University of Alberta

An Analysis of Later Stone Age Assemblages in Southwestern Tanzania

by

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A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the requirements for the degree of *Master of Arts*

Department of *Anthropology*

Edmonton, Alberta

Fall 2000

0-612-59741-5

University of Alberta

Library Release Form

Name of Author: *Charmaine Gayle Sipe*

Title of Thesis: *An Analysis of Later Stone Age Assemblages in Southwestern Tanzania*

Degree: *Master of Arts*

Year this Degree Granted: *2000*

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Date: August 2, 2000

Abstract

This thesis presents data on the excavation of a single test pit at the site of IdIu22 located near the Songwe River in southwestern Tanzania and is part of an ongoing research project by Dr. P. Willoughby to establish a culture historical sequence for this area. Lithic assemblages excavated in 1997 from test pit 4 are analyzed using a classification developed by M. Mehlman for East African stone tools. Stone artifacts are also assessed by technology. Analysis and discussion will be centered on placing the site in a temporal context. Therefore the lithic material is also compared to Middle Stone Age and Later Stone Age assemblages in other parts of East Africa in an attempt to understand the nature of lithic variability. It is concluded that IdIu22 is a Later Stone Age site with occupation extending from the Late Pleistocene to the Holocene.

University of Alberta

Faculty of Graduate Studies and Research

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled *An Analysis of Later Stone Age Assemblages in Southwestern Tanzania* submitted by *Charmaine Gayle Sipe* in partial fulfillment of the requirements for the degree of *Master of Arts*.

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Date approved: July 31, 2000

Dedication

This thesis is dedicated to my family, without their sacrifice, support and nagging this document would not have been completed. They have been my rock.

Acknowledgments

I would like to express my gratitude, first and foremost, to Dr. P. Willoughby for her academic support. I am continually amazed at the breadth of her knowledge. Second, thank you to Katelin Nagy for her wonderful illustrations. I am in awe of her talent. Finally, thanks to the various graduate students who volunteered their time and skill in the lab. You made the time spent in there so enjoyable.

Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction and Background

1.1 Introduction and general background

Contrary to Butzer's (1971:462) description of Africa as a "cultural backwater" in the Upper Pleistocene, the African continent must be considered a principal player in the global scheme of evolution. All stages of human evolution are represented on this continent and our own species, *Homo sapiens*, is acknowledged by the majority of palaeoanthropologists to have originated on the "dark continent" somewhere between 100,000 and 200,000 years ago (Klein 1992; Willoughby 1993; Foley and Lahr 1997; Deacon 1998; Stringer and Andrews 1988; J. Clark 1989). However, many Palaeolithic archaeologists still rely on the Eurocentric view that considers Western Europe as the center for innovation and culture in the remote past. The earliest stone artifacts, dating to around 2.4 million years ago (mya), are found in East Africa (Schick and Toth 1993: 78, Klein 1989:163, Clark 1993:149). Recent evidence shows that Africa was the heartland of modern human origins. Modern human fossil remains in association with stone artifacts, with increasingly earlier dates, indicate that African people were innovators in stone age technologies and culture in all periods during the Pleistocene. "No longer can this continent be regarded as peripheral or lagging behind in the cultural innovations which distinguish anatomically modern people from their predecessors" (Phillipson 1994:100).

Stone artifacts and retouched tools represent the first evidence of material culture and human behaviour. Assemblages, or groups of stone tools which are found together, have been traditionally divided into chronological stages based on their form, function, which types are present and in what frequencies. These stages/periods were defined on increasing complexity in manufacturing and shape, and are seen as markers of changing intelligence (Binford and Binford 1969; Bordes 1961; de Sonneville-Bordes and Perrot 1954-56; G. Clark 1977). For North Africa and Eurasia, the major chronological divisions are Lower Palaeolithic, Middle Palaeolithic and Upper Palaeolithic. The earliest stage in the Lower Palaeolithic, the Oldowan, is characterized by core and flake tools including choppers and polyhedrons (Klein 1989:165, Whittaker 1994:25). These were later replaced, approximately 1.4 mya (million years ago) (Klein 1989:167,424) by the handaxes and cleavers of the Acheulean, which lasted until around 200,000 BP (before present). The Middle Palaeolithic, which dates from 200,000 to 30/40,000 BP is flake-based, but composed of retouched stone artifacts such as scrapers, points and denticulates, manufactured using varying amounts of Levallois technology. In contrast, the Upper Palaeolithic (30/40,000 - 10,000 BP) is blade-based and dominated by end scrapers, burins and truncations. For sub-Saharan Africa similar stages are referred to as the Early Stone Age (ESA), the Middle Stone Age (MSA), and the Later Stone Age, (LSA), respectively. These stages change at approximately the same time as the chronological divisions of North Africa and Eurasia. However, the LSA of sub-Saharan Africa is technologically more like the Mesolithic or Epi-palaeolithic of Europe and North Africa rather than the Upper Palaeolithic, in that it is dominated by backed bladelets and geometric segments (G. Clark 1977).

The technological changes observed in Africa are often accompanied by changes in the hominid species. The start of the Oldowan tool tradition is associated with the appearance of *Homo habilis* and the Acheulean is associated with *Homo erectus* and archaic *Homo sapiens*. Approximately 200,000 years ago the Middle Stone Age started in sub-Saharan Africa and sometime between 100-200,000 years ago (or 100-200 kya) modern *Homo sapiens* evolved in Africa, according to mitochondrial DNA and fossil evidence (Cann et al. 1987; Stringer and Andrews 1988). The technology, however, did not change as abruptly as it had earlier when a new hominid species appeared. Fossil remains of modern humans are associated with Middle Palaeolithic (MP) technology in North Africa and Middle Stone Age or MSA technology in sub-Saharan Africa. Jebel Irhoud in North Africa and Border Cave or Klasies River Mouth Cave (Klein 1989:285-286) in South Africa are examples of sites with modern skeletal remains in association with MP/MSA artifacts. However, when modern *Homo* humans appeared in Europe approximately 40-30,000 years ago, their appearance was accompanied by technological changes that signaled the beginning of the Upper Palaeolithic. Anthropologists now question whether behavioural modernity (in an Upper Palaeolithic sense) accompanies anatomical modernity and, if not, how behavioural modernity is expressed archaeologically: when does modern behaviour begin, and are all anatomically modern *Homo sapiens* modern in their culture too?

Features of the Upper Palaeolithic which are said to mark behavioural modernity in Europe includes standardized blade technology, parietal and portable art, and new kinds of tools in bone, antler and ivory. Some researchers believe (Chase and Dibble 1987; Hayden 1993, Mellars 1991), that it is not until 40-30 kya that "modern" behaviour developed (Stringer and Gamble 1994), regardless of when (or where) modern anatomy developed. African modern humans developed similar technologies at roughly the same time. In sub-Saharan Africa this new technology is called the Later Stone Age (LSA) and extends from 40 kya to the appearance of pastoralism or agriculture, a few thousand years ago. This raises questions of whether or not the MSA/LSA transition marks the development of behavioral modernity in Africa as it supposedly does in Europe or can one see modern behavior archaeologically in the Middle Stone Age?

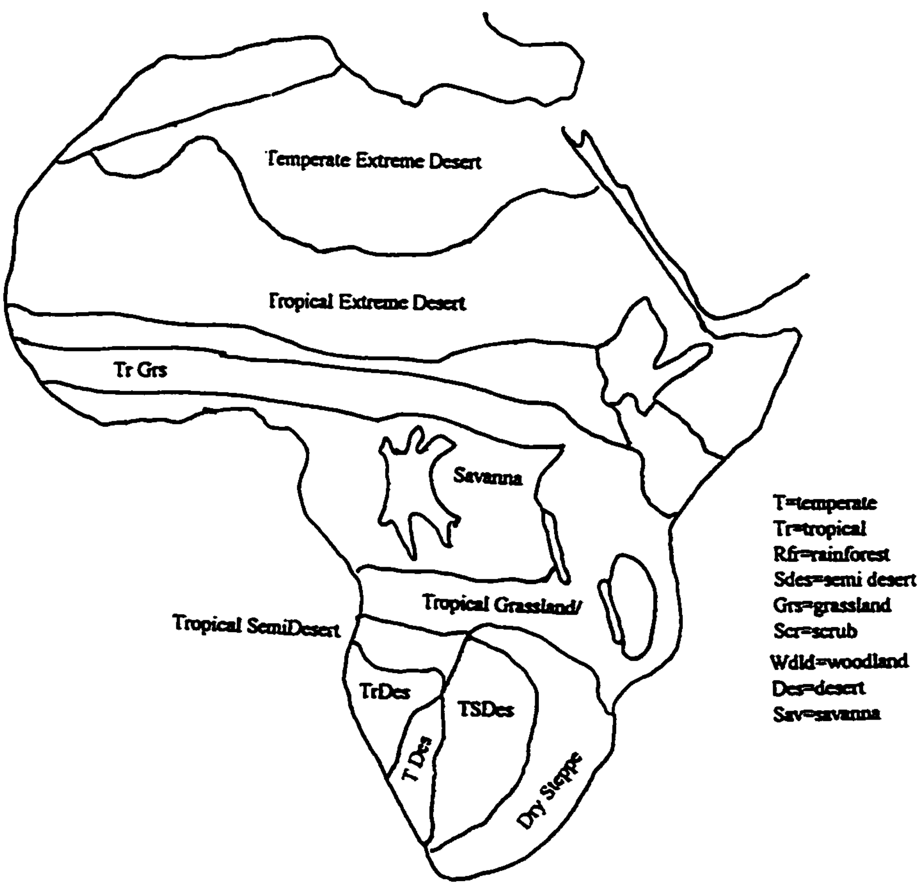
Other archaeological features of behavioural modernity include is a tool kit in a wider variety of raw materials, rather than just stone. At the beginning of the Upper Palaeolithic, tools also begin to be manufactured in bone, ivory and antler. There are tools present that seemed designed for specific functions, the bone harpoons for fishing during the Magdalenian period are one example. Technology changes more rapidly; rather than a long period of stasis, as seen in the Lower Palaeolithic, now there are many divisions in a short period of time (Aurignacian, Perigordian, Magdalenian, Azilian, etc) and they appear to be regionally specific. There is physical evidence of symbolic thought; in parietal art, such as the cave paintings at Lascaux, France, and/or mobilary art such as the famous Venus figurines (Mellars 1991). There are objects of personal ornamentation found in Upper Palaeolithic sites again in a variety of materials including bone, teeth, and stone.

In addition to artifacts, there is increasing complexity in the organization of occupation sites, with definite areas for specific functions. For example, at sites such as Dolní Vestonice (Czechoslovakia) and Pushkari 1 (Ukraine) (Klein 1982), there are cooking, tool making and sleeping areas and they are separate from each other. Occupation sites are more numerous and it is more common to find both cave and open-air sites (Straus 1995; Klein 1992; Mellars 1991). A variety of food sources such as fish, shellfish, and plant foods are exploited in any given region, in addition to hunted meat. This is a contrast to older sites where the evidence appears to indicate a diet dominated by hunted or scavenged meat. All of these features seemingly explode on the archaeological scene at approximately 40,000 years ago and define the Middle/ Upper Palaeolithic boundary in Europe. Because of this explosion, some researchers including Lewis Binford (1973, 1989) and Richard Klein (1989, 1995), believe that behavioral modernity, regardless of area, does not begin until 40,000 years ago when the Upper Palaeolithic begins in Europe and North Africa (or the coeval LSA in sub-Saharan Africa).

However, other research believe there are LSA/Upper Palaeolithic elements in various areas of Africa during the MSA which may indicate the presence of modern behaviour. J. Desmond Clark (1988), for example, suggests that the regional differentiation in African stone tool assemblages is the beginning of ethnicity and thus a subtle modern behavioural marker. There is blade technology present in the Acheulean at 240,000 B.P. in the Kapthurin Formation near Lake Baringo in central Kenya (McBrearty et al. 1996, Bar-Yosef and Kuhn 1999) and tanged elements may indicate functional equivalent choices in hafting technology in the Aterian in North Africa (Debénath 1994). The Howiesons Poort industry of South Africa dated to approximately 60-80,000 BP (Deacon 1989; Klein 1989:308; Ambrose 1998: 388) is technologically LSA (Upper Palaeolithic) in its concentration of large geometric tools, yet is MSA in age, as it is always sandwiched between an upper and lower MSA layer made on flake blades (blade-like blanks produced on a prepared core) (Deacon 1989;Thackeray 1992).

The portion of Africa this study is concerned with is known collectively as East Africa, although the area is also considered part of sub-Saharan Africa. East Africa proper includes Kenya, Uganda and Tanzania but Ethiopia and Somalia are sometimes included (Robertshaw 1995:57). The Sahara Desert may have presented a major geographic barrier for some of the time period this study is concerned with (200,000 - 10,000 years ago). Consequently, when talking about the effect of the environment on regional homogeneity, effectively, East Africa would be linked geographically more with the areas south of the Sahara desert than with North Africa. At the farthest point in time (for this study), between 150 - 130 kya (OIS 6 or Oxygen Isotope Stage 6) at the maximum of the penultimate glaciation there was an extended desert throughout North Africa. In contrast, at 125 - 120 kya (OIS 5e) there was a moist phase causing increased rainforest and the deserts to be virtually covered with vegetation (Van Andel and Tzedakis 1996 in Adams 1998). Desert conditions in the Sahara Desert at the Last Glacial Maximum (LGM), averaging around 18,000 BP (Figure 1.1) resulted in an extension of its southern edge by at least five degrees (Adams 1998:1), which also contributed to a drier and cooler climate in the uplands southeast of the desert and in East Africa. The tropical rainforest along the equator in central Africa may have also disappeared or shrunk into small patches or refugia. In the early Holocene, 9,000 BP (Figure 1.2) the Sahara desert, as it exists today, has disappeared replaced by tropical grassland. The tropical rainforest and woodland areas have expanded considerably.

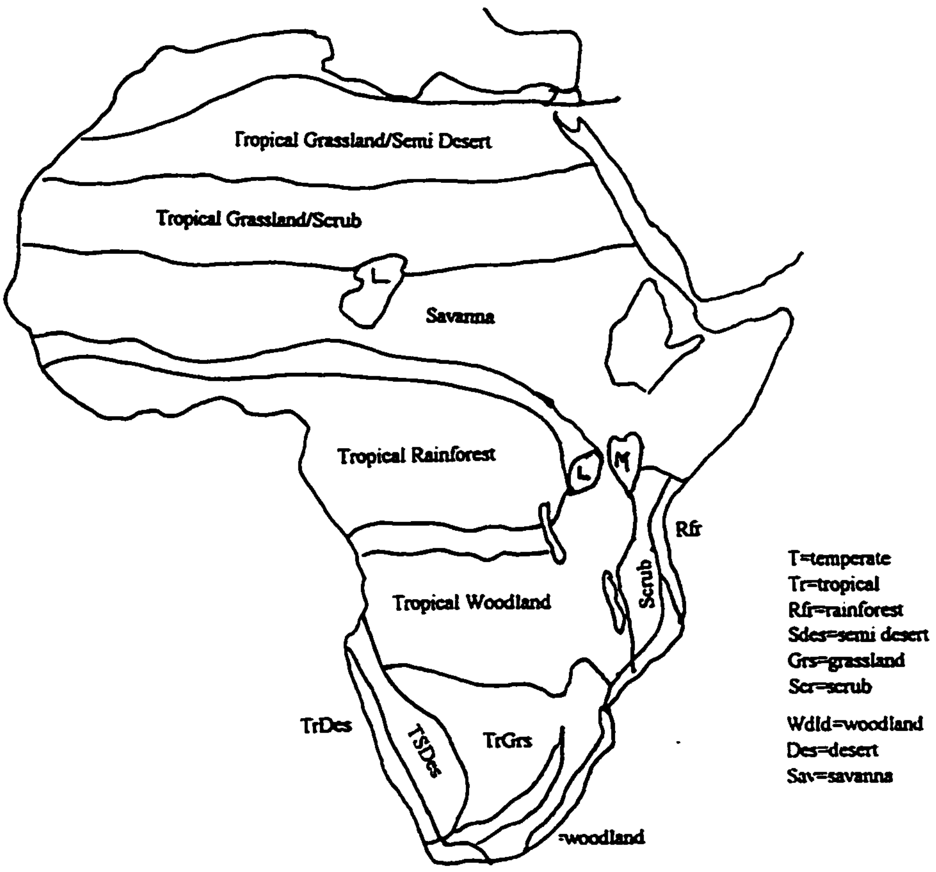
Figure 1.1 Map of Africa at 18,000-13,000 BP (LGM)



redrawn from J.M. Adams & H. Faure (1998), after Van Andel &Tzedakis (in press)

In the western and southern rift valleys the tropical woodland indicates a humid environment. There is savanna at the northern end of the Great Rift Valley.

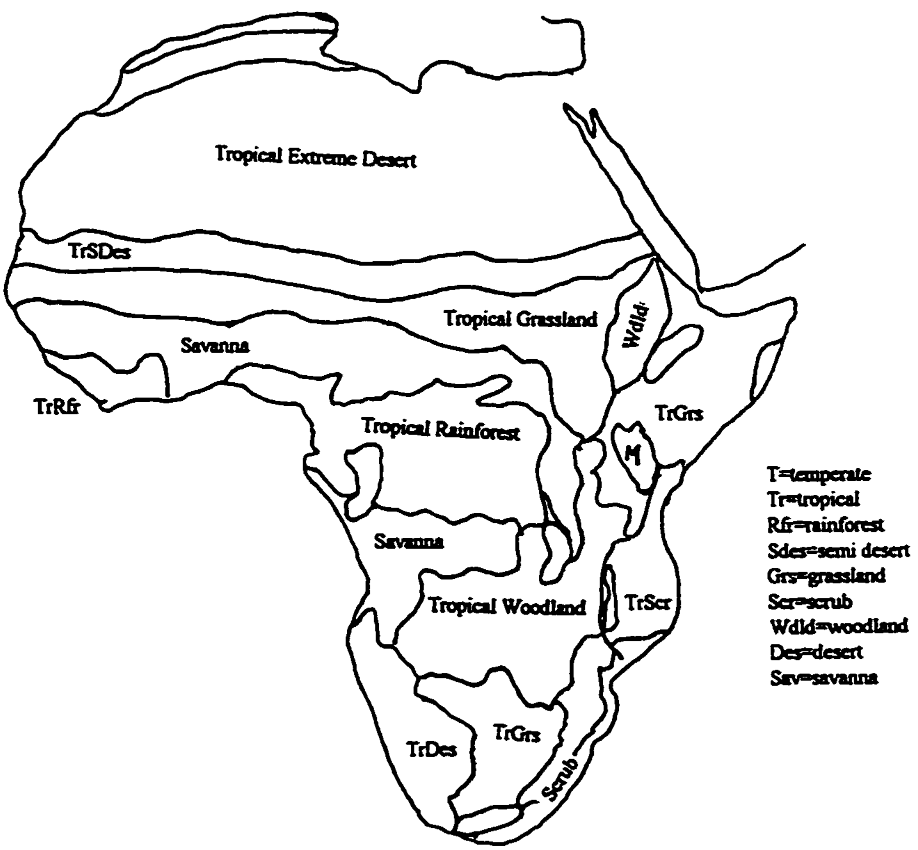
Figure 1.2 Map of Africa at 9,000 - 9,500 BP



redrawn from J.M. Adams & H. Faure, (1998), after Van Andel &Tzedakis (in press)

At approximately 4,000-5,000 BP the conditions are relatively similar to the present although it is generally moister (Figure 1.3). The Sahara and the Namib desert are present although not at the extent they are today. Tanzania had a mixture of woodland and scrub. There were slightly more forested areas due to the slightly moister conditions but the highlands are considered to be similar to current conditions (Adams and Faure 1998).

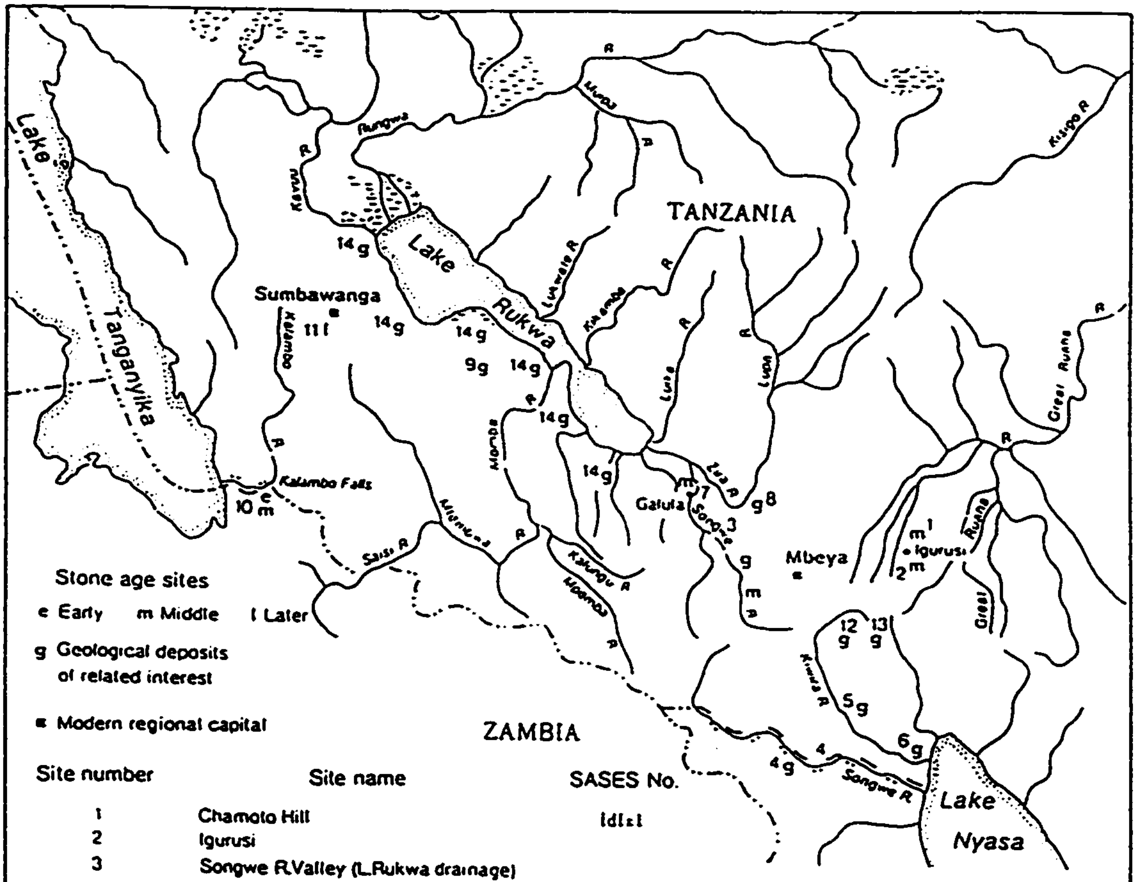
Figure 1.3 Map of Africa at 4,000-4,500 BP



redrawn from J.M. Adams & H. Faure, editors, http://www.esd.ornl.gov

This thesis presents results of the excavation of a single test pit from the site of IdIu22, one of a series of archaeological sites found in rockshelters in a region known locally as Mapogoro, east of the Songwe River in the Lake Rukwa basin of southwestern Tanzania (Figure 1.4). It was excavated as part of an ongoing research project by Dr. P. Willoughby, University of Alberta to establish a culture historical sequence for this area and to understand the MSA and LSA adaptation and behaviour. Surface collections were made in 1990 during a survey of the Songwe river valley and test excavations were conducted at Mapogoro in 1995 and 1997. All lithic artifacts have been sorted using a typology or classification developed by Mehlman (1989) for stone artifacts from Lake Eyasi in northern Tanzania. Tool production and technological attributes will also be assessed using information from a variety of sources. Analysis and discussion will be centered on placing the site in a temporal context. Thus the lithic artifactual material will also be compared to MSA and LSA assemblages in various regions of East and South Africa in an attempt to understand the range of technological change in time and space. It is concluded that IdIu22 is a LSA site where occupation may extend from the Late Pleistocene to the Holocene.

Figure 1.4 Southwestern Tanzania



Site number	Site name	SASES No.
1	Chamoto Hill	IdIz1
2	Igurusi	
3	Songwe R.Valley (L.Rukwa drainage)	
4	Songwe R.Valley (L.Nyasa drainage)	
5	Tukuyu	
6	Kyela	
7	Galula	
8	Zira River	
9	Kipele	
10	Kalambo Falls	
11	Milanzi Rockshelter	IaIo3
12	Elton Plateau	
13	Ileysha	
14	Rukwa Rift Valley	

1.2 Theoretical Problem

Current research trends in African Later/Upper Pleistocene stone age archaeology have emphasized the question of modern human origins as a result of new dating technologies and recent fossil discoveries. This emphasis has had some unexpected consequences for African archaeology. Firstly, researchers began to question the human fossil record and what it means to be an anatomically modern human: is it strictly a matter of biology, or is it something that cannot be seen archaeologically? Searching for answers to this question has revealed many gaps geographically and temporally in African prehistory especially at the time of the MSA-LSA transition. This chapter will present a discussion of modern human origins and its implications for research in Africa, then problems with African archaeology will be addressed.

From an historical perspective, a revolution in dating techniques along with genetic data prompted revisions and debate about the African origin of modern humans. Prior to the discovery of new chronometric dating techniques in the late 1980s and early 1990s, anthropologists were secure in the belief that at the Middle and Upper Paleolithic boundary, 30 - 40,000 years ago, modern humans appeared, replaced archaic *Homo sapiens* (including the European Neanderthals) and a new era in human evolution began. Other regions in the world were assumed to follow this same pattern, which was first recognized in Europe. The existing fossil record seemed support this assumption. Artifacts dated with radiocarbon techniques also supported the conclusion of smart, linguistically and symbolically capable modern humans coming in and replacing the indigenous 'semi-humans'. Radiocarbon dating revolutionized archaeology in the late

1950s. Increasing technological skill was the basis in which prehistorians organize artifacts into a time line and artifacts were dated relative to those that came before. The idea of increasing technological skill as an indication of time does not give the investigator an actual date. The methods used for C14 dating have changed somewhat since the 1950s; dates are now calibrated to reflect the different levels of carbon 14 in the atmosphere at any given time. AMS (accelerator mass spectrometry), a variation of the same technique, can use a very small amount of material for dating (Taylor 1997: 82). The main drawback of C14 dating was and still is its time limitation to approximately 40,000 BP. Therefore, it cannot help with the modern human origins debate (Aitken et al 1993: 4). This restricts the use of radiocarbon dating in archaeology, and places the bulk of the African stone age record beyond its limits.

Two fields of study using techniques developed in the late 1980s and early 1990s, brought the subject of modern human origins to the forefront of palaeoanthropology: geochronological methods like electron spin resonance (ESR) and thermoluminescence (T/L), and mitochondrial genetic research for understanding human history. When these methods were applied to data from sites, scholars were required to rethink their original theories about modern human evolution, modern human behaviour and how that was visible archaeologically (e.g. Schwarcz and Grün 1993 (ESR), Aitken and Valladas 1993 (T/L)) as the old theories did not correlate well with the new evidence.

In the Middle East there are three sites pertinent to this discussion, Skhul, Qafzeh and Kebara, which have all have yielded human fossil material. Skhul and Qafzeh have anatomically modern human "proto-Cro-Magnon" fossil material, Kebara has

Neanderthal remains (Bar-Yosef 1993: 135). Radiocarbon dating initially placed the Skhul and Qafzeh material at the limit of C14 dating, approximately 40,000 B.P. (Aitken et al. 1993: 4) while the Neanderthal of Kebara was dated to 60,000 B.P. by T/L. ESR and T/L dating techniques challenged existing interpretations as they placed Skhul and Qafzeh at 100,000 B.P., not after Neanderthals but earlier and/or possibly contemporaneous with them (Bar-Yosef 1993).

The ESR technique uses tooth enamel which, according to H. Schwarz and R. Grün (1993: 40, 42) is a relatively common material at most archaeological sites. While the frequent presence of teeth at archaeological sites may be questioned, teeth are almost as durable as stone tools and thus make an excellent material for analysis. Electron charges are trapped in the enamel from radioactive radiation in the surrounding matrix and immediate environment. The charges, once exposed to ESR, emit an intense light and this light can be measured. The intensity is a measure of the amount of energy in the enamel to the rate at which the energy was trapped; this ratio can then be transformed into a date (Schwarcz and Grün 1993). ESR does have its problems since researchers are unsure at what the rate tooth enamel absorbs radiation. Consequently, two dates are given with this method, linear uptake (LU) and early uptake (EU). The linear uptake rate assumes that a steady rate of absorption of radiation from the surrounding matrix over the artifact's depositional life. In contrast, the early uptake rate assumes an initial large amount of absorption at the time of deposition but the subsequent amount of absorption would be minimal. By this method, EU is considered a minimum date. Henry Schwarz believes that LU dates are more representative of the actual dates (Schwarcz and Grün

1993:44) because independent age estimates are closer more often to LU dates (Schwarcz and Grün 1993:44). Regardless, this dating technique dated the anatomically modern human remains at Qafzeh, at 100-120 kya.

Thermoluminescence uses a variety of burnt materials and was initially developed for dating ceramics and it dates the last time an object was heated. Thus, in the case of a ceramic pot, it is possible to infer when the object was made. The trapped electrons within the material can be measured by exposure to heat and a date can be calculated from the measure of electrons. For stone tool manufacturing, flint or chert and quartz are the most common raw materials. Both materials are suitable for dating with this method although flint is considered a more stable mineral by Aitken and Valladas (1993:31).

A variation of this technique, optical stimulated luminescence (OSL) uses a light on buried sediments (Aitken and Valladas 1993:28). Again, the amount of trapped electrons is a measurement of the time elapsed, a date, since the material was last heated or exposed to light . Each time the artifact or sediment is heated beyond 400° C the "clock" is reset to zero.

The resetting of the artifact's clock is also a potential problem with this dating technique as it can yield misleading dates. The possibility exists that the last date the artifact was heated high enough to reset its clock to zero may not be indicative of the actual age of the artifact. Fires in the area after the artifact was deposited might change the date. Or, the artifact may not have been heated high enough to reset the clock. This technique produced a date of 60 kya for the Kebara fossil material and 90 kya for the

Qafzeh fossil material (Aitken and Valladas 1993:29).

It was genetic research, however, that really made the difference and prompted one of the most controversial (and ongoing) debates in palaeoanthropology. Part of the mitochondrial DNA (mtDNA) genome evolves at a clock-like rate via neutral mutation and is used to determine the probable date of the origins of modern humans and the location of the our last common ancestor (Cann et al. 1987). Mitochondrial DNA research is based on the DNA located in the mitochondria, organelles within the cell cytoplasm. This DNA has several benefits: it is not involved in the sexual mixing of male and female gametes as is nuclear DNA and thus one does not have to consider recombination as a factor in its variation. Finally, because it is passed only through the female line it seemed reasonable to assume female lineages could be traced through time.

This line of research was first pursued by Rebecca Cann, Mark Stoneking and the late Alan Wilson in 1987. Cann et al. (1987) took samples from 147 individuals which were selected to represent five geographical populations from around the world: Southeast Asia, Europe, Africa, Asia and African Americans. They determined there were 133 mtDNA types using a restriction analysis. Restriction analysis is a method of mapping the DNA strand. Restriction enzymes are introduced to a medium containing the DNA. These enzymes recognize specific sequences on the DNA molecule and split the DNA strands at that point (King and Stansfield 1990: 274-275). A variety of enzymes are usually introduced which result in a number of DNA fragments. The resulting lengths called restriction fragment length polymorphism (RFLP) can then be compared to a known portion of DNA and thus the RFLP is mapped.

In order to determine the rate of accumulations several known dates were considered. Cann et al. (1987) estimated the rate by considering the extent of differentiation in the populations of New Guinea, Australia and the New World (Cann et al 1987:33). Based on the colonization dates of 30,000 ya for New Guinea, 40,000 ya for Austalia and 12,000 ya for the New World (ibid.), they calculated the mean rate of accumulation to be between 2-4% per million years. This rate combined with an average of 0.57% divergence resulted in a date of 140,000-290,000 years for the common ancestor of the surviving mtDNA types.

As they traced the lineage, Cann et al. determined that Africa was the likely place of origin. Africans had the most number of mutations (divergence) from the modern sample indicating their ancestors had been split from the common ancestor first. Additionally, in the two primary branches of the evolutionary tree constructed using the most parsimonious method (the least number of mutations), the one branch lead exclusively to African mtDNA while the other branch also contained African mtDNA.

Cann et al.'s (1987) research was not received well, as reviewed by Vigilant et al. (1991: 1503) because there were a number of perceived problems with the study. The problems consisted of: the use of restriction analysis to compare mtDNA types (considered to be an indirect method) (ibid), used the mid-point rooting method for placing the common mtDNA ancestor on the human mtDNA tree (considered to be an inferior method) (ibid.), the lineage conclusions were not well validated statistically and finally, they used African Americans to represent native African mtDNA types (Vigilant et al. 1991:1503).

Vigilant et al. (1991) repeated Cann's research and addressed the perceived problems. First, they purified DNA, amplified two segments of the mtDNA control region and then directly sequenced the segments, a method called Polymerase Chain Reaction (PCR). The principal difference between the two methods is PCR is a direct method and restriction analysis is an indirect method (Vigilant et al. 1991:1503).

Instead of using North American samples of various geographical populations, Vigilant used samples from the actual geographical areas that included 121 native Africans from various sub-Saharan locations. Vigilant's research subsequently validated Cann et al's use of African American mtDNA as representative of native African mtDNA.

An outgroup rooting method was used for establishing the time of origin with chimpanzees as the outgroup. This method assumes that there is not the same rate of evolution in all lineages. The difference between humans and chimpanzees in the control region sequences (15.1%) is calculated with the date of the human-chimpanzee divergence (4-6 mya) (Sarich and Wilson 1967). This results in a date in the range of 166,000 - 249,000 ya for the ancestor of modern humans consistent with Cann et al.'s date of approximately 200,000 years ago.

Finally, Vigilant statistically tested the African origin hypothesis using two different methods: the "winning sites" method and the "geographic states" method. The winning sites method is based on the number of mutations; the geographic states method tests the geographical areas of the sample. In both tests the African origin tree is statistically the most likely even with other places as possible outcomes.

The new study by Vigilant did not quiet all the dissenters (and still has not) but it did answer most of the problems of the first analysis. One problem that did resurface was the rooting method for the tree. Many believed a non-human outgroup (interspecies) should not be used since there was no proof that chimpanzees mtDNA evolved at the same rate as humans. Consequently another group was proposed, the same group that Cann et al. used in the original study and was severely criticized for; the initial human colonization of Papua New Guinea. The justification: humans were being compared to humans (intraspecies). The date of colonization was revised, at the time of this controversy (approximately 1992), to be around 60,000 ya (Stoneking 1993a: 66, Stoneking 1993b: 96). Regardless, a date of 63,000 - 416,000 (ibid.) for the last common ancestor was the result. It still agrees with the previous studies although the range is larger.

The currently accepted dates for the origin of modern humans, between 100,000 to 200,000 years ago, place their appearance within the Middle Stone Age in Africa. Thus, researchers interested in archaeological evidence of modern human behaviour sparked a renewed interest in the material culture of the Middle Stone Age of sub-Saharan Africa. An unexpected result, however, is that it has highlighted some problems in East African archaeology. There has been a polarization on the time periods studied. Archaeologists have emphasized the more recent periods of human prehistory: Iron Age, Later Stone Age (LSA) and Neolithic and/or the earliest period, the Early Stone Age (ESA). The emphasis on the ESA is as a result of anthropologists and lay persons fascination with human origins. The romantic idea of a Louis Leakey type figure, pith helmet on head, exploring unknown regions of Africa and discovering the world's oldest stone tools captures the public's imagination, and of course the funding sources. Interest in the later cultures may be due to preservation factors; as more varied artifacts are found in the later archaeological record and are thus easier to locate. Within these time periods there has also been an emphasis on different topics. The ESA has focused on the archaeology of human origins from the very earliest appearance of hominids to, as discussed earlier, anatomically modern *Homo*. The Iron Age, the Neolithic and part of the LSA are in the Holocene Epoch (10,000 years ago to present). The emphasis in these periods have been in pottery, pastoralism, art, linguistics and the nature of pre-colonial society and cultures (Robertshaw 1995).

There is also definitional problem with the Middle Stone Age. The term Middle Stone Age was first defined by Goodwin and Van Riet Lowe (1929) on the basis of lithic assemblages from South Africa. However, since that initial definition, the term has come also define the time period from 200,000 to 30,000 years ago regardless of the type of technology practiced during this time (Mehlman 1989; Miller 1993). Chronology has become confused with technology.

Additionally, lithic terminology is not necessarily universal: sub-Saharan Africa nomenclature is different from European Palaeolithic. Although, the creation of specific African terms different to Europe, (e.g. Early Stone Age instead of Lower Palaeolithic) was a deliberate attempt in 1947 by the Consultative Committee on African Terminology during the First Pan African Congress on Prehistory (Robertshaw 1995; Mehlman 1989) to separate African archaeology from European models, terms and approaches. It was hoped it would foster a distinct and separate identity for Africa and it has been relatively successful. The establishing of a three-age system, Early, Middle and Later Stone Age at the 1947 conference did help the confusion somewhat. The previously mentioned assemblages thus became incorporated within the larger culture historical stages. A secondary effect was that it also established the Middle Stone Age as a distinct sub-Saharan, not just as a South African entity. But, researchers unfamiliar with African lithic studies have to familiarize themselves with the different terminology and compare their stages with non-African lithic information in order to obtain a global perspective.

European-trained archaeologists like Louis Leakey suggested that stone age peoples moved from North to South Africa in successive migrations leaving Mousterian tools (and the technology) in their wake (L.S.B. Leakey 1936), a so-called diffusionist model. They proposed the regional assemblages were sub-Saharan variations of European stages such as the Mousterian. Thus, assemblages became known as the "Magosian", "Stillbay", or Kenya Mousterian" (Miller 1993:8, Mehlman 1989:4), which were comparisons to European assemblages (ibid.). It was not until 1959 during the Fourth Pan-African Congress that the elimination of the names of the regional variants was final. Now the terms and their descriptions occur in the literature only in a historical context.

One remaining issue arose during the 1959 conference and it is the crux of this discussion. The three-age system was used to denote cultures that practiced similar technologies, had similar assemblages and occurred contemporaneously with each other.

The term MSA meaning both a time and a stone tool assemblage is still prevalent throughout the modern academic literature. Thus, the original confusion of chronology and technology remains.

Officially now in the literature, there are three ages for sub-Saharan Africa: the ESA, the MSA, and the LSA. According to Mehlman (1989: 4, 6) there are (or should be) five age classifications: the ESA, the first intermediate period, the MSA, a second intermediate period and the LSA. The intermediate stages are more difficult to define and especially the second intermediate stage as it is not referenced to a type site. The Sangoan should be considered the first intermediate stage according to Mehlman. This is based on McBrearty's (1986) analysis and description of Sangoan assemblages in Kenya and the location of the Sangoan levels, before the MSA levels and after the Acheulean levels, of at Kalambo Falls (Clark 1974). However, a review of the relevant literature reveals the Sangoan mentioned as a precursor to the Middle Stone Age but not as an official first intermediate stage.

The second intermediate stage is not common in the literature and there is controversy. Historically, the Magosian was considered the second intermediate stage because it showed a size reduction of MSA elements plus the addition of microliths and blades, two hallmarks of the LSA (Mehlman 1989:5) which provides a good definition of a MSA/LSA transitional assemblage or a second intermediate stage. By this definition, the second intermediate stage is present in several sites in sub-Saharan Africa: Kisese II in Tanzania (dated to 31,000 B.P.), Prospect Farm in Kenya (dated 31- 22,000 B.P.) (Mehlman 1989:14) (Figure 1.5). Mehlman in his dissertation considers Nasera (levels 6 and 7) and Mumba III (Lower) to be "MSA/LSA Intermediate". The Magosian type site, however, proved to be a mixture of MSA and LSA levels (Mehlman 1989:5) and therefore it is not a valid type site. Nonetheless, to be more accurate about the cultural chronology of sub-Saharan Africa the intermediate stages should be included. Thus there is enough information to justify the inclusion of two intermediate stages in the cultural chronology for sub-Saharan Africa.

1.3 Previous Research

The MSA represents an integral area of research in the biological and socio-cultural development of modern *Homo sapiens* but it has only become a focus of research in the last decade for reasons already discussed in this chapter.

The first step of archaeological investigation of any area is establishing the chronological sequence of events or a culture historical framework (answering the when and where questions). Establishing such a framework in an area, any area, has not received "good press" in academic circles lately. Despite the laudable and requisite goal of modern archaeology to know "why, who and how" things occurred (processual archaeology), present-day Africanist researchers have had little information on which to base their interpretations. A culture-historical framework should not be the ultimate goal of the archaeologists (Binford 1963) but it is a very necessary first step. Only once the framework has been rigorously established can researchers go on to understand the various processes that resulted in the archaeological record.

Establishing a cultural-historical framework for the MSA has been difficult. The few discovered MSA sites are separated spatially and temporally, so it is difficult to determine if the differences are geographical, cultural or research specific. MSA and LSA sites also often lack continuous sequences so it is difficult to observe the pattern of change over time between them. New research by L. Wadley (1997:439-444) at Rose Cottage Cave in South Africa and work by Ambrose (1984, 1998) at the *Enkapune ya Muto*, in Kenya are contributing information in this regard as both sites have produced more or less continuous MSA to LSA sequences excavated using modern archaeological methods. Although the assemblages at Rose Cottage Cave are to some extent specific to South Africa, the site nonetheless represents an unparalleled opportunity to study MSA and LSA assemblages individually and the transition from the MSA to the LSA. For Enkapune ya Muto, Ambrose has managed to push back the beginning of the LSA at this site to earlier than 46,000 BP (Ambrose 1998:377; Kusimba 1999:165). Regardless of the paucity of continuous sequences, there are still a number of sites that contribute to the ever expanding regional cultural-historical framework for East Africa.

At the basic culture historical level, for lithic studies at least, Merrick (1975) and Mehlman (1987) both developed. Merrick's (1975) and Mehlman's (1989) typologies were developed with two goals: one, a typological framework specifically for East African lithic material and two, a specific African system that would be able to bring out transitional assemblages and indicate changes in technology. Merrick based his system on his work at Lukenya Hill and Prospect Farm in the Nakuru Basin, both in Kenya and Olduvai Gorge in Tanzania but he also considered data from three sites in northern

Tanzania: Kisese II, Apis Rock and different portions of Olduvai Gorge (sites he did not excavate himself) (Figure 1.5). Mehlman based his work northern Tanzania, at Nasera Rock (north of Olduvai) and Mumba (eastern part of Lake Eyasi). In addition to excavating at these two sites himself, Mehlman also researched the collections of Kohl-Larsen, a previous (1930s) excavator in the Eyasi area. Mehlman's more recent work incorporates Merrick's typology but both authors stressed the use of minimal categories to observe changes in stone tool production over time.

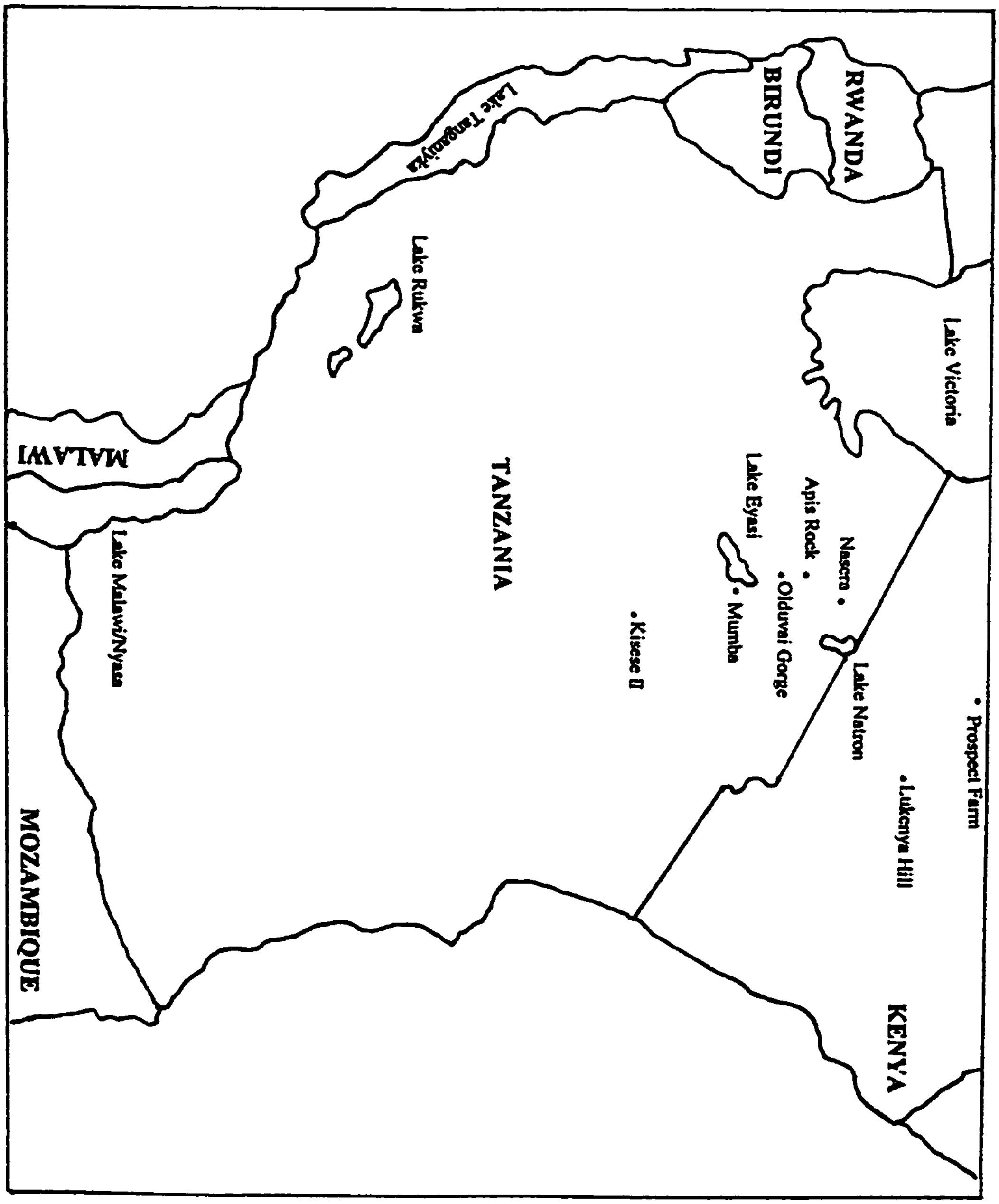
This was in direct response to the real inadequacies of using an European typology to analyze African material. European typologies are based on classification systems developed by François Bordes and Denise de Sonneville-Bordes and Jean Perrot. Bordes created a 63 item typology for Middle Paleolithic retouched tools (1954), while de Sonneville-Bordes and Perrot (1954-56) created a similar 105 item typology for the Upper Palaeolithic. The tool types are formalized and strictly defined; there is no allowance for variation. The implications of this rigid classification system are twofold: ignore the variation in artifacts or make the artifacts fit into existing categories.

The European organizational systems categorized stone tools into discrete time periods. The time periods had definite typological boundaries and were mutually exclusive. Thus a stone tool classified as Middle Palaeolithic was only rarely found (or vice versa) in the Upper Palaeolithic. Thus an assemblage was classified as Middle or Upper Palaeolithic, one or the other; there were no allowances for transitional industries. European trained African archaeologists using this system to establish a culture historical framework found it difficult to incorporate African material into the European modeling.

Even though there is still much to be learned about the archaeological sequence of East Africa, behavioural interpretations based on lithic evidence are emerging. Using raw material choices, Brandt (1988) and Kusimba (1999), infer changing land use and relate it to environmental conditions during the terminal Pleistocene and Holocene.

Brandt (1988) excavated at the site of Buur Heybe in southern Somalia. His research project tested a cost-benefit model of hunter-gatherer subsistence strategies. This model proposes that human society is organized in a manner that will allow the group to obtain resources with the least cost. A similar model has also been proposed by Binford (1980) although he was addressing mobility patterns directly. The model predicts that when resources (plant foods, water and wild game) are predictable and plentiful, the group size will be larger, there will be increased sedentism, territories and well defined and defended and there is a reduction in information exchange between groups. In contrast to a situation when resources are scarce and unpredictable, the group size will be smaller, nomadism increased, territories are less defended and there is an increase in information exchange between groups. Brandt uses information from artifact types/style, artifact function, raw material choices and mortuary practices to test the model. With respect to site IdIu22, tp4, it is the artifact types and raw material choices that are the most relevant.

Figure 1.5 East African Stone Age archaeological sites



Kusimba (1999) also tests the land use patterns of hunter-gatherers at a similar time period, the terminal Pleistocene to early Holocene at Lukenya Hill in Kenya. This study has the advantage of also using a lithic classification system similar to the one used in this document. She tests the same model as Brandt but uses raw material choices and artifact typology for five LSA assemblages. She then compares the data with ethnographic information for hunter-gatherers who live in deserts, woodland and forest areas today. Both environmental conditions are similar to that experienced in Tanzania experienced during similar times (Figures 1.2, 1.3, Adams and Faure 1998) although the conditions in Tanzania may have been milder than Kenya (Adams and Faure 1998).

Enkapune ya Muto, the previously mentioned site, in Kenya, contains ostrich eggshell beads early in the LSA (Ambrose's term for this time) at +40,000 BP. From the appearance of drilled and worked beads and on analogy with Kalahari !Kung groups he infers gift-giving, exchange and symbolic behaviour. Both gift-giving and exchange, are ritual behaviours that are examples of reciprocal generosity. There is a symbolism or unwritten implication (social and/or economic) attached to the objects (the beads) that is not the actual definition of the object. In other words, it is what the object represents not what the object actually is. These behaviours imply a social system that indicates a level of altruism, a method of helping others either in your group or a group one wishes to be on good terms with, for whatever reason (eg. access to land food or water). These actions are all hallmarks of modern human behaviour (Ambrose 1998:388-389).

In most of Tanzania, this type of research has not been done. Only recently, with Mehlman's work in northern Tanzania in the 1970s and 1980s (Figure 1.5), has some basic culture historical framework been established for the MSA and LSA. As is apparent from the location of stone age sites (Figure 1.5) this study in southwestern Tanzania is a small but necessary contribution to the East African prehistoric framework.

Chapter 2
Description of Area and Site

The area of concern in this study is located in the Lake Rukwa rift valley of southwestern Tanzania along the Songwe River which drains into Lake Rukwa (Figure 1.2). Lake Rukwa is located in the Western or Albertine Rift, slightly east of Lake Tanganyika and north of Lake Nyasa/ Malawi. The rift that transects East Africa is actually in the shape of an upside down "Y". The Western Rift is the left hand portion of the upside down Y where it splits into two. The portion of the Albertine Rift Valley that contains Lake Rukwa and the Songwe River is a flat-bottom shaped trough known as the Rukwa Trough.

2.1 Geology of Area

Spurr (1953) and Harkin (1960) briefly discuss the geology of southern Tanzania. C. Vance Haynes Jr. (1970) discusses the Quaternary geology of northern Malawi and southwestern Tanzania, based on information he collected while working here with Desmond Clark in 1966. As a result, there is a definite need for current, datable geological based research in southern Tanzania.

The area was tectonically and volcanically active during the Pliocene-Pleistocene. This activity created the Poroto Ridge, which is comprised of a series of cinder cones and a volcano named Mount Rungwe, in the late Pliocene to early Pleistocene. The resultant uplift cut the Songwe River into two (Spurr 1953:10; Harkin 1960), the Northern Songwe River (Lake Rukwa drainage) and the Southern Songwe

River (Lake Malawi/Nyasa drainage). Since that time numerous advances and retreats of Lake Rukwa have occurred further complicating the sedimentary sequence. The exposures along tributaries of the Songwe River, the Nyasa and the Nyara, west of Mbeya reveal rolled pumice and ash beds intercalated with gravels and mudstones. The gravels and mudstones relate to a time when Lake Rukwa was larger. The younger of the gravels in this area contain Middle Stone Age artifacts (Haynes 1970:316) and the overlying sediment (marl) is dated (C^{14}) 32,000 ± 3,000 BP. The exposure is further complicated by subsequent downcutting and deposition (Clark 1988:279). Along the Songwe river west of Mbeya, there are exposures of lapilli (pyroclastics) that confirm the volcanic history of the area. In the Galula area, at the south end of the rift there are lake sediments. At the top of the lake sediments, recovery of mollusc shells have given a date of 10,000 B.P (Haynes 1970:316). The lapilli tuff located along exposures of the Songwe river could possibly be dated using potassium argon according to Haynes (1970: 314) but it appears that this has never been done, since no date could be found in the literature.

2.2 Site history and description

Southwestern Tanzania was first visited by the archaeologist J. D. Clark (1970) in 1966. He directed a multi-disciplinary team that investigated the geological, palaeontological and archaeological history of the Lake Malawi Rift area and southern Tanzania (Clark et al. 1970: 305-354). McBrearty, Wynn and Waane surveyed the area in 1976 and a number of MSA and LSA sites were identified west of Mbeya city (McBrearty et al. 1982, Wynn and Chadderdon 1982) (Figure 2.1). In 1990 a field project under the direction of P. Willoughby began. The initial research objective was to discover and record prehistoric sites in order to expand the geographical and temporal range of human occupation in stone age Tanzania. The 1990 surface survey revealed MSA, LSA and Iron Age sites, some of which had been previously documented by the earlier archaeologists (Willoughby 1993). The sites were designated in accordance with the Standardized African Site Enumeration System (SASES) (Nelson 1993). The system is patterned after the Borden (1954) system, developed and used in Canada. For Africa, the system begins at 40° North Latitude and 20° West Longitude and extends south and east to 58° East Longitude and 38° South Latitude to encompass the entire African continent. There is a primary grid and a secondary grid of both latitude and longitude which are in 6° increments (blocks of 6 degrees). Each successive increment division has a letter attached to the square. By convention this is a four letter designation (e.g. IdIu) comprised of upper and lower case letters which corresponds to latitude and longitude degrees of the African continent. Latitude is listed first and the first letter is upper case which indicates the primary grid. The second letter, lower case indicates the secondary grid. The final two letters, again an upper case and lower case combination indicate the primary and secondary grid, respectively, of longitude.

During Willoughby's survey a "site" was defined on the density of artifacts on the surface; in this case at 10-20 pieces per m^2 (Willoughby 1993: 12). A "locality" had more that a single find, but less than a site and were defined in reference to sites (e.g. IdIu10E as east of IcIu10). Almost one hundred locations were sampled, giving a total of 9609 artifacts. These were classified using Mehlman's typology (1989) and a number of typological and technical attributes were also recorded. Some test excavations were also done on open terraces. There were twelve sites assigned to the MSA, seven sites had some LSA components, three sites were LSA, six were Iron Age, four sites had evidence of both MSA & LSA (Table 2.1). A report was also written by G. Miller discussing the typology and technology of some of the surface MSA material (Miller 1993) collected during this year.

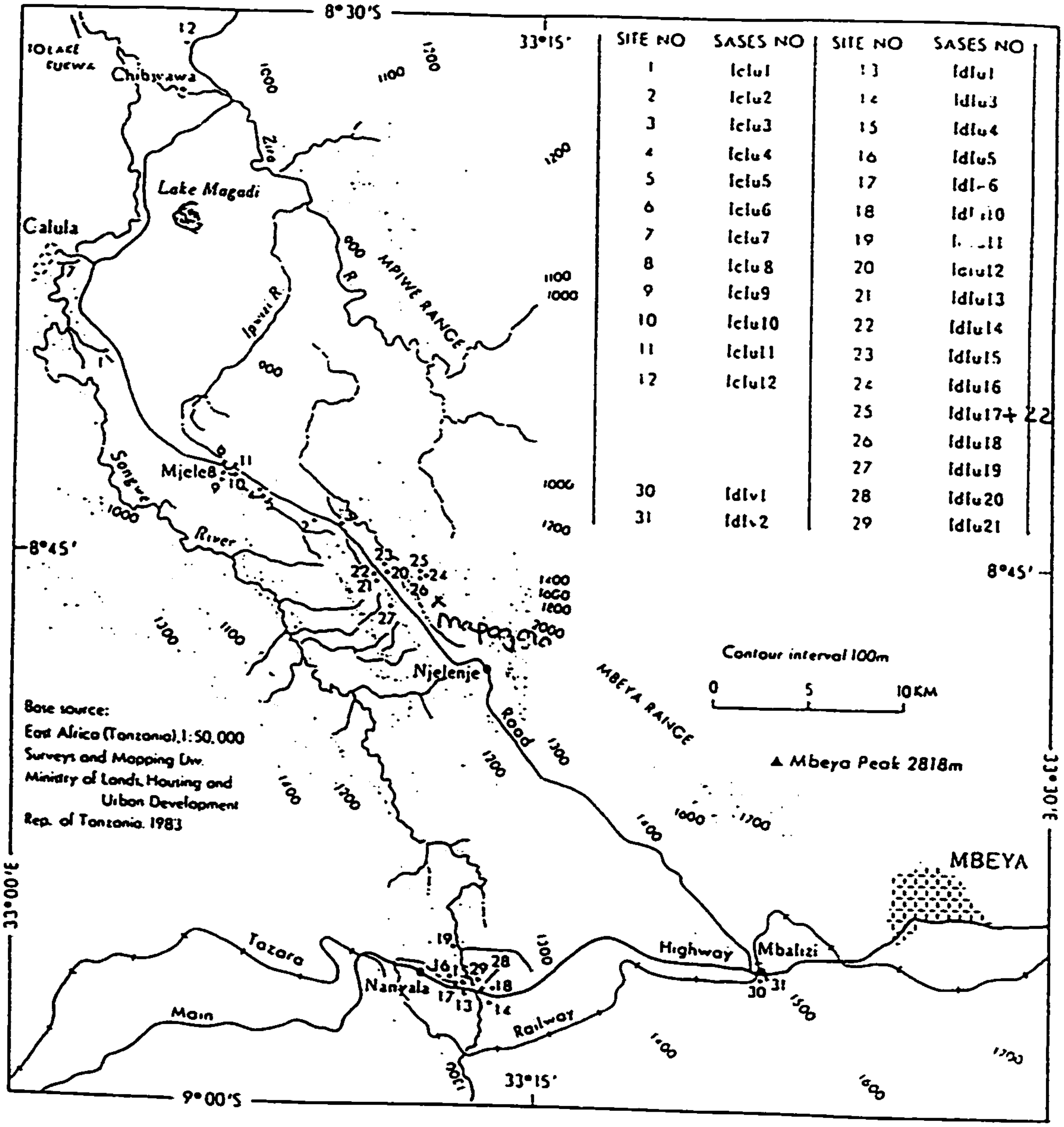
Table 2.1 Summary of the 1990 survey sites by proposed cultural affiliation

MSA	Mixed MSA &LSA	LSA	LSA & IA	IRON AGE	MSA & IA
IcIu 2,3,4 IdIv 1,2 IdIu 1,3,4,10,12,19,20	IcIu 8,10 IdIu 5,6	IcIu 5,9,12	IcIu 1 IdIu 13,17	IcIu 7,11 IdIu 14,15, 16,18	IdIu 21

MSA sites were generally located on the river terraces of the Songwe River. Sites that had artifacts which were classified as LSA and Iron Age were, for the most part, located in rockshelters, including those at Mapogoro.

MSA sites also tended to contain a wide range of raw materials including volcanic rocks, cryptocrystalline silica such as chert or flint, and quartz. Their manufacturers carried the raw material over some distances as these distinctive materials are found throughout the study area. Cryptocrystalline silica are the family of rocks

Figure 2.1 Location of archaeological sites in the Songwe River Valley



SITE NO	SASES NO	SITE NO	SASES NO
1	Iclu1	13	Idlu1
2	Iclu2	14	Idlu3
3	Iclu3	15	Idlu4
4	Iclu4	16	Idlu5
5	Iclu5	17	Idl-6
6	Iclu6	18	Idl[illegible]10
7	Iclu7	19	[illegible]
8	Iclu8	20	Iciul2
9	Iclu9	21	Idlu13
10	Iclu10	22	Idlu14
11	Iclu11	23	Idlu15
12	Iclu12	24	Idlu16
		25	Idlu17+22
		26	Idlu18
		27	Idlu19
30	Idlv1	28	Idlu20
31	Idlv2	29	Idlu21

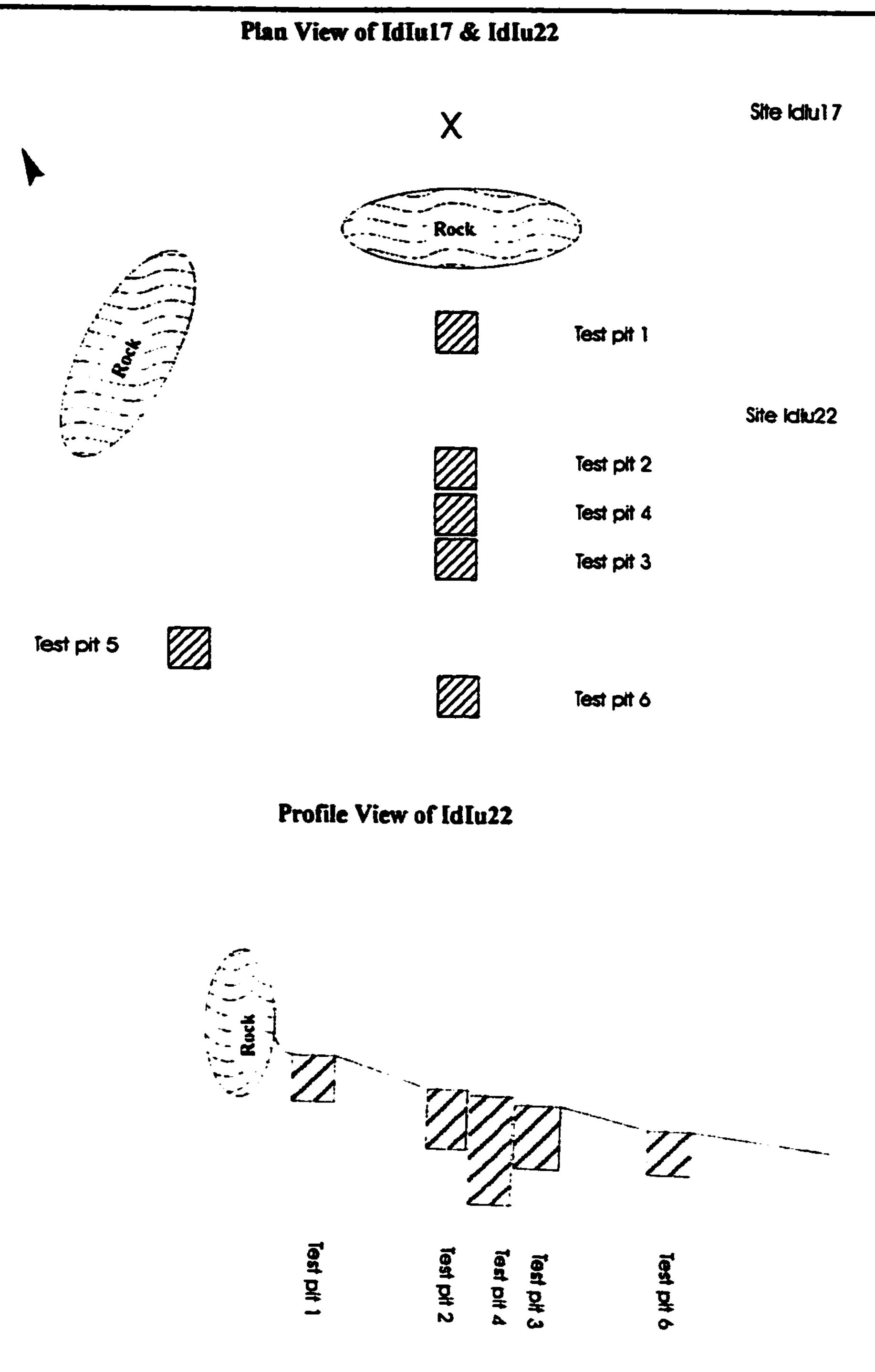
referred to as chalcedonies (Bates and Jackson 1984: 81,120). They are known for their fine or hidden (crypto) crystalline (invisible to the naked eye) structure that impart properties that make the rock excellent for stone tool production. Cryptocrystalline silica can form in nodules, pebbles or tabular slabs (Plummer and McGeary 1991: 128). They are commonly known as chert or flint, but in this study no distinction was made.

One quarry source for these raw materials was identified as IdIu19 (Figure 2.1) (Willoughby 1993:13). Lenses of cryptocrystalline silica were also observed in the volcanic rocks at Mapogoro, including those right next to IdIu22. In contrast, LSA sites consisted primarily of artifacts produced from quartz, plentiful and locally available in small pebbles, which are worked in a bipolar fashion or in a single direction to produce pyramidal bladelet cores. This does not mean that MSA sites used volcanics or cryptocrystallines exclusively. For the 1990 MSA sites, of the seven raw material types (the raw material choices for the area are: quartz, quartzite, chert or flint, obsidian, volcanic but not obsidian, other metamorphic and other sedimentary), 50% of pieces are quartz and 34% are chert or volcanic. For the 1990 LSA sites, 91% are quartz and 5.7% are chert or volcanic.

In 1995 Willoughby returned to the Mbeya area to attempt to find a stratified archaeological sequence. She chose to test excavate site IdIu17, discovered in the 1990 survey season, based on surface occurrences of Iron Age ceramics mixed with LSA quartz artifacts. During the course of the 1990 survey a number of rockshelters were identified on a series of hills northeast of the village of Njelenje, at a location known locally as Mapogoro. The site is located in one of these rockshelters and the area excavated was behind the drip line. This area was dry and seemed to be in primary context, or at least minimally disturbed. Site IdIu17 is located 33°11.626'E longitude and 8°45.611'S latitude at an elevation of 1232 metres. The site was estimated to be 50 m^2 in area. Two 1 m^2 test pits were excavated, labeled IdIu17 test pit 1 and 2. Both test pits were excavated in 10 cm arbitrary levels. Excavation was suspended for these two test pits following the discovery of a burial at approximately 80 cm below surface that was considered to be intrusive into the LSA levels. A sample of human bone was submitted to Isotrace for dating but the absence of collagen meant that no result could be obtained.

Site IdIu22 (Figure 2.2) is presently an open air site used as a farmer's field, but it appears to be a collapsed rockshelter. Test pit 1 was located south of a large rock, either a piece of the rockshelter roof or possibly the back wall of the rockshelter (Figure 2.2). It appears that the rock shelter collapsed during the Holocene and that, until then, it was continuously occupied by stone age peoples. Test pit 1 was excavated to 1 metre below datum, at which point bedrock was reached. Excavation of the 1 m^2 test pit was also in 10 cm arbitrary levels and there was no evidence of disturbance below 20 cm. Bone fragments recovered at the 50-60 cm level yielded a date of 7540 ± 280 (TO-5674) from Isotrace. However, this was the only date available as there was little organic material including no charcoal.

Figure 2.2 Sketch map of IdIu17 and IdIu22, plan and profile view



There were 15,460 artifacts recovered from this test pit. Of these, 10, 570 artifacts were measured and entered into the statistical database, SPSS. The remainder were small angular waste chips, too small to measure; for each level, they were counted and weighed as a bulk sample.

Test pit 1 yielded 408 retouched tools which are 3.9% of the measured artifacts (2.6% of the total). Cores were 2.5% of the measured artifacts (n=267) (Table 2.2). Debitage comprised the major portion of measured artifacts (n=9892) at 93.6%. The ground stone category had three artifacts over the entire test pit which made up less than 1%.

Table 2.2 General Category frequencies, IdIu22 test pit 1

	IdIu22 test pit 1				
	Tools	**Cores**	**Debitage**	**Ground Stone**	**Totals**
n	408	267	9892	3	10,570
%	3.8%	2.5%	93.6%	.0%	100%

. In the retouched tool category, backed pieces comprised the majority of the 408 retouched tools (Table 2.3). This one category comprised 56.1% of the total. Within the 229 backed pieces, 98 or 24% were geometric microliths (triangles, trapezes and crescents). The frequencies of the tool types is presented in Table 2.3. A geometric microlith is produced using the microburin technique, a method by which a blade is notched in one or two places and then snapped (Figure 2.3). The edges of the middle segment are then retouched, shaping the piece into a geometric shape, hence the name geometric microlith. This technology was rediscovered by J. Tixier based on assemblages in North Africa (Tixier 1974). The microburin technique is prevalent in North Africa in the Epi-Palaeolithic, representing terminal Pleistocene and Holocene occupations. Ambrose (1998) postulates that at his site Enkapune ya Muto in Kenya microburins were present during the Holocene, but not in the Pleistocene LSA levels. If this idea is not regionally specific it may be a method for estimating the date of IdIu22 site. Regardless, the distribution of the tool types place test pit 1 in the LSA.

Figure 2.3 Microburin technique, based on Tixier (1974:17)

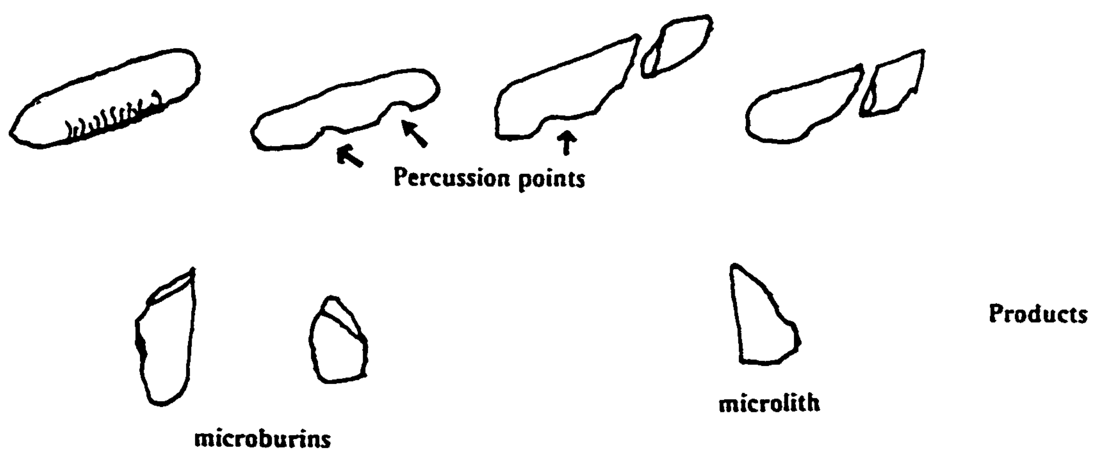


Table 2.3 Tool type frequency, IdIu22, tp1

Tool types	n	%
scrapers	127	31.1
backed pieces	229	56.1
points	3	0.7
burins	25	6.1
bifacially modified pieces	3	0.7
becs	12	2.9
composite tools	3	0.7
heavy duty tools	5	1.2
other tools	1	0.2
Total	408	100

The distribution of the core subtypes is presented in Table 2.4. Again, core types that are indicative of the LSA such as pyramidal/prismatic and divers single platform have the highest frequency. Combined with other types that do not have a high frequency but occur in the LSA like single platform core/core scraper, opposed double platform and adjacent double platform core and core/core scraper they form 60% of the core types. To further reinforce the LSA dating of the artifacts, two categories that are truly indicative of the MSA, radial/biconic and disc cores had the lowest frequency and there were no Levallois cores.

Table 2.4 Core type frequency, IdIu22 tp1

Core Types	**n**	**%**
part peripheral	43	16.1
radial/biconic	6	2.2
disc	9	3.4
single platform pyramidal/prismatic	47	17.6
divers single platform	59	22.1
single platform core/core scraper	13	1.9
opposed double platform	13	4.9
adjacent double platform	27	10.1
adjacent double platform core/core scraper	1	0.4
multiple platform	20	7.5
bipolar	23	8.6
bipolar core fragment	2	0.7
amorphous/casual	4	1.5
Total	267	100

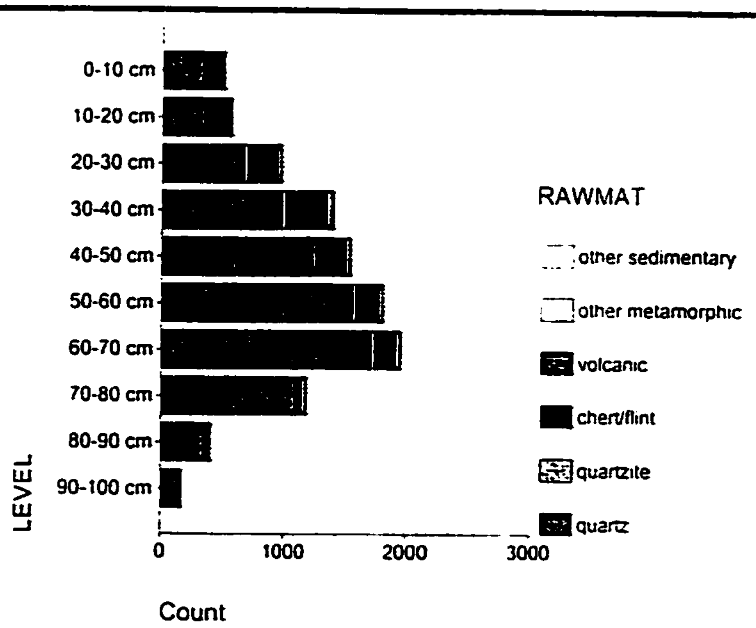
The frequency of the raw material is presented below in Table 2.5. Quartz comprised the major portion of raw materials at 80% (n=8456) with cryptocrystalline silica making up the second major component at 16.2% (n=1711). This is again generally consistent with LSA assemblages (Willoughby 1993; Mehlman 1989).

In order to determine change in the 1 metre depth of the test pit, the subtype variables for each tool type category were compared against the levels. Raw material was the only variable which showed any directional change in Figure 2.4. The conclusion reached from the excavation of test pit 1 was first, it was LSA material. However, the research goal in 1995, stated previously, was to discover a deeper, longer stratigraphic sequence. The second result, indicated a stratigraphic sequence had not been found but the material excavated conformed well with the published literature on the LSA.

Table 2.5 Raw Material frequency, Idu22 test pit 1

	quartz	quartzite	c.silica	volcanic	other metamorphic	other sedimentary	Total
n	8456	115	1711	280	6	2	10570
%	80%	1.1%	16.2%	2.6%	0.1%	0%	100%

Figure 2.4 Raw Material distribution, IdIu22 test pit 1



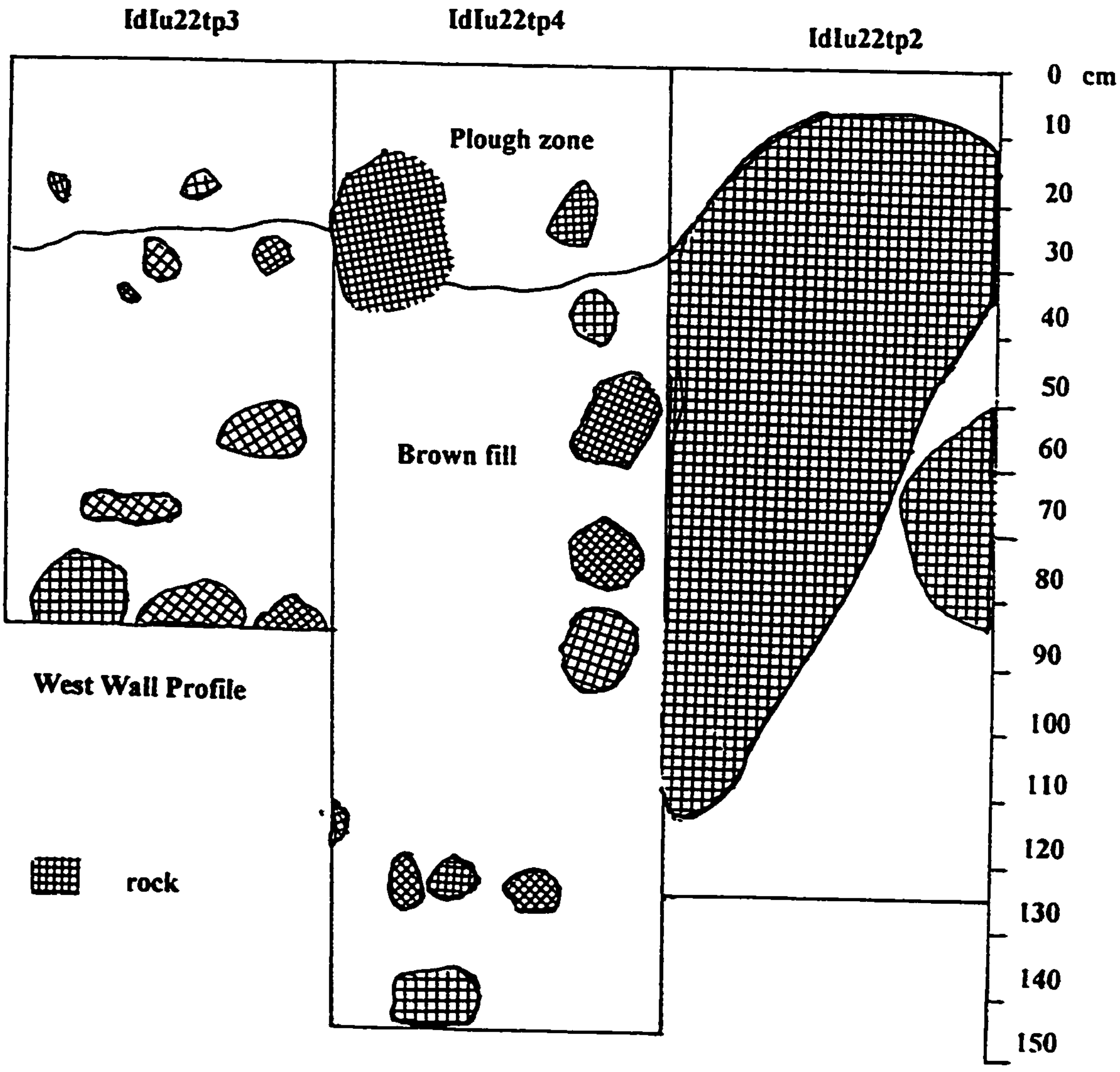
In the 1997 field season, there were 5 test pits, numbered 2-6, excavated at site IdIu22 by Willoughby, C. Campbell and local workers. Test pits 2 and 3 were excavated 1 metre apart from each other and 8-10 metres from test pit 1, which had been excavated in 1995. The 1m baulk area between tp2 and tp3 became tp 4 (Figure 2.5). This thesis is concerned with a single test pit, test pit 4, from the 1997 field season. Test pits 5 and 6 were excavated to determine the spatial limits of the site. The amount of artifacts recovered in these two test pits confirmed the general limits of the site had been determined. Test pit 2 had approximately 12,203 artifacts, test pit 3 had 12,686 and test pit 4 had 21,358 artifacts. In contrast, test pits 5 and 6 had 2752 and 2913, respectively (Table 2.6)

Table 2.6 Number of artifacts in 1997 test pits

	test pit 2	test pit 3	test pit 4	test pit 5	test pit 6
n	12,203	12,686	21,358	2,752	2,913

Test pit 2 was excavated to 125 cm, tp3 was excavated to 85 cm until it got too dangerous then and tp4 was excavated to 145 cm (Figure 2.5). This was the deepest test pit to date and the reason it was chosen for this study. It presents an opportunity to study a deep artifactual sequence. During the course of the excavation the area of test pit 2, 3 and 4 was step trenched. The excavation of tp4 was suspended at 145 cm because of a large rock covering the entire basal surface. It is very likely this is bedrock although the possibility exists it could simply be roof fall from the rockshelter. Future excavations opening up a wider area should be able to resolve this possibility. All test pits excavated in the 1997 season were excavated in 5 cm arbitrary levels. All artifacts were collected for each level and were washed, bagged and tagged. At the end of the excavation season the artifacts were then shipped on loan to the University of Alberta for analysis under agreement with the Tanzanian Department of Antiquities.

Figure 2.5 West wall profile of test pits 2, 3, and 4



Preliminary geoarchaeological work was carried out, during this 1997 field season by C. Campbell, Department of Earth and Atmospheric Sciences with the goal of obtaining reliable dates. Soil geochemistry was performed on each of the 5 cm levels in test pit 4. Results of these tests are still forthcoming. As well, further soil samples were taken at 15 cm intervals to be sent to H. Schwarz at McMaster University for optical spin luminescence (OSL), which was discussed earlier in this study (Chapter 1). Again, results are forthcoming and were not available at the time of writing. Upon return to Canada, test pit 4 was the first material to be sorted, measured and computerized for this study by this writer. Methods and objectives will be discussed in the following chapter. Discussion of the results will be presented in subsequent chapters. At the time of writing, all six test pits have been completely measured and the data entered but they will not be considered further here.

Chapter 3
Methods and Objectives

3.1 Objectives

As analysis proceeded, it became apparent that the research goal of finding a stratified sequence exhibiting technological change had not been realized. Test pit 1 at IdIu22 was excavated in 10 cm. units in 1995 to bedrock and revealed no significant change by depth aside from raw material frequencies (Table 2.5, Chapter 2 and graph, Figure 2.5). Although an artifact-rich site had been found, the research project's search for a stratified archaeological sequence extending into the MSA remained elusive. Consequently this became the focus of the 1997 field season. A number of test pits were dug to determine if site IdIu22 contained multiple levels which would exhibit technological change over time. Test pit 4 was chosen as the sample population for this thesis because it was the deepest test pit excavated to date and the possibility of meeting the goal of the research project was greatest.

An additional research goal is to determine if there is a MSA level and/or a continuous sequence from the MSA to the LSA. Even a second intermediate level would be significant, as no stone age site has ever been excavated from this region before. The original definition of the MSA by Goodwin and Van Riet Lowe (1929), relies on retouched tool types produced on radial (circular) cores; the most diagnostic tools include scrapers and points. Cores consist of radial, disc or Levallois types.

Technologically the artifacts have faceted platforms and the dorsal surface of flakes generally have a convergent flaking pattern rather than a parallel pattern as seen in the LSA (Willoughby 1996: 58; Ambrose 1998: 377).

To satisfy both of the research goals, analysis of test pit 4 is presented in two parts: the first dealing with typological issues and the second with technological aspects. The typological aspect deals with classification of artifact types and frequency of types over time and space. Typological variables will be discussed in detail in section 3.2.1. There is also a technological portion to the study, examining methods of manufacture and recording those processes that distinguish the MSA or LSA, and those that show a change over depth (=time). The discussion on technological variables will follow that of the typological variables (section 3.2.2). There is one exception, raw material. Raw material types are not considered a typological element nor are they considered a technological attribute but influence both. Raw material is discussed in the chapter on typological analysis (Chapter 4).

The metrical data and analysis of typological and technological variables, however, will be presented in separate chapters. Typological analysis will be discussed in Chapter 4 and analysis on the technological variables will be discussed in chapter 5.

3.2 Methods

Since the previous excavations in 1995 at 10 cm arbitrary levels yielded no observable change except in raw material, tand since there was no visible stratigraphy the 1997 excavation strategy changed slightly: test pits were excavated in 5 cm levels. It was thought that this strategy would provide finer resolution, better control and potentially reveal more information. The number of artifacts for each level were counted, in the field, bagged and labeled.

Artifacts were sorted, classified, and information collected for 23 variables. The classification method used to sort the artifacts into types was Mehlman's typological system (1989). Mehlman (1989: 111-157) described and defined the criteria for each one of the artifacts in his 105 item typology. An adaptation of the typological variables Mehlman developed is presented in Table 3.1. The artifacts were first sorted into the gross categories of tools, cores, debitage and ground stone (Table 3.1). The artifacts were then sorted into the types of tool, core, debitage or ground stone (the first set of numbers). Finally those types were further sub-classified into the type of scraper, backed piece, bipolar core, etc. Those sub-types are represented by the numbers in parentheses in Table 3.1 and indicate how many different sub-types there are within each category. Thus, for example in the scraper category there are 23 different types of scrapers but in the bec category, another tool type, there is only one type of bec.

Although all of the artifacts collected were put into categories not all of the typological categories will be considered in this thesis. The typological variables that were considered for this study are presented in Table 3.3 in section 3.2.1.

Table 3.1 Lithic Artifact Typology (adapted from Mehlman 1989)
(Numbers in brackets indicate artifact subtype number)

A. Tools (Trimmed Pieces)
1. Scrapers (#1-23)
2. Backed pieces (#24-34)
3. Points (#35-37)
4. Burins (#38-40)
5. Bifacially modified pieces (#41-43)
6. Becs (#44)
7. Composite tools (#45-48)
8. Outils écaillés (#49)
9. Heavy duty tools (#50-52)
10. Other (#53-56)

B. Cores
1. Peripherally worked (#57-60)
2. Patterned platform (#61-68)
3. Intermediate (#69-73)
4. Bipolar (#74-75)
5. Amorphous (#76)

C. Debitage
1. Angular Fragments (#77-81)
2. Specialized flakes (#82-83)
3. Flakes (#84-87)
4. Blades (#88-91)
5. Levallois flakes (#92-93)

D. Ground Stone
1. Hammerstone (#94)
2. Anvil stone (#95-97)
3. Pestle rubbers (#98-99)
4. Polished axes (#100-101)
5. Stone disc (#102-103)
6. Sundry ground/polished (#104)
7. Manuport (#105)

I have separated the research project's 23 variables into metric, non-metric and calculated variables (ratios) for discussion purposes only and are presented below in a table format.

Table 3.2 Project Variables

Metric	**Non-metric**	**Calculated Ratios**
length	abrasion	breadth/length
thickness	percentage cortex	thickness/breadth
breadth	flake scars	thickness/length
weight	toth number	platform area
platform length	platform facets	flake area
platform breadth	dorsal scars	relative area
platform angle	scar pattern	
angle of retouch	retouch	
	planform	

Not all of the variables are applicable for each piece. Length, breadth, thickness, weight, raw material and abrasion were measured for all artifacts. Tools also had angle of retouch, type of retouch and platform measurements if the platform was present. Cores and ground stone tools had percentage of cortex and number of flake scars removed and recorded. In the debitage category all flakes and blades that had platforms had those measurements included. Only size attributes and raw material were recorded for angular fragments, pieces without a platform or retouch. For any of the artifacts where a variable was not applicable, a value was assigned to indicate missing or non-applicable data. All of the variables presented in Table 3.1 and the information on those variable in the previous paragraph reflect the complete set of variables studied in Willoughby's research project.

3.2.1 Typological Variables

All artifacts were first sorted by level into categories or types. The typology used for this analysis is one that was developed by Michael Mehlman (Table 3.2) for MSA and LSA assemblages from Lake Eyasi in northern Tanzania. The typology also incorporates the works done by Nelson (1973), Clark and Kleindeinst (1974) and Merrick (1975) (Mehlman 1989: 122-126) therefore the comparability with regional assemblages outside Tanzania is enhanced.

As well, Mehlman's comparisons with Merrick's are of particularly relevance because both studied similar MSA and LSA assemblages. They emphasized attributes that were diagnostic of each time period and were concerned with transitional elements but unlike the typological systems used for European stone tools, there is no temporal separation of the categories.

The variables of concern for this study are first, the distribution of the main groups: tools, cores, debitage and ground stone. Then located within the tool, core and debitage categories are the diagnostic variables, which are considered important to meet the research goals. This information is presented in Table 3.3. The ground stone category is not considered pertinent to later analysis due to its low frequency and thus is not included in the table. For cores, the most diagnostic types are at the subtype level: bipolar (14), amorphous (15), peripherally worked (11), intermediate (13), and patterned platform (12) rather than the individual types. Within the tool category backed pieces are important according to Mehlman (1989) and Ambrose (1998) and scraper types are considered important according to Mehlman (1989), therefore the remaining groups in the tool category are not discussed in this study. Within the backed pieces category there are also diagnostic types, consequently this study will focus on the geometric pieces (# 24, 25, and 26) and the divers backed (#32). At each step the variable is analyzed on a macro scale, the test pit is treated as a single sample. Then, the variable is analyzed on a level by level scale, a population of 29 samples, to determine if there has been any change with depth.

3.2.2 Technological Variables

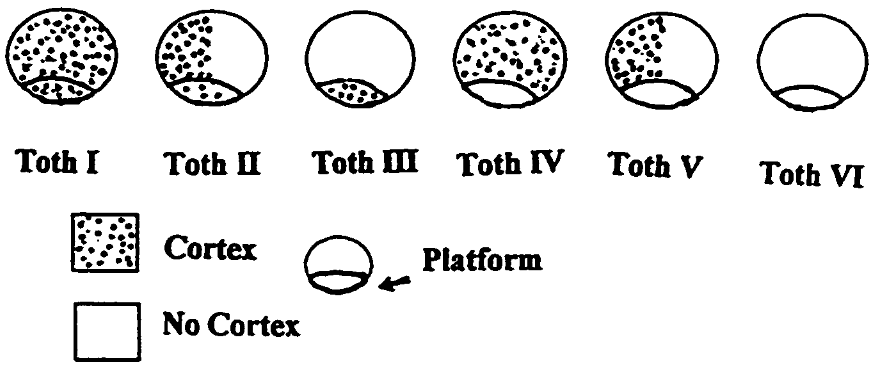
The technological variables used to determine information about the tool production process are recorded are from a variety of sources. They are: Toth number (see page 54), dorsal scar pattern, planform (these three variables are explained immediately following), flake length, breadth, thickness and weight and breadth to length and breadth to thickness ratios. Just as with the typological variables, the frequency of the technological variables will be considered with the test pit as a single population, to determine if there is a tendency toward a particular technological process. The variables will then be compared against the levels, a population of samples, to see if there is any change with depth. Significance will also be tested where possible.

Table 3.3 Typological Variables (most important types) for analysis, IdIu22 test pit 4 (derived from Mehlman 1989: 111- 157)

Tools		**Cores**	**Debitage**
Scrapers	**Backed Tools**		**Flakes**
small convex (1)	crescent (24)	Bipolar	whole flakes (84)
convex end (2)	triangle (25)	amorphous	trimmed/utilized flakes (85)
convex double end (3)	trapeze (26)	peripheral	
convex end & side (4)	curved backed (27)	intermediate	
circular (5)	straight backed (28)	patterned platform	
nosed end (6)	orthagonal truncation (29)		
convex side (7)	oblique truncation (30)		
convex dbl. side (8)	angle-backed (31)		
nosed side (9)	divers backed (32)		
sundry end (10)	backed awl/drill/percoir (33)		
sundry double end (11)	backed fragment (34)		
sundry end+side (12)			
sundry side (13)			
sundry dbl. side (14)			
concave (15)			
concavity (16)			
notch (17)			
sundry combination (18)			
convex end + combination (19)			
convex side + combination (20)			
divers (21)			
convergent (22)			
scraper fragment (23)			

While examining Oldowan flakes from Koobi Fora, Kenya, Nick Toth (1982:73-75) established a series of scores relating the amount of cortex on the dorsal surface of a whole flake with the presence or absence of cortex on the striking platform. Toth's premise is that the amount of cortex in two areas can indicate the stages of tool production (Figure 3.1). An artifact with no cortex on the dorsal surface and the platform would come from inside the core, would be coded a Toth type VI. If there is no evidence of the stages up to Toth type VI, the assumption is that the core was provisionally flaked elsewhere. On the other end, if there is cortex on the entire dorsal surface and on the platform, the flake is one of the first flake removals. This combination would be a Toth type I and would indicate the initial stages of tool production. In the middle of these two examples is a Toth type III: there is cortex on the platform but not on the dorsal surface of the flake. Toth proposes this combination is an example of bipolar technology. Bipolar technology is usually found in LSA but to some extent, it is also determined by raw material size and shape (ie. as pebbles). Small cores cannot be flaked easily; it is easier to position the core on a hard surface, usually another rock, strike the core at the other end to break it. The Toth number will be considered for whole flakes and trimmed or utilized whole flakes.

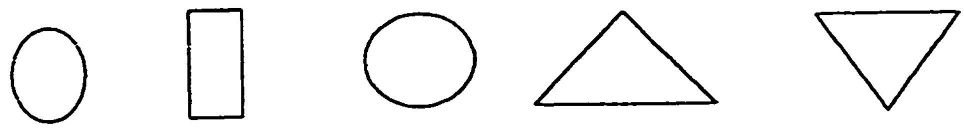
Figure 3.1 Toth Types (from Toth 1982: 73-75)



The direction of the dorsal flake removals is noted and again for whole flakes and trimmed or utilized whole flakes. McBrearty (1986: 183) used only: radial (1); same pattern, simple (2); same pattern, parallel (3); opposed platform (4); transverse (5) or plain (6). Willoughby also includes an unknown value (0).

Also taken from McBrearty (1986: 198-199) is the overall planform variable. This variable refers to the overall shape of the flake (see Figure 3.2). There are 6 values for this: (1) convergent; (2) parallel; (3) divergent; (4) intermediate; (5) circular and (6) unknown. Willoughby also includes a circular value for the planform variable to highlight any discoidal elements. McBrearty (1986: 199) used only 1-4; convergent, parallel, divergent and intermediate.

Figure 3.2 Planform



The number of facets on the platform are counted. From Goodwin and Van Riet Lowe's definition of the MSA, a faceted platform indicates MSA technology; a single platform facet would indicate LSA technology. Mehlman's research (1989) also supports this conclusion.

Finally, artifact size measurements are considered for flakes. Only whole flakes and trimmed/utilized flakes are considered for this portion of the analysis. Flake length, breadth and thickness are measured in millimetres and are assessed for the test pit as a whole. Flake length is the length along the bulbar axis; flake breadth is perpendicular to flake length and flake thickness is perpendicular to flake breadth along a three dimensional axis. The breadth to length (b/l) and breadth to thickness (b/t) ratios are also assessed. The breadth to length ratio is a measurement of the 'real' length of the flake. Fore example, end struck flakes will have a ratio of ≤ 1.00 (the length will be equal or greater than the breadth), side struck flakes have a ratio > 1.00 (the breadth is greater than length). The breadth to thickness ratio is a measurement of how "fat" the piece is.

As a final part of the flake measurements, flake weight is considered. It is measured in grams and again is assessed for the test pit as a whole.

The results of the excavation of test pit 4 are presented in the following chapters for the variables discussed in this chapter. They are separated into two chapters; chapter 4 deals with the typological variables, chapter 5 deals with the technological variables.

3.5 Review of Comparable Sites

This section presents a review of the comparison sites that are used in this thesis. The primary study, by Mehlman has already been referred to but only in the methods section as it is his typology this study uses. The dating, description of the lithic industries and culture historical chronology he established for his sites, Nasera and Mumba, and northern Tanzania have not been discussed until the present section.

Mehlman began excavations in 1977 at two rockshelters: Nasera, north of Olduvai Gorge and Mumba on eastern to southeastern edge of Lake Eyasi. The latter site had been previously excavated by Kohl-Larsen (K-L) in the 1930s. Although Mehlman determined there were serious biases in the K-L excavation, the richness of the Mumba site made it an excellent site. Consequently, Mehlman excavated new areas and re-excavated much of the 1938 areas (in addition to viewing the collections at the university in Tübingen) to determine the biases. Nasera had also been previously excavated in 1932 but in this case by a trained archaeologist (L.S.B. Leakey). Mehlman's excavations were designed to tie in Leakey's 1932 trenches to the current excavation.

Table 3.4 and Table 3.5 present a partial culture history (the stone age portion) for Mumba and Nasera, respectively. Table 3.6 presents the chronology of Mumba and Nasera, relative to each other in order to place the two sites in context. It must be stressed that these two sites presented an extensive amount of material ranging in time from some point the Middle Pleistocene (approximately 200,000 ya) to the present. It is not limited to a lithic analysis although it does begin with lithic artifacts. In addition to the lithic analysis, he also used faunal correlates, ceramic analysis, chronometric dating, obsidian sourcing, and he cross referenced Mumba and Nasera to other sites in northern Tanzania to help date his excavation material, validate and establish a regional chronology. Thus his culture historical chronology for this region is based on several sources of evidence.

Each industry is named according to a local place name; similar lithic industries in the two sites, dating to the same culture, were designated with the same name. Beginning with the oldest lithic industry, present only at Mumba (there is an earlier industry at Lake Eyasi, the Njarasa, classified as Sangoan but it is not at the rockshelter; only in the lake shore site), the Sanzako (Bed VI-B) is characterized by a high frequency of bifacial modified pieces with heavy duty tools and a low frequency of retouched points. Scrapers types are limited; sundry side scrapers comprise over half of the types and any version of end or convex edged scrapers are rare. The Sanzako does share types and technology with the earlier Njarasa but it is distinguished from the Njarasa on the basis of differing raw materials, more varied tool types and artifact size. It is separated from the overlying industry in Bed VI-A (Kisele industry) by a lower frequency of

Levallois technology and heavy duty tools.

The Kisele industry is present at Nasera (Levels 12-17 and Levels 18-25) and Mumba (Bed VI-A). Mehlman terms this industry as "unquestionable MSA" (1989:199). Retouched points are frequent (always 10% or more), bifacially modified pieces and scrapers are also common. Heavy duty tools are rare and there are no blades, uncertain backed tools and burins. The scraper types are more varied than previous industries and include small convex and end/nosed forms. There is a low frequency of Levallois cores, bipolar cores are infrequent but radially prepared cores are frequent.

The Mumba industry is classified as an intermediate MSA/LSA but when Mehlman assigns this industry to a techno-complex (1989:560) he adds a post-MSA designation to the intermediate classification. There are some distinctive classes of backed artifacts that, according to Mehlman, separate the Mumba from the following industry, Nasera, enough differences to call for two intermediate industries. Mumