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1980
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Palaeont. afr., **23**, 127–151 (1980)

FURTHER OBSERVATIONS ON THE NATURE AND PROVENANCE OF THE LITHIC ARTEFACTS FROM THE MAKAPANSGAT LIMEWORKS

by

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ABSTRACT

A selected sample of 45 lithic specimens from the Makapansgat Limeworks site, considered to be artefacts showing acceptable evidence of having been deliberately flaked or utilized, are illustrated, described and discussed.

The sample comprises a single stalactite fragment from the grey breccia (Member 3), 2 chert pieces from the pink breccia (Member 4), 24 chert and dolomite pieces and 7 of quartzite from the Phase II breccia (Member 5), 2 pieces — one of quartzite and one of vein quartz — of doubtful provenance, and 9 chert pieces from the overburden.

Recognition of deliberate flaking of the native rocks (dolomite and chert) is often difficult because of the feebly conchoidal fracture often produced, and the susceptibility of the dolomite to weathering. Experimentally produced fracturing in chert demonstrates that such artificial fractures differ clearly from those produced by the normal break-up of this rock. The repeated appearance of two crude tool forms is discussed.

The method adopted here in the analysis of the small-scale damage on working edges of suspected artefacts is considered to demonstrate independently their authenticity or otherwise. This procedure, whereby eight perceptible attributes are differentiated and evaluated, should prove useful in augmenting other criteria employed in the examination of all primitive materials suspected to be cultural.

The Limeworks artefacts are also broadly discussed with reference to the Limeworks stratigraphy as originally described by Brain (1958) and as recently proposed by Partridge (1979).

The derivation of suspected artefacts in the overburden and in Member 5 are discussed. It is concluded that the great majority of those in the overburden were derived by decalcification of the underlying breccias, while those in the pebble bands of Member 5 appear to be primarily of intracavernous origin.

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INTRODUCTION

The Makapansgat Limeworks australopithecine site (fig. 1) covers an area of slightly more than 1,5 hectares on a rocky, tree and shrub covered dolomite hillside facing north-west. The deposit represents the basal remnant of a vast dolomite cavern together with its calcified infill; almost the entire cavern roof and the upper part of the infill have been removed by erosion. The remaining consolidated infill ranges up to 25 m in depth, its weathered surface sometimes outcropping through a thin (up to 50 cm-thick) earth and rubble overburden. The cavern deposit was almost completely encircled by the excavations of limeworkers who dumped an estimated 200 000 tons of waste on the hillside near their excavations between 1912 and 1935. While the miners' quarries have provided valuable sections of virtually the entire deposit, much of the cavern infill was not mined and still remains unexplored.

Professor R.A. Dart directed the first active period of scientific investigation at the Makapansgat Limeworks from 1947 onwards, concentrating on hand sorting of the limeworkers' dumps which contained thousands of tons of fragmented, potentially fossil bearing cavern breccias. Although out of direct stratigraphic context, the individual breccia blocks could often be assigned

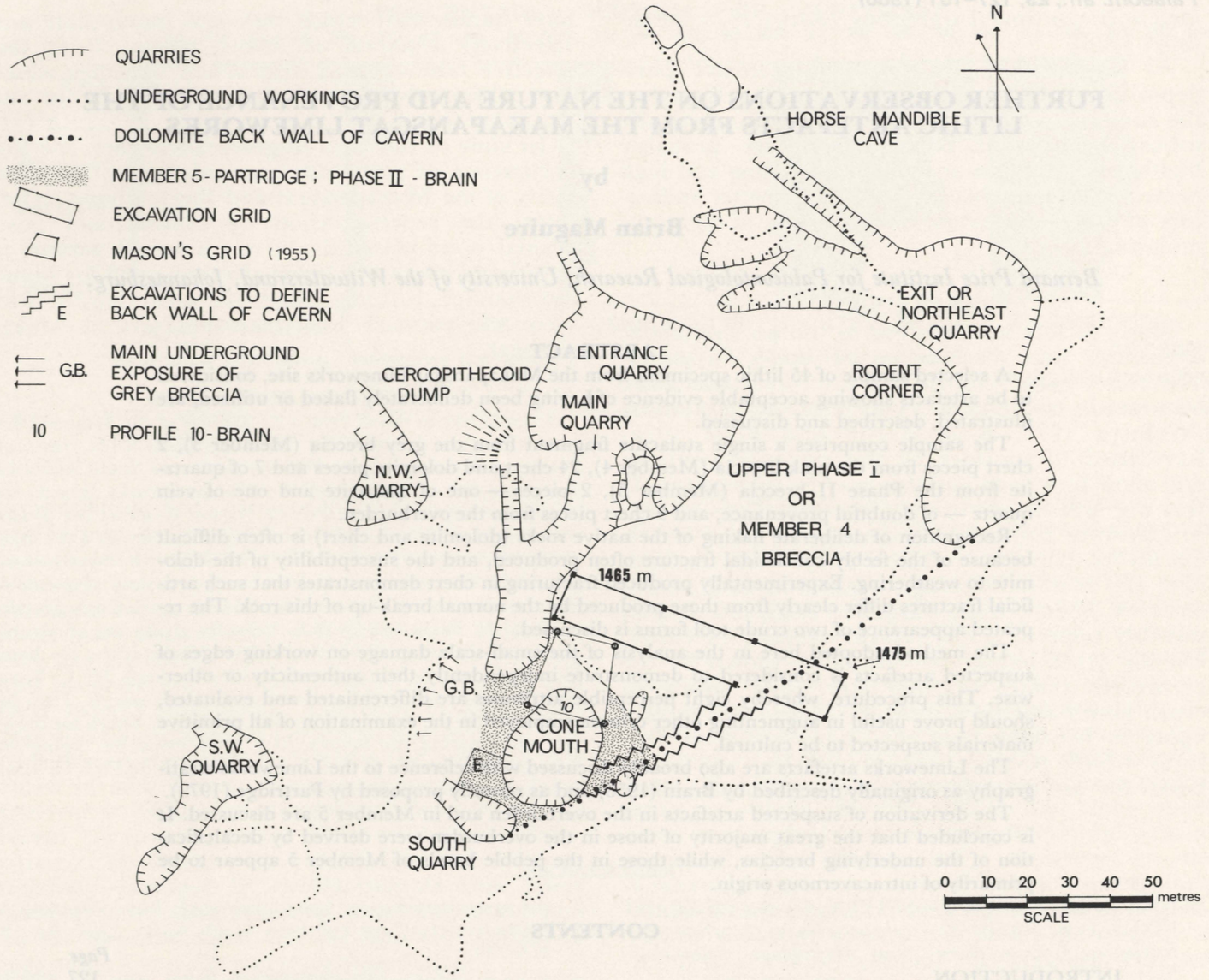


Figure 1. Map of the Makapansgat Limeworks site showing some of the major features.

with considerable certainty to one of the four main breccial horizons then recognised in the Limeworks deposit (Brain 1958). The remarkably abundant and widely varied faunal remains, including *Australopithecus africanus,* have come almost exclusively from this dumped waste as have associated cultural materials in bone and to a lesser extent of stone.

The writer, under Dart's direction, conducted investigations at Makapansgat from 1960–1966, approximately half of this period being devoted to active excavation, collection and observations at the site and the remainder to laboratory work at the Bernard Price Institute for Palaeontological Research.

Two preliminary accounts of the Limeworks lithic artefacts dealt with some 2 000 chert pieces and 1 000 quartzite pieces excavated from the unconsolidated overburden (Maguire 1965, 1968). A variety of evidence suggested that the artefactual component of the overburden was derived primarily from decalcification of the underlying cavern infill. Subsequent work has amply reinforced these earlier conclusions, and some preliminary results are discussed in this paper.

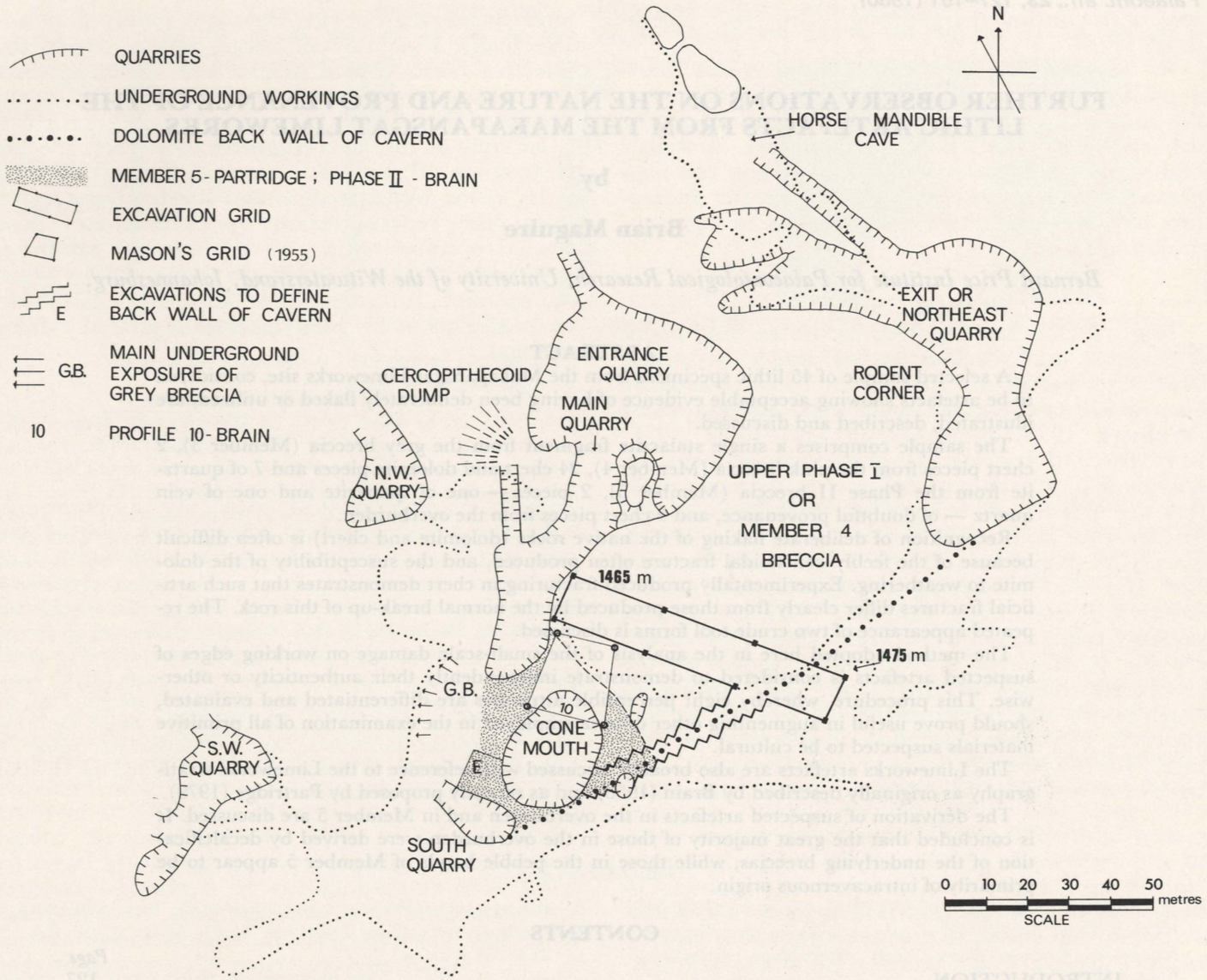
STRATIGRAPHY AND ASPECTS OF DEPOSITIONAL HISTORY

Figure 2 illustrates the stratigraphy of the Limeworks and is based on Brain (1958) and Partridge (1979). The composite nature of this stratigraphic column is stressed, for at no known point in the deposit is the entire vertical sequence represented. Furthermore, the maximum thickness of some of these units may greatly exceed the estimates illustrated in the profile (fig. 2).

Summary of Stratigraphy (fig. 2)

Member 1

Up to 15 m of travertine, sometimes banded and contaminated, formed the limestone floor of the ancient cavern. Fossil bones may occur in the reddish brown and white banded travertines. Many of these bones are articulated, unlike the vastly



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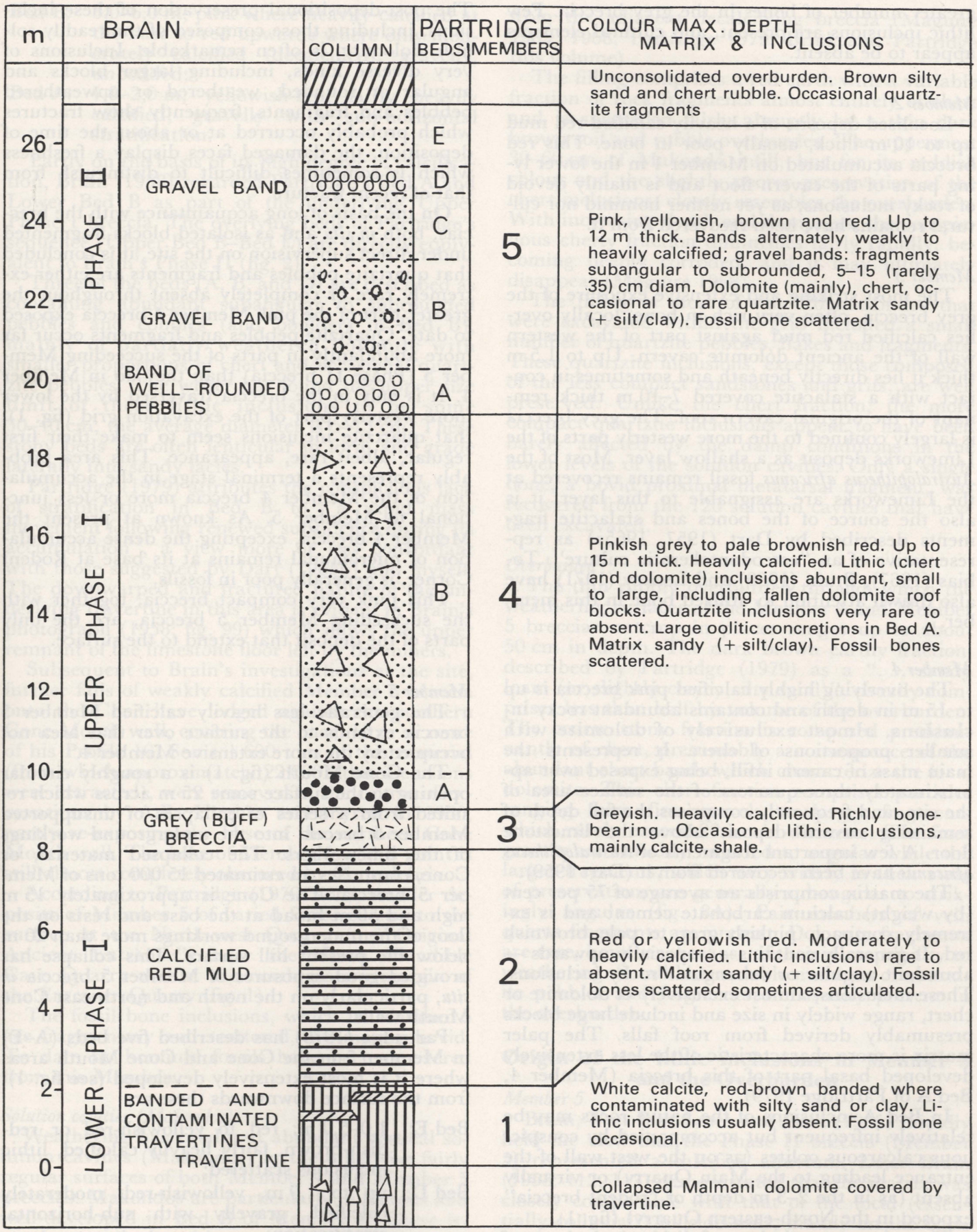

Figure 2. Stratigraphy of the Limeworks deposit (after Brain 1958 and Partridge 1979).

greater number of bones in the grey breccia. Few lithic inclusions are present, and cultural elements appear to be absent.

Member 2

Localised deposits of a heavily calcified red mud up to 10 m thick, usually poor in bone. This red breccia accumulated on Member 1 in the lower lying parts of the cavern floor and is mainly devoid of rocky inclusions; as yet neither hominid nor cultural remains have been recovered from it.

Member 3

The most striking and extensive exposure of the grey breccia, often very rich in bone, locally overlies calcified red mud against part of the western wall of the ancient dolomite cavern. Up to 1,5 m thick it lies directly beneath and sometimes in contact with a stalactite covered 7–10 m thick remnant of the original cavern roof. The grey breccia is largely confined to the more westerly parts of the Limeworks deposit as a shallow layer. Most of the *Australopithecus africanus* fossil remains recovered at the Limeworks are assignable to this layer; it is also the source of the bones and stalactite fragments described by Dart (1957, 1965a) as representative of an "osteodontokeratic culture". Tobias (1967), Brain (1969) and Leakey (1971) have also drawn attention to utilized bone in this member.

Member 4

The overlying highly calcified pink breccia is up to 15 m in depth and contains abundant rocky inclusions, almost exclusively of dolomite with smaller proportions of chert. It represents the main mass of cavern infill, being exposed over approximately three-quarters of the surface area of the site, and frequently comprises the full depth of remaining cavern deposit above the limestone floor. A few important fragments of *Australopithecus africanus* have been recovered from it (Dart 1959).

The matrix comprises an average of 75 per cent (by weight) calcium carbonate cement and is extremely compact, pinkish grey to pale brownish red. It generally contains — especially upwards — abundant angular or subangular rocky inclusions. These inclusions, almost exclusively of dolomite or chert, range widely in size and include large blocks presumably derived from roof falls. The paler matrix is more characteristic of the less extensively developed basal part of this breccia (Member 4, Bed A of Partridge 1979).

In Bed A inclusions of the native rocks may be relatively infrequent but accompanied by conspicuous calcareous oolites (as on the west wall of the entrance leading to the Main Quarry) or virtually absent (as in the 2–3 m depth of "rodent breccia" exposed in the North-eastern Quarry) (fig. 1).

The close association of lithic inclusions of varied morphology and varying degrees of weathering is a common feature throughout Member 4. The post-depositional preservation of these inclusions, including those composed of the readily soluble dolomite, is often remarkable. Inclusions of very diverse kinds, including larger blocks and angular or rounded, weathered or unweathered pebbles and fragments, frequently show fractures which probably occurred at or about the time of deposition; the damaged faces display a freshness which is sometimes difficult to distinguish from that of recent fracture.

On the basis of long acquaintance with the breccias, both *in situ* and as isolated blocks fragmented under direct supervision on the site, it is concluded that quartzite pebbles and fragments are either extremely rare or completely absent throughout the greater part of the pink Member 4 breccia exposed to date. Quartzite pebbles and fragments occur far more abundantly in parts of the succeeding Member 5 (Phase II breccia) than they do in Member 4. It is only in the breccia traversed by the lower more westerly part of the excavation grid (fig. 1), that quartzite inclusions seem to make their first regular, albeit rare, appearance. This area probably represents a terminal stage in the accumulation of the Member 4 breccia more or less junctional to Member 5. As known at present the Member 4 breccia, excepting the dense accumulation of microfaunal remains at its base at Rodent Corner, is generally poor in fossils.

This pink very compact breccia, together with the succeeding Member 5 breccia, are the only parts of the deposit that extend to the surface.

Member 5

The generally less heavily calcified Member 5 breccia extends to the surface over that area not occupied by the more extensive Member 4.

The Cone Mouth (fig. 1) is a roughly circular opening to the surface some 25 m across which resulted from a series of collapses of unsupported Member 5 breccia into the underground workings of the limeworkers. The collapsed material, or Cone, comprises an estimated 15 000 tons of Member 5 breccia. The Cone is approximately 15 m high and 50 m broad at the base and rests on the floor of the underground workings more than 20 m below the present hill surface. This collapse has provided good exposures of Member 5 breccia *in situ*, particularly on the north and north-east Cone Mouth walls.

Partridge (1979) has described five beds (A–E) in Member 5 in the Cone and Cone Mouth areas where it is most extensively developed (see fig. 1); from the surface downwards these are:

Bed E: 1,0–5,0 m: red to yellowish-red or reddish-brown, fairly heavily calcified, lithic inclusions scattered;

Bed D: up to 1,0 m, yellowish-red, moderately calcified, gravelly with sub-horizontal stratification;

Bed C: 2,0–10,0 m, red, weakly calcified, lithic inclusions rare;

Bed B: 3,0–6,0 m, pink where heavily calcified at the base to red upwards where only moderately calcified (decalcified), gravelly, unbedded;

Bed A: 1,0–2,0 m, yellowish-red, fairly heavily calcified, gravelly with sub-horizontal stratification.

Partly on the basis of its high degree of calcification, Brain (1958) regarded Partridge's Bed A and Lower Bed B as part of the underlying Upper Phase 1 breccia. The overlying beds of Partridge's sequence (Upper Bed B–Bed E) are directly equivalent to Brain's Phase II (fig. 2).

Three of the beds (A, B, and D) are described as containing abundant subangular to subrounded pebbles and cobbles (and boulders in Bed B), mainly of partially weathered dolomite with smaller proportions of chert and occasional quartzite pebbles. The writer has found the upper size limit of these lithic inclusions to be some 30–40 cm; the average diameter is 5–15 cm. These stony beds are often lenticular in form and grade laterally into sandy facies.

Partridge (1979) attributes the conspicuous lack of stratification in Bed B to "a rapid mass movement following renewed subsidence during its accumulation", a view more or less concordant with those suggested by Dart (1965b) and myself. The downwarped and fractured nature of the underlying travertine in this area is evident in Brain's photograph (1958: fig. 99) which shows the upper remnant of the limestone floor left by the miners.

Subsequent to Brain's investigations at the site, further falls of weakly calcified Member 5 breccia onto the Cone have lodged against the northern Cone Mouth wall, covering the basal 10 m or more of his Profile 10. Some 1 600 tons of this material (from which approximately 22 000 lithic inclusions were extracted), were removed in the course of excavations by A.R. Hughes and myself in 1960, partly re-exposing the base of the northern Cone Mouth wall. The base of Member 5 at this point is still almost completely obscured by Cone debris.

According to Partridge (1979: 486), smaller deposits of Member 5 of varied facies extend to the surface at the North-west Quarry (or "Original Ancient Entrance") near the Horse Mandible Cave Quarry and at the north-eastern margin of the Entrance Quarry (fig. 1).

The fossil bone inclusions, which in Member 5 are fragmentary and scattered, are mainly bovid. To date no hominid fossils have been recovered from this Member.

Solution cavities (Makondos)

Weathering has produced abundant vertical solution cavities (Makondos) in the otherwise fairly regular surfaces of both Member 4 and Member 5 breccias. Makondos are particularly numerous and well-developed in Bed B of Member 4. These irregular-mouthed cavities are up to 2 m in diameter and taper downwards to a depth of about 5 m. The unconsolidated filling is residual material from the adjacent decalcifying breccia (Maguire 1965, 1968, Partridge 1979, Brink and Partridge this volume).

The filling comprises a red earth with a variable fraction of rock fragments almost entirely of chert and is succeeded fairly abruptly by a thin dark brown soil and rubble overburden. The uppermost 30–60 cm of Makondo infill, but for its reddish colour and the slightly poorer preservation of the chert inclusions, closely resembles the overburden. With increasing depth and dampness, the conspicuous cherty fraction diminishes fairly rapidly, becoming deeply corroded, and it may ultimately disappear (Maguire 1968).

The filling of most of the 120 makondos that were excavated within the grid included a small number of quartzite pebbles, flakes and fragments. These quartzite inclusions, except those composed of the less compact sandstones and grits, are well preserved. Unlike the chert fraction, the more compact quartzite inclusions appear to have been barely affected by the damp conditions in the lower levels of the solution cavities. Only a single bone, a bovid proximal metatarsal fragment, was recovered from the 120 solution cavities that have been excavated.

Overburden

The thin rubbly overburden through which the weathering surfaces of the Member 4 and Member 5 breccias outcrop in places ranges up to about 50 cm in depth. The dark brown earthy fraction, described by Partridge (1979) as a ". . . sandy loam (or slightly clayey silty sand)", usually comprises less than half by volume of the overburden. The coarse stony fraction is composed predominantly of chert, presumably a consequence of the abundant chert bands which characterize the local dolomite. This chert fraction comprises particles ranging from fine gravels to larger fragments which rarely exceed 20 cm in diameter. The finer gravels are variably rounded to angular while the larger fragments, which vary widely in their state of preservation, are generally subangular to strikingly angular (fig. 8A). Fair numbers of vein quartz fragments are present. Dolomite fragments are rare, however, because of their susceptibility to weathering. Small but variable numbers of quartzite pebbles and fragments are usually present in the overburden.

Origin of the lithic inclusions in Member 5 and the Overburden

Member 5

Brain, Van Riet Lowe and Dart (1955) initially held the view that the Phase II breccia (Member 5) represented a calcified alluvium. Later Brain (1958: 112, 113) demonstrated that the matrix was closely comparable with that of the local (essentially colluvial?) hillside soils, mainly on the basis of the relatively low coarse sand fraction and the relatively high silty fraction. Partridge (1979) largely supports this view. While concluding that

the Phase II breccia did not represent a true alluvian, Brain (1958) nevertheless suggested that the stony inclusions comprised materials that had been transported for a short distance before entering the cave, but he did not state how this might have occurred.

Partridge (1979) suggested that the five beds of Member 5 were deposited by ". . . rapid episodic flushing of unconsolidated gravelly soil from the hillside into depressions containing impermanent pools"; and that, although the fine matrix certainly includes a substantial colluvial component, the presence of a large proportion of subrounded weathered dolomite fragments seemingly constituted gravels derived from an alluvial terrace or mudflow deposit that had undergone a degree of post-depositional weathering prior to being washed into the cave.

Over a number of years the writer has examined perhaps 100 000 of the lithic inclusions from Member 5 and disagrees with these conclusions for several reasons. The stony inclusions of Member 5 display a fair degree of homogeneity both in composition and in several morphological features. Although some specimens in a sample of 40 000 range in size up to about 40 cm in greatest dimension, such large specimens are rare (less than 0,2 per cent of the total). The great majority are less than 15 cm in diameter. Most of them are of dolomite or cherty dolomite, a considerably smaller number are of chert, and the small remainder (approximately 1 per cent) predominantly of quartzite with occasional fragments of vein quartz and rare fragments of mudstone and shale. Despite their comparative rarity, quartzite fragments are nevertheless estimated to occur with much greater frequency here than they do in Member 4.

The dolomite pebbles and fragments are generally subangular to subrounded and of very irregular shape, ranging from stout to flattened, the bounding faces being variously curved, irregular, or flat. Many are wedge like or slab like. Most of them, being dolomitic, have a characteristic whitish or grey weathered surface or "crust" which is usually finely gritty or powdery to the touch and may be easily rubbed off. The chert fragments, in contrast, are often distinctly angular. The angles of the dolomite fragments are, almost invariably, only well defined when bounding faces have fractured at about the time of deposition of the pebble. Not a single well-rounded pebble of dolomite or chert has been observed in the deposit.

In sharp contrast, however, the very much smaller sample of quartzite fragments, a relatively insoluble and more resistant material, includes a number of well-rounded pebbles and many which are moderately rounded.

Thus, while the stony inclusions of Member 5 are predominantly dolomitic, the rubble of the local hillside is primarily composed of chert. Also, several significant fractions of the cherty hillside rubble are not represented in the large samples of lithic materials examined from the Cone breccias. For example, there seems to be no evidence of the appreciable proportion of rounded or sub-rounded finer gravels present on the hillside which would be transported far more easily than any larger lithic detritus of whatever composition accompanying them. The larger lithic hillside fragments include an appreciable proportion of highly angular chert fragments displaying plane, natural faces such as those illustrated in Figure 8A. Such hillside chert fragments, both from the point of view of their angularity and their wide-ranging states of preservation, appear to be completely absent from the Cone breccias.

Even supposing the presence of a nearby alluvial terrace or mudflow deposit as envisaged by Partridge (1979), the writer cannot conceive of a situation in which only some of the constituents were selectively washed into the cavern together with an evident component of colluvial soil, but to the exclusion of any other typical coarser hillside detritus.

I suggest that the dolomite and chert inclusions in the Member 5 breccia are primarily of intracavernous origin and that they were subjected to considerable weathering, both corrosional and corrasional, within the cavern prior to and at the time of deposition. There seems to me little doubt that the rounded quartzite pebbles and fragments, which include numerous deliberately struck flakes, are foreign elements that were artificially introduced into the cavern.

The Overburden

Referring to the solution cavities, Partridge (1979: 487) states that:

"These contain residual material, produced by decalcification and *in situ* weathering of the surrounding sediments; this is overlain by recent colluvium with a clear transition."

While there is a fairly clear transition insofar as colour, and possibly finer fractions are concerned, an appreciable proportion of the stony fraction of the overburden does not represent "recent colluvium". Several reasons support this statement:

1. The uneven weathering surfaces of the Member 4 and 5 breccias, thinly covered by overburden, cover 1,5 ha. The dolomite inclusions which strongly predominate in these breccias are relatively soluble, and the small number resisting complete dissolution until freed from the parent breccia mass appear to have a short surface history. The less abundant chert inclusions and the occasional or rare quartzite inclusions are relatively insoluble and on weathering free from the breccia are directly incorporated into the overburden.

   The recovery in the overburden of quartzite pebbles with vestiges of adherent breccia, long separated from the parent breccia mass, not only indicates the presence of original breccial inclusions within the overburden, but also, in the case of those recovered very close to the up-

slope back wall of the cavern, the extremely slow down-slope movement of such elements. It is evident that large numbers of chert fragments in the overburden must have been derived by decalcification of the underlying breccia; and with little doubt some, if not all, of the quartzite pebbles without adherent matrix were similarly derived, except the small percentage of later contaminants referred to below

2. Quartzite specimens on the overburden surface were locally confined to the cavern site and, furthermore, occurred near the Cone Mouth with a frequency twenty to forty times greater than that calculated for the entire north-easterly half of the deposit (fig. 3). The same strong concentration of quartzite fragments in the vicinity of the Cone was confirmed by the excavation of the overburden from the permanent grid and that part of the back wall of the cavern between the permanent grid and the Cone (fig. 1).

   Quartzite elements including flakes may clearly be seen weathering out of the breccia surface where this is exposed; again, such *in situ* specimens are strongly concentrated about the Cone Mouth.

