A PRELIMINARY REPORT ON THE STONE ARTEFACTS FROM COLLESS CREEK CAVE, NORTHWEST QUEENSLAND

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INTRODUCTION

Today the gorge system of which Colless Creek is a part is an oasis, a permanent stream system lined by tropical gallery forest running through semi-arid terrain. Colless Creek Cave itself is currently an oasis of information within the archaeological literary desert of the Top End; no other sites have been published within a 500km radius. This paper is a preliminary report on the analysis of stone artefacts from the cave. It is preliminary in two senses. First, it analyses material from only two test squares excavated in 1979. Second, it describes only artefact densities, rates of discard, artefact sizes, and the proportions of artefact types. No analysis of stone working technology is presented. This paper is concerned only with chronological changes within the cave; no account is taken of spatial variations within the cave, or of relationships to other sites.

THE SETTING

The site is located in the gulf fall zone of the Barkly Tablelands, approximately 7km from where the tableland abruptly gives way to the Carpentarian plain (Lat. 138°26′ E, Long. 18°42′ S). At this point Colless Creek flows through the Cambrian Thorntonia Limestone which in fact is a dolomite, not a limestone. Chert from this and neighbouring formation, the Camooweal dolomite, provides the only raw material suitable for stone artefact manufacture which can be obtained near the cave.

The closest non-chert rock used by Aborigines in the area is the sandstone from the Lawn Hill Formation, 2-3 km to the north. Non-chert stone suitable for producing chipped artefacts occurs more than 20 km to the northeast where greywackes and quartzites crop out.

Colless Creek flows east into Lawn Hill Creek, which in turn runs north onto the Carpentarian plain (Fig. 1). Both streams have cut deep gorges in the dolomite plateau through which they pass. Both streams are permanent because they are fed from massive aquifers underlying the Barkly Tablelands. Thus, although the region is semi-arid, receiving 250-380mm of rain per year, Colless Creek Gorge supports a lush gallery forest of tropical vegetation (eg. *Livistona*, *Pandanus*, *Macrozamia*, *Melaleuca*).

PALAEOENVIRONMENTS

There is little direct evidence for environmental conditions in northern Australia over the last 50,000 years. The limited evidence at Lake Woods and Lake Gregory, in the NT and WA respectively, suggests that the lakes were very much larger than now at some stage prior to 26,000 years ago (Bowler 1983a). Bowler (1983a:5) proposes that this decreased water stress resulted from an increased precipitation/evaporation ratio, perhaps five times greater than today. This interpretation is generally supported by evidence from Colless Creek Cave itself (Hughes 1983) which is discussed below. By analogy with southern Australian in the same period conditions were probably cooler and wetter than today (Bowler 1976; Bowler 1983b).

The evidence from Lake Woods and Lake Gregory, again supported by data from Colless Creek Cave, suggests that from around 25,000 years ago until about 14,000 years ago there was a change to drier conditions (Bowler 1983c; Hughes 1983). By analogy with southern Australia the dessication peaked around 18-15,000 years BP (Bowler 1983d, 1976:67-73). After 14,000 years BP the climate ameliorated and rainfall and temperature returned to more or less their present regime.

In assessing palaeoclimatic change in the Colless Creek area it is necessary to differentiate the environmental history of the gorge from that of the surrounding upland areas. During historic droughts Colless Creek and Lawn Hill Creek continued to flow because they are dependent on the underground reservoir to the south as well as on surface runoff. It is likely that a similar situation applied in the past and that even in the very arid period from 22,000 to 14,000 BP there would have been water available in the gorges. Also, lower evaporation rates at the time may have aided in retaining water in the gorge system. This suggestion is supported by the existence of relict species of tropical plants, such as <u>Livistona</u> and <u>Macrozamia</u>, which have survived in the sanctuary of the gorges for many hundreds of millenia. Faunal remains found in Colless Creek Cave between 18,000 and 14,000 BP, such as freshwater mussel, fish and turtle also indicate the existence of water in the gorges at these times. Whether that water flowed permanently or only periodically is a question that cannot be answered at present. Before and after the Late Pleistocene arid phase, rainfall was probably more frequent and consequently stream flows somewhat like those of today could be expected.

Unlike the gorges, the adjacent plateau areas are watered solely by precipitation and are therefore more sensitive to climatic change. Today the plateau is a semi-arid grassland which receives water only in a short summer wet season. Hughes (1983) has argued that changes in runoff into Colless Creek Cave reflected changes in absolute rather than effective rainfall. As the water entering the cave passes through vertical fissures connected to the plateau above, the hydrologic history of the cave can be taken as a reliable indicator of absolute precipitation on the plateau. Using this argument Hughes (1983) postulated that a wet period sometime prior to 18,000 BP was a result of higher absolute rainfall than today. Following that wet phase was a drier period which presumably became most arid between 18,000 BP and about 14,000 BP. Hughes (1983) also noted that today the catchment area for fissures leading to the cave consists of bare rock with truncated remnants of soils; whereas the cave alone contains thirty to forty cubic metres of sediment derived from that catchment. It is therefore possible that the

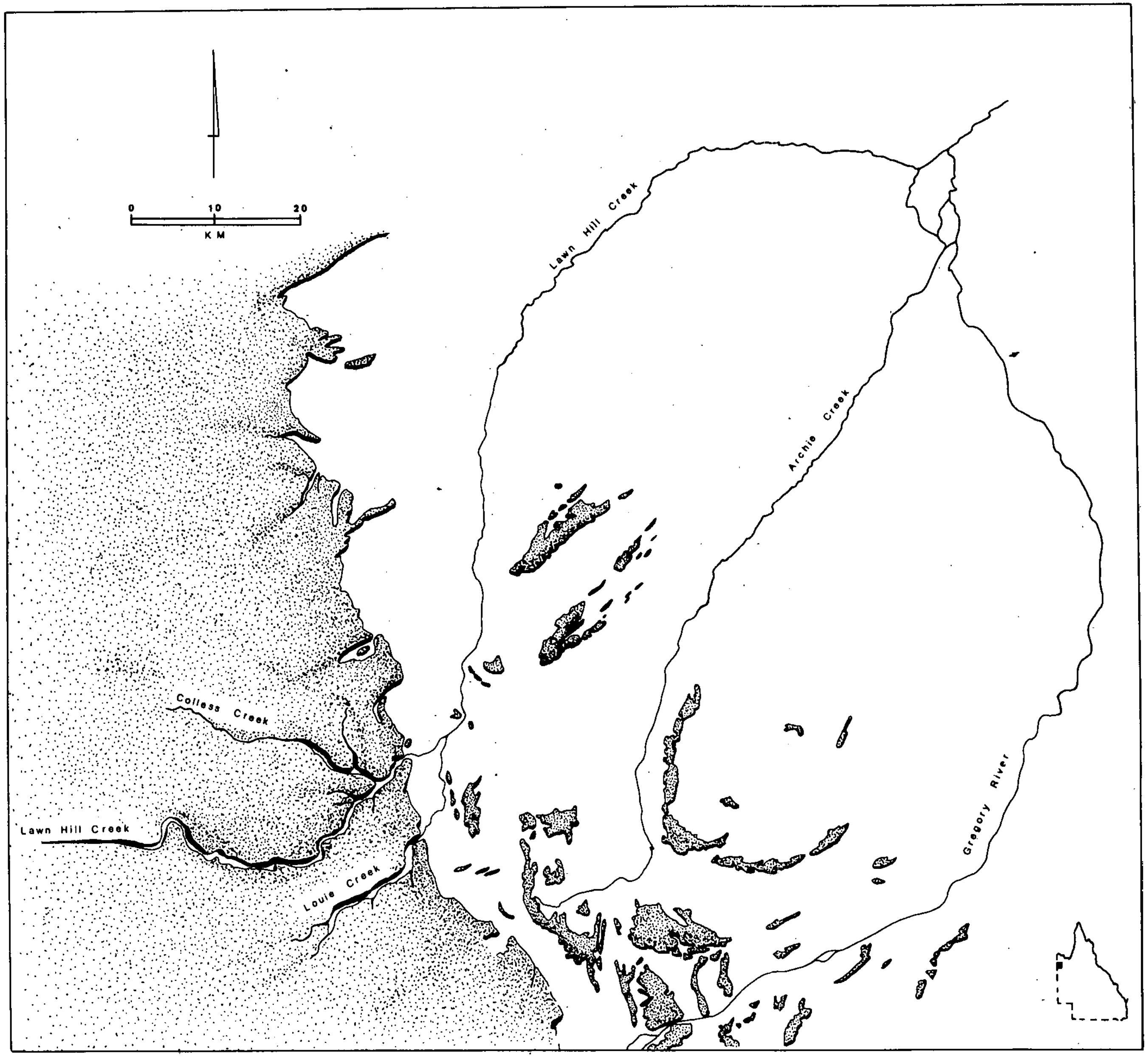

Figure 1. Map of the Lawn Hill area

last 20-30,000 years has seen a progressive denudation of soil on the plateau, at least in the vicinity of the cave, and associated changes in floral communities. Changes in soil and plant cover, in association with variations in rainfall and temperature, must have produced dramatic environmental change on the plateau, from a situation with deeper and more extensive soil cover and perhaps open forests under a wetter climatic regime prior to 18,000 BP, to an arid landscape between about 18,000 and 14,000 BP, ameliorating gradually until the present (cf. Nix and Kalma 1972). Colless Creek Cave contains evidence for human occupation throughout this period.

The arid phase in particular was probably stressful on both humans and the environment. It is thought that the climatic and hydrological zones of central northern Australia were compressed northward towards the Gulf of Carpentaria(Nix and Kalma 1972). Colless Creek would have lain within an expanded arid zone rather than in the semi-arid tropical savanna as it does today. Bowler has suggested that the greatest mobility in these environmental boundaries occurred in the climatically sensitive semi-arid zones. Thus, the following hypothesis:

> ...within these regions the changes would probably have been sufficient to induce significant and, hopefully, detectable changes in the distribution and adaptation of human populations. In the semi-arid zone the alternation of periods of increased productivity with more desertic conditions would have imposed considerable stress on the population. (Bowler 1976:75).

The Lawn Hill region provides a situation in which to test this proposition. The potential of this area is made even more striking by the contrast between gorge and plateau.

COLLESS CREEK CAVE

Colless Creek Cave faces east into a small tributary valley on the southern side of Colless Creek Gorge. The cave is 15m above the level of the creek, at the top of a steep scree slope, and at the base of a 15m high vertical cliff. The cave itself is 7m wide, 2m high and extends 12m into the cliff face. A plan of the site, together with the location of four test squares excavated in 1979, is given in Figure 2. The cave floor is veneered with a lag of gravel and artefacts and there are several large blocks of roof fall protruding from the deposit.

