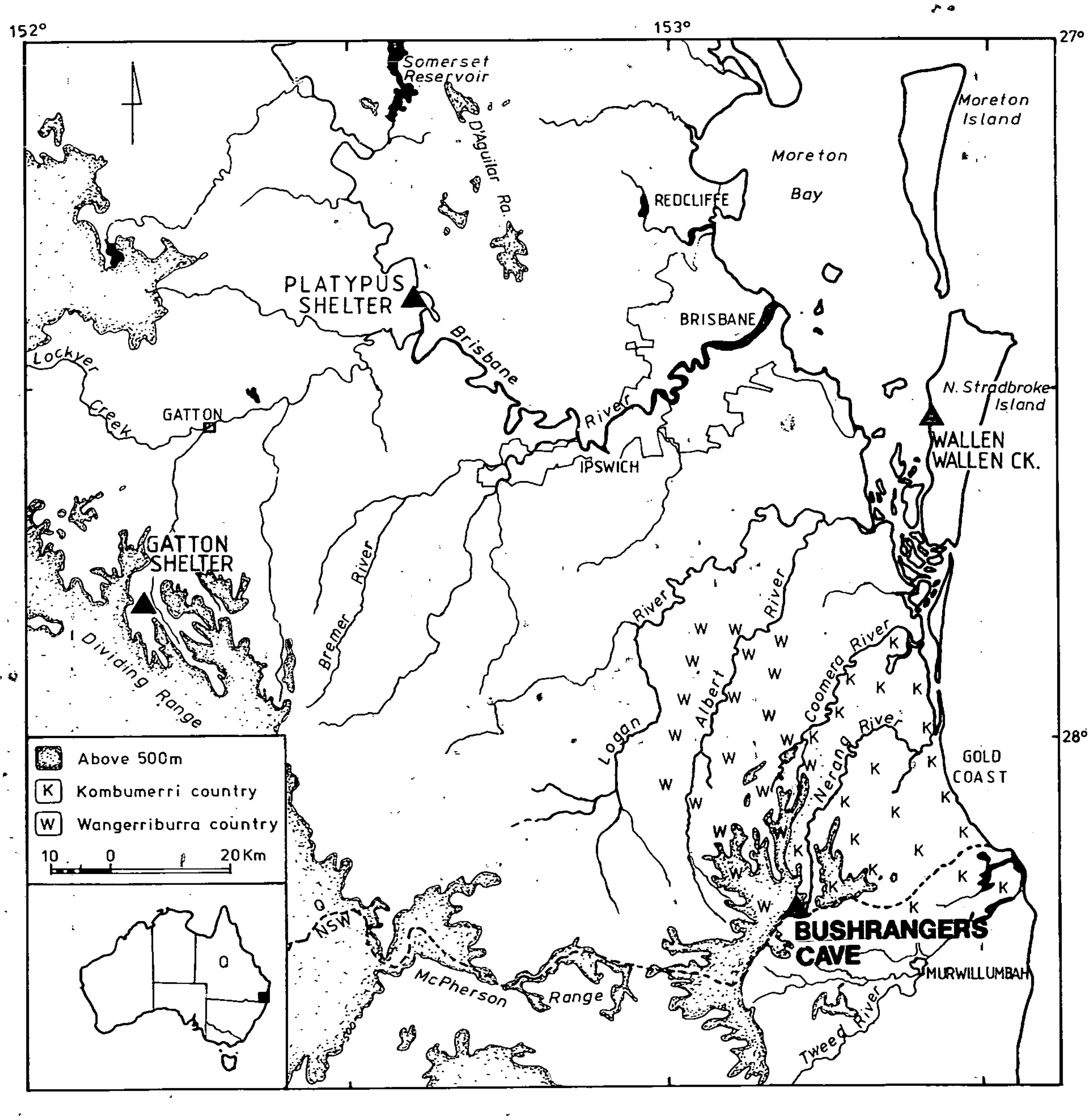

Figure 1. Map of the study area showing location of Bushrangers Cave (from Hall 1986:89).

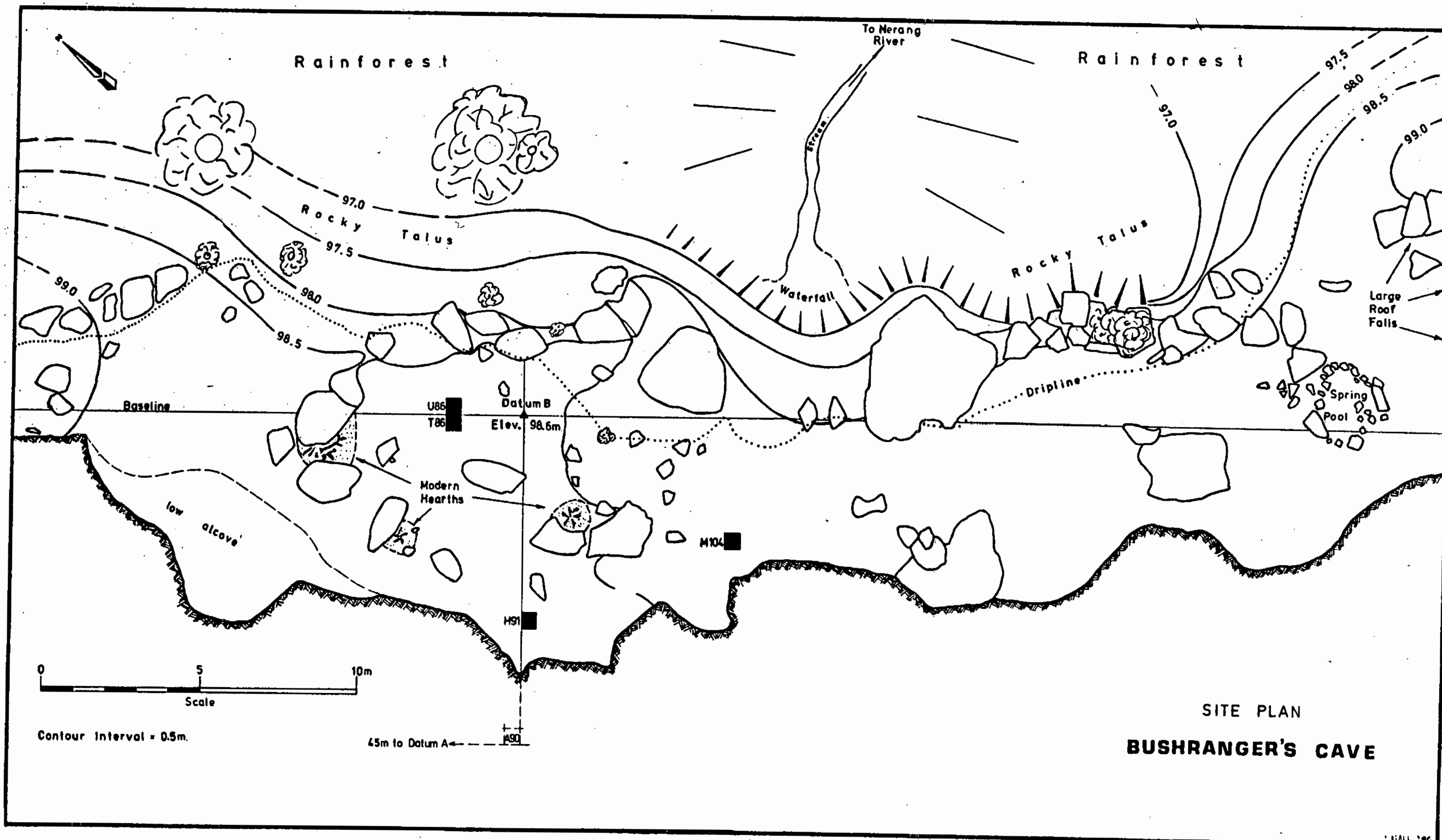

Figure 2. Site plan of Bushrangers Cave (from Hall 1986:90).