3. The recovery and reuniting of long separated counterparts of some forty quartzite pebble pounders (hammerstones) and other artefacts show quite conclusively that the pounding and fracturing of quartzite was carried out on the site. It indicates, too, that these activities were extensive. The chert materials appear to have been weathered from the Member 4 and Member 5 breccias. Since quartzite inclusions are very rare in Member 4, most of the quartzite elements in the overburden are considered to have been derived from Member 5, which was originally almost certainly more extensively developed horizontally than is the weathered part remaining today. A relatively small number of quartzite pieces (8–15 per cent) appear to be deliberately struck flakes or deliberately flaked pieces. While many of these may be referable to the "Limeworks industry" they quite evidently range widely in age and include some later pieces of indeterminate Acheulean and Middle Stone Age facies. This insignificant percentage of later pieces seems to represent "contaminating" elements dropped on the site at later times and quite clearly bears no direct relationship to the main assemblage.

DATING OF THE LIMEWORKS DEPOSIT

Because the calcified infills of the southern African australopithecine sites are not amenable to current absolute dating techniques, their approximate and relative ages have been assessed indirectly on the basis of faunal comparisons and correlations with dated sites elsewhere in Africa. Recent estimates (Brock, McFadden and Partridge 1977, Partridge 1979), contrary to many expressed earlier, suggest that Makapansgat is somewhat older than Sterkfontein, which is now broadly estimated at 2,5 – 3 million years (Tobias 1976, 1978). Very recent palaeomagnetic evidence from Makapansgat (Brock *et. al.*, 1977, Partridge 1979) indicates that the basal travertine (Member 1) predates 3,32 My and that the grey breccia (Member 3) predates 2,90 My. Recent work (Butzer 1971: 1200) also suggeats that the Limeworks breccias probably accumulated over a far longer span of time than was thought hitherto.

The lithic artefacts described in the present paper are tentatively estimated to range in age from 3,0 My or slightly more for the single stalactite pestle or pounder from the grey breccia, down to 2,3 My for the 31 pieces from Member 5, which evidently represent beds B to D; the ages of the chert discoidal and flake — the former possibly the older — from Member 4 (Upper Phase 1), would then lie between the two extremes.

THE LIMEWORKS LITHIC ARTEFACTS

The Limeworks artefacts, as might be expected in view of their great age, provide problems of classification and description and sometimes of recognition. These problems relate to such features as their relative crudity, their wide range in size and shape, and the manufacture of most of them from the local native rocks, dolomite and chert, the first of which is highly soluble and both of which generally yield very indifferent conchoidal fracture. The much smaller numbers of quartzite artefacts associated with those of dolomite and chert in the upper breccias and in the overburden have been used mainly as pounders; their frequent fragmentation on the site seems to have been largely accidental, and evidence of deliberate or competent flaking is minimal.

The earliest report on artefacts in the Limeworks breccias came from Van Riet Lowe (Brain, Van Riet Lowe and Dart 1955) after examination of 129 suspect fragments extracted by Brain in 1954 from the base of the Phase II breccia at Profile 10 (Brain 1958, see also figs. 1, 2). Van Riet Lowe considered that 17 of these specimens (15 of dolomite, one of vein quartz and one of quartzite) were undoubted artefacts and assigned them to a developed stage of the Kafuan Culture. Unfortunately, little attention was given to these artefacts by other workers. The present writer concluded independently that large numbers of crude artefacts of dolomite and chert were present in this Member 5 breccia (Report 5 to R.A. Dart 10/5/60).

In a brief period of excavation at the Limeworks in 1955 Mason (1965) recovered 5 755 pebbles assignable to the "upper gravel horizon" from collapsed Member 5 of the Cone, and he excavated a further 14 118 pebbles directly from the lower horizon. This large sample was mainly of dolomite pebbles and some of chert but included a very small number of quartzite pebbles and fragments.

Mason (1965) compared the Limeworks materials with pebbles showing natural fracture caused

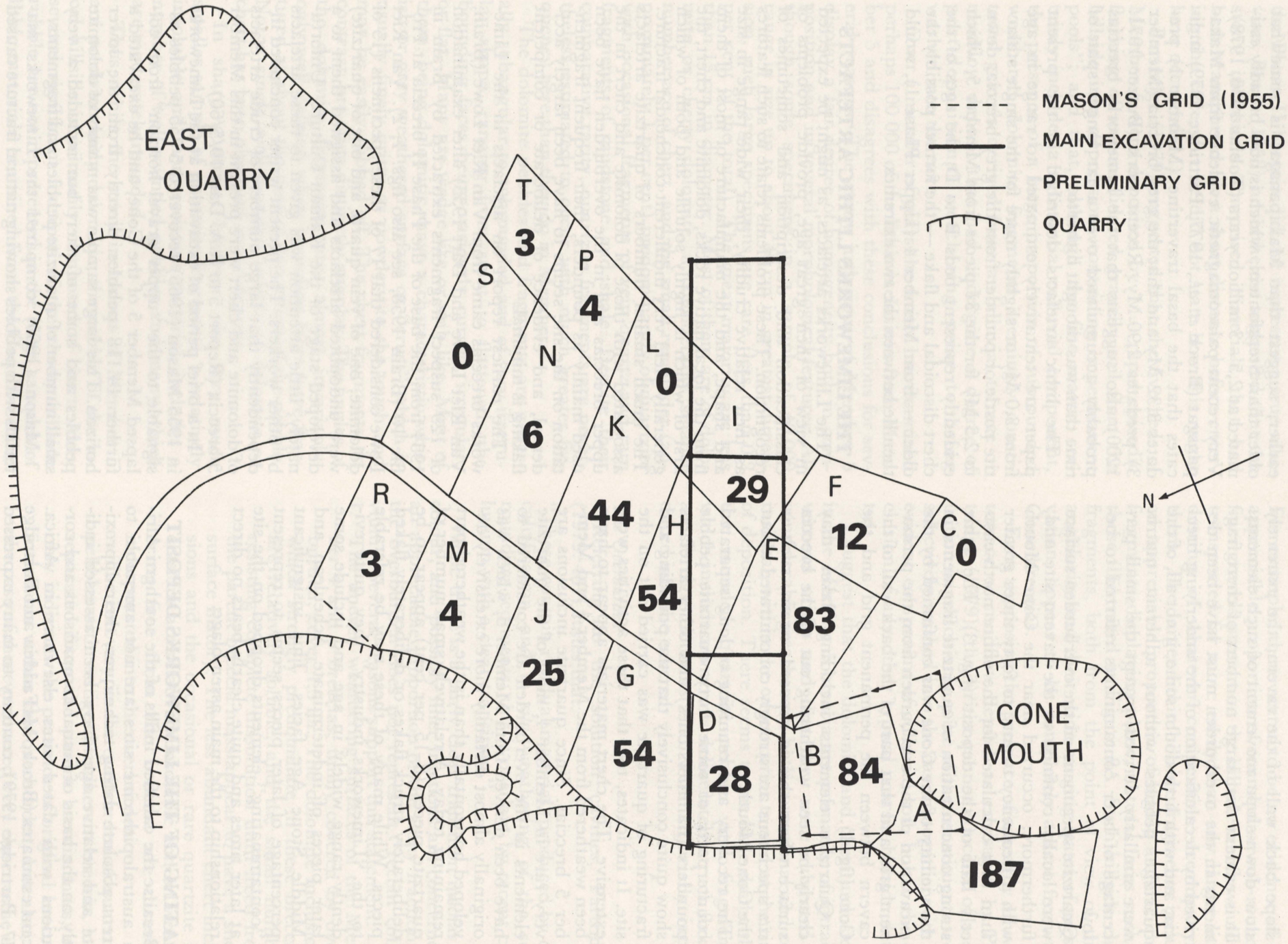

Figure 3. Distribution of the 620 foreign stones (almost exclusively quartzites) recovered in 1962 from the surface of the Lime works deposit.

by alluvial, fluvioglacial, colluvial and other natural forces and concluded that none of the Limeworks pebbles could be accepted as artefacts. However, he acknowledged that all the identifiable fractures on the Limeworks pebbles were conchoidal, and that in this sense they differed from alluvial, fluvioglacial or colluvial pebbles where numerous plane fractures could be seen (Mason 1965). Whereas Mason reported only three flakes from his samples, the writer examined comparatively large samples of pebbles and fragments from Member 5 gravels and noted the presence of appreciable numbers of cortical and other flakes. These observations would materially affect Mason's histogram which contrasts the high proportion of "fractured slabs and cores" with the almost negligible proportion of flakes he considered to be present in his sample — a feature he regarded as typical of assemblages of natural origin.

At the time of the writer's first report on the Limeworks lithic artefacts (Maguire 1965), Dart invited T.C. Partridge to report independently on the suspected materials recovered from the breccias. While emphasising the preliminary nature of his account and the difficulty of recognising deliberate flaking in the native rock, Partridge (1965) concluded that the samples suggested "tool-making of an extremely crude nature and as yet unsystematized form". He accepted as evidence of preparation or use only those objects displaying flaking in some form and illustrated a flake (p. 115) ". . . showing small-scale utilizational (?) damage described in the test".

The assemblage of suspect quartzitic materials excavated by the writer from the "pink breccia" (a term that at one time loosely applied to both Member 4 and Member 5) was examined by Dr. Mary Leakey (1970: 19) who concluded that ". . . although it included a number of quartzite flakes and utilised pieces, there do not seem to be recognisable tool forms among the *in situ* specimens".

In the course of my work at the Limeworks a total of 16 139 suspected chert artefacts and 1 977 pebbles and fragments of quartzite were recovered from the overburden of the grid and that part of the cavern back wall between the grid and the Cone Mouth. Whereas all possible fragments of quartzite were recovered, only the "suggestive" fragments of chert were extracted, since virtually all of the sieved lithic materials were composed of this rock. The "suggestive" features related partly to form and partly to the frequent evidence of suspected deliberate fractures.

It is appropriate to discuss now in some detail the fracture characteristics of the local dolomite, chert and quartzite. The fracturing properties of dolomite and chert are fairly comparable, ranging from conchoidal to feebly conchoidal, variously uneven or quite flat. The finer details of fractured surfaces in the dolomite, generally clearly seen when fresh, are easily obscured or lost by weathering, as has occurred in the case of the Member 5 dolomite artefacts. Intensive scrutiny is often required to recognise these features on specimens retrieved from this breccia. Conversely, these details are often remarkably well preserved in the older materials from the Member 4 breccia.

Natural collapses in the ancient Limeworks cavern must have undoubtedly produced numerous fractures very similar to those purposefully induced. However, the fracturing pattern of pieces considered to be too large to have been deliberately struck indicates that such fractures are generally more irregular than those deliberately induced and are not readily confused with them.

The scars resulting from deliberate flaking usually show fairly well defined fissuring, radiating out from the point of impact, and often extending over the entire scar (fig. 10A, B and E). The lines or ridges vary from close to regular to irregularly spaced, sub-continuous or broken, and from barely raised to sometimes coarse and prominent. Coarser grained cherts may show similar fissuring (figs. 11F, 12D).

The natural breakup of chert occurs mainly along flat or nearly flat fracture surfaces (or fracture planes) which are abundant, and lie not only parallel with the bedding planes, but are also inclined at widely varying angles to them. These surfaces are usually conspicuously smooth. Weathering fragments of chert often show such incipient fracture planes as comparatively straight, often intersecting, fine lines traversing the surfaces of the fragment in various directions. The natural fragmentation of chert, therefore, usually results in highly angular fragments bounded by flat faces and straight margins (fig. 8A).

Deliberate fracturing may well result in a fracture running partly or wholly along a natural fracture plane. Fractures of this type, even by reference to associated features, are often barely distinguishable from natural breakup along these surfaces. Usually, however, localised percussion of chert produces a fracture which is wholly opposed to the natural fracture planes (fig. 8B, 9B). The bulb of percussion is generally poorly defined or virtually absent, a feature also noted in the chert artefacts experimentally produced by the writer when using a quartzite pebble as a hammerstone.

In the very fine grained cherts the pattern of fissuring is often extremely fine and indistinct, sometimes barely discernible or apparently absent even under magnification. Since this rock is relatively insoluble, the features of scarring have usually been well preserved in the materials examined.

The raw materials chosen for making the artefacts of chert in the overburden appear to have been little-weathered chert slabs ranging up to about 60–80 mm in thickness. The comparatively rough cortex of the upper and lower bedding planes, originally in contact with the dolomite above and below the slab, may be retained on the tools or removed.

The well preserved chert tools from the Member 5 breccia were apparently made in the same manner, and it would appear that the raw materials

had undergone little or no rounding prior to being worked. The artefacts of dolomite or cherty dolomite were derived from subangular to more often subrounded pebbles. While the rounding of these pebbles was apparently a pre-depositional feature, the white weathered state of the artefacts and of the accompanying dolomitic inclusions, appears to have been largely the result of post-depositional weathering.

The local quartzites usually yield a conchoidal fracture when struck (figs. 11, 12, 14, 22). Being insoluble, the quartzite artefacts are well preserved. However, deliberate flaking of the quartzite at the site appears to have been either minimal or crude and unaccomplished. Present in low proportions in the overburden and in Member 5, very few quartzite artefacts have been recovered from typical Member 4 breccia although the presence of rare *in situ* quartzite fragments has been noted.

Several quartzite flakes (figs. 11, 14b) and flaked pieces (figs. 12b, 22) have been illustrated in this paper. The abundant evidence of the use of this material primarily for percussional activities of a repetitive nature and the very characteristic nature of the resultant damage was noted in an earlier paper (Maguire 1965).

Subsequent examination, including experimental work on the fracturing properties of the local materials, led to the conclusion that most of the suspect fractures were indeed deliberate, particularly in the cherts. However, it was decided that the presence of authentic artefacts should be more objectively established by a completely independent analysis of perceptible small-scale damage on the margins of the entire sample of 16 139 suspected artefacts. The detailed analysis of this small scale damage was considered to be objective in that it involved the appraisal of eight distinct, observable components. In isolation from whatever flaking damage is present, it was considered to identify independently any tools present.
The *combination* of all of the following attributes relating to such small-scale damage was considered to be particularly suggestive of artificial damage:

1. an *abundance* of small-scale damage;
2. the *contemporaneity*, as assessed by patination, of the components of this damage;
3. the marked *localisation* of the damage;
4. the *confinement of such damage to evident or presumed working features,* such as entire margins (including notches) or pointed extremities;
5. *the close spacing and, especially, complete confluence of the components of the damage*;
6. the *directions of the causal forces of the components of the damage being uniform, or otherwise evidently patterned or regulated*;
7. the *chipping or scarring being of uniform or comparable size*, i.e. uniformly coarse or uniformly fine;
8. the small-scale damage and the grosser damage by primary preparation exhibiting contemporaneity as assessed by patination and the degree of fine "abrasion" due to weathering.

A small percentage (7 per cent) of specimens showing what was regarded as very clear evidence of deliberate flaking, but no evidence of fine damage by preparation or utilisation, were classified as crude cores and unutilised pieces and were included in the resulting assemblage of 6 787 chert artefacts.

Subsequent examination of 2 328 better-preserved specimens from this assemblage showed not only that the fine damage and the major preparatory flaking damage frequently occurred together, but also that they had been almost invariably contemporaneous (Maguire 1968).

A definite assessment of the nature of the smaller scale characteristically unifacial damage evidenced on the working edges of the Limeworks artefacts is difficult, and it has not been determined with certainty whether this damage was due to preparation or utilisation. That the fine marginal damage was found to be associated almost invariably with the damage attributed to deliberate flaking further supports the authenticity of the identified artefacts.