In 1979 Phil Hughes and Ken Aplin excavated four 50 x 50cm squares. Two (P46 and Q46) were located at the rear of the shelter where animal disturbance had revealed a 30cm vertical section in the deposit. Another two squares (T39 and U39) were dug on the northern side of the cave where no disturbance had occurred. Although I have since excavated a further ten squares I shall restrict my comments here to the two initial test squares Hughes and Aplin dug at the back of the cave (P46 and Q46), as these are the only ones analysed at the moment.

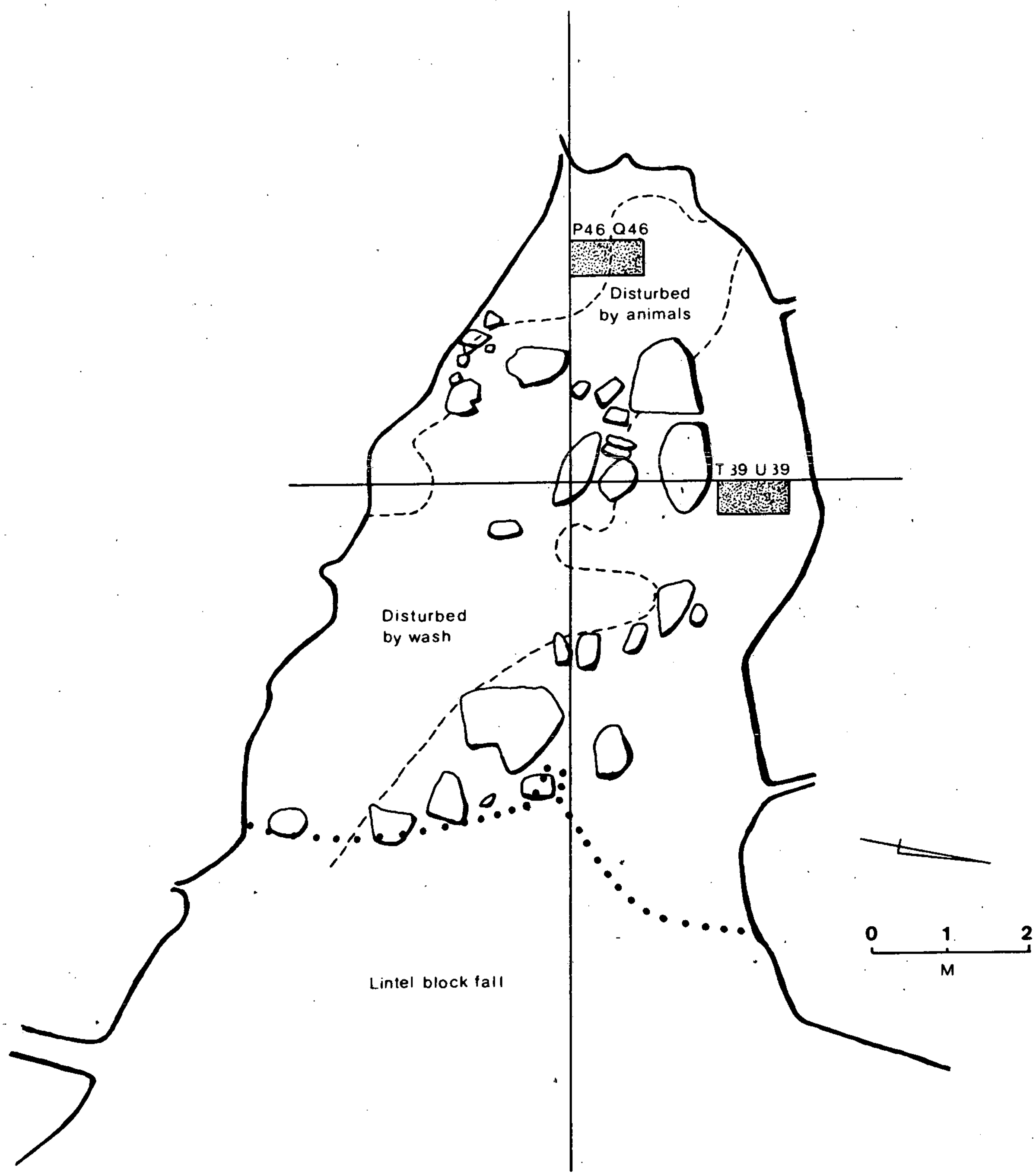

Figure 2. Floor plan of Colless Creek Cave showing the squares excavated in 1979

STRATIGRAPHY

In all four squares the same stratigraphic sequence was found. Hughes and Magee have discussed the history of sediment accumulation elsewhere (Hughes 1983; Magee and Hughes 1982). Only a summary of their arguments is provided here. Hughes identifies two distinct layers separated by a gravel lag (see Fig 3). The upper layer, Unit A, consists of dolomite gravel, derived from roof fall, in a dark brown (10YR 4/3) sandy matrix made up of pedorelicts of calcareous clay and quartz grains with clay rich cutans (Magee and Hughes 1982).

Unit B, the layer below the gravel lag, consists of reddish brown (5YR 4/4) sediment containing occasional fragments of dolomite gravel and nodules of secondary carbonate. A small percentage of gravel, plus quartz grains and pedorelicts, are found in a matrix of well organised iron-rich calcareous clay which includes cutans and secondary carbonate precipitated in voids and around grains (Magee and Hughes 1982).

Magee and Hughes (1982) argue that, with the exception of roof-fall and cultural material, most of the deposit has entered the cave through fissures at the rear. The source of this sediment appears to be clay-rich soil found on the plateau above the cave. They suggest that the origin of the matrix of both Units A and B is substantially the same, and that the differences between them are largely a result of prolonged _in situ_ weathering of Unit B. The main evidence given in support of this is the destruction of pedorelicts and the reorganization of material to form the matrix seen in Unit B (Hughes 1983:60). Other support comes from the highly degraded condition of the stone artefacts and bone fragments in Unit B. Hughes conclusion about Unit B was that,

> The relatively high degree of pedogenic organisation indicates considerable weathering of the deposit over a long period of time under much wetter conditions than today. (Hughes 1983:61).

Although this stratigraphic sequence occurs in all trenches excavated in the cave Unit A is not represented in square Q46 as animal disturbance and water have removed the upper 25cm of sediment to expose the gravel lag separating the two strata. Hughes used this to advantage by excavating Q46 and obtaining a sample of Unit B without having to remove the overlaying material. Table 1 shows the correlation between the spits in Q46 and those in P46.

AGE OF THE DEPOSIT

The deposit was dated using C14 determinations on freshwater mussel shells. Because of an absence of shell in Unit B only the upper layer has been dated. In order to check the reliability of the shell material for dating, a sample of living mussels was collected and their shells tested for C14 activity. The result, 99.3 $\pm$ 1.0% (ANU 2444), indicates that the dates are relatively accurate and that age estimates are unlikely to be more than 1000 years greater than the true ages of the shells (Magee and Hughes 1982). Samples of shells have also been analysed by x-ray defraction techniques to determine whether any recrystalisation of the carbonate has occurred (P.J.Hughes pers com). No evidence for recrystalisation has been observed.

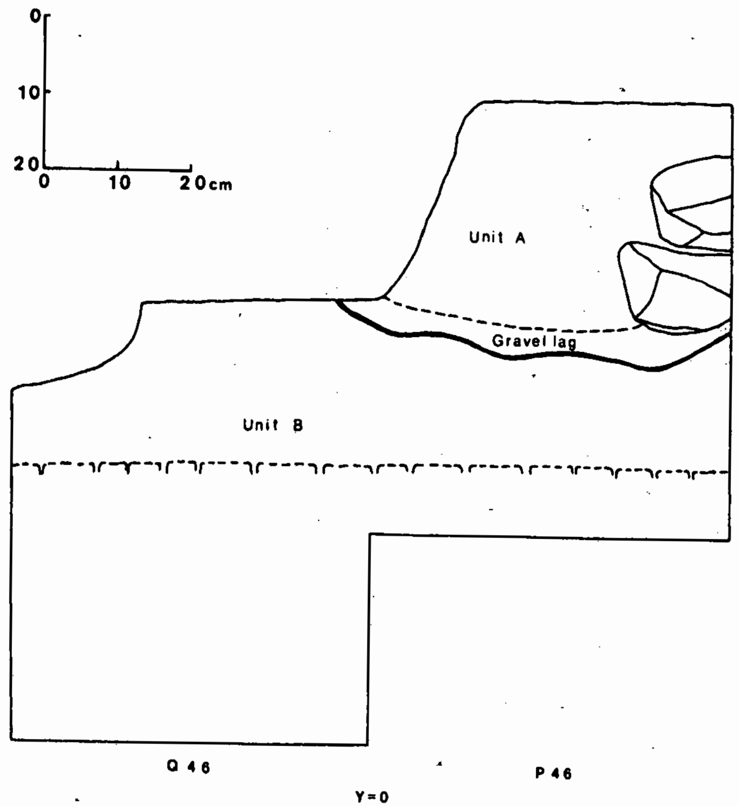

Figure 3. Stratigraphy in squares P46 and Q46

Table 1. Correlation between spits in P46 and Q46

Stratigraphy	P46	Q46
A	1	
A	2	
A	3	
A	4	
A	5	
A	6	
A	7	
A	8	
A	9	
A	10	
LAG	11	1
B	12	2
B	13	3
B	14	3
B	15	4
B	16	4
B	17	5
B	18	6
B	19	7
B	20	8
B	21	9
B	22	10
B	23	11
B		12
B		13
B		14
B		15
B		16
B		17
B		18
B		19
B		20
B		21

Four dates obtained from P46 and two further dates from U39 and T39 give an internally consistent chronology, age increasing with depth (Table 2). Three age estimates in three different squares (P46/10, U39/5, T39/6) give roughly the same date for the initiation of Unit A sediment accumulation, thereby supporting the usefulness of this series of dates. The variation in these determinations (ANU 2331, ANU 2509, ANU 2508) may result from two factors in addition to any inherent variability in the age estimates. First, the spits in U39 and T39 presumably cover a large amount of time and the age estimate for any spit may only be the midpoint of the time spanned by that spit. Thus, it is not surprising that the estimates for U39/5 and T39/6 are slightly less than the P46 determination of the same event. In addition, the date in T39 is from the second lowest spit in Unit A. Although the lowest spit (T39/7) possessed a small quantity of shell it was highly fragmented and degraded and unlikely to produce sufficient dateable material. Second, although the beginning of Unit A accumulation should be broadly contemporary across the cave floor it need not be precisely so. The three dates are thus less in conflict than first impressions may indicate.