Four squares, each 50 x 50 cm, were excavated as a test of the archaeological potential of the site (Hall 1986). Squares H91 (in the rear of the shelter), T86/U86 (in the front of the shelter inside the dripline), and M104 (in the depression below the waterfall) were selected. Stratigraphic details of deposit in these squares is given by Hall (1986). Excavation used 2.5-5.5 cm deep spits and all material was wet sieved through 3mm and 1.5mm wire mesh. Charcoal samples were obtained mainly by flotation.

In his preliminary site report Hall (1986:94) reported two radiocarbon dates. The samples used for these determinations were chosen from the lowest concentration of charcoal in the deposit to provide basal dates for occupation in the shelter. From the rear of the cave (H91), slightly higher than the lowest artefacts, a calibrated date of about 5500 years BP was obtained. From the front of the shelter (U86), below all artefacts and culturally derived bone, a charcoal sample yielded a date of slightly more than 6300 years BP (Table 1). These age determinations are interpreted as accurate estimates of the approximate time that archaeologically visible occupation began in the shelter.

After a preliminary analysis of the material recovered from H91, Hall (1986) identified a distinct increase in the density of artefacts and bones about 18 cm below the surface. A further charcoal sample from this level was submitted for radiocarbon assessment, and the resulting estimate of 2045 years BP (calibrated) provides an approximate date for the increase in cultural material (Table 1). This second date permitted an examination of the rate of archaeological changes in the rear of the cave, and to this end a detailed examination of the stone artefacts was carried out.

ARTEFACT NUMBERS

Artefact identification methods employed were the same as those reported by Hiscock and Hall (1988). Stone fragments were accepted as artefacts only when the identification was positive. Objects were called artefacts if they possessed attributes demonstrating that the fracture had been initiated by the application of an external blow: positive or negative ringcracks, positive or negative bulbs of force, eraillure scars, remnants of flake scars (eg. dorsal scars and ridges).

Using these criteria a total of 179 artefacts were identified in H91 (Table 2). Only the 135 artefacts which are larger than 5mm were classified into artefact types. Most of these artefacts were flakes (85%). Smaller numbers of retouched flakes (7.4%), flaked pieces (5.9%), and eraillure flakes (1.5%) were identified. No cores were recovered from square H91. All artefacts less than 5mm were flakes or broken fragments of flakes.

The number of artefacts identified in H91 in this study is distinctly lower than that reported by Hall (1986:95) in his preliminary study. This discrepancy resulted from Hall's inclusion of numerous small heat-shattered fragments of chert. Re-examination of the collection using the stringent criteria described above, led to the conclusion that those heat shattered fragments were not the result of prehistoric stoneworking and should therefore be excluded from artefact counts.

This conclusion does not negate the inferences drawn by Hall in his earlier paper. A regression analysis his artefact counts for each spit and those presented here show that there is an extremely strong relationship between the two data sets (Figure 3). The strength of this correlation is shown by the r^2 value of 0.933. This demonstrates that Hall consistently overestimated the number of artefacts in each spit, and that at all levels of the deposit the artefact numbers he reported overestimate the real number to the same degree (approximately 1.5x). As a consequence, the chronological trends described by Hall (1986) are accurate. The cause of the correlation between numbers of artefacts and numbers of heat shattered fragments is dealt with later in the paper. What is of importance here is the implication for chronological change of the new radiocarbon date and the revised artefact counts.

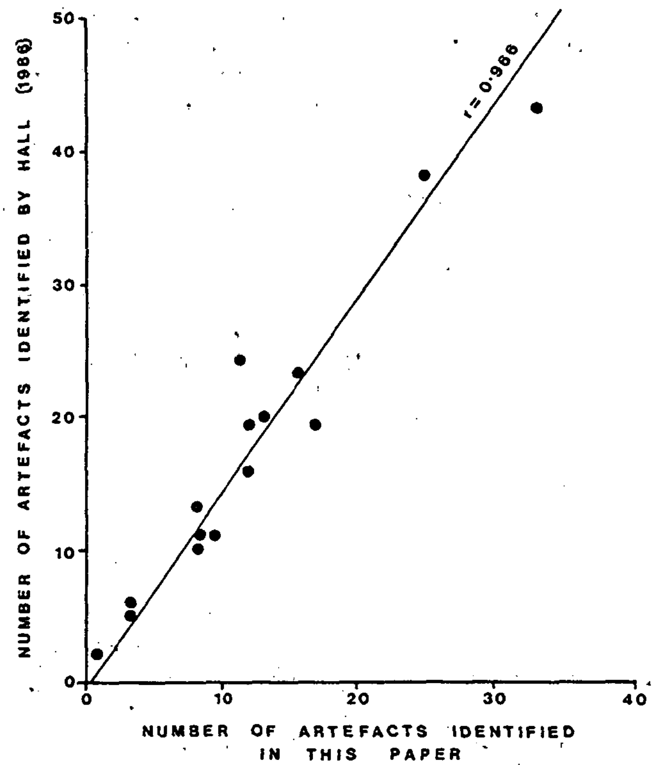

Figure 3. Regression analysis showing closeness of fit between Hall's (1986) artefact counts and those used in this paper.

Chronological changes in artefact densities are illustrated in Figure 4. Densities are highest in the upper levels, suggesting an increase in discard rates through time. This inference is confirmed by employing an age/depth curve to estimate the ages of spits 1-5 and spits 6-12, and thereby to calculate artefact discard rates (Table 3). During the last 2350 years, represented by spits 1-5, the discard rate was 1.7 times greater than during the previous 3,350 years.

Although the overall trend is an increase in artefact discard, there is a clear bimodal pattern evident in the densities illustrated in Figure 4. Densities rise from the earliest occupation levels until spit 7 when they decrease sharply. Artefact densities begin to increase again in spit 5 and decrease in spit 1.