To determine tool types, the overall morphology of each piece was considered in conjunction with the position and morphology of the working edge or dominant working edge. That the working edge(s) should provide a readily identifiable feature (see figs. 9B, 12–21) is largely due to the greater regularity over that area produced by preparation and almost certainly by use. The small-scale damage shown by the presumed working edges is predominantly unifacial and generally directed towards the more irregular of the two faces. Two simply defined main types of tools were recognised in a sample of 1 881 chert artefacts: scrapers and planes.

The terminology used for naming the two main tool types has a functional connotation; this was simply a matter of convenience although it is thought that the functional connotations may be partly warranted.

Scrapers (71,4 per cent) are defined as tools with a lateral working edge. They are usually relatively broad and variable in shape (figs. 12D, 13, 15–16, 19–21).

Planes (21,4 per cent) possess a terminal working edge, a flat base and are relatively stout. They are usually far more regular in shape than the scrapers, the shape generally conforming with a rectangular solid (parallelepiped) but with a wedge like working extremity (figs. 12, 17, 18).

Both tool types were further subdivided into simply recognised categories based directly on the overall morphology of the working edges. Both types included the four categories — notched, straight-edged, convex and pointed; the scrapers included a fifth category, "blunt-nosed" and the planes two extra categories termed "compound" and "miscellaneous".

Notched scrapers (842) (figs. 12D, 13, 19, 20) and notched planes (100) (figs. 12A, B, 18C) comprised half the total assemblage, the notched

scrapers alone representing 44,8 per cent of the total. The numerically dominant notched scrapers are quite frequently double notched (figs. 12D, 13F, 20B).

A common feature of the single-notched scrapers is the presence of a marginal point of varying size on one or both sides of the notch; in many of the double-notched specimens a generally small point lies between the two notches. It is often evident that particular attention has been given to the preparation of these "spurs" or points.

The remainder of the assemblage (7,3 per cent) constituted "pounders", "anvils", "cores" and "un-utilised or little used flakes and fractured fragments".

The great majority of the approximately 5 000 quartzite pebbles and fragments recovered from the surface, the overburden and the solution cavities have suffered a very similar type of artificial damage, apparently by repetitive percussion and crude, possibly accidental, flaking. An appreciable number crudely simulate the "notched scrapers" and "planes" which occur so frequently in the associated chert materials. These quartzite artefacts — with the exception of an evident small percentage of later elements — are closely comparable with those excavated from the Member 5 breccia of the Cone. Moreover, the large sample of chert artefacts excavated from the overburden are closely comparable with those excavated from the solution cavities and from the Member 5 breccia. Consequently, with the exception of the relatively small number of "contaminants" referred to earlier, it is concluded that the chert tools and the mainly percussionally damaged quartzite artefacts associated with them in the overburden, the solution cavities and in Member 5, represent the same crude industry.

DESCRIPTION OF FIGURED SPECIMENS

The 45 specimens figured here were selected with a view to illustrating some features of deliberate damage found throughout the Limeworks breccias and the overburden. These features include preparatory flaking damage, smaller scale damage by utilisation or preparation and the two recurrent tool forms. The very varied forms of these artefacts, the range of raw materials used, and the varied states of preservation of the materials (calcite, dolomite, chert, vein quartz and quartzite) have also been illustrated.

Only a single specimen has been taken from the grey breccia (Member 3), and two from Member 4; most of them (31) were recovered from Member 5 and nine came from the overburden. Two additional pieces shown are assignable to the breccias, but their provenance is uncertain.

Member 3

More than 30 tons of this breccia have been prepared, consisting almost exclusively of blocks recovered from dumps of mining waste. Although no longer in stratigraphic context, the small block from which the illustrated stalactite pestle (fig. 4a) was taken is assignable with little doubt to the grey breccia. Only about one hundred lithic fragments have been extracted from the 30 tons of grey breccia that have been prepared. These mainly comprise fragments of stalactite together with small fragments of chert, dolomite and shale. Four very small chips of grey quartzite and an unusually marked waterworn pebble of banded ironstone (Dart 1974) represent materials foreign to the site.

The single calcite specimen (fig. 4A) is representative of the limited evidence of lithicultural activities contemporaneous with the more extensive utilisation of bone in Member 3 times.

The smoothly worn, almost polished area of damage on the calcite pestle is strictly confined to the presumed working surface of this tool. By comparison with a wide range of comparative and experimental materials, the damage is attributed either to repetitive percussion or long continued abrasion, or possibly both.

The stalactite fragment (fig. 4B) with which the pestle like piece is compared, was recovered from a different block of Member 3 breccia. It has been shown simply to contrast the comparatively fresh state of the irregular fracture caused by its detachment and the very strikingly worn state of the butt end of the pestle from the same bed.

Member 4

Approximately 7 tons of pink breccia blocks have been prepared to date, most of them having been taken from the dumps of mining waste. One block, weighing approximately 300 kg and referred to by Dart (1965b) in some detail, was dislodged from its position *in situ* from the western face of the cutting leading into the Main Quarry very near the present surface. The non human primate cranial material which was extracted from this block and described by Maier (1972) was accompanied by abundant well preserved inclusions of dolomite and chert, some of which appear to have been unnaturally fractured and utilised.

To date a total of 525 fragments of dolomite and chert have been extracted from blocks of Member 4 breccia for analysis. A preliminary estimate suggests that only 30–50 of these specimens are artefacts.

Figure 5 illustrates a bipyramidal core (?) of chert from a block of pale pink breccia which contained relatively few other rock fragments. It probably came from Bed A of Member 4. It bears a general but probably fortuitous resemblance to an illustrated "discoidal" from Bed 1 at Olduvai (Leakey 1971: fig. 33). The otherwise sharp, fresh margin is more irregular and appears blunted by coarser damage over about half the perimeter (top and left of figure), suggesting that this piece had been used as a chopper.

The small block of pink breccia (fig. 6) recovered from a Limeworks dump almost certainly came from the extensive Bed B of Member 4,



Figure 4. (A) a stalactite fragment the butt-end of which has been excessively worn; interpreted as being a result of sustained pounding and/or abrasion.
(B) a second stalactite also recovered from a block of Member 3 breccia for comparison. Note the fresh state of the coarse fracture scar caused by its detachment.



Figure 5. An unusual bipyramidal core or "discoidal" of chert, extracted from a block of Member 4 breccia. The greater part of the margin is sharp and fresh, interrupted over 70–80 mm (top of figure) by localized damage.

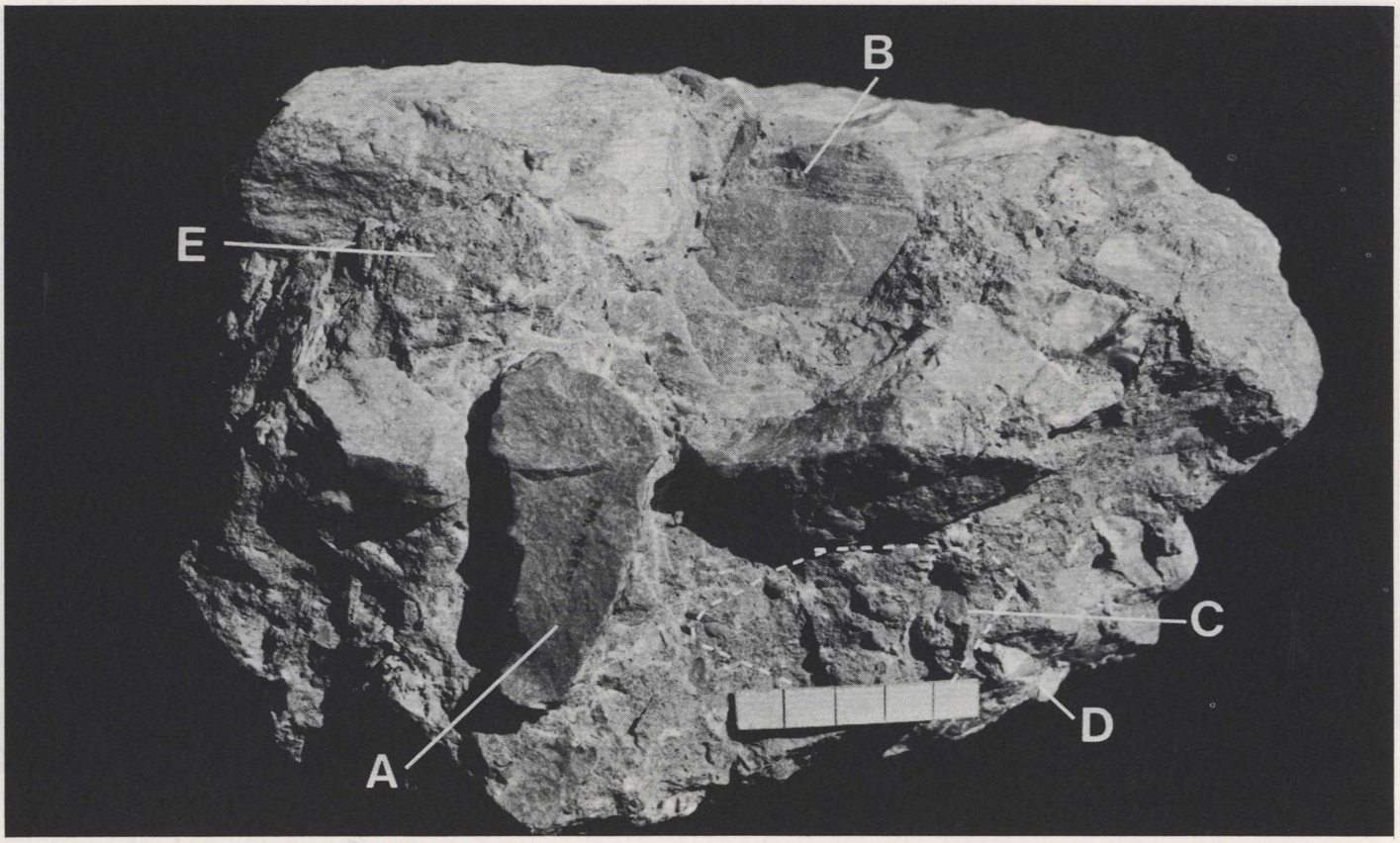

Figure 6. A block of Member 4 breccia showing:
(A) the *in situ* position of a utilised flake (fig. 7); ventral face;
(B) a damaged chert pebble;
(C) a loose cluster of blowfly pupae;
(D) a bone flake;
(E) a fragment of quartzite, rare in this breccia, and considered to have been artificially introduced.

largely because of the abundance of dolomite and chert inclusions. The various objects associated in this small block include the utilised chert flake extracted from it (figs. 6A, 7), other fragments of native rocks showing suspect damage (B), a bone flake (D), a diffuse cluster of blowfly pupae (C) and the remnant of a quartzite fragment — considered foreign to the site — which has been damaged by blasting (E).

Member 5

The described specimens, with only two exceptions (figs. 14B, 15), were recovered from collapsed Member 5 on the northern side of the Cone in the vicinity of Profile 10.

Figure 8 contrasts the frequently flat fractures produced during the natural break-up of chert (fig. 8A) and the conchoidal or more or less conchoidal flake scars exhibited by a globular or polyhedral core of cherty dolomite (fig. 8B). Note that none of the numerous arrises on this core, from which at least seven flakes have been struck, shows perceptible small scale damage or wear. This core is unusual in its relative symmetry and the large number of flakes that were struck from it. Few of the Limeworks cores are either regular in shape or appear to have yielded more than three or four utilisable flakes. The chert notched scraper (fig. 9A) was prepared experimentally, using a quartzite pebble as a hammerstone. This deliberately flaked specimen is compared with a weathered notched scraper of cherty dolomite (fig. 9B) from Member 5 to illustrate the striking similarity of the two pieces. The apparently deliberate character of the damage suffered by the Limeworks specimen is also demonstrated by comparison of natural and unnatural damage shown in Figure 8A, B.

Figures 10 and 11 illustrate the nature of the flakes and flaking damage in the native rocks chert and dolomite (figs. 10, 11F, G) and in quartzite (fig. 11A–E) from Member 5.

Figure 10A illustrates the nature of the raw material most commonly used for toolmaking in dolomite, i.e. sub-rounded pebbles sometimes showing shallow to deep furrowing caused by corrosive weathering. The viewed face of this pebble has been repeatedly flaked, the flake scar occupying the lower half of the picture clearly having resulted from the striking of a large flake from a point on the oblique lower right margin. The whole of the latter margin shows multiple small scale damage, including shallow chipping overlain by finer wear, suggesting that the pebble had been used as a pounder and that the striking of the flake may have been accidental.

The cortical flake (fig. 10C) with an unusually

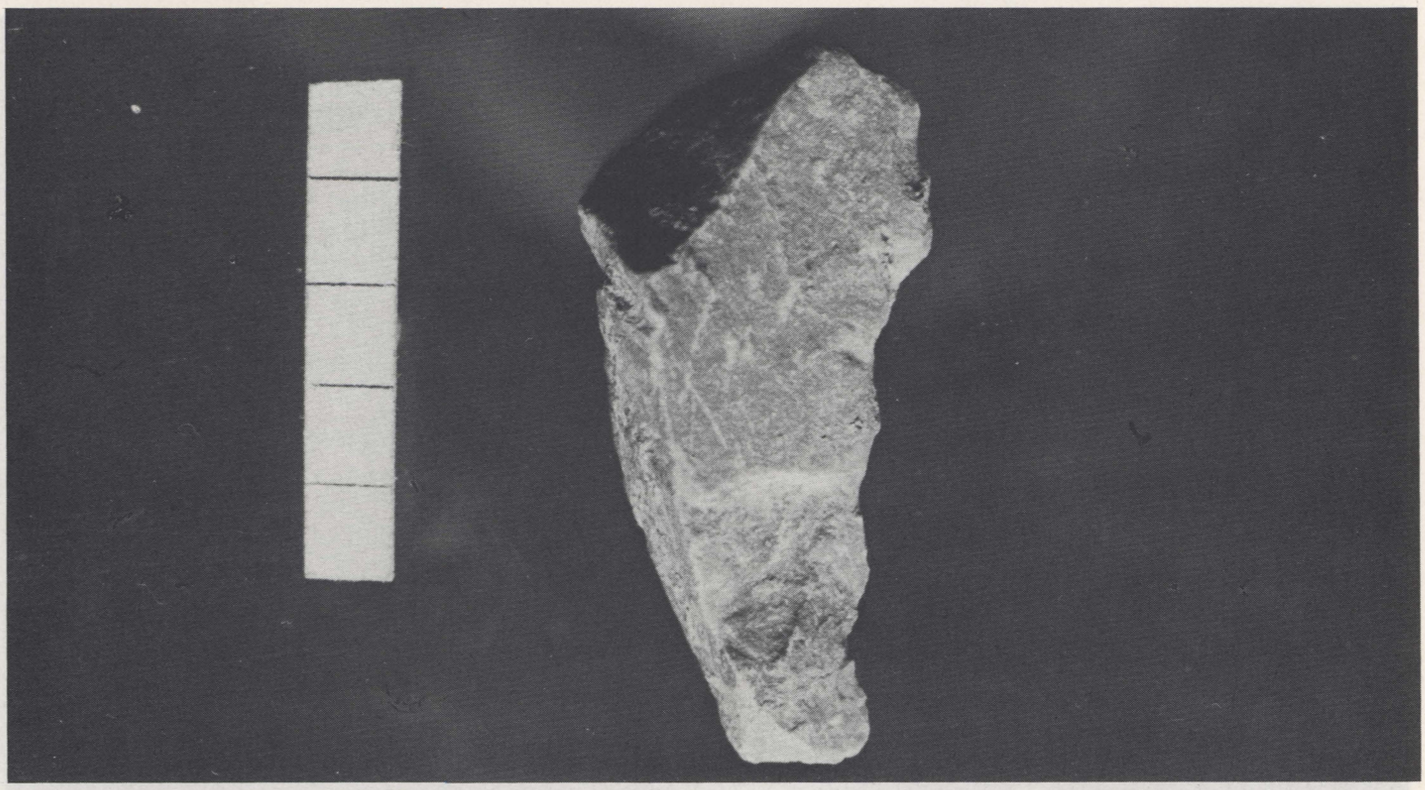

Figure 7. The utilised flake of impure chert from the block of Member 4 breccia (fig. 6): Note the scar on the tri-faceted dorsal face showing where a thin flake has been struck from the dorsal ridge.