Table 2. Radiocarbon dates from Colless Creek Cave (Hughes 1983)

Square/Spit	Lab No.	Age (b.p.)	Depth below Surface
P46/2	ANU 2330	5070 ± 250	3cm
P46/5	ANU 2507	13620 ± 160	10cm
P46/8	ANU 2506	14150 ± 160	19cm
P46/10	ANU 2331	17290 ± 470	27cm
U39/5	ANU 2509	15820 ± 190	14cm
T39/6	ANU 2508	16170 ± 260	20cm

Age/depth curves cannot be constructed for T39 and U39 because a period of 17,000 years is compressed into only 15cm of deposit which was excavated in only 4-5 spits, each of which therefore covers a considerable time span. However, the P46 sequence does allow the construction of a depth/age curve (Figure 4). Extrapolating from this curve, age ranges were assigned to the spits (Table 3). These age ranges are as precise as the data permits. It should be noted, however, that the dates from P46/5 and P46/8 are so close that the age-depth curve at this point is nearly vertical, and the time span of spits P46/5-8 is comparatively short. Spits 6 and 7 were virtually contemporary and so were combined for all analyses. The same problem is found to a lesser extent in spits P46/6-7 and P46/8; ie. the calculated age range of the spits is not large compared to the standard deviation associated with the radiocarbon determinations. Although it is possible to eliminate these doubts simply by combining spits, the chronological change in artefacts remains the same even if spits are combined. Thus, the analyses to follow are presented using the spits assigned ages in Table 3.

Although errors are likely to occur in this sort of calculation, it is apparent that sedimentation during the period 17,000 to 13,500 BP was much more rapid than at later periods. This depth/age curve will be used later in the paper to estimate artefact discard rates.

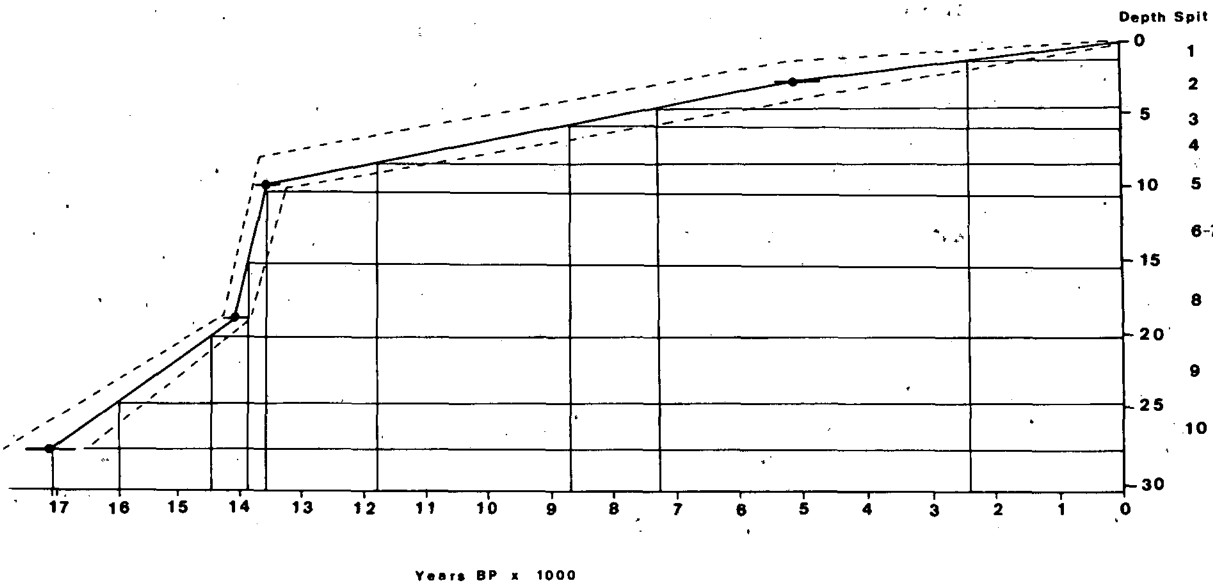

Figure 4. Age/depth curve for P46

Table 3. Age range of each spit in P46

Spit	Age (years b.p.)	Time Represented	Kg/100yrs.
P46/1	0 - 2450	2450 yrs	0.25
P46/2	2450 - 7300	4850 yrs	0.26
P46/3	7300 - 8750	1450 yrs	0.75
P46/4	8750 - 11850	3100 yrs	0.38
P46/5	11850 - 13625	1775 yrs	0.60
P46/6-7	13625 - 13800	175 yrs	8.80
P46/8	13800 - 14500	700 yrs	3.01
P46/9	14500 - 15900	1400 yrs	1.67
P46/10	15900 - 17290	1390 yrs	2.47

ARTEFACT IDENTIFICATION

Although the methods used in the stone analysis will be presented in detail at a later date a brief statement is necessary here. Fragments of stone were identified as artefacts only when the identification was positive. Objects were only called artefacts if they possessed one or more of the following characteristics:

1. A positive or negative ring crack.
2. A distinct positive or negative bulb of force.
3. A definite eraillure scar in an appropriate position beneath a platform.
4. Definite remnants of flake scars (eg., dorsal scars & ridges).

These traits were chosen because they indicate the application of an external force to a core.

Four types of artefacts were identified. They were defined as follows:

Flake: This is the piece of rock struck off a core. It exhibits a set of characteristics which indicates that it has been struck. The most indicative of these are ringcracks which show where the hammer hit the core. The ventral surface may also be deformed in particular ways, for example a bulb or eraillure scar.

Core: A piece of stone with one or more negative flake scars but no positive flake scars.

Retouched Flake: A flake which has had flakes removed from it, identified by flake scars onto the ventral face and/or deriving from the ventral surface.

Flaked Piece: This is a chipped artefact which cannot be classified as a flake, core, or retouched flake. The reason it cannot be placed in one of these classes is that the defining attributes are missing. This often happens when a piece of stone which has negative flake scars also contains a number of incipient fracture plains. Artefacts which are heavily weathered or which have been shattered in a fire are difficult to categorise and are often only identifiable to this level. Rather than guessing whether an artefact is a core or a flake I have provided this 'uncertain' category. Note, however, that this class was used as a last resort, only when an artefact was definitely chipped but could not be placed in another group.

There are several reasons why it is necessary to subdivide the artefacts into these groups. Each group is technologically different, that is, each is a different product of knapping behaviours and fracture patterns. Consequently, this classification provides a great deal of information about the human behaviour which created the assemblage. More important is the fact that particular attributes can be measured on some artefact types but not others (eg. you cannot examine the ventral surface of a core), and that measuring the same behaviour on two different artefact types may require different measurements.

A further category, "Non-diagnostic " (ND), was provided for. This refers to fragments of chert which might have been produced by stone working but which could not be definitely identified as artefacts. These were usually small cubes or rhombs of chert with flat faces caused by splitting along incipient fracture planes which run through the material. Many of these non-diagnostic pieces may be the result of natural shattering of chert blocks (remember this is a cave in chert bearing dolomite). Nevertheless, it is possible that a proportion of the ND fragments found in each spit are the direct result of human activities. This proposal will be discussed later in the paper.

The type of raw material used in artefact manufacture was also recorded. The aim of studying raw materials was to discover the numbers of artefacts made on non-local rocks which were imported to the site. To this end artefact raw materials were classified as either locally available (found within 3km of the cave) or not locally available (found more than 3km from the cave). Chert and limestone can be obtained locally. Greywackes, sandstones, quartzites and silcretes are not found close to the cave, and were collectively labelled as non-local.

CHANGES IN ARTEFACT DENSITIES OVER TIME

Squares P46 and Q46 yielded 3,289 artefacts, of which 2,341 came from Unit A. The remaining 948 artefacts were recovered from Unit B (including the gravel lag).

Chronological changes in artefact densities are given in Tables 4 and 5. Densities were expressed in two ways. First, the number of artefacts per kilogram of sediment was calculated using the weight of all sediment under 5cm (very little of the deposit is coarser than 5cm). Second, the number of artefacts per cubic metre of deposit was calculated. Temporal changes in artefact densities are similar for both types of density calculation.

Artefact densities are high in the top few spits of the deposit and they decline rapidly with depth until P46/10 and P46/11, where the density becomes much higher again. This increase is probably related to the concentrating effect of erosional processes which created a lag deposit at this point. Below this, in Unit B, densities decline steadily until they are consistently at or below 1 artefact/kg of sediment, or 2000 artefacts/cubic metre. When densities are expressed as n/kg the highest density is at the top of the deposit, whereas when density is expressed as n/cubic metre it is highest at P46/10. It should be noted that densities have little meaning unless the length of time over which the artefacts accumulated is taken into account. When this calculation is made a very different picture appears.

CHANGES IN THE DISCARD RATE OF ARTEFACTS

As explained previously only the spits in Unit A in P46 can be adequately dated by reference to an age/depth curve. Thus it is only the period between 17,000 BP and the present for which artefact discard rates can be calculated. At the moment this information is available only for the area at the rear of the cave, near P46.

Using the ages previously inferred for each spit in P46 the chronological changes in artefact discard rates were calculated. Figure 5 shows that the discard rate is highly variable. One pattern that is very clear is that the discard rate was relatively low over the last 13,500 years BP and much higher in the preceding 3500 years. As mentioned earlier, this pattern is the same even if spits are grouped together (see Table 6).

SEVEN POSSIBLE EXPLANATIONS

Archaeologists have used artefact discard rates to infer a variety of prehistoric situations, yet rarely is there any attempt to systematically test those inferences or to reject alternatives. It is necessary to eliminate more likely explanations before resorting to less likely and more complicated ones.