It is our contention that these variations in artefact densities and discard rates reflect prehistoric changes in the nature of stoneworking and the intensity of occupation. A detailed study of the artefactual material recovered from H91 reveals that changes in artefact discard rates are related to alteration to the pattern of stone procurement and reduction.

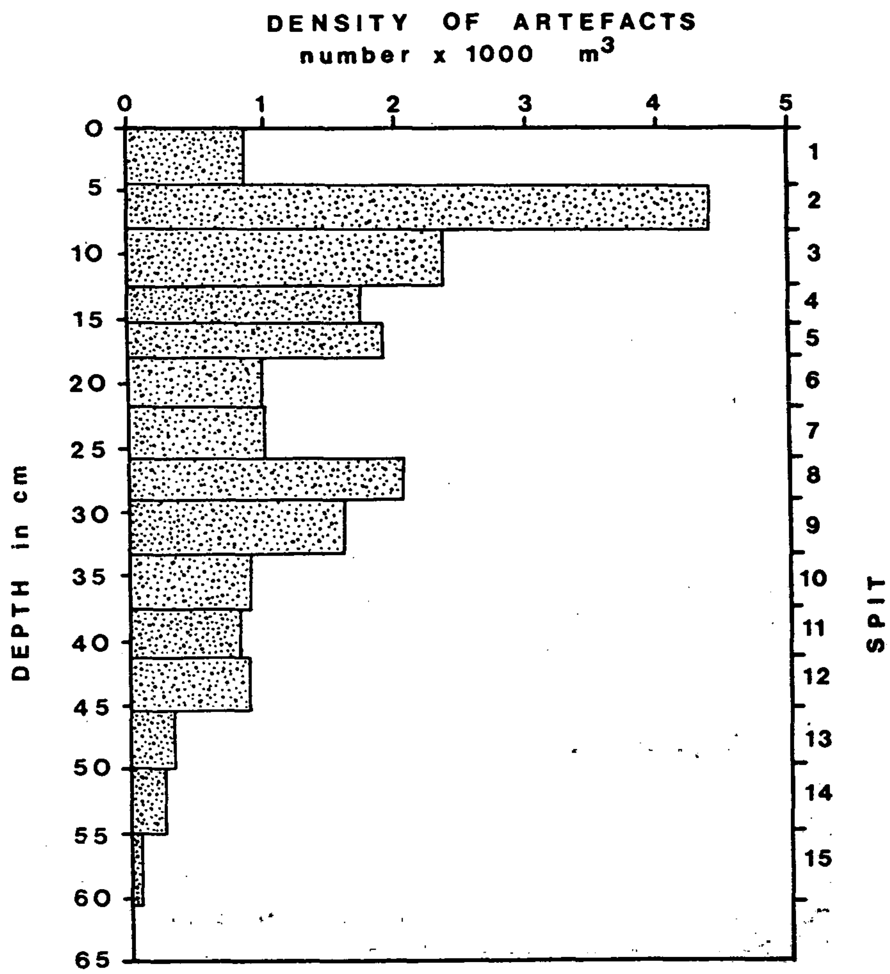

Figure 4. Vertical change in artefact densities at Bushrangers Cave

CHRONOLOGICAL CHANGE IN RAW MATERIAL USAGE

During all periods of occupation chert was the dominant material used in stone artefact manufacture (Table 4). Other sedimentary rocks occur infrequently and in low numbers. Basalt artefacts make up 32% of the chipped stone assemblage and are found in most spits.

Chronological changes in raw material procurement strategies at this site are most readily observed in terms of the ratio of chert to basalt flakes in each spit (Figure 5). Using a ratio of <2:1 (chert:basalt) as a measure of basalt richness, the deposit can be divided into three periods. In spits 6-11 basalt is common, constituting 33-50% of all stone artefacts. Below spit 11 and above spit 6 basalt is relatively infrequent, constituting only 0-25% of artefacts. Thus, during the early phase of site occupation, prior to about 5400 years BP, knappers concentrated on chert materials and rarely discarded basalt artefacts. From 5400 years BP until approximately 2350 years BP knappers procured proportionately much more basalt for their stoneworking activities. In the last 2350 years knappers again focused on working chert and only infrequently procured basalt.

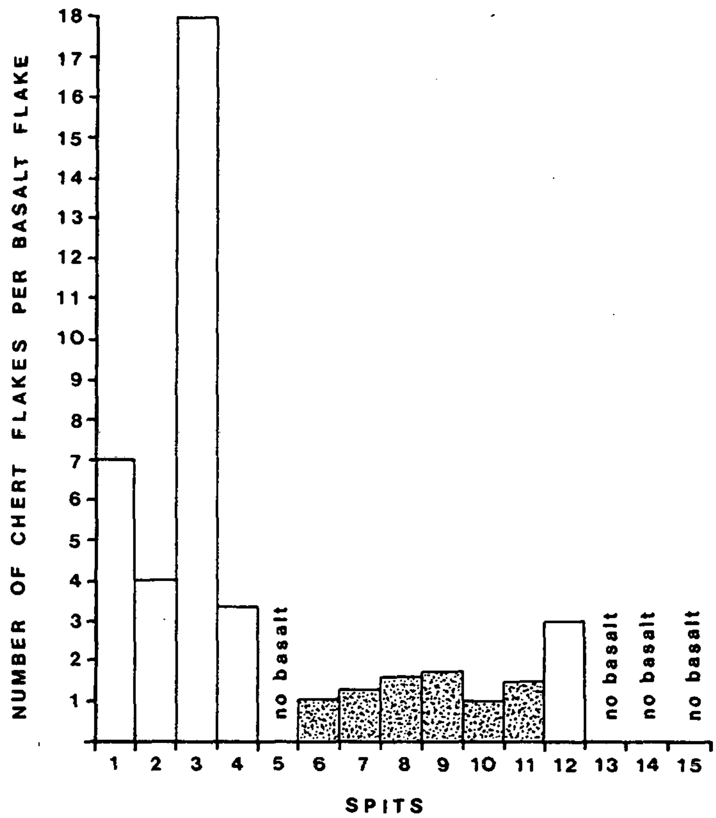

Figure 5. Changes in the ratios of chert and basalt flakes at Bushrangers Cave.

These changes in raw material procurement and usage may have been associated with alterations to the stoneworking technology which was employed at the site and a change in the form of the artefacts being produced. This suggestion is supported by evidence that chert and basalt were knapped in different ways, and produced artefacts of different sizes and shapes.

EFFECTS OF RAW MATERIAL

A distinct contrast between chert and basalt unretouched flakes was observed. Table 5 gives descriptive statistics for the size of unretouched flakes of both rock types. Basalt flakes are on average heavier and larger in all dimensions than chert flakes. These size differences are related to variations in core shape and blow location. Table 6 demonstrates that platforms are larger on basalt flakes than on chert flakes. This pattern probably indicates that, on basalt, blows were placed further from the edge of the platform and that the faces of basalt cores was more gently curved.