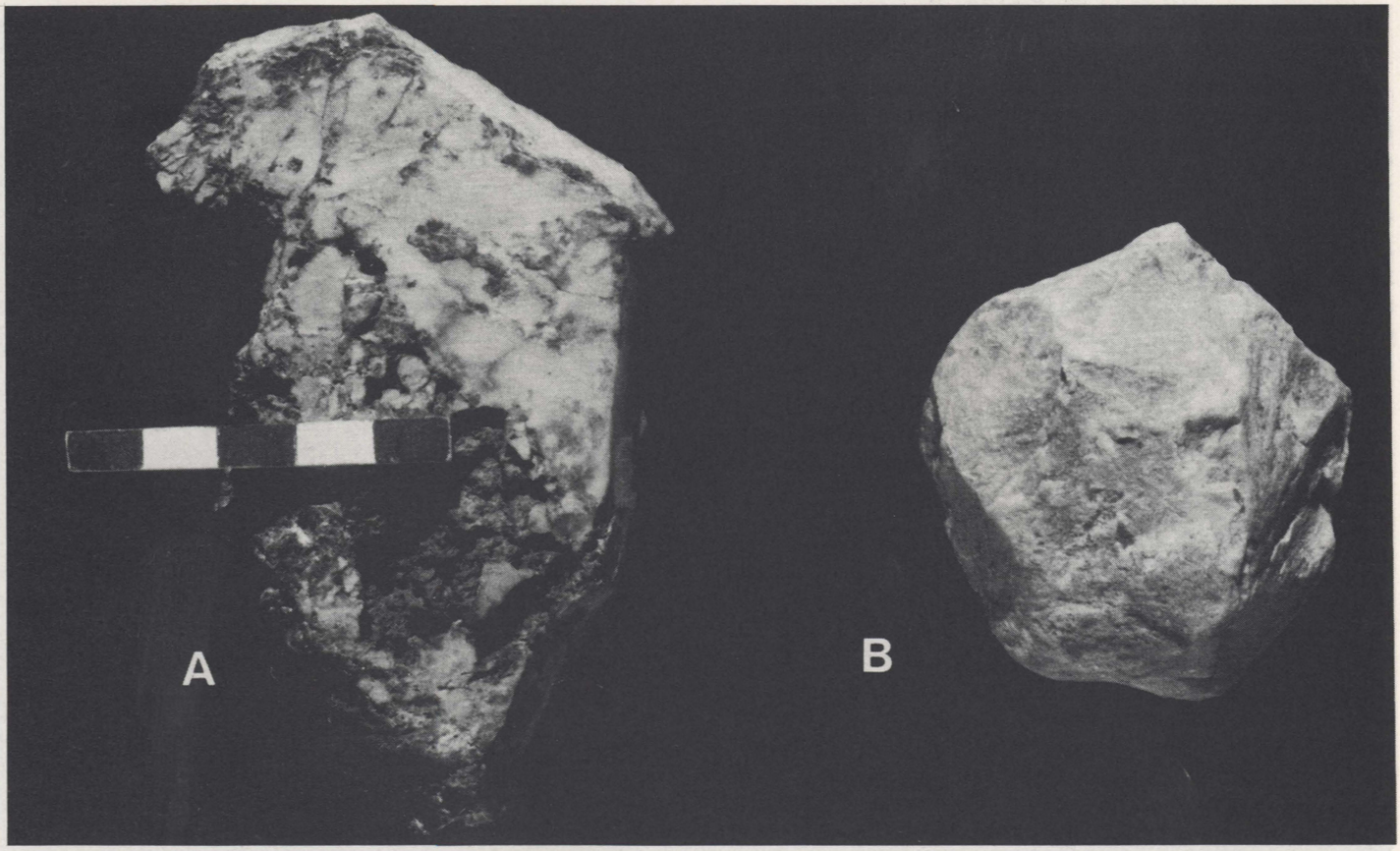

Figure 8. (A) a weathered chert slab illustrating natural break-up along flat fracture surfaces or planes;
(B) contrasting the more or less conchoidal flaking shown on a globular core of cherty dolomite from Member 5. At least seven flakes have been deliberately struck from this core.

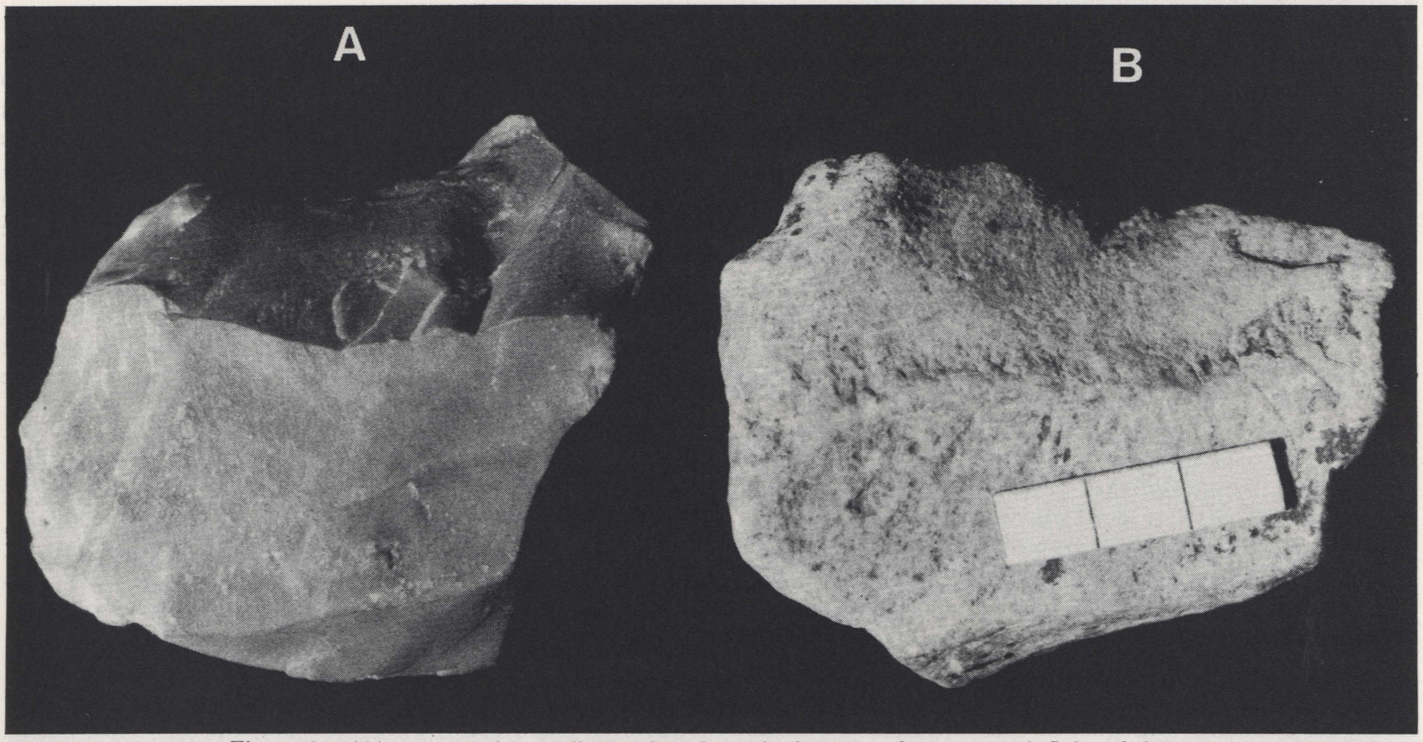

Figure 9. (A) an experimentally produced notched scraper from a struck flake of chert;
(B) a weathered notched scraper of cherty dolomite from Member 5.

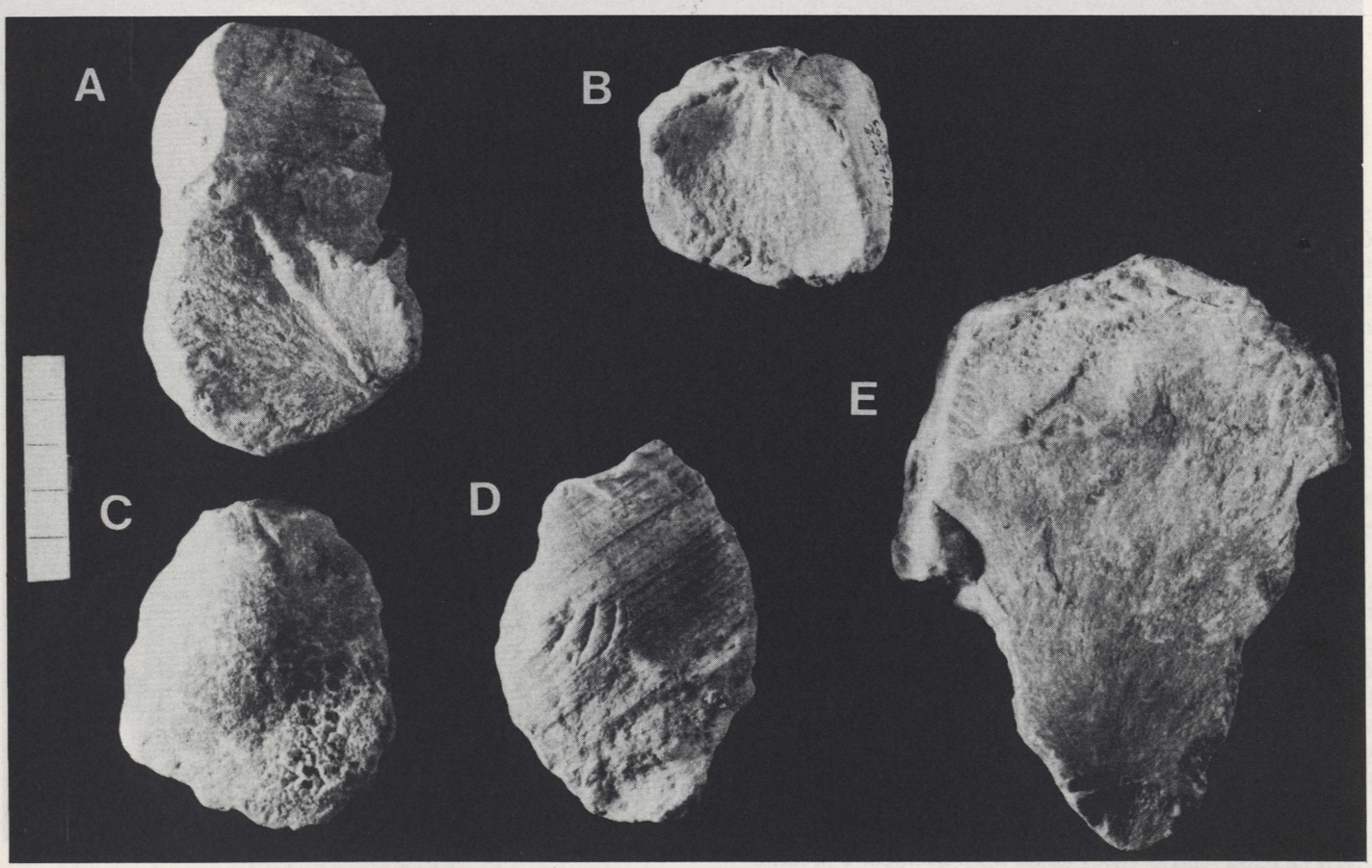

Figure 10. Five artefacts from Member 5 breccia showing deliberate flaking. All are of cherty dolomite, except D which is of chert.
(A,B) cores or hammerstones;
(C–E) utilised flakes; in E, removal of a stout flake dorsally from either lateral has produced a hand axe-like tool with pointed extremity.

prominent bulb is of dolomite. The dorsal face shows considerable small scale chipping and scarring of the margins, the left lateral margin (as orientated in the picture) having been neatly trimmed by flaking. The large stout flake (fig. 10E) was struck from a comparatively large, irregular and slightly rounded dolomite pebble, the point of impact being on the left of the pointed tip. As adjudged by patination, this is one of the few tools that appears to have been reworked. At least two very bold flakes were struck from the dorsal face. The two scars intersect at about 90° in a conspicuous median ridge, the removal of the flakes producing a pointed hand axe-like tool. The first of the two flakes was struck from the margin in the direction of the dorsal face; the second flake, apparently removed at a much later date, was struck in the direction of the opposite margin, using the first flake scar as a striking platform. This stout flake, the smaller chert flake (fig. 10D) and other small chert flakes (fig. 11F, G) all show evidence of use in the degree of wear on their working edge; this small scale, characteristically unifacial damage is directed towards the dorsal faces. Virtually the entire margin of the smallest of these flakes (fig. 11G) has been damaged, both intensively and apparently contemporaneously, in this manner.

The quartzite flakes (fig. 11, A–E) are all cortical flakes, except one (fig. 11C) which shows overall preparation. Small scale damage attributed to utilisation rather than preparation is usually less readily evident in the quartzitic materials than it is in tools made of the native rocks. The writer attributes this feature to the fact that although the two materials are of comparable hardness the quartzite is tougher and more resistant to most forms of mechanical damage.

While many of the quartzite pebbles and fragments in Member 5 show evidence of deliberate damage by repetitive percussion, the total sample is very much smaller than that from the overburden, and the presence of tool forms crudely replicating those in chert and dolomite is not easily appreciated. However, a notched and pointed quartzite plane (fig. 12B) may be compared with a chert specimen showing even more minimal preparation (fig. 18C) which was excavated from the overburden.