Between the time artefacts are made and when they are discovered and analysed, they may pass through a series of cultural and non-cultural processes. For example, a flake might be struck at a quarry, carried away and used, resharpened, and finally discarded. Even after an artefact has been incorporated into a deposit it is subject to disturbance, including disturbance during excavation, storage and analysis. To

Table 4. Chronological changes in artefact densities in P46

Excavation unit	Layer	Age (in years BP)	Sediment Wt (in kgs)	Depth (in cms)	Volume (in cubic metres)	kg/100 yrs	Depth/100 yrs	Number of artefacts	Density		Number of artefacts per 100 yrs
									#/kg	#/m^3	
1	B	undated - older than 17,000	5.1	2.5	0.006	-	-	71	13.9	11,833	-
2	B	"	9.4	4.0	0.010	-	-	46	4.9	4,600	-
3	B	"	10.1	3.0	0.008	-	-	26	2.6	3,250	-
4	B	"	7.6	3.0	0.008	-	-	16	2.1	2,000	-
5	B	"	18.4	4.0	0.010	-	-	19	1.0	1,900	-
6	B	"	11.3	2.0	0.005	-	-	17	1.5	3,400	-
7	B	"	10.8	3.0	0.008	-	-	10	0.9	1,250	-
8	B	"	6.9	2.0	0.005	-	-	4	0.6	800	-
9	B	"	7.0	2.0	0.005	-	-	3	0.4	600	-
10	B	"	7.4	3.0	0.008	-	-	1	0.1	125	-
11	B	"	8.6	2.0	0.005	-	-	3	0.3	600	-
12	B	"	9.9	2.0	0.005	-	-	6	0.6	1,200	-
13	B	"	11.1	2.0	0.005	-	-	5	0.5	1,000	-
14	B	"	14.5	3.0	0.008	-	-	3	0.2	375	-
15	B	"	13.7	3.0	0.008	-	-	2	0.2	250	
16	B	"	12.6	3.0	0.008	-	-	5	0.4	625	-
17	B	"	13.0	3.0	0.008	-	-	7	0.5	875	-
18	B	"	13.9	3.0	0.008	-	-	6	0.4	750	-
19	B	"	11.9	3.0	0.008	-	-	1	0.1	125	-
20	B	"	16.9	3.0	0.008	-	-	4	0.2	500	-
21	B	"	16.6	3.0	0.008	-	-	14	0.8	1,750	-

Table 5. Chronological changes in artefact densities in Q46

Excavation	Layer	Age (in years BP)	Sediment Wt (in kgs)	Depth (in cms)	Volume (in cubic metres)	kg/100 yrs	Depth/100 yrs	Number of artefacts	Density		Number of artefacts per 100 yrs
									#/kg	#/m^3	
1	A1	0-2,450	6.1	1.6	0.004	0.25	0.0653	217	35.6	54,250	8.9
2	A1	2,450 - 7,300	12.6	3.2	0.008	0.26	0.0660	451	35.8	56,375	9.3
3	A1	7,300 - 8,750	10.9	1.8	0.005	0.75	0.1241	247	22.7	49,400	17.0
4	A1	8,750 - 11,850	11.7	2.4	0.006	0.38	0.0774	243	20.8	40,500	7.8
5	A1	11,850 - 13,625	10.6	2.2	0.006	0.60	0.1239	101	9.5	16,833	5.7
6 & 7	A2	13,625 - 13,800	15.4	4.8	0.012	8.80	2.7429	128	8.3	10,667	73.1
8	A2	13,800 - 14,500	21.1	4.8	0.010	3.01	0.6857	231	11.0	23,100	33.0
9	A2	14,500 - 15,900	23.4	4.4	0.009	1.67	0.3143	170	7.3	18,889	12.1
10	A2	15,900 - 17,290	21.0	2.8	0.007	2.47	0.3294	553	26.3	79,000	39.8
11	B	undated	13.1	2.7	0.007	-	-	274	20.9	39,143	-
12	B	undated	11.4	2.9	0.005	-	-	64	5.6	12,800	-
13	B	undated	10.5	3.2	0.008	-	-	72	6.9	9,000	-
14	B	undated	13.2	3.4	0.009	-	-	74	5.6	8,222	-
15	B	undated	10.2	2.2	0.006	-	-	40	3.9	6,667	-
16	B	undated	9.4	2.0	0.005	-	-	31	3.3	6,200	-
17	B	undated	10.0	2.2	0.006	-	-	22	2.2	3,667	-
18	B	undated	10.2	2.0	0.005	-	-	22	2.2	4,400	-
19	B	undated	9.0	2.2	0.006	-	-	16	1.8	2,667	-
20	B	undated	11.7	2.4	0.006	-	-	15	1.3	2,500	-
21	B	undated	11.7	3.0	0.008	-	-	15	1.3	1,875	-
22	B	undated	12.9	2.8	0.007	-	-	21	1.6	3,000	-
23	B	undated	11.6	2.2	0.006	-	-	13	1.1	2,167	-

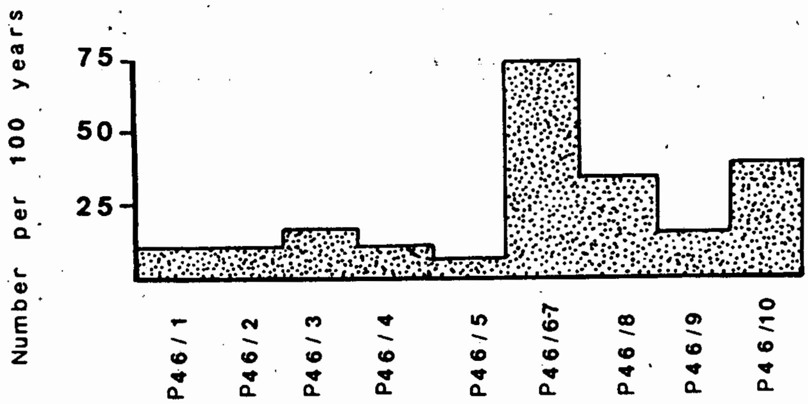

Figure 5. Rate of artefact discard

Table 6. Discard rate of artefacts in P46

Spit Group	Time Represented	Number of Artefacts	No. Artefacts per 100 yrs
P46/1-2	7300 yrs	668	9.2
P46/3-4	4550 yrs	490	10.8
P46/5	1775 yrs	101	5.7
P46/6-8	875 yrs	359	41.0
P46/9-10	2790 yrs	723	25.9
P46/1-5	13625 yrs	1259	9.2
P46/6-10	3665 yrs	1082	29.5

infer what prehistoric people were doing it is necessary to work backwards through this chain of events which connect existing residues to prehistoric activities (cf. Schiffer 1972, 1976; Binford and Bertram 1977:77-79; Gifford 1981:386-389; Sullivan 1978:204-210).

Daniels (1972) distinguished three different groups of events in this 'chain': research factors, post-depositional factors, and, historical factors. Research factors stem from the archaeologists own work, they are the bias involved in his/her own methods. Post-depositional factors are those agencies that "...alter the state or position of artefacts after they have been abandoned and before the archaeologists begins to study them" (Daniels 1972:202). Historical factors are the variety of prehistoric human behaviours, the ancient environment and human responses to it. Similar divisions have been made by others (eg. Sullivan 1978).

In practice this framework means that as an archaeologist works backward along the chain of events which has created a deposit, each event must be understood before inferences are drawn about the preceding one. For example, research which aims at describing prehistoric stone using behaviour at a site must consider post-depositional modifications to the deposit in order to reconstruct the assemblage as it was when the site was in use. It would then be necessary to infer the discard pattern so that the number and range of stone artefacts handled prehistorically could be calculated. Only then could the human behaviour that produced the artefacts be deduced. Schiffer (1976:43) has called these series of calculations "transformations" because they transform the archaeological material into information about past events.

Having provided this methodological basis I will now discuss seven possible explanations of the changes in artefact discard rates in square P46.

1. Methodological error/bias. Errors or bias resulting from research methods often go unrecognised. Bias may occur during artefact recovery (eg. choice of trenches, excavation methods, sieve sizes, sorting procedures), or during identification and analysis (eg. misidentification, measurement error or incorrect contextual information). There are three possible sources of error which might explain the changing discard rates identified in P46. First, the changes might be due to a systematic recovery error such as less efficient artefact recovery (presumably of smaller size classes) in the upper 5 spits. This explanation could be tested by excavating and analysing further squares, and by plotting only the discard rate of larger size classes known to be totally recovered. Second, the radiocarbon dates from which the age of each spit was calculated might be seriously in error. Although this source of error is unlikely given the consistent and detailed dating evidence it can be checked by obtaining more dates and by refining the methods used in their interpretation. Third, there might be a systematic error in artefact identification such that identification in the upper 5 spits is less efficient. This possibility can be tested by re-sorting samples of the material and assessing the error identified.

2. Post-depositional modification. A myriad of post-depositional factors might create the pattern identified in P46. Only two types of disturbance seem likely enough to warrant testing. The first is a possible

systematic dating error arising from post-depositional alteration of the C14 activity of samples or from vertical movement of the dated material relative to the artefacts, thereby leading to false associations of dates and objects. Again improved dating methods and dates from elsewhere in the cave would test this proposition. The second is a possible concentration of artefactual material in spits 6-10, without a concomitant concentration of their associated C14 sample. Although this sort of modification is unlikely it can be tested by an analysis of artefact conjoins and an examination of chronological changes elsewhere in the cave. Further work on the gravel component of the sediment in the deposit might also provide data to test these propositions.

3. <u>Spatial change in the location of discard areas within the cave</u>. It is possible that the changes in discard rate identified in P46 simply reflect changes in discard areas. For example, during the period 13,500-17,000BP, artefacts might have been discarded mainly in the rear of the shelter, whereas in more recent times artefacts tended to be discarded elsewhere in the cave. If this were the case, the number and variety of activities undertaken in the cave might have remained constant throughout its occupation history. This hypothesis can easily be tested by excavations in other parts of the site. If the hypothesis is correct they should have reversed sequences where discard rates are higher in the last 13,000 years. If the hypothesis is incorrect the sequence found in P46 will be duplicated.

4. <u>Changes in the system of artefact manufacture and use</u>. It is always likely that changes in artefact numbers and sizes are superficial reflections of changes in stone working technology or stone artefact use. There are many hundreds of mechanisms that can have this effect. Access to quarries is one example. If the source of stone material changes, or if the system of acquiring the material changes, artefact sizes or numbers may alter. Another example is artefact use. If the uselife of artefacts was shortened, discard rates might increase.

To test this hypothesis the archaeologist would need to reconstruct the patterns of artefact manufacture, artefact use and the interrelationship between them. The model would be refuted if the archaeological change in discard patterns cannot be accounted for by changes in the behaviour associated with artefact manufacture and use.

5. <u>Increase in cave use</u>. The increased discard rate between 13,500 and 17,000 BP may indicate a greater preference for cave use at that period. This can be tested by finding and analysing open sites which were inhabited throughout the last 18,000 years. If this explanation is correct the discard rates at open sites should increase after 13,500 BP when the discard rate in the cave decreases.

The proposition that the artefact discard rate reflects changes in the extent of cave use can also be examined in another way. If the amount of occupation increases but the nature of the occupation remains the same there should be synchronous changes in all aspects of cave use, not artefact-related behaviour alone. Bone and shell are found throughout Unit A. If this hypothesis is correct the rate of bone and shell accumulation should parallel artefact discard rates.

6. Population Pressure. What I mean here by population pressure is a situation in which a population of a particular size finds it comparatively difficult to exploit some or all of the resources within its territory, or to maintain itself by exploiting only resources utilized previously. Two direct solutions to this problem are available: change the population size, and/or concentrate on resources that the group can exploit more efficiently. During the period 14,000 to 17,000 BP the area was probably considerably more arid than it is now (Hughes 1983). One obvious hypothesis is that aridity increased the logistical problems associated with exploiting resources on the plains and/or plateau areas. One consequence could be that during this period of stress Colless Creek gorge, and therefore the cave, was more intensively occupied. This might have occurred by permanent habitation in the gorge, more frequent visits or visits of longer duration. This hypothesis can be tested by finding and analysing a number of sites in the region which were occupied over the same time span as Colless Creek Cave. If this model is correct the discard rate at all sites in or near the gorge should increase between 13,500 and 17,000 BP, and at the same time the discard rate at sites away from the gorge should decrease. Furthermore, the changes in artefact discard rate should be accompanied by parallel changes in bone and shell accumulation rates.

7. Population increase in the region. The grandest hypothesis that might be offered is that between 13,500 and 17,000 BP the number of people in the region increased, and in more recent periods the population size decreased. This hypothesis can be tested by finding and analysing a number of sites in the region which were occupied over the same time span as Colless Creek Cave. If this model is correct the discard rate at sites all over the region should increase between 13,500 and 17,000 BP. Furthermore, at each of these sites there should be parallel changes in several types of debris such as faunal remains, artefacts, manuports or potlids. However, even if the amount of different materials in each site, and the numbers of sites, increased synchronously in the period between 13,500 and 17,000 it would be very difficult to test whether such increases were a result of increased numbers of people, or simply of a general intensification of the amount of activities in the region.

In view of the arguments described earlier, the order in which I have presented these hypotheses is important. The explanations were placed in the reverse order in which they might have affected the data. For example, any post-depositional modification of archaeological material occurred after the prehistoric behaviour that created that debris. There is little sense in investigating population change as an explanation until possibilities such as measurement error, post-depositional effects or technological change have been eliminated. My suggestion therefore is that until definitely rejected an hypothesis higher on this list of seven must be considered a more likely explanation than hypotheses lower on the list.

Five of these suggested explanations refer to prehistoric human behaviour. Hypotheses 3 and 4 involve changes in the rate or location of discard per person. This has been termed 'complex functional change' by Smith (1982:114). In contrast hypotheses 5 to 7 require that the rate and amount of artefacts discarded by each person remains constant while the intensity of cave use increases. In this context 'intensity' can become greater by increasing the number of people at the site, the duration of their stay, or the frequency of their visits. Smith termed these situations 'simple functional change' (Smith 1982:114).

The information presented in this preliminary report is insufficient for the sort of rigorous testing that is required to differentiate between these seven hypotheses. Hence, I make no attempt in this paper to test these competing explanations. Such testing must await the gathering of appropriate information. The following sections will simply present information on artefact sizes and types, some of which bears upon the above hypotheses. I shall assume, for the moment, that no major errors result from data collection or post-depositional effects.

ARTEFACT SIZE

Weight was chosen as the best measure of artefact size. Because virtually all artefacts were made on one type of raw material (chert) which is obtained from closely related sources, weight is a reasonable indication of artefact mass.

The number, total weight and average weight of artefacts in each spit of P46 and Q46 is shown in Tables 7 and 8. A number of observations can be made from these simple statistics. Figure 6 illustrates the chronological changes in average artefact size for square P46. The trend is remarkably similar to that exhibited for discard rates. Spits 6-9 are clearly different from spits 1-5. _If_ these size differences reflect some technological changes between spits 5 and 6, and between spits 9 and 10, then the evidence may support hypothesis 4.

On the basis of this evidence from square P46, the artefactual sequence at Colless Creek Cave can be divided into three phases, which are summarised in Table 9. The three phases are as follows:

Phase 1 : 13,500 BP - Present

Throughout this period the range in average weight of artefacts is small, from 1.0 gm to 1.9 gm. The overall mean is only 1.4 gm. In the south of the continent all major changes in stone artefact sizes are said to take place within this period (eg. Mulvaney 1975; White and O'Connell 1982:120). At Colless Creek Cave, however, average artefact sizes appear to be comparatively constant throughout the Holocene and terminal Pleistocene.

Phase 2 : 15,900 BP - 13,500 BP

For this period the average artefact weight is markedly higher. Mean artefact weights are greater than 4 gms in all spits (ie.6-9).

Phase 3 : Before 15,900 BP

The earliest phase of occupation, that principally of Unit B, is characterized by small artefacts, smaller in fact than at any time during the last 16,000 years. The average weight of artefacts from all spits prior to 16,000 BP is 1.4 gms, but in most spits the average weight is less that 1 gm. Three possible reasons are offered as to why diminutive assemblages occurring prior to 16,000 to 17,000 BP have not been discussed by other researchers. These are:

1. Colless Creek Cave Unit B is older than most other assemblages discussed. This suggestion is supported by the geomorphic reconstruction (Magee and Hughes 1982). It is also relevant that recently discovered sites of great antiquity have contained small artefacts (Pearce and Barbetti 1981:174-175, 178).

Table 7. Number and weight of artefacts in each spit in P46

Spit	P46/1	P46/2	P46/3	P46/4	P46/5	P46/6&7	P46/8	P46/9	P46/10	P46/11	P46/12	P46/13	P46/14	P46/15	P46/16	P46/17	P46/18	P46/19	P46/20	P46/21	P46/22	P46/23	Total
Total # of Artefacts	217	451	247	243	101	128	231	170	553	274	64	72	74	40	31	22	22	16	15	15	21	13	3020
Total wt of Artefacts (gms)	418	452	356	348	178	588	1665	1118	1201	427	62	50	65	53	30	16	11	8	6	11	10	4	7077
Av. wt of Artefacts (gms)	1.9	1.0	1.4	1.4	1.8	4.6	7.2	6.6	2.2	1.6	1.0	0.7	0.1	1.3	1.0	0.7	0.5	0.5	0.4	0.7	0.5	0.3	2.3
Number of Flakes	195	416	225	231	93	113	169	131	483	253	56	70	69	31	28	17	21	13	14	13	17	11	2669
Wt of Flakes (gms)	205	321	221	187	157	374	755	598	676	246	36	46	52	20	23	6	10	3	5	6	8	3	3158
Av. wt of Flakes (gms)	1.1	0.8	1.0	0.8	1.7	3.3	4.5	4.6	1.4	1.0	0.6	0.7	0.8	0.7	0.8	0.4	0.5	0.3	0.4	0.5	0.5	0.3	1.5
Number of Cores	1	0	1	1	0	2	12	4	6	0	0	0	0	0	0	0	0	0	0	0	0	0	27
Wt of Cores (gms)	19	0	67	42	0	62	576	169	169	0	0	0	0	0	0	0	0	0	0	0	0	0	1104
Av. wt of Cores (gms)	19	0	67	42	0	31	48	42	28	0	0	0	0	0	0	0	0	0	0	0	0	0	40.8
Number of Retouched Flakes	4	8	5	0	1	1	3	5	11	4	0	0	0	2	0	0	0	0	0	0	0	0	44
Wt of Retouched Flakes (gms)	96	45	57	0	0	6	22	78	105	75	0	0	0	18	0	0	0	0	0	0	0	0	502
Av. wt of Retouched Flakes (gms)	24	5.6	11.4	0	0	6	7.3	15.6	9.6	18.8	0	0	0	9	0	0	0	0	0	0	0	0	11.4
Number of Flaked Pieces	17	27	16	11	7	12	47	30	53	16	8	2	5	7	3	5	1	3	1	2	4	2	279
Wt of Flaked Pieces (gms)	98	86	11	119	21	146	312	273	251	105	26	4	13	15	7	10	1	5	1	5	2	1	1512
Av. wt of Flaked Pieces (gms)	5.8	3.2	0.7	10.8	3.0	12.2	6.6	9.1	4.7	6.6	3.3	0.5	2.6	2.1	2.3	2.0	1.0	1.7	1.0	2.5	0.5	0.5	5.4
Number of Non-diagnostic	179	439	287	251	91	132	394	133	697	814	165	196	248	82	83	64	30	43	61	46	33	16	3824
Wt of Non-diagnostic (gms)	165	280	99	81	28	354	1197	811	661	549	76	58	94	24	22	13	23	7	10	9	5	4	3939
Av. wt of Non-diagnostic (gms)	0.9	0.6	0.4	0.3	0.3	2.7	3.0	6.1	1.0	0.7	0.5	0.3	0.4	0.3	0.3	0.2	0.6	0.2	0.2	0.2	0.2	0.3	1.0

Table 8. Number and weight of artefacts in each spit in Q46

Spit	Q46/1	Q46/2	Q46/3	Q46/4	Q46/5	Q46/6	Q46/7	Q46/8	Q46/9	Q46/10	Q46/11	Q46/12	Q46/13	Q46/14	Q46/15&16	Q46/17	Q46/18	Q46/19	Q46/20	Q46/21	Total
Total # of Artefacts	71	46	26	16	19	17	10	4	3	1	3	6	5	3	7	7	6	1	4	14	269
Total wt of Artefacts (gms)	129	32	25	8	5	6	5	< 1	< 1	< 1	< 1	1	1	< 1	< 2	1	1	< 1	< 1	3	221
Av. wt of Artefacts (gms)	1.8	0.7	1.0	0.5	0.3	0.4	0.5	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.8
Number of Flakes	61	38	21	13	19	17	9	4	3	1	3	6	5	3	7	7	6	1	4	14	242
Wt of Flakes (gms)	63	29	11	5	5	6	3	< 1	< 1	< 1	< 1	1	1	< 1	< 2	1	1	< 1	< 1	3	133
Av. wt of Flakes (gms)	1.0	0.8	0.5	0.4	0.3	0.4	0.3	0.1	0.1	0.2	0.1	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.2	0.6
Number of Cores	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Wt of Cores (gms)	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Av. wt of Cores (gms)	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
Number of Retouched Flakes	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Wt of Retouched Flakes (gms)	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	44
Av. wt of Retouched Flakes (gms)	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
Number of Flaked Pieces	7	8	5	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	24
Wt of Flaked Pieces (gms)	11	3	14	3	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	33
Av. wt of Flaked Pieces (gms)	1.6	0.4	2.8	1.0	0	0	2.0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.4
Number of Non-diagnostic	106	81	63	30	55	22	26	19	8	13	16	16	13	30	38	22	42	16	21	13	650
Wt of Non-diagnostic (gms)	41	82	13	8	23	6	4	3	1	1	2	1	2	3	5	3	6	2	1	1	208
Av. wt of Non-diagnostic (gms)	0.4	1.0	0.2	0.3	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3

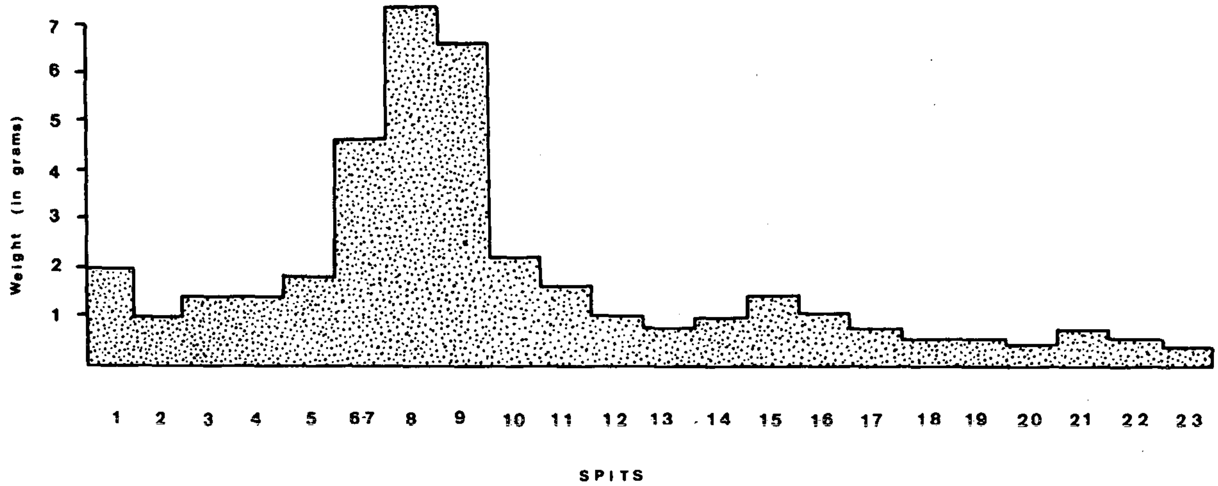

Figure 6. Average weight of artefacts in P46

Table 9. Chronological changes in artefact weight in P46 and Q46

	Upper 5 spits (<13k)	Spits 6-9 (13-16k)	Lower spits (>17k)
Number of artefacts	1259	529	1232
Weight of artefacts	1752g	3371g	1810.5g
Av. wt of artefacts	1.4g	6.4g	1.4g

2. Alternatively, the stone-using behaviour which occurred at Colless Creek before 16,000 BP was different from the behaviour in other sites of the same age. There is insufficient published data from any Pleistocene site (including Colless Creek Cave) to discuss this proposition.

3. The description of Pleistocene assemblages is inadequate for the purposes of this comparison. To some extent this is true since only one report makes any effort to describe fully flake size and morphology (cf. Wright 1971).

Changes in the proportion of artefact types are not responsible for the data illustrated in Figure 6. The same trend (small, large, small) is found if the average weight of flakes or flaked pieces is plotted (see Tables 7-8). Although the average weight of cores and retouched flakes varies widely between spits, no temporal change is evident. Figure 7 gives the relative size of retouched flakes in comparison to unretouched flakes for each spit. Between 13500 and 16000 BP retouched flakes were only twice the average weight of flakes whereas at other times retouched flakes were much larger in comparison to the sample of flakes from which they were selected. This pattern results from the greatly varying size of unretouched flakes and the relatively constant size of retouched flakes.

ARTEFACT TYPES

Table 10 lists, for each spit in P46, the proportions of the four artefact types defined earlier. Like most assemblages each spit is dominated by unretouched flakes. In Unit A (spits 1-10) cores and retouched flakes are present in very low percentages. Cores are absent in Unit B and retouched flakes are virtually absent. Flaked Pieces are more common in the lower parts of the deposit, perhaps the result of changes in raw material selection, different knapping techniques, or even increasing degradation of the material with depth. Another noticeable trend is that in spits 6-10 cores and retouched flakes are more common than in any other part of the sequence.

Another way of viewing these changing proportions of artefact types is to examine for each spit the number of flakes per core. Figure 8 illustrates this data for P46. No spits below P46/11 have cores and so the calculation cannot be made for Unit B. Spits 6-10 have relatively low numbers of flakes per core.

Until technological studies are finished it is impossible to accurately estimate the length of reduction processes (ie. the number of flakes removed from each core). Nevertheless, the high numbers of flakes in spits 1-5 were almost certainly produced by more cores than are found in P46. Perhaps this means that between 13,500 and 17,000 BP the discard location of large objects such as cores was in the area at the rear of the cave, whereas at other times the larger objects were thrown elsewhere. Alternatively, the differences might reflect greater curation and/or longer reduction processes before 17,000 BP and after 13,500 BP. Either of these explanations would be consistent with the information on artefact sizes already presented.

The observation made previously, that flaked pieces are proportionately more common in lower spits, can be further examined by reviewing frequencies of artefact types. Figure 9 illustrates the changing proportion of artefacts which were able to be identified as flakes, cores

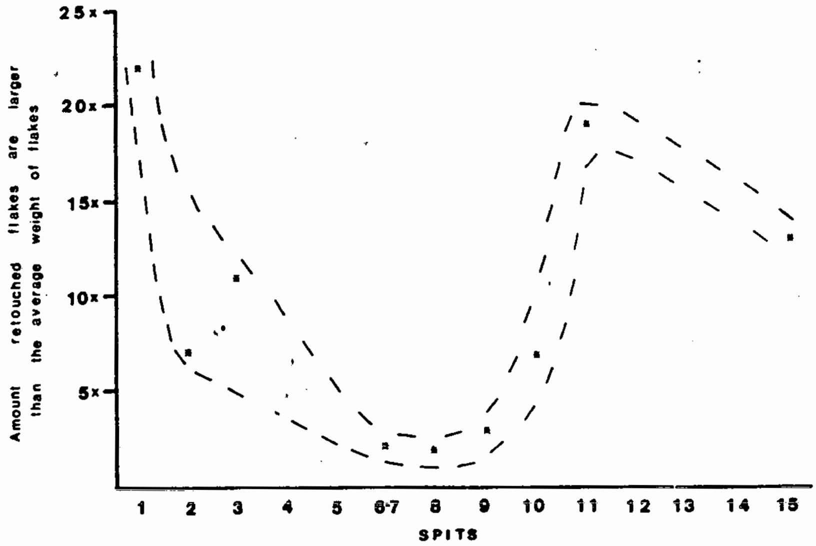

Figure 7. The average weight of retouched flakes in comparison to the average weight of flakes in P46

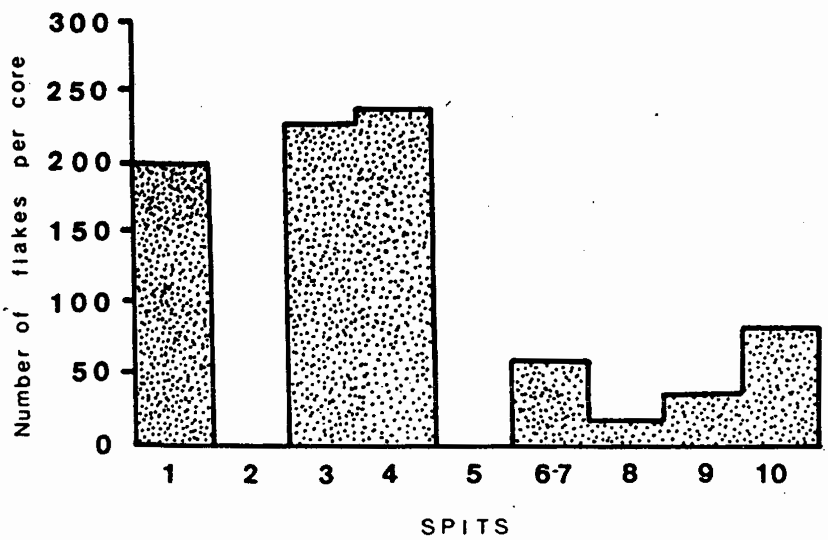

Figure 8. Number of flakes per core in P46

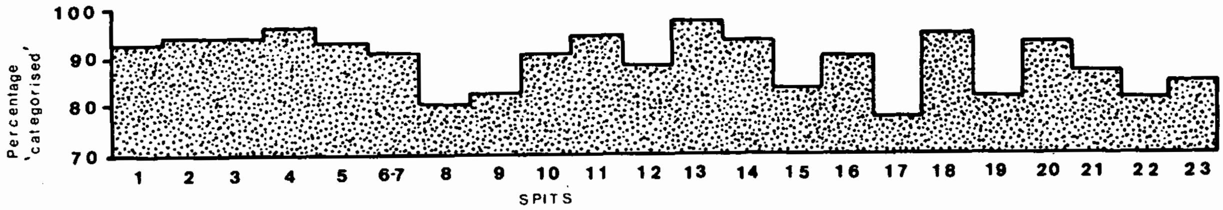

Figure 9. Percentage of categorised artefacts in each spit

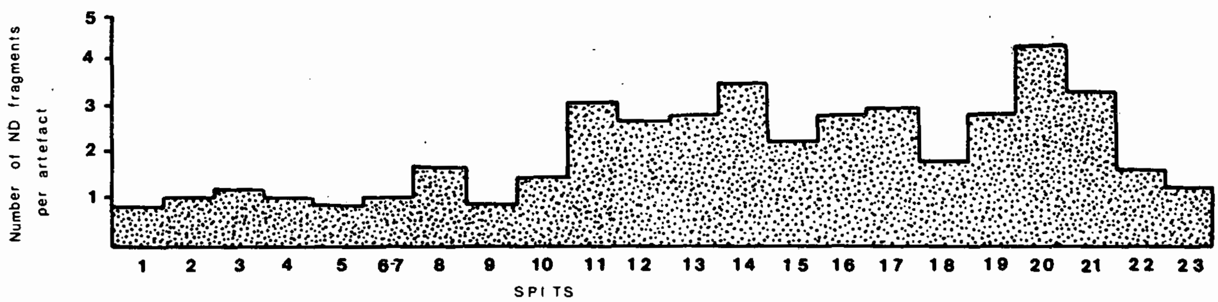

Figure 10. Number of ND fragments per artefact in each spit

Table 10. Percentage of artefact types in each spit of P46

SPIT	1	2	3	4	5	6-7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
FLAKES	90	92	91	95	92	88	73	77	87	92	88	97	93	78	90	77	96	81	93	87	81	85
CORES	0.5	0	0.5	0.5	0	2	5	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
RETOUCHED FL	2	2	2	0	1	1	1	3	2	2	0	0	0	5	0	0	0	0	0	0	0	0
FLAKED PIECE	8	6	7	5	7	9	20	18	10	6	13	3	7	18	10	23	5	19	7	13	19	15

or retouched flakes. The proportion of these `categorised' artefacts in each spit changes subtly from between 90-100% in the top of the deposit to between 80-90% in the lowest spits in P46. Thus, the proportion of flaked pieces in the assemblage increases with depth. Figure 9 also indicates that over the last 14,000 years the percentage of categorised artefacts has been consistently high, whereas in earlier levels the percentage varies much more wildly.

Figure 10 shows that ND (Non-diagnostic) fragments also become more frequent with depth compared with artefacts. That is, as artefact density declines with depth they are to some extent replaced by ND fragments. The question therefore arises, are ND fragments a result of knapping behaviours? If so is the proportional increase in ND and Flaked Pieces with depth a result of post-depositional degradation, or of changes in raw materials and/or knapping techniques? Limited aspects of this question are discussed below.

THE QUESTION OF NON-DIAGNOSTIC FRAGMENTS

Earlier I raised the question of whether ND fragments were the product of knapping or natural rock fragmentation. The morphology of the stones in this category is of no help in answering this question. ND pieces are fragments of chert which had split along incipient fracture planes. Thus although they could be a biproduct of stone working (eg. a shattered core) there is no clear morphological evidence to indicate that this is the case.