As a result of these size differences, flakes of each raw material exhibit different shapes (Table 7). Chert flakes tended to be longer relative to their width. This is seen in both the mean value of the elongation index and in the percentage of flakes with an elongation index >2.0. The small platforms of chert flakes gave them a shape which expanded along the percussion axis, whereas basalt flakes were more likely to be parallel or contract away from the platform. Basalt flakes were consistently thin in comparison to their width, whereas chert flakes were sometimes extremely thick relative to their width. These differences in flake shape reflect differences in core shape, core preparation, and the nature of blows.

Non-metrical characteristics of flakes confirm these inferred contrasts in the way chert and basalt were knapped (Table 8). The relatively large squat basalt flakes with large platforms are a result of the following practices:

* Low platform angles on cores
* Imprecise blow location
* Moderate platform preparation, consisting largely of creating conchoidal surfaces. Platform faceting occurs but is relatively infrequent.
* Infrequent overhang removal.
* Large amounts of force applied in an outward direction (away from the body of the core). The result is a high proportion of feather terminations and more step than hinge terminations.
* Relatively high proportion of flakes removing cortex.

This combination of practices is consistent with the reduction of lenticular-shaped nodules of stone such as occurs in knapping river cobbles and bifacial cores. Since cortex typical of river cobbles is found on the dorsal face of some basalt flakes it is likely that basalt was procured from gravel beds in the nearby creek. An additional reason for these knapping practices may have been the manufacture and resharpening of axes. One basalt flake contains a ground and striated surface on the dorsal face, and was probably removed from an edge-ground axe. Since axes generally have a lenticular form, it may be that some of the basalt flakes without grinding were also produced during axe manufacture.

The smaller, more elongate chert flakes with small platforms are a result of the following practices:

* Higher platform angles on cores
* Relatively precise blow location
* Moderate platform preparation, including greater amounts of platform faceting.
* More frequent overhang removal.
* Low or moderate amounts of force applied in a normal or inward direction. The result is a relatively few feather terminations and many more hinge than step terminations.
* Relatively few decortication flakes.

This combination of practices suggests that flakes were struck from both small cores and retouched flakes. Bifacial reduction was probably uncommon, although core rotation and reshaping of the platform by flaking may have been more frequent on chert than on basalt. Furthermore, in comparison to basalt reduction more effort was expended on maintaining the shape of chert cores and retouched flakes.

Thus the technology which prehistoric knappers employed at this site appeared to depend on the stone material being worked. Chert was reduced by the precise application of relatively low amounts of normally directed force, close to the platform edge of relatively sharply curving but prepared cores or retouched flakes. In comparison, basalt was flaked by the imprecise application of large amounts of outward force, placed further from the platform edge of more gently curving and less prepared cores. As a result of the different knapping procedures the flakes of each stone type are markedly dissimilar. As a consequence, the raw material types must be separated in discussions of technology, and especially in any description of chronological change in technology. Since few basalt flakes were recovered from many of the spits in H91 the following discussion of technological change deals only with chert knapping as inferred from chert flakes.

CHRONOLOGICAL CHANGE IN CHERT STONEWORKING

The artefactual sequence in H91 was divided into three vertical groups for the purposes of assessing chronological change:

Spits 6-12 are those bracketed between the radiocarbon dates and represent the earlier, basalt-rich stone assemblage. Artefacts in these spits were deposited between about 5700 years BP and 2350 years BP.

Spits 4-5 are those immediately above the levels rich in basalt but below the major increase in artefact density. It is estimated that artefacts in these spits were probably deposited between about 2350 years BP and 1550 years BP.

Spits 1-3 are the uppermost levels containing the chert-rich assemblage. Artefacts in these spits were probably deposited during the last 1550 years.

Although flake sample sizes are small in each of these groups they are sufficient to indicate temporal trends. Flake thickness does not change through the sequence, but the average length and width of flakes is markedly larger in spits 4-5 than at other levels of the deposit (Table 9). Flake platforms are also larger in spits 4-5 than in other levels (Table 10). The shape of flakes in spits 1-5 is more elongate and less diverging than in spits 6-12 (Table 11). Spits 4-5 contain flakes which are thinner relative to their width.

Underlying these trends in flake size and shape are technological changes in some knapping procedures (Table 12). Technological trends can be summarized as follows:

1. Platform angles became higher in spits 4-5 and then became much lower in spits 1-3.
2. Faceting becomes relatively common in spits 4-5, replacing surfaces with several scars. This trend is reversed in spits 1-3, with faceting becoming infrequent but several scars more common.
3. The frequency of overhang removal decreased through time.
4. Abrupt terminations are common early and late in the sequence but are absent in spits 4-5. Given the larger flake size in spits 4-5 this probably indicates that greater force was being employed at that period.
5. No decortication flakes were recovered in spits 4-5, although they are found in earlier and later levels.

The nature of the chronological change varies with the attribute being examined. Some knapping procedures, such as platform faceting, were used more often for a period of time and then returned to approximately previous levels. Other knapping procedures, such as overhang removal, were used with ever-decreasing frequency through the occupation of the site. Still other aspects of knapping showed no change at all. For example, there is no change in blow location, as indicated by platform type; a conclusion which is consistent with the observation that average flake thickness was the same at all levels of the deposit.

It is likely that some of these trends are interrelated. Relatively high amounts of platform faceting in spits 4-5 probably facilitated the maintenance of cores with high platform angles and may have aided in the removal of feather terminated flakes. Further description and explanation of these technological changes cannot be made until further excavation has increased sample sizes. What we wish to comment further upon here is the observation that backed blades were manufactured and discarded in both spits 4-5 and spits 6-12, despite the differences in the systems of knapping and raw material procurement which were employed.

CHRONOLOGICAL CHANGES IN RETOUCHED FLAKES

Three classes of retouched flake were recognised in H91. Backed blades were flakes steeply, and often bi-directionally, retouched along one lateral margin (Figure 6a). Burinates were retouched flakes in which flakes had been struck off along, and parallel to, the lateral or distal margins (Figure 6b). Amorphous retouched flakes were those retouched flakes with small amounts of unifacial retouch and which did not clearly fall into either of the other categories of retouched flake (Figure 6c-d). Some of the specimens classified as amorphous retouched flakes may well be unfinished backed blades (eg. Figure 6c), while other specimens are technologically distinct and cannot be interpreted as incomplete examples of other forms of retouched flakes (eg. Figure 6d).

The numbers and raw materials of each of these types of retouched flake are given in Table 13. Both of the backed blades were made on chert and mudstone. One burinate was made on chert, and another was made from quartzite. Amorphous retouched flakes were made from chert and from basalt.

The frequency of retouched flakes varied greatly between raw material types (Table 13). Very few basalt flakes were retouched. A larger proportion (approximately 10%) of chert and mudstone flakes were retouched. Relatively higher frequencies of quartzite and silcrete flakes were retouched.