Ten pieces representative of the notched tools which strongly predominate in the native rock artefact assemblages from Member 5 and the overburden (figs. 18C, 19A, 20) are illustrated in Figures 12–13. All are of dolomite or chert except the quartzite notched plane (fig. 12B) referred to above. The characteristic feature of these tools,

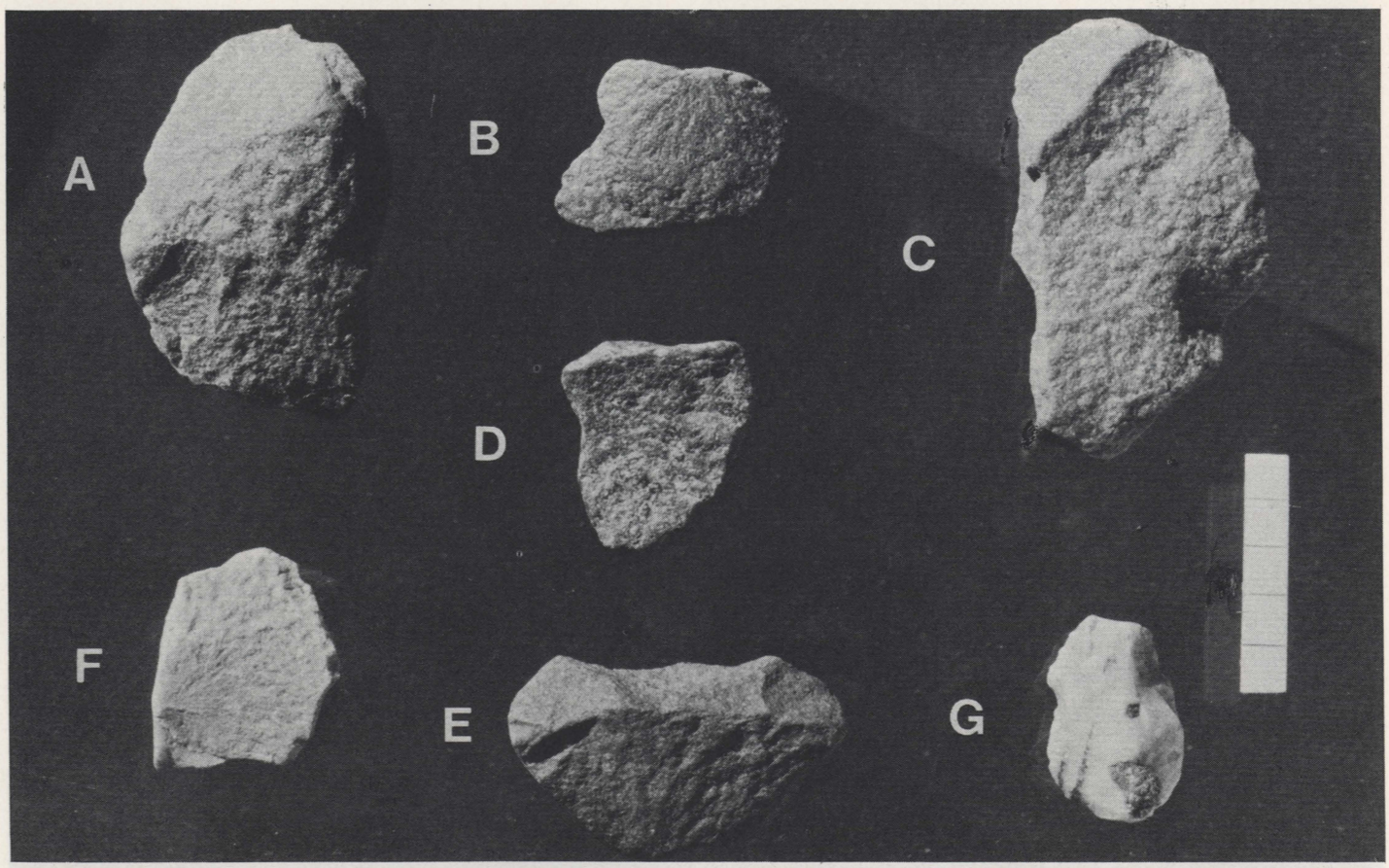

Figure 11. A series of seven flakes from Member 5 breccia.
(A–E) Quartzite;
(F,G) Chert.
G shows completely unifacial small-scale damage by preparation or utilisation (or both) about the entire margin, the damage being directed towards the dorsal (viewed) face.

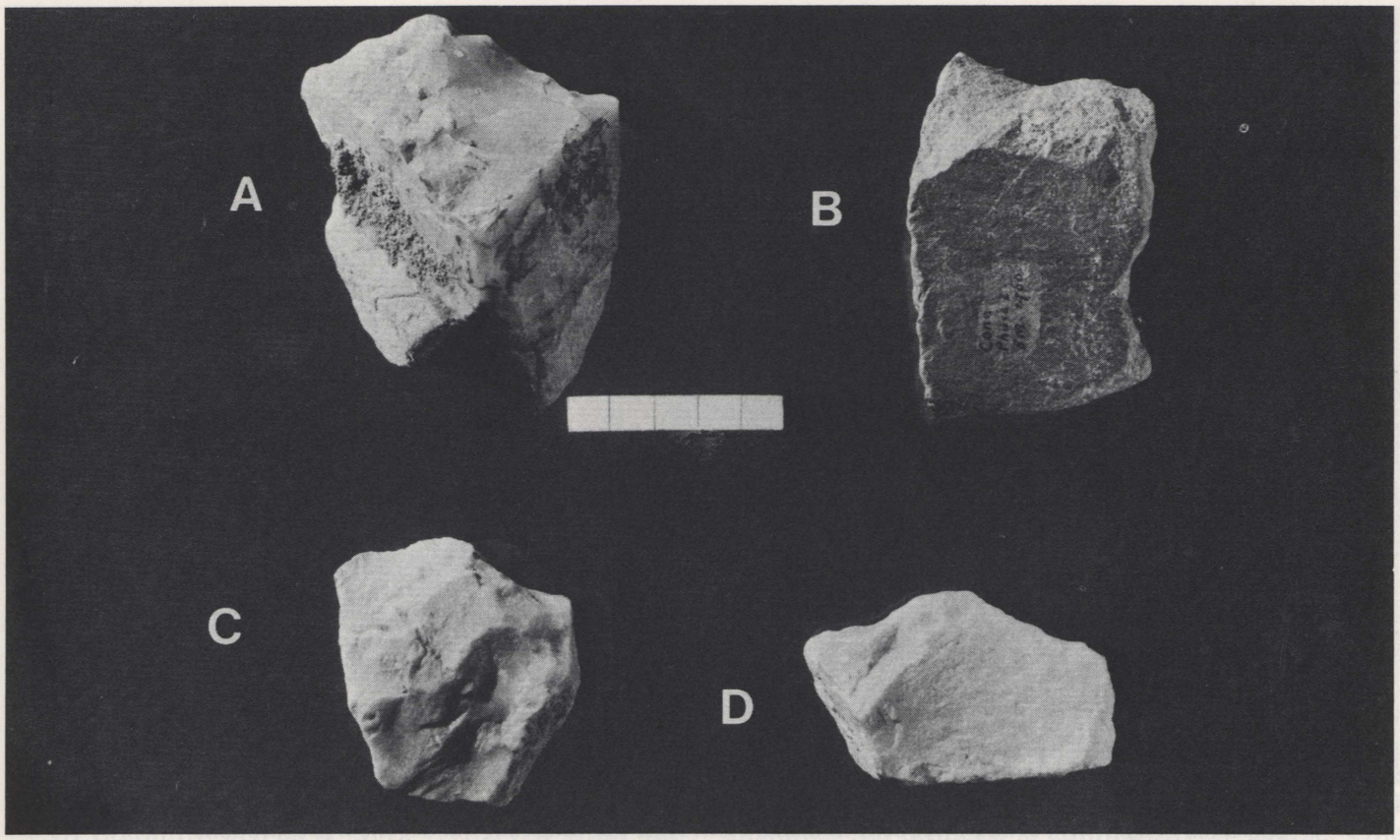

Figure 12. Four notched tools from Member 5.
(A,B) Notched planes, showing little preparation;
A — produced on a stout flake of chert,
B — produced on a terminally flaked natural slab of quartzite.
(C) Double-notched plane or scraper of chert, showing overall preparation.
(D) Typical double-notched scraper of chert.

rather than overall shape, is the presence of one, two or more marginal notches displaying appreciable small scale damage which is usually completely unifacial and strictly confined to these indented working edges.

The very crude tool (fig. 12A), probably made on a very stout irregular flake and showing very little preparation, may be classed as a notched plane; the same applies to the specimen which has received overall preparation by flaking (fig. 12C). The remainder (figs. 12, 13) are notched scrapers and may be compared with specimens from the larger assemblage from the overburden (figs. 19, 20). They all appear to be on flakes or split pebbles, the small scale damage along the indented working edges being characteristically unifacial. In the case of the notched scrapers the direction of this finer damage is generally towards the dorsal face; in the case of the planes, towards the assumed dorsal face. Where exceptions occur, the small-scale damage is almost invariably directed towards the less regular of the two faces (e.g. fig. 13A).

While the small scale marginal damage on working edges, which is probably due partly to preparation and partly to utilisation, is a characteristic feature of these tools, the degree and nature of preparation by flaking varies widely. Figure 13A illustrates a deeply white weathered cortical flake apparently used as a notched scraper. Figure 13D illustrates a wedge like specimen, the indented working edge being formed at the intersection of two flake scars — the double-notched specimen (fig. 12D) was evidently made in similar fashion; the double notched specimen (fig. 13F) shows virtually overall preparation.

Flaking or splitting along natural fracture planes (fig. 13B) is a far less common feature of the notched scrapers than it is of the tools classified as planes. Flaking has generally been opposed to the natural lines of fracture.

The well preserved chopper like tool (fig. 14A) was probably split off a 40–50 mm thick slab of lightly weathered chert. The vestiges of weathering dolomite on the unworked laterals indicates that the width of the tool represents the full thickness of the original band of chert which provided the raw material. The bifacial nature of the damage to the working edge suggests that, unlike the planes and scrapers, this tool was used for chopping work.

The quartzite specimen (fig. 14B) appears to represent part of an originally very broad flake which broke longitudinally. Note the uniform and completely unifacial trimming of the working edge and the absence of perceptible damage of any kind

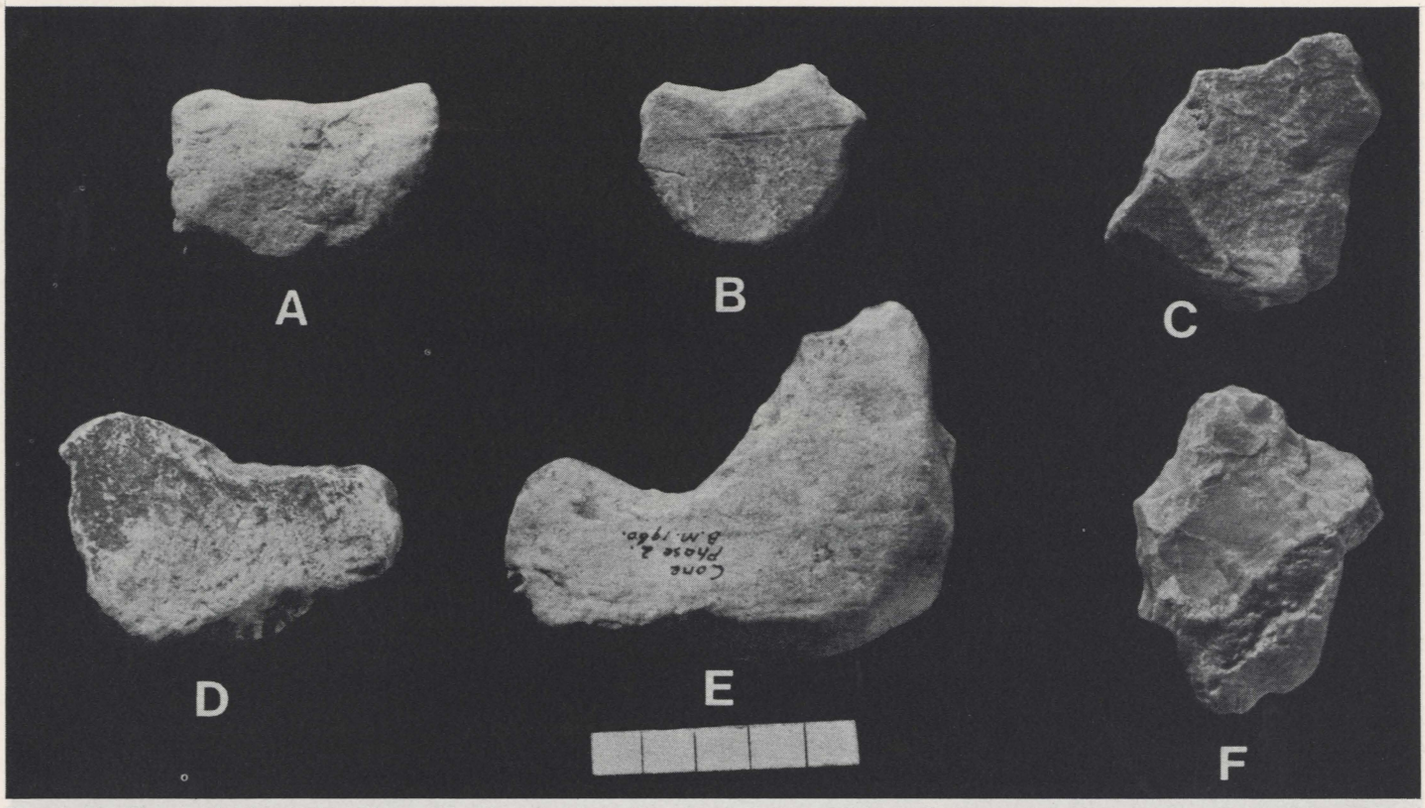

Figure 13. Six notched scrapers from Member 5, probably all on flakes. All are of cherty dolomite except the double notched specimen of chert (F). E and F are seen in dorsal view. Note the wide range in degree of preparation.

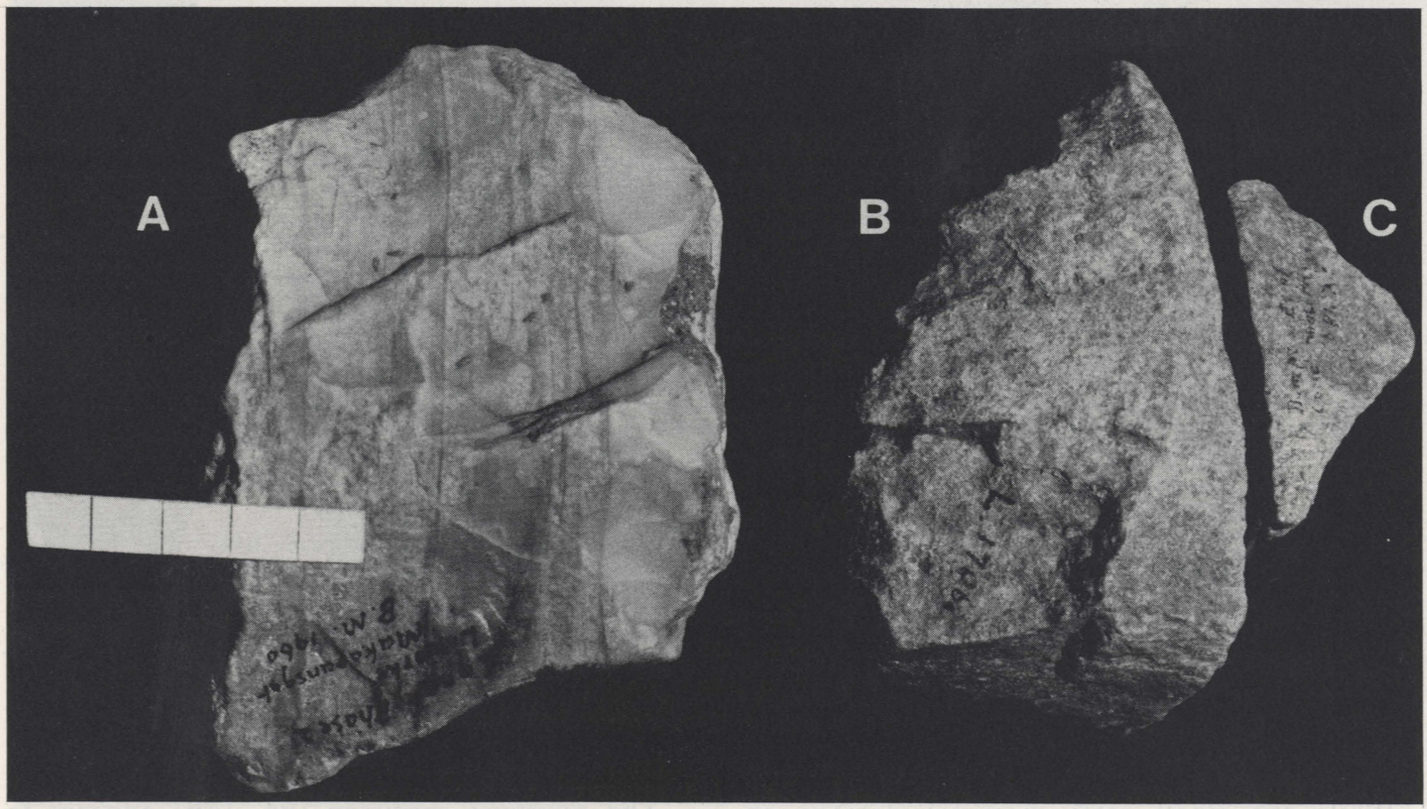

Figure 14. (A) chopper-like chert tool;
(B) a quartzite flake from Member 5;
(C) a dissociated fragment belonging to (B), discovered separately in Member 5 breccia.
B was originally a very broad ovate flake which later broke in two along a natural fracture plane. Note the uniformly coarse, continuous and completely unifacial marginal trimming of the convex lateral.

along the broken margin. This specimen came from a dump but has adherent breccia matrix. It was almost certainly excavated from *in situ* Bed E breccia near Profile 10. Figure 14C shows a later recovered fragment of the tool.

Two further examples of well defined small scale marginal damage are shown (figs. 15, 16), the damage being predominantly unifacial, uniform, continuous and its components identically patinated. The chert side scraper (fig. 15) came from the southwest side of the Cone near the base.

Figure 16 is considered to represent a side scraper made from a largely cortical flake. The ventral face and all other damaged areas are identically patinated and hence exhibit contemporaneity; note also that the complete trimming of the margin by regular flaking clearly preceded the finer damage to the working edge.

Three of the chert planes recovered from Member 5 (fig. 17) may be compared with three chert planes from the overburden (fig. 18). One specimen (fig. 17A) shows apparently overall preparation and closely resembles a stout irregular flake from Member 4 illustrated by Partridge (1965: 113, Plate I and fig. 1.1).

The Overburden

No dolomite artefacts were recovered from the overburden. Excepting the quartzite materials, the extremely low numbers of other lithic fragments also considered foreign to the site and the large numbers of vein quartz fragments which have been excluded from the present discussion, the large assemblage of overburden artefacts is all in chert (figs. 19, 20, 21). All were recovered from 0–50 cm, the full depth of the overburden.

The notched scrapers from the overburden (figs. 19, 20) differ in no important respects from those already described from Member 5. The presence of points or spurs adjacent to the notches (figs. 20 A–D, 19A) is a frequent feature of these notched tools as well as those from Member 5. These points also frequently show evidence of preparation or utilisation.

Tools that are evidently compound or for multiple use (fig. 20B) provide obvious difficulties in any formalised scheme of classification.

The tools classified as planes (fig. 18) are generally more regular in shape than the scrapers, far greater advantage having been taken of natural fracture planes, either by splitting along such planes or attempting to do so.

Figure 18A and B illustrates a commonly occurring form in which crude preparation is overall but for the two steep lateral margins. The two sides of these tools are cortical, as in the "chopper" (fig. 14A) from Member 5.

The boldly flaked straight edged scraper made from a flake (fig. 21) illustrates the nature of the small scale damage on a working edge — in this instance the damage is comparatively coarse. One end of this tool (seen obliquely on the right) provides a similar but shorter working edge, the blunt point at the corner seemingly being a deliberate feature.



Figure 15. A flat based chert pebble from Member 5 showing continuous small-scale damage of the margin. The almost overall polish is a feature of cherty materials recovered in comparatively small numbers from the south-west side of the Cone.

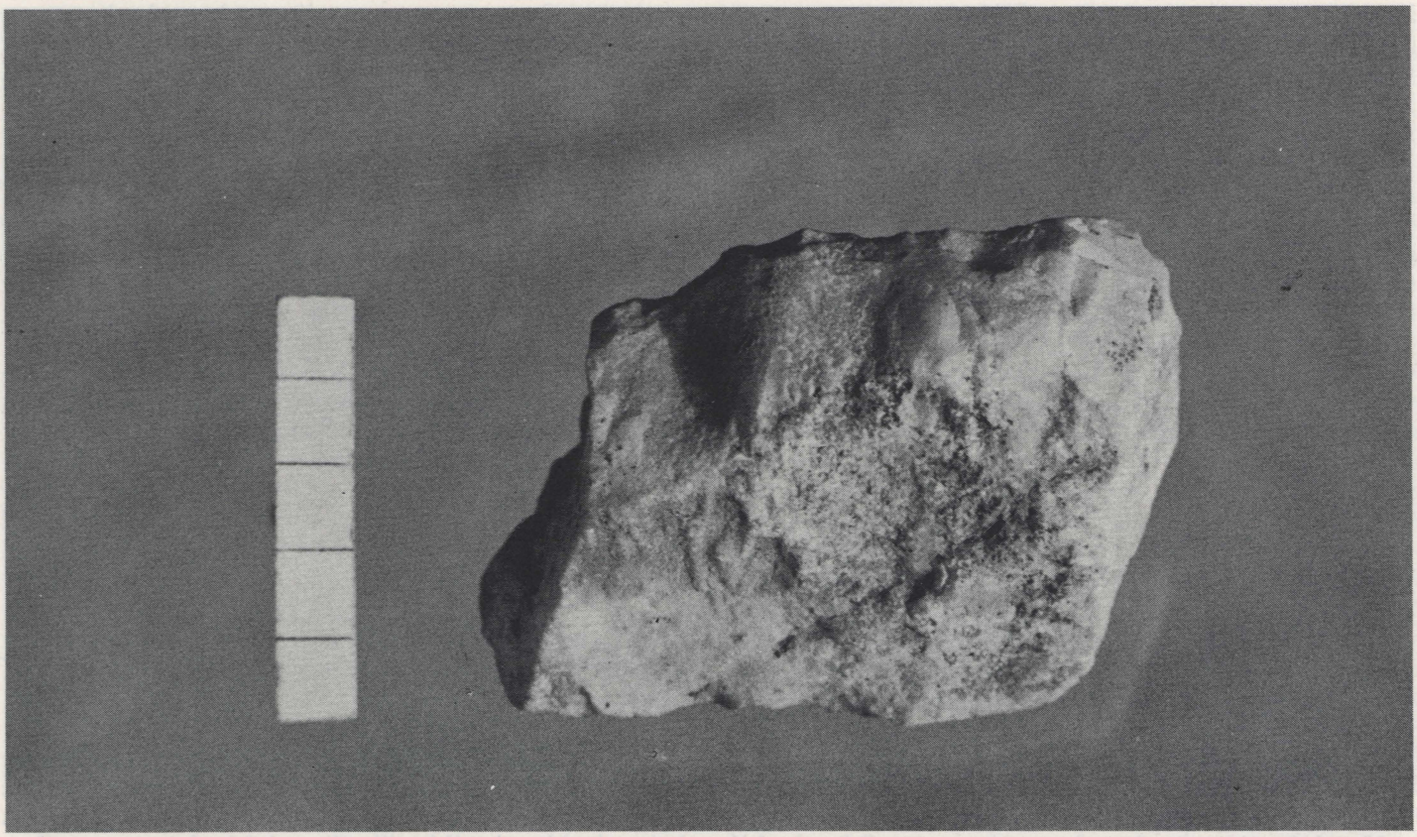

Figure 16. A straight-edged chert scraper from Member 5. Much of the viewed face and the right end are natural cortex. Note the uniform preparation by flaking of the working edge (top) which has been followed by continuous small-scale chipping of the same edge.

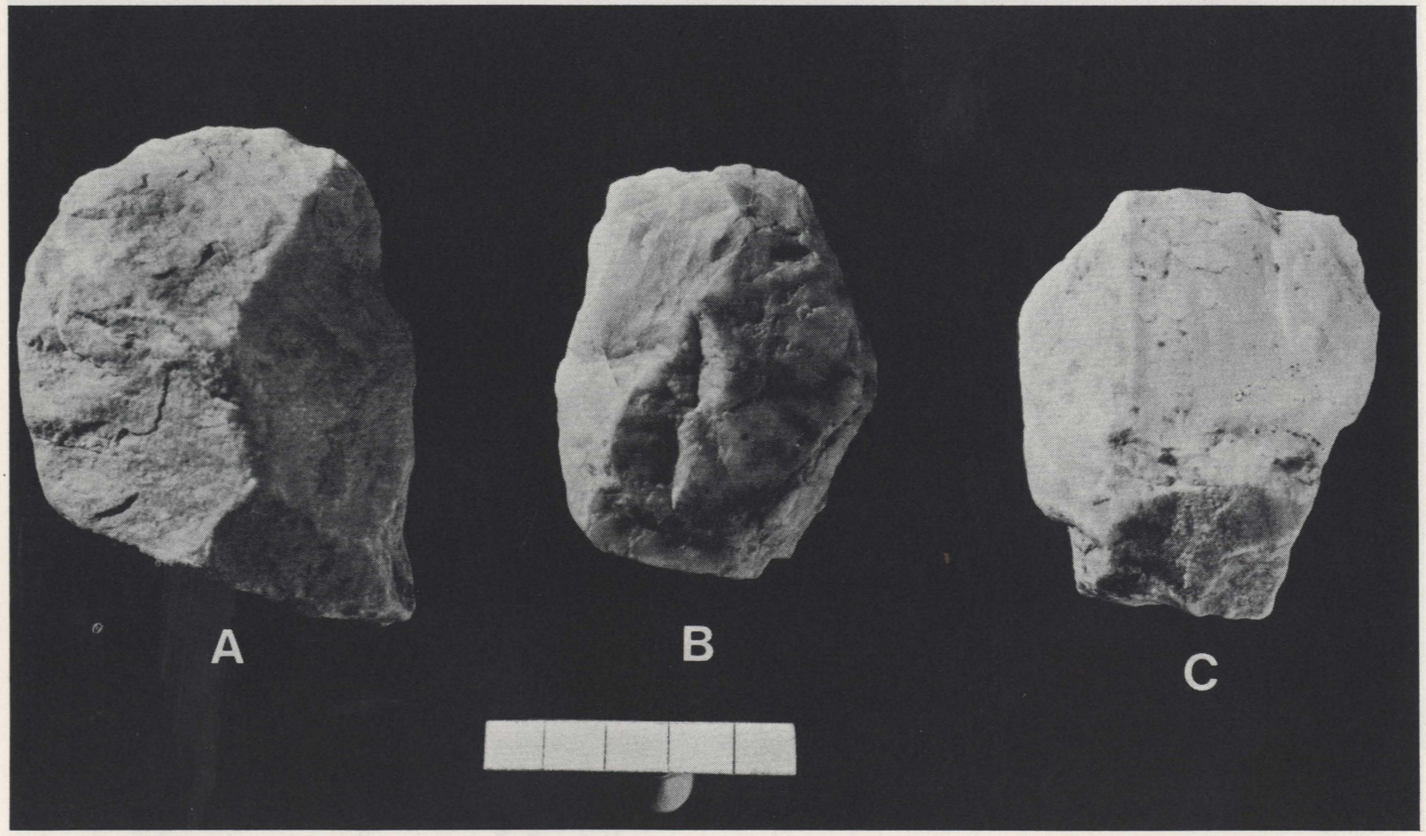

Figure 17. Three chert planes from Member 5 seen in dorsal view, finely damaged working edges uppermost. The flat base of C is probably cortical, otherwise preparation appears to have been overall.



Figure 18. Three chert planes from the overburden, terminal working edges uppermost.
(A,B) only the steep lateral margins are cortical;
(C) a crudely prepared specimen which is largely cortical.
Note the short lateral point produced between two flake scars on the working edge.



Figure 19. (A) a chert notched scraper from the overburden:
(B) a weathered specimen in cherty dolomite from Member 5 (same specimen as fig. 13B) for comparison with A.

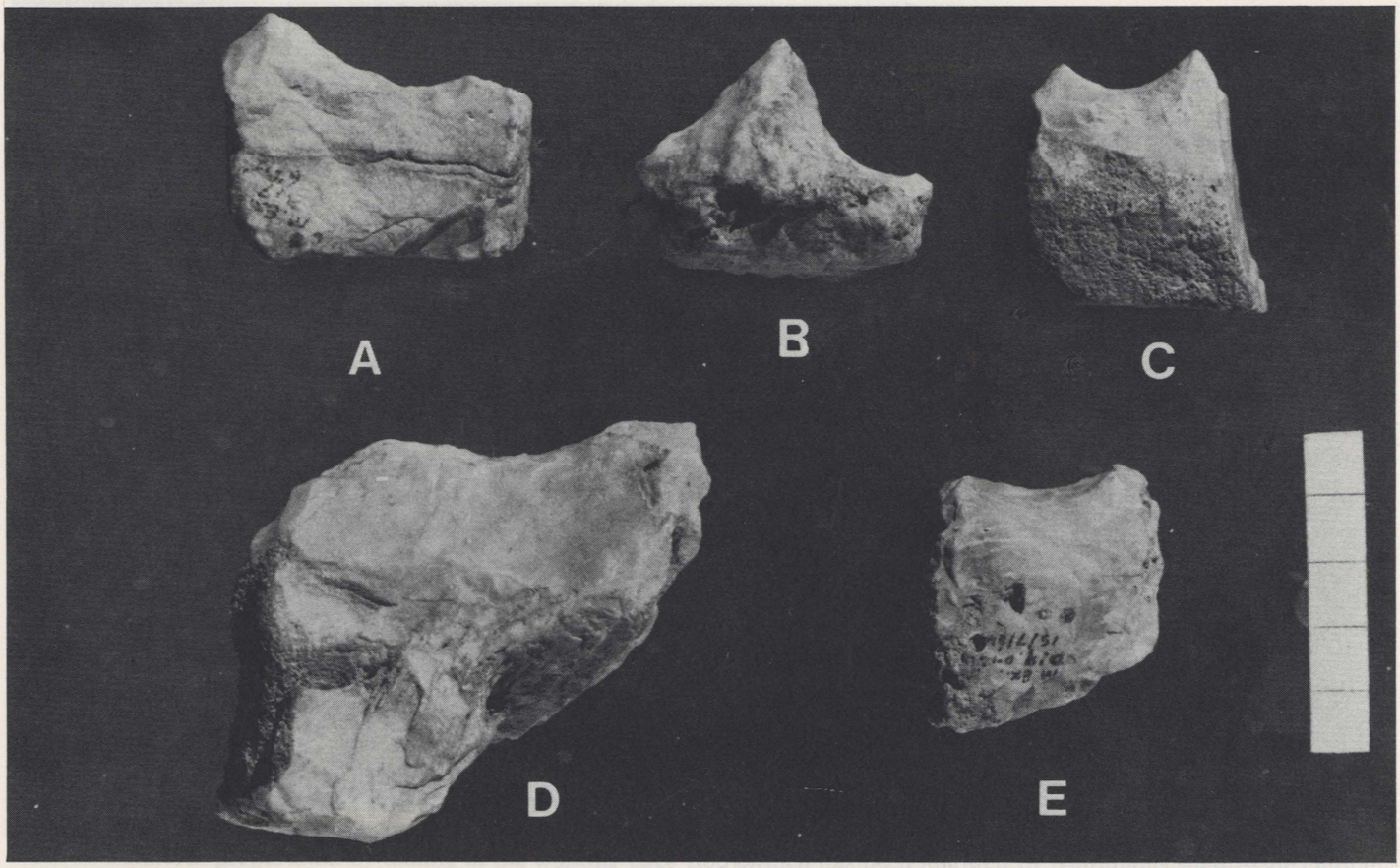

Figure 20. Five chert notched scrapers from the overburden, seen in dorsal view. All show evidence of preparatory work, and all except E appear to be on flakes. B appears to be a multi-purpose tool, the smaller-scale marginal damage being continuous and intense over the entire perimeter.



Figure 21. A stout straight-edged chert scraper from the overburden. This tool was made on a struck flake, preparation of the dorsal face involving removal of three flakes. Note the regular unifacial small-scale damage along the main working edge.

Breccia of uncertain provenance

The split quartzite pebble (fig. 22) showing considerable scarring by flaking was recovered from the surface near the exit cutting of the North-east Quarry (fig. 1). The flaking and chipping along the convex lower edge suggests that this piece may have been intended as a planing tool; however, the somewhat random striking of at least four flakes from it (fig. 22, left) suggests that it may also have served as a core. The writer thinks it probable that this specimen was derived from the upper levels of the original deposit of Member 5.

Figure 23 illustrates a much damaged subspheroidal hammerstone or pounder made of vein quartz which was recovered from a dump of mining waste west of Horse Mandible Cave (fig. 1). The adherent breccia appears to be of Member 5 type. While numerous very crude tools and utilised fragments of vein quartz are associated with those of chert and quartzite in the overburden, pounders resembling this subspheroid are rare.

DISCUSSION

The 45 artefacts described and illustrated in this paper were selected from various of the lithicultural samples to present a broad picture of toolmaking activities and of the raw materials used throughout the Limeworks deposit.

I believe that the criteria used in the analysis, and particularly those referring to the small scale damage on the working edges of suspected artefacts, are valid. Natural mechanical damage is considered to be identifiable by its more or less random nature. In extreme form, such as in the active transport of rock fragments by water, natural damage results in gradually increasing smoothness and symmetry of the transported fragments. This aspect of symmetry or regularity, in many respects comparable with that sometimes produced artificially on hammerstones by repeated percussion, is a consequence of the pebble having been subjected to countless active stresses applied from many different directions. The rock fragments in the Limeworks sample show no obvious signs of having been subjected to such highly repetitive natural forces.

Mason (1965) and others have suggested that various natural forces in the soil, including the phenomenon known as "soil creep", cause fractures on rock fragments which may be difficult to distinguish from those deliberately produced on stone artefacts. While it is clear that such natural fracturing must occur, all the available evidence provided by the analysed lithicultural materials taken from the rubbly soil of the Limeworks overburden clearly indicates that damage attributable

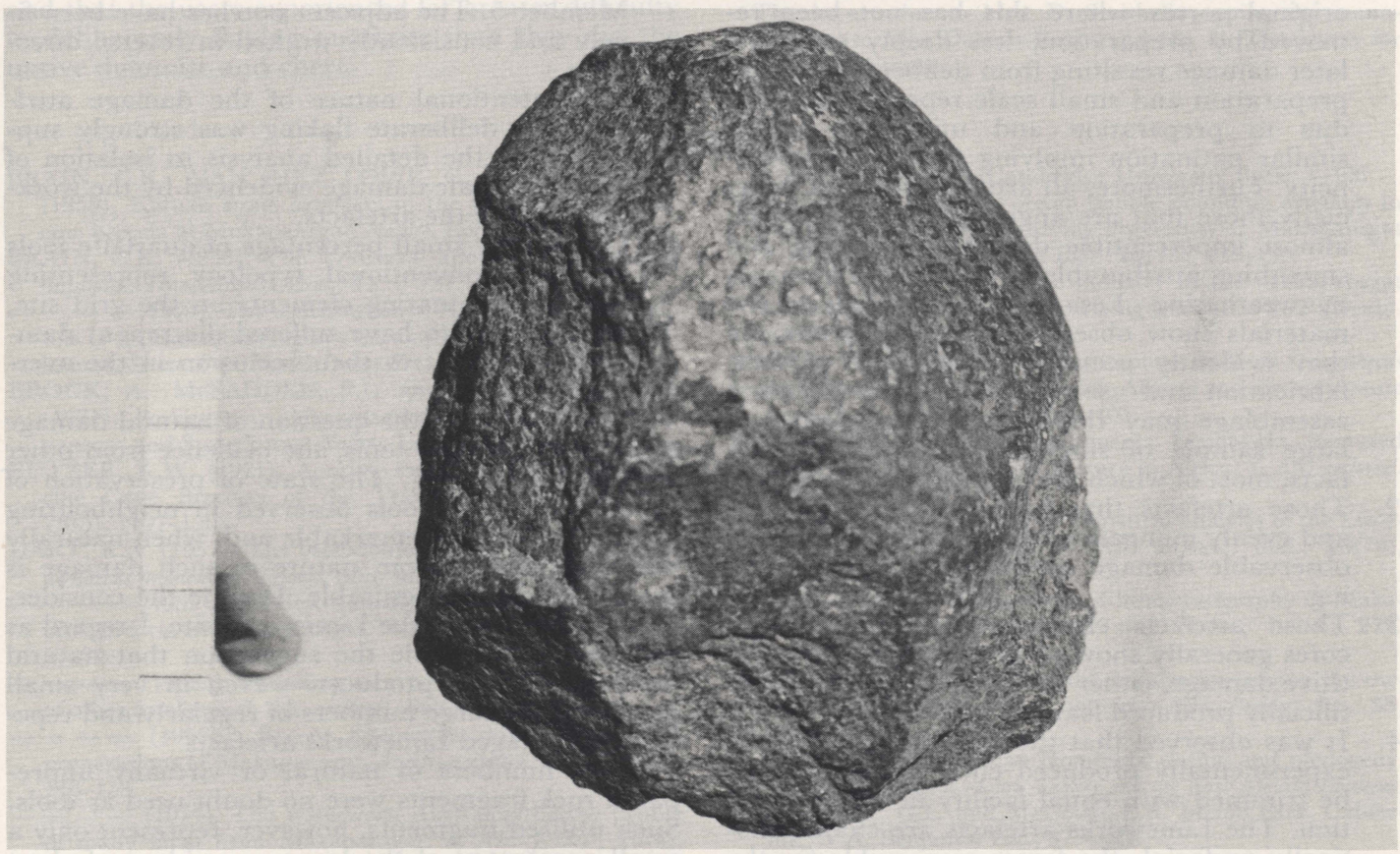

Figure 22. A stout quartzite core or plane-like tool weathered from breccia of indeterminate provenance; made from half of a moderately waterworn pebble which was split by a blow struck in the middle of a flat side. The resulting fracture face provided the striking platform for preparing the trimmed convex edge below. The flaking on the left appears somewhat random.

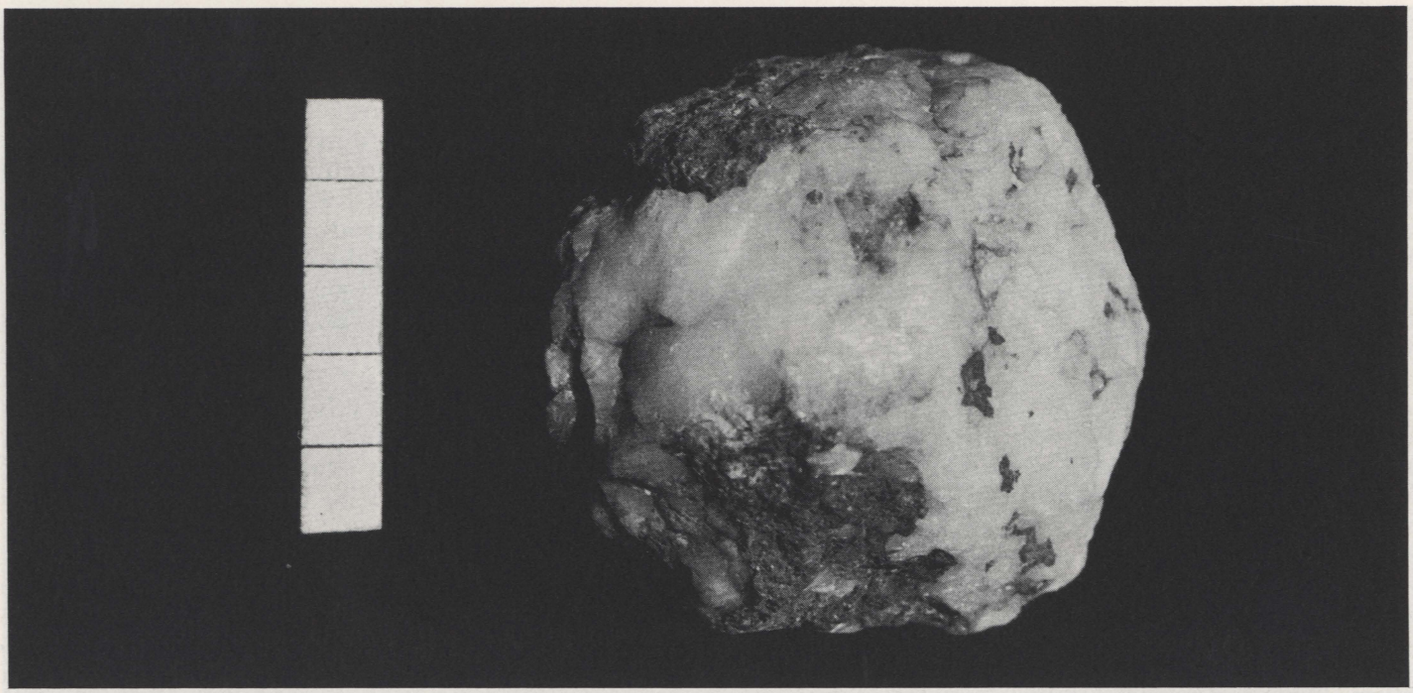

Figure 23. A subspheroidal pounder or hammerstone of vein quartz recovered from a Limeworks dump. The adherent breccia appears to be Member 5.

to soil creep is negligible. This conclusion is supported by several observations.

1. The 2 328 selected specimens show special features of patination: more deeply patinated original cortex where this has not been removed by preparation; less deeply patinated later damage resulting from deliberate primary preparation and small scale repetitive damage due to preparation and utilization — their similar patination implying their contemporaneity. Furthermore, all artificial features, especially those that are angular, show a uniform, almost imperceptible degree of rounding and smoothing attributable to subsequent abrasion by weathering. Less than 1 per cent of the materials show observable discrepant damage that evidently occurred subsequent to their fabrication and use as tools. The overburden assemblage may therefore be regarded as a large sample of singularly undamaged artefacts, most of which are considered to be tools.
2. Those artefacts that have been very densely and evenly manganese stained show no trace of observable damage subsequent to their staining.
3. Those artefacts clearly representing simple cores generally show no perceptible later repetitive damage, either fine or coarse, on their artificially produced features.
4. It was observed that the working edges of the experimentally produced chert artefacts could be trimmed with equal facility in either direction. The Limeworks artefacts are characteristically unifacial, the forces responsible for the small scale damage on working edges being almost invariably directed towards the more irregular of the two faces — usually the dorsal face. Occasional, evidently deliberate variations occur; note, for example, the perfect state of preservation of the working edges of the double notched scraper (fig. 12D) from Member 5. The adjacent notches have been finely and consistently worked in reverse directions.
5. The intentional nature of the damage attributed to deliberate flaking was strongly supported by the detailed analysis in isolation of the small scale damage evidenced by the working edges of the artefacts.
6. Of the very small percentage of quartzite tools of more conventional typology representing later contaminating elements on the grid site, none appear to have suffered discrepant damage subsequent to their inclusion in the overburden.

With a bearing on the question of natural damage and the Limeworks tools, the evidence from other sites is illuminating. The state of preservation of middle stone age tools observed in neighbouring open sites is often remarkable and, when naturally damaged, the random nature of such damage is usually readily recognisable. Despite the considerably greater age of the Limeworks site, I regard as completely untenable the suggestion that natural fracture was the producer — even in very small part — of the large numbers of regularly and repetitively damaged Limeworks artefacts.

Large numbers of natural or virtually unprepared rock fragments were no doubt used as tools. Such utilised fragments, however, represent only a small percentage of the large assemblage of chert artefacts recovered from the overburden.

The selected sample of more than 1 800 chert artefacts excavated from that part of the overbur-

den covered by the excavation grid represents the most critically analysed sample of the overburden assemblage. The artefacts are generally crude, and vary widely in shape and size. However, although ranging from approximately 12–200 mm in greatest dimension, most of them (89,5 %) fall about equally within the size ranges of 25–50 mm and 50–100 mm. Most of these artefacts comprise tools termed notched scrapers and planes. The marked unifaciality of the small-scale damage to working edges, which is attributed to utilisation or preparation or both, is a very characteristic feature.

Evidence has been presented that quartzite was artificially introduced into the cavern site and also that the crude quartzite tools in the overburden and solution cavities — and many, if not all of the associated chert artefacts — were derived by decalcification of the underlying cavern breccias. That these elements were largely derived by decalcification of an originally more extensively developed Member 5 breccia is indicated by their present overwhelming concentration in the immediate vicinity of the Cone (fig. 3) — both in the *in situ* Member 5 breccia and in the overburden. Except for their rare appearance in what appears to be a terminal stage of the accumulation of Member 4 breccia, quartzite inclusions appear to be exceedingly rare in the older parts of the calcified deposit.

It is concluded that the quartzite pebbles and fragments were primarily utilised for percussion and that the users experienced far greater difficulty in deliberately flaking quartzite than they did the native dolomite and chert.

Elsewhere I suggested that, in its cultural aspects, the Limeworks deposit appears to represent a logical progression from the use of the most easily available and tractable materials to those less easily procurable but of a more durable and efficient nature (Maguire 1968). Thus, mainly bone and occasionally stalactite fragments were used in Member 3 times; native dolomite and chert were used in Member 4 times; native rocks and small numbers of introduced pebbles of quartzite were used as raw materials in Member 5 times. The evidence from the overburden suggests that the more durable material, quartzite, was more frequently used in the terminal stages of the accumulation of the Member 5 breccias. However, it would appear that it was only at this very late stage in the cavern's history that the hominid inhabitants had learned to flake the local quartzites fairly proficiently.

ACKNOWLEDGEMENTS

I am indebted to Professor Raymond Dart who initiated these investigations and particularly to Professors M.A. Raath, T.N. Huffman and Dr. J.M. Maguire for much advice and assistance in the preparation of the final draft.

For advice and criticism I would particularly thank Dr. Mary Leakey, Dr. C.K. Brain, Mr. P. Beaumont, and Drs. Brian Fagan and C.F. Sampson. Advice and assistance have also come from Dr. J.W. Kitching, Professor P.V. Tobias, and Mr. Alun R. Hughes. The late Mr. William Makondo is remembered for his quite invaluable assistance in the recovery of lithicultural materials from the Limeworks site.

Thanks are due to Mrs. D. Smith for typing the manuscript, and to Miss Dolores Rokos and Mr. H. Thackwray for technical assistance.

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