Other lines of evidence may shed light on the origins of these fragments. By comparing the chronological changes in ND pieces to the chronological changes in artefacts it is possible to infer that the two trends are related. Figure 11 compares artefact discard rate to the accumulation rate of ND fragments. The trends are extremely similar. Both rates increase greatly in the period 13,500 to 17,000 BP. Taken by itself this evidence is inconclusive because the rate of artefact accumulation and the rate of sediment accumulation change synchronously. Thus, if ND fragments were the result of natural fragmentation, and if they were being washed into the cave from the plateau above, their frequency might be adequately explained by reference to the rate of sediment input and accumulation. The large size of these fragments, however, argues against the suggestion that they were washed into the cave with the finer sediments.

To test this proposition further I compared chronological changes in average artefact weight to changes in the average weight of ND fragments in each spit (Figure 12). Again the trends are very similar. When artefact size increases in the 13,500-17,000 BP period so does the size of ND fragments. Although further tests would be desirable, this seems good circumstantial evidence that at least a large proportion of ND fragments result from activities related to human occupation of the shelter, perhaps artefact manufacture, or possibly other humanly induced processes (eg. increased use of fire at the site).

CHANGES IN RAW MATERIALS

The analysis of stone types presented here is at the simplest of all levels: a two-fold division between local and non-local materials. The vast majority of artefacts in P46 are made on local cherts. Only six

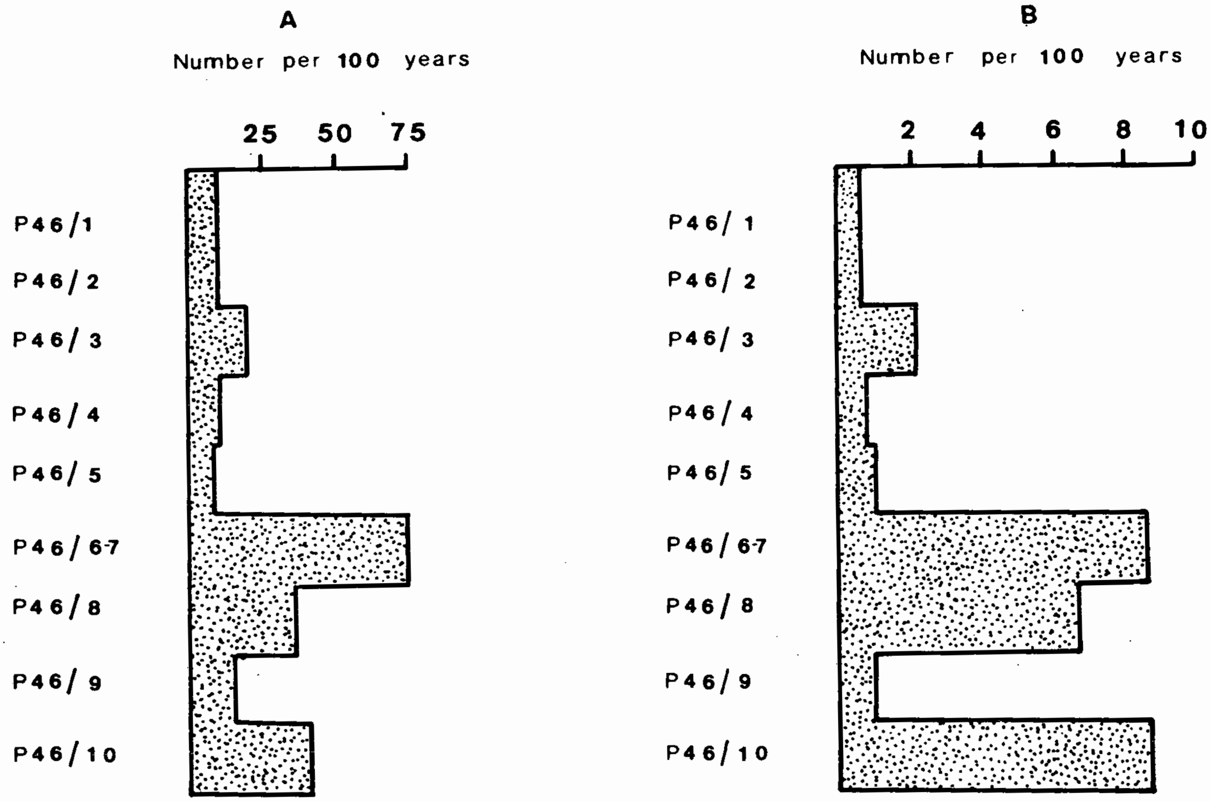

Figure 11. a) The discard rate of artefacts in P46
b) The accumulation rate of ND fragments in P46

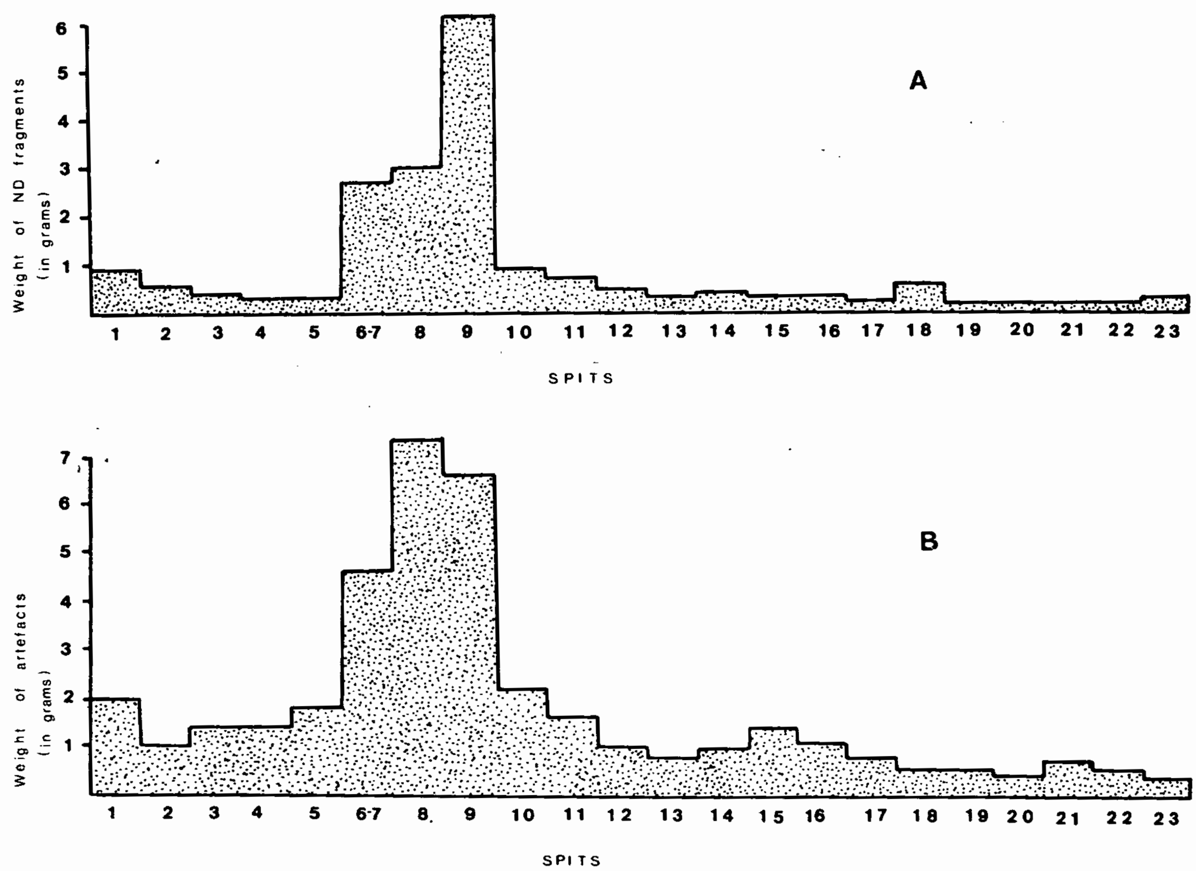

Figure 12. a) Average weight of ND fragments in each P46 spit
b) Average weight of artefacts in each P46 spit

spits contain non-local raw materials. Quartzite artefacts occur in spits 1, 3, 11 and 22, quartz occurs in P46/14, and one greywacke flake was found in P46/4. In addition to these non-local materials there are a number of artefacts made on dolomite, a local non-chert material which were identified only in spits 3, 4, 5 and 7.

The recognition of non-local materials was difficult in Unit B as all the artefacts were heavily patinated and had an off-white colour, thus eliminating colour as a useful guide. Patination and encrustations also tended to obscure any grains which might differentiate the rock from the local chert. Thus there may be more non-local materials in the lower spits of P46 than have been identified.

The rarity of non-local stone probably relates to the distance from the sources of those materials. Quartzites and greywackes have been transported southward at least 30 km. The existence of these non-local resources in the deposit therefore reflects access to, and at least occasional exploitation of, a territory wider than merely the gorge and adjacent plateau. I have argued above that the P46 sequence can be divided into three phases, from the present until 13500 BP (spits 1-5), 13500 to 17000 BP (spits 6-10), and before 17000 BP (spits 11-23). Both the oldest and youngest of these contains non-local stone materials, but the middle phase contains only local materials. Is this absence of \`exotics' between 13,500 BP and 17,000 BP representative of the site? If so, does that absence represent a reduction in the size of the territory exploited by groups using the cave? Focussing on the resources of the gorge could indicate population pressure during this period of aridity (hypothesis 6). Alternatively the absence of exotic stone materials may reflect technological changes (eg. reduced curation, change in size of available raw material), or changes in the location and scheduling of activities (ie. no longer go near those quarries). Future research will attempt to eliminate the less likely of these alternatives.

USE OF FIRE IN THE REAR OF THE CAVE

Earlier in the paper I noted that any attempt to equate artefact discard rates with \`intensity of site usage' must be supported by synchronous trends in other aspects of human behaviour, such as discard of food remains, trampling of the cave floor or production of parietal art. One type of prehistoric activity which can be deduced from an analysis of chert artefacts is the lighting of fires on the cave floor. A number of studies have been conducted on the effects of heat upon rocks (eg. Purdy 1974, 1975; Purdy and Brooks 1971; Faulkner 1972; Mandeville 1973; Mandeville and Flenniken 1974; Flenniken and Garrison 1975) and have established the interpretive principles with which to identify products of heating. Potlids occur when stone is rapidly raised to high temperatures. Differential expansion of the rock and ultimately potlid fractures result (Purdy 1975:135-136). Potlids can therefore be taken to indicate \`cooking' of the stone, probably when fires/hearths are placed on top of the artefacts lying on the floor of the cave.