Table 14 shows the vertical distribution of retouched flakes in H91. In addition to the finished backed blades recovered from spits 4 and 8 it is considered likely that the three lowest amorphous retouched flakes may actually be unfinished backed blades. This indicates that the manufacture of backed blades probably took place at the site from the earliest occupation until at least 1550 years BP. There is no evidence from H91 that backed blades were manufactured during the last 1550 years. Burinates and amorphously retouched flakes are found in the upper half of the deposit.

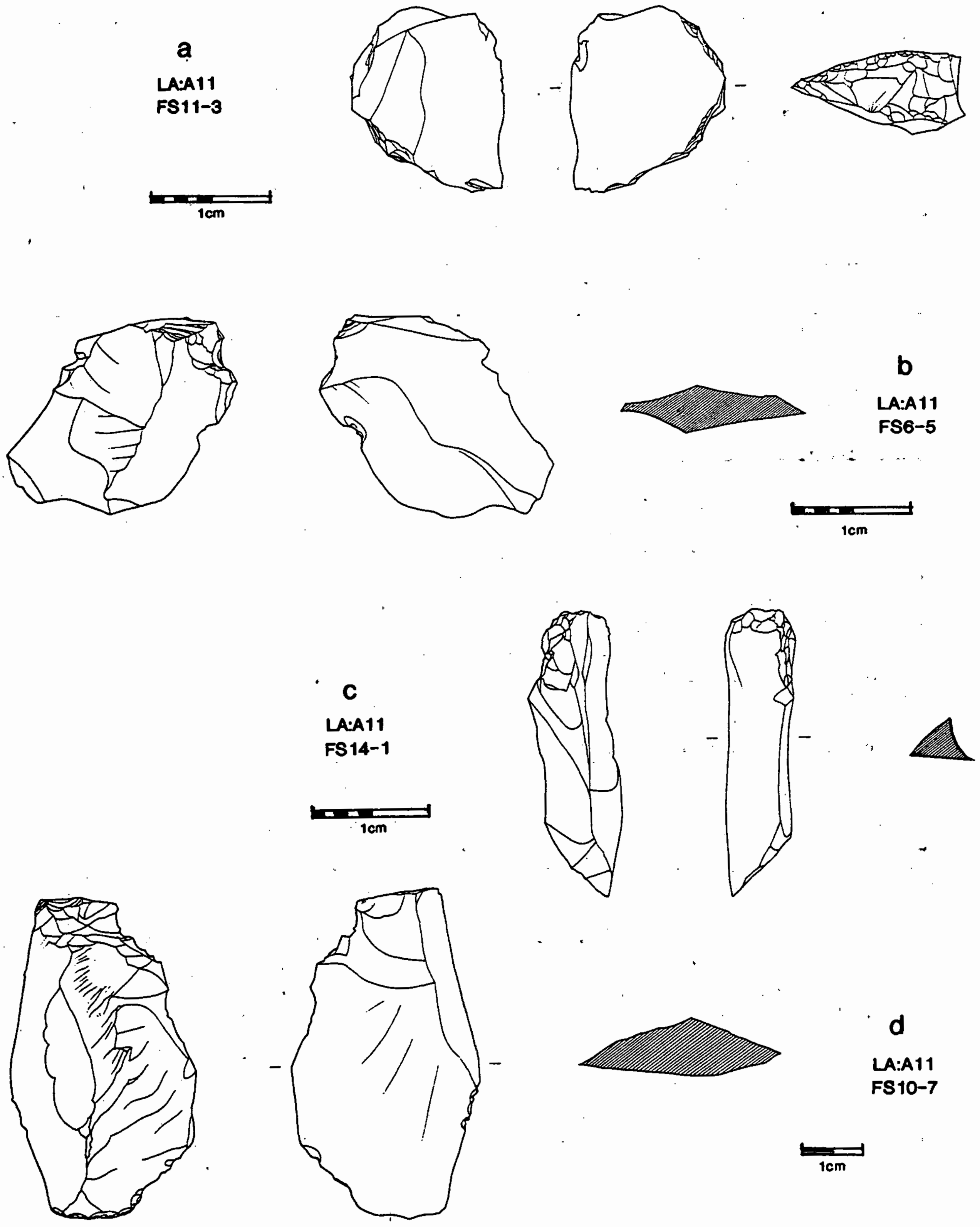

Figure 6. Backed blades (a), burinates (b) and amorphous retouched flakes (c,d) from pit H91, Bushrangers Cave.

Retouched flakes are proportionately more frequent in the lower portions of the deposit (Table 15). A similar trend occurs in the frequency of flakes with edge damage (Table 16). These chronological changes occur on both chert and basalt and are largely coincident with the marked technological change which occurs between spits 3 and 4. It might be suggested that the decrease in retouched and edge-damaged artefacts in spits 1-3 indicate less intensive use of stone materials in the last 1550 years. If this were the case then the less intensive use of stone might reflect a decreased use of the site generally. This suggestion is not supported by the data on heat shattering of stone and faunal material.

HEAT ALTERATION

Approximately one quarter of the artefacts recovered from H91 show signs of damage from excess heat. Table 17 shows chronological change in the frequency of artefacts which have negative potlids, crenated fracture, and/or crazing. These forms of heat damage increase through the sequence and are approximately twice as common in spits 1-3 as in spits 6-12, a trend which is suggestive of an increase in the use of hearth fires.

A similar pattern is observed in Table 18 which estimates that non-artefactual heat-shattered fragments of stone were deposited at increasingly greater rates through the sequence in H91. As a consequence the rate at which fragments accumulated in spits 1-3 was approximately three times faster than in spits 6-9. This pattern also suggests that hearths were more common in the recent past than in the earlier periods of shelter occupation.

Temporal changes in heat damage, and by implication the intensity of hearth use, parallel changes in the artefact discard rate. It is the similarity in these two trends which produced the strong correlation between Hall's (1986) artefact counts and those presented in this paper. This dual trend, toward higher rates of artefact discard and hearth use through time, indicates that for a number of activities the shelter was increasingly used. A similar trend in the accumulation of faunal material supports this proposition.

FAUNAL MATERIAL

Although some components of the faunal assemblage from H91 may have derived from non-cultural agencies (Hall 1986:99), the vast majority (by weight) of faunal assemblage comprises pademelons and possums, the bones from which were almost certainly deposited as a result of human predation and consumption. Consequently, changes to the amount of bone discarded in the cave provide a rough measure of prehistoric food preparation activities at the site. Figure 7 illustrates the vertical changes in the concentration of archaeological bone in H91. Spits 1-5 have greater amounts of bone than earlier levels, suggesting an increase in the bone discarded through time. Estimates of the accumulation rate of bone (Table 19) also reveal a marked increase in the deposition of faunal material during the last 2500 years.

Hall (1986:98) has noted that the faunal assemblage is very consistent throughout the past 6000 years. Consequently the increase in faunal discard rates probably represents more intense food processing activities rather than an alteration to hunting strategies.