The number of chert potlids per 100 years was calculated (Figure 13a). The trend over time is remarkably similar to that already described for artefacts (Figure 13b). One conclusion that might be drawn is that between 13,500 and 17,000 BP the use of fire in the rear of the shelter was far more intense than at any later time. The increased number of potlids during the earlier period, however, is probably a function of the increased stone material on the cave floor which might

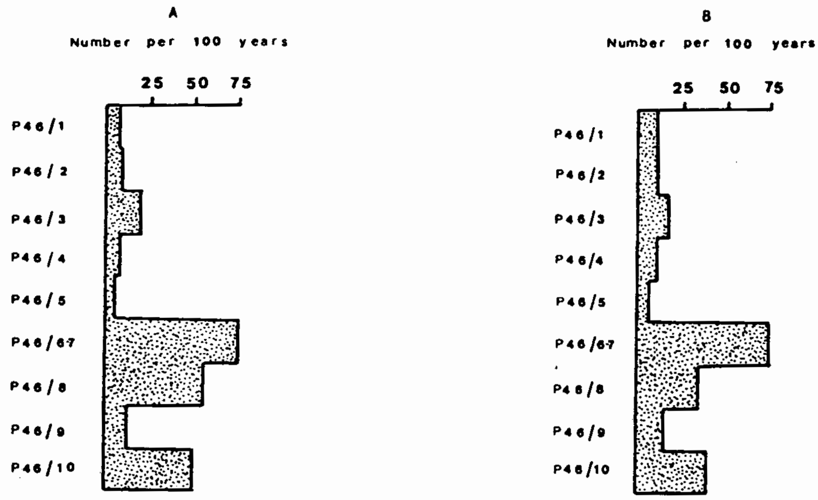

Figure 13. a) Accumulation rate of Potlids in P46
b) Discard rate of artefacts in P46

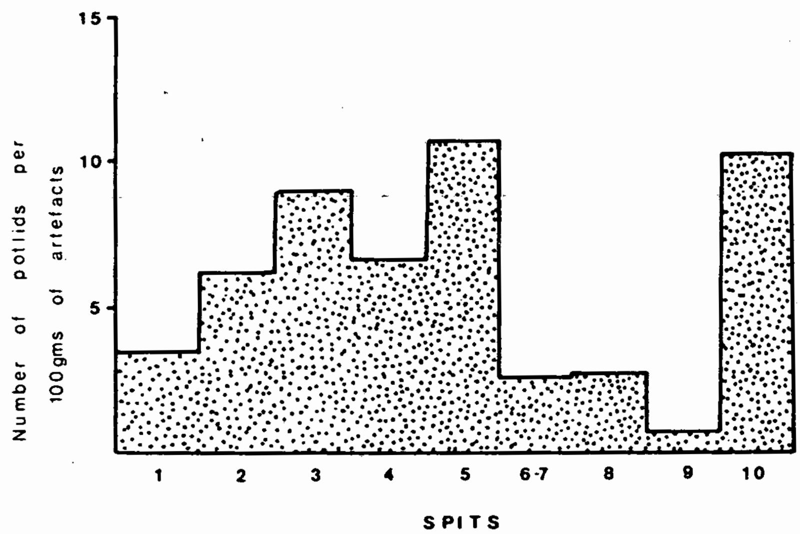

Figure 14. The number of potlids per 100g of artefacts in each spit in P46

be subjected to fire at that time. Assuming that this is the case and that for a given amount of burning the density of potlids is proportional to the amount of stone material directly exposed to excessive heat, then one indication of the amount of burning will be the ratio of potlids to artefacts. Figure 14 shows the number of potlids per 100 grams of artefacts for each spit in Unit A of P46. The pattern is a complex one with a variable but decreasing proportion of potlids from 13,500 until the present. Prior to this, from 13,500 until about 16,000 BP, potlids were uncommon in comparison to artefacts. Below this spit 10 again shows a high amount of potlids. The higher number of potlids in spit 10 is probably related to the prolonged exposure of artefacts in the lag which is incorporated in the basal portions of the spit. From this perspective it is clear that as the artefact discard rate increases in the 13,500-17,000 year BP period the amount of burning declines, although the products of each burning event are more numerous.

CONCLUSION

This preliminary analysis has initiated several lines of enquiry, most of which are not brought to fruition here. These themes can be seen by discussing some of the implications the data has for Australian prehistory.

Much of this paper has concerned changes in artefact discard rates identified in P46, a 50 x 50 cm square at the rear of the shelter. Seven different explanations are offered for the higher discard rates between 13,500 and 17,000 years BP. Four of these can be tested using information already obtained. Methodological error can be eliminated by re-recording artefacts and using different approaches to the same question. Post-depositional processes will be better defined after further analyses of sediment samples and stone artefacts. Two other possibilities, spatial change in discard areas and technological change, can be examined when the artefacts from the twelve squares dug in 1982 are analysed in detail.

I have argued that until these four hypotheses are rejected it will not be profitable to investigate possible changes in prehistoric population size or distribution. Even if these first four explanations can be adequately rejected, however, the testing of models of 'simple functional change' (ie. hypotheses 5, 6, and 7) will be difficult. Before the latter three can be tested more sites of the same age would have to be found in the region.

The examination of these changes in artefact discard rates should be of interest to those studying Late Pleistocene adaptations in inland Australia. The major model of Pleistocene occupation discussed today was proposed by Bowdler (1977) who argued that "coastally adapted" people arrived in Australia prior to 30,000 years BP and continued to inhabit only the coastline and major river systems until they were pushed inland at the end of the Pleistocene by marine transgressions. She predicts that if this model is correct,

> We would expect to find sites older than say 12,000 BP only near Pleistocene coastlines, on major river systems or lakes connected to the latter. Sites showing successful desert or montane adaptations will only be of the order of 12,000 years old (Bowdler 1977:234).

This hypothesis is contested by Bowler (1976), Jones (1979; Jones and Bowler 1981) and Horton (1981). They suggest that much of the continent was occupied prior to about 25,000 years BP, and that only at the onset of marked aridity from 22,000 to almost 12,000 did people retreat to the coast.

Although these models suggest very different patterns of colonisation they all postulate that arid Australia was unoccupied from about 22,000 until well after 15,000 BP. White and O'Connell (1982:223) have pointed out that available data do not support these models. Late Pleistocene dates are reported from Mt. Newman (Maynard 1980) and Koonalda Cave (Wright 1971), sites which were in landscapes undoubtedly at least as arid in that time as they are today. In presently semi-arid landscapes, sites such as Kenniff Cave (Mulvaney and Joyce 1965) were also occupied at times when conditions would have been far more arid. Colless Creek Cave provides another, even stronger, argument against wholesale abandonments of at least the arid margins of the interior.

It was soon evident following the 1979 field season that the occupation history of this site extended back through the Pleistocene arid phase to a period before 20,000 BP when conditions were apparently wetter than at present. The stratigraphic, archaeological and dating evidence gave no indication of a cessation of cave use during the height of the arid phase from about 18,000 to 16,000 BP. At that time Colless Creek was near the centre of the palaeo-continent and the nearest coastline, the northeast coast of Queensland, was about 900 km away. Using these data Hughes (Hughes and Lampert 1980:53-54) suggested that Colless Creek Cave was indeed an exception to current colonisation models. The stone artefact analyses have refined this picture; in fact it is possible that use of the cave was most intense at the height of the arid phase. Certainly the rate of artefact discard at the rear of the shelter was greatest from 13,500 to 17,000 BP, and if the ND fragments relate to human activities, as hypothesised above, their increase in the same period reinforces this suggestion. The use of fire appears to have decreased during this period.

The evidence from Colless Creek does not support any of the colonisation models which postulate the abandonment of arid zones at the height of the arid phase. While the economic focus of the occupants of the cave would certainly have been on the resources of the streams and associated gallery forests, these would have been insufficient to ensure the long term survival of the local population, and there must have been a considerable adjustment by these people to the arid landscape in which they lived.

The coastal orientation of known archaeological sites may therefore reflect the fieldwork habits of prehistorians rather than the adaptive strategies of Pleistocene populations (cf. Bowdler 1982). Since archaeologists seem to prefer the coast we must be careful that our research bias does not determine our interpretations of Australian prehistory. Further fieldwork in inland Australia must be a priority for the 1980's; and dating the initial occupation of various inland areas will be only the first step towards defining the intensity, efficiency and pattern of Aboriginal resource use. Colless Creek Cave itself does appear to contain sufficient information to test models relating human behaviour to long term environmental change in inland Australia.

This preliminary information from Colless Creek Cave bears upon another major model of Australian archaeology, that the Pleistocene is a period of immense technological conservatism and uniformity, with stone assemblages characterised by large implements (eg. Howells 1973:127; Bowdler 1977:233; White and O'Connell 1982:65-67, 105; Flood 1983:48-50, 97; Mulvaney 1975:172-180). This vision of Australian stone working is based solely on descriptions of artefact size and implement typology. It is quite possible that the supposed uniformity of Pleistocene assemblages results more from the generalised level of typological analyses than from any real conservatism in the technologies. One has only to compare a Kartan industry to Pleistocene artefacts at Lake Mungo or to this assemblage at Colless Creek Cave to see something of the wide range of size and morphology that existed across the continent. It is yet to be demonstrated that the chronological arrangement of assemblages into an assumed "sens de l'evolution typologique" is an adequate explanation of this spatial variation (cf. Lorblanchet and Jones 1979).

Through time the stone artefacts in P46 show continuity and a complex set of changes. The average size of discarded retouched flakes does not change through time. Yet there are major changes in unretouched flake size. When average artefact weights are examined they correlate very closely with artefact discard rates. From the present back until 13,500 BP artefacts average 1.5 gms. From 13,500 until 16-17,000 artefacts were more than three times larger than this. Prior to 17,000 BP the assemblage consists entirely of very small flakes (less than 1 gm on average). Do these changes reflect different types of prehistoric stone working? This question cannot be resolved until the technological changes in the cave are assessed. Certainly there are major changes in artefact size throughout the Pleistocene, no matter what the explanation.

In writing this paper I have reversed usual archaeological practices. "Implements", that is retouched flakes and cores of particular shapes, are usually described in detail, while flakes are ignored. By taking a contrary approach, I find that Colless Creek Cave yields information which conflicts with two aspects of the generally accepted "direction of typological evolution" as described for Australia. Firstly, over the last 20 millennia size changes occur in the "debitage" but not in the retouched artefacts. Secondly, the oldest artefacts are the smallest artefacts, not the largest as would have been predicted by previous models and assumptions. It might be noted that part of this conflict arises because descriptions in the literature deal only with "implements" whereas I am dealing with the sizes of all recognisable artefacts. This does not negate my observations, however, and it is likely that at Colless Creek Cave we are observing a very different prehistory from than which has been described elsewhere on the continent. Part of my future research in the area will be to define the nature of these differences.

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