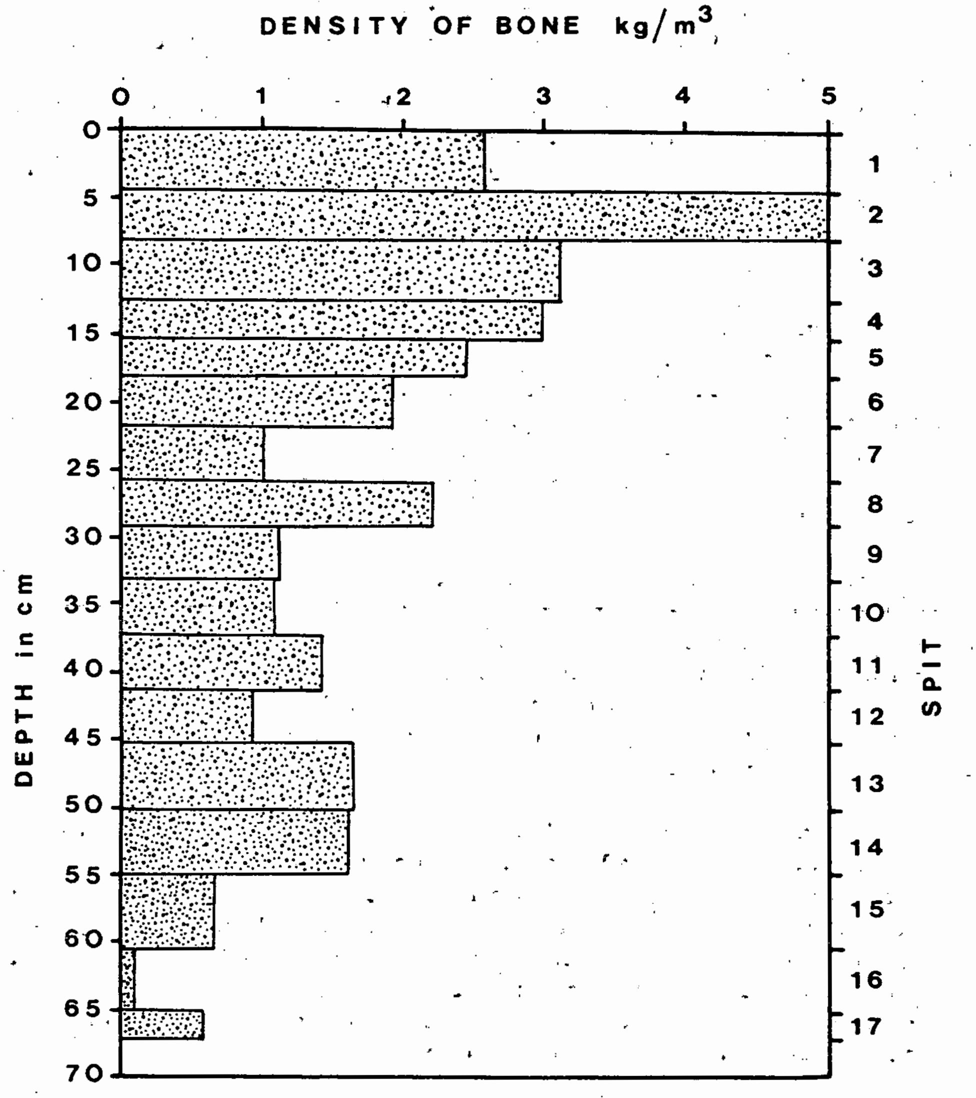

Figure 7. Vertical change in bone density in pit H91, Bushrangers Cave.

CONCLUSION

Bushrangers Cave provides evidence of human occupation from about 6000 years BP until the recent past. During the last 2,500 years artefacts and faunal material were discarded more rapidly, and heat shattering of rock was more pronounced. We suggest that these data indicate more intensive artefact manufacture, food consumption and hearth use, and taken together imply more intensive use of the shelter during the last 2,500 years than previously. At the moment this conclusion applies only to square H91 at the rear of the shelter and cannot be taken as a statement of changing shelter use in general. Fieldwork currently planned should test the degree to which chronological changes in prehistoric activities in H91 are mirrored elsewhere in the site.

Further excavations may also refine the dating sequence at the site and thereby provide information about variations in occupation during the last 2,500 years. A decrease in artefact discard rate in the late Holocene has been observed in sites throughout eastern Australia, including those in the Moreton region (cf. Hiscock 1986; Morwood 1986). The sharp decline in the density of artefacts and bones in spit 1 at Bushrangers Cave is suggestive of a similar trend here, but the rate of sedimentation and discard of cultural items in the top 15 cm cannot be calculated until the site is dated more precisely.

Analysis of the faunal material and stone implement types show considerable consistency throughout the history of occupation. At all levels of the site the food remains are dominated by animals which are representative of rainforest edge habitats (Hall 1987:18), and backed blades were manufactured at the site from 6000 years BP until at least 1500 years ago. The absence of backed blades in the upper levels of H91 may simply reflect the low frequency of retouched flakes in the top three spits.

Analysis of the H91 stone artefacts demonstrates multiple changes to prehistoric strategies of stone procurement and knapping during the history of human occupation at this cave. Chronological changes in knapping technology can not be explained in terms of a change in the stone materials employed. Although the stoneworking technology did alter when the use of basalt diminished about 2,500 years ago the technological change was not directly conditioned by a shift in the proportions of raw material types which were procured. The chronological changes in knapping which were identified on chert were not a result of such shifts in raw material proportions, and technological changes were identified in portions of the deposit which did not contain changes in raw material usage. Furthermore, although the sample size was too small for statistical analysis, some of the trends observed on chert were also apparent on basalt. For example, the only basalt flakes with faceted platforms were recovered from spit 5, the same spit in which platform faceting on chert becomes common. Thus, despite differences in the properties of basalt and chert, similar chronological changes may have occurred on both raw materials (see also Hiscock and Hall 1988). This conclusion suggests that the changes in raw material procurement and usage observed at Bushrangers Cave may have resulted from two processes:

1. Alterations to stoneworking technology may have made previously unsuitable stone materials a usable or even preferred stone for artefact manufacture.

2. The availability of a particular rock material may have changed through time, either as a result of geomorphic change in the surrounding landscape or because of changes in the nature of human activities (eg. re-scheduling of movements or exhaustion of material at a quarry).

Assessing these potential explanations of technological change at Bushrangers Cave requires information about the prehistoric exploitation of stone materials and knapping at this and other sites in the region which is not currently available, and is outside the scope of this site report. Nevertheless, the data presented in this paper has demonstrated that, at Bushrangers Cave, the archaeological sequence documents a series of alterations in the procurement and reduction of stone materials during the last 6000 years. This confirms Hall's hypothesis that Holocene economic and social reorganization should be visible at Bushrangers Cave. Further research at the site should elucidate the nature of those reorganizations.

ACKNOWLEDGMENTS

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Table 1. Radiocarbon dates from Bushrangers Cave.

Square	Spit	Sample no.	C14 age (years bp)	Lab. no.	CALIBRATED DATES Age (years BP)	Two sigma range
H91	5	LA:A11/FS8	2090±90	Beta-18897	2045	1830-2319
H91	12	LA:A11/FS21	4720±100	Beta-4851	5360*	5055-5649
U86		LA:A11/FS80	5540±100	Beta-4852	6304	5998-6529

* = One of four calibrated dates (5450, 5360, 5331, 5299). The date given in the table is closest to the midpoint of the calibrated range and was used in the calculation of an age/depth curve.

Table 2. Numbers of artefacts in H91.

Spit	ARTEFACTS >5MM Flakes	Retouched Flakes	Flaked Pieces	Eraillure Flakes	Artefacts <5mm	TOTAL
1	7	-	1	-	3	11
2	20	1	1	-	11	33
3	17	1	-	1	6	25
4	9	2	2	-	0	13
5	9	-	-	-	3	12
6	8	-	-	-	0	8
7	7	1	1	-	3	12
8	11	2	-	-	3	16
9	9	1	2	-	5	17
10	3	-	-	-	6	9
11	4	1	-	1	2	8
12	7	-	1	-	0	8
13	3	-	-	-	0	3
14	1	1	-	-	1	3
15	-	-	-	-	1	1
TOTAL	115	10	8	2	44	179

Table 3. Estimated artefact discard rate in H91.

Spit	Number of artefacts	Density of artefacts ($\#/m^3$)	Estimated Age range (years BP)	Estimated discard rate of artefacts (#/100 years)
1-5	94	2100	0-2350	4.00
6-12	78	1139	2350-5700	2.33

Table 4. Raw material of artefacts >5mm in H91.

Spit	FINE GRAINED SILICEOUS Chert	 Mudstone	COARSE GRAINED SILICEOUS Quartzite	 Silcrete	BASALT
1	6	1	0	0	1
2	16	0	1	0	5
3	18	0	0	0	1
4	10	0	0	0	3
5	8	0	0	1	0
6	4	0	0	0	4
7	5	0	0	0	4
8	7	1	0	0	5
9	7	0	1	0	4
10	1	0	1	0	1
11	3	1	0	0	2
12	5	1	0	0	2
13	3	0	0	0	0
14	1	0	1	0	0
TOTAL	94	4	4	1	32

Table 5. Size of unretouched flakes in H91.

Variable	Measure	Chert	Basalt
WEIGHT (gm)	Mean	1.14	3.13
	Minimum	0.1	0.1
	Maximum	7.8	14.2
	Range	7.7	14.1
	Std dev.	1.64	4.13
	N	40	20
LENGTH (cm)	Mean	1.56	1.77
	Minimum	0.5	0.4
	Maximum	4.5	3.6
	Range	4.0	3.2
	Std dev.	0.89	1.01
	N	40	21
WIDTH (cm)	Mean	1.21	1.83
	Minimum	0.5	0.5
	Maximum	2.3	4.0
	Range	1.8	3.5
	Std dev.	0.48	0.98
	N	49	21
THICKNESS (cm)	Mean	0.30	0.39
	Minimum	0.1	0.1
	Maximum	1.0	1.0
	Range	0.9	0.9
	Std dev.	0.19	0.22
	N	56	24
VENTRAL AREA (cm^2)	Mean	2.22	4.15
	Minimum	0.45	0.40
	Maximum	9.89	12.40
	Range	9.44	12.00
	Std dev.	2.20	4.00
	N	40	20

Table 6. Platform size of unretouched flakes in H91.

Variable	Measure	Chert	Basalt
PLATFORM WIDTH (cm)	Mean	0.71	1.30
	Minimum	0.1	0.2
	Maximum	1.9	4.0
	Range	1.8	3.8
	Std dev.	0.42	1.04
	N	42	20
PLATFORM THICKNESS (cm)	Mean	0.23	0.28
	Minimum	0.1	0.1
	Maximum	0.6	0.7
	Range	0.5	0.6
	Std dev.	0.17	0.17
	N	47	23
PLATFORM AREA (cm^2)	Mean	0.21	0.46
	Minimum	0.01	0.02
	Maximum	1.14	1.89
	Range	1.13	1.87
	Std dev.	0.28	0.56
	N	42	20

Table 7. Shape of unretouched flakes in H91.

Variable	Measure	Chert	Basalt
ELONGATION	Mean	1.25	1.03
	Minimum	0.45	0.40
	Maximum	2.40	3.00
	Range	2.05	2.60
	Std dev.	0.51	0.56
	% L>2W	12.5	5.0
	N	40	20
PARALLEL INDEX	Mean	2.66	1.79
	Minimum	1.00	0.80
	Maximum	17.00	4.50
	Range	16.00	3.70
	Std dev.	2.97	0.96
	% Contracting	0	15.8
	N	34	19
RELATIVE THICKNESS	Mean	5.08	5.40
	Minimum	0.5	2.5
	Maximum	10.0	10.0
	Range	9.5	7.5
	Std dev.	2.32	2.19
	N	49	21

Table 8. **Technological attributes of complete unretouched flakes in H91.**

Aspect of Technology	Trait	Measure	Chert	Basalt
CORE SHAPE	Platform angles	% flakes <70°	33	52
		mode	70-79°	60-69°
PRECISION OF BLOW	Platform size	% shattered	22.1	4.5
		% focalized	20.6	13.6
		% wide/bending	57.4	81.8
PLATFORM PREPARATION	Platform surface	% cortex	4.3	4.5
		% shattered	22.1	4.5
		% single scar	55.9	81.8
		% several scars	10.3	4.5
		% faceting	7.4	4.5
OVERHANG REMOVAL	Overhang removal	% flakes with overhang removed	7.3	4.6
APPLIED FORCE	Termination	% feather	67	80
		% hinge	28	5
		% step	5	15
		ratio hinge:step	5.5:1	0.3:1
DECORTICATION	Amount of Cortex	% flakes with cortex	12.5	20.0
		% flakes with >50% cortex	0	5.0
N			40	20

Table 9. **Size of chert flakes in H91.**

Variable	Measure	spits 1-3	spits 4-5	spits 6-12
WEIGHT (gm)	Mean	1.23	1.30	0.89
	Minimum	0.1	0.1	0.1
	Maximum	7.8	2.8	3.4
	Range	7.7	2.7	3.3
	Std dev.	1.97	1.06	1.22
	N	22	6	12
LENGTH (cm)	Mean	1.52	1.86	1.22
	Minimum	0.7	0.6	0.5
	Maximum	4.3	4.5	2.8
	Range	3.6	3.9	3.0
	Std dev.	0.82	1.32	0.65
	N	23	8	15
WIDTH (cm)	Mean	1.12	1.46	1.05
	Minimum	0.5	0.7	0.2
	Maximum	2.3	1.9	2.3
	Range	1.8	1.4	2.1
	Std dev.	0.44	0.43	0.59
	N	29	8	17
THICKNESS (cm)	Mean	0.29	0.29	0.29
	Minimum	0.1	0.1	0.1
	Maximum	1.0	0.5	0.8
	Range	0.9	0.4	0.7
	Std dev.	0.19	0.12	0.21
	N	31	10	20
VENTRAL AREA (cm^2)	Mean	2.01	3.86	1.78
	Minimum	0.49	0.60	0.45
	Maximum	9.89	8.55	6.44
	Range	9.40	7.95	5.99
	Std dev.	2.11	2.78	1.83
	N	22	6	12

Table 10. Platform size of chert flakes in H91.

Variable	Measure	spits 1-3	spits 4-5	spits 6-12
PLATFORM WIDTH (cm)	Mean	0.69	0.84	0.69
	Minimum	0.1	0.2	0.2
	Maximum	1.9	1.4	1.6
	Range	1.8	1.2	1.4
	Std dev.	0.43	0.49	0.39
	N	23	5	12
PLATFORM THICKNESS (cm)	Mean	0.23	0.27	0.20
	Minimum	0.1	0.1	0.1
	Maximum	0.6	0.6	0.6
	Range	0.5	0.5	0.5
	Std dev.	0.17	0.18	0.16
	N	24	7	14
PLATFORM AREA (cm^2)	Mean	0.22	0.29	0.16
	Minimum	0.01	0.02	0.02
	Maximum	1.14	0.84	0.96
	Range	1.13	0.82	0.94
	Std dev.	0.30	0.34	0.26
	N	23	5	12

Table 11. Shape of unretouched chert flakes in H91.

Variable	Measure	spits 1-3	spits 4-5	spits 6-12
ELONGATION	Mean	1.35	1.28	1.06
	Minimum	0.56	0.60	0.45
	Maximum	2.40	2.37	1.60
	Range	1.84	1.77	1.15
	Std dev.	0.51	0.64	0.41
	% L>2W	18.2	16.7	0
	N	22	6	12
PARALLEL INDEX	Mean	2.83	3.19	2.15
	Minimum	1.00	1.29	1.13
	Maximum	17.00	9.50	3.00
	Range	16.00	8.33	2.07
	Std dev.	3.67	3.54	0.67
	% <2.0	45.5	60.0	72.7
	N	18	6	11
RELATIVE THICKNESS	Mean	4.76	5.79	4.93
	Minimum	0.50	2.33	1.00
	Maximum	9.00	10.00	9.00
	Range	8.50	7.67	8.00
	Std dev.	2.29	2.36	2.57
	N	29	8	17

Table 12. Technological attributes of unretouched chert flakes in H91.

Aspect of Technology	Trait	Measure	Spits 1-3	Spits 4-5	Spits 6-12
CORE SHAPE	Platform angles	% flakes <70°	55.0	20.0	18.2
		mode	60-69°	80-89°	70-79°
PRECISION OF BLOW	Platform size	% shattered	24.1	25.0	23.5
		% focalized	17.2	12.5	17.6
		% wide/bending	58.6	62.5	58.8
PLATFORM PREPARATION	Platform surface	% cortex	7.0	0	0
		% shattered	24.1	25.0	23.5
		% single scar	51.7	62.5	58.8
		% several scars	13.8	0	11.8
		% faceting	3.5	12.5	5.9
OVERHANG REMOVAL	Overhang removal	% flakes with overhang removed	6.3	10.0	14.3
APPLIED FORCE	Termination	% feather	65.4	100.0	68.4
		% hinge	30.8	0	26.3
		% step	3.9	0	5.3
		ratio hinge:step	8:1	-	5:1
DECORTICATION	Amount of Cortex	% flakes with cortex	13.6	0	16.7
		% flakes with >50% cortex	0	0	0
N			32	10	21

Table 13. Relationship of retouched flake type to raw material type in H91.

Implement type	Chert and mudstone	Quartzite and Silcrete	Basalt	Total
Backed blades	2	0	0	2
Burinate	1	1	0	2
Amorphous retouched flake	5	0	1	6
Percentage of flakes retouched	9	20	3	6

Table 14. Vertical distribution of retouched flakes in H91.

Spit	Backed blades	Burinates	Amorphous retouched flakes	Total
1	0	0	0	0
2	0	1	0	1
3	0	0	1	1
4	1	1	0	2
5	0	0	0	0
6	0	0	0	0
7	0	0	1	1
8	1	0	1	2
9	0	0	1	1
10	0	0	0	0
11	0	0	1	1
12	0	0	0	0
13	0	0	0	0
14	0	0	1	1
15	0	0	0	0
TOTAL	2	2	6	10

Table 15. Chronological changes in the frequency of retouched flakes in H91.

Spits	Percentage of chert flakes which are retouched	Percentage of basalt flakes which are retouched	Percentage of all flakes which are retouched
1-3	3.0 (N=33)	0 (N=6)	4.3 (N=46)
4-5	16.7 (N=12)	0 (N=3)	10.0 (N=20)
6-12	12.5 (N=24)	4.5 (N=22)	9.3 (N=54)

Table 16. Chronological changes in the frequency of edge damage in H91.

Spits	Percentage of chert flakes which are edge damaged	Percentage of basalt flakes which are edge damaged	Percentage of all flakes which are edge damaged
1-3	18.2 (N=33)	0 (N=6)	19.6 (N=46)
4-5	33.3 (N=12)	33.3 (N=3)	30.0 (N=20)
6-12	29.2 (N=24)	13.6 (N=22)	25.9 (N=54)

Table 17. Chronological changes in heat shattering of artefacts in H91.

Spit	Total number of artefacts	No. of artefacts heat damaged	Percentage of artefacts damaged
1	8	4	50
2	22	7	32
3	19	2	11
4	13	4	31
5	9	1	11
6	8	0	0
7	9	2	22
8	13	2	15
9	12	3	25
10	3	0	3
11	6	0	6
12	8	1	13
13	3	3	100
14	2	0	0
1-3	49	13	27
4-5	22	5	23
6-12	51	8	14

Table 18. Estimated accumulation rate of non-artefactual heat shattered fragments of stone in H91.

Spit	Number of fragments	Density of fragments (#/m^3)	Estimated Age range (years BP)	Estimated accumulation rate of fragments (#/100 years)
1-3	36	1185	0-1550	2.32
4-5	11	765	1550-2350	1.38
6-12	27	394	2350-5700	0.81
1-5	47	1050	0-2350	2.00
6-12	27	394	2350-5700	0.81

Table 19. Estimated accumulation rate of bone in H91.

Spit	Weight of bone (g)	Density of bone (g/m^3)	Estimated Age range (years BP)	Estimated accumulation rate of bone (g/100 years)
1-3	103.1	3394	0-1550	6.7
4-5	39.5	2748	1550-2350	4.9
6-12	92.2	1346	2350-5700	2.8
1-5	142.6	3187	0-2350	6.1
6-12	92.2	1346	2350-5700	2.8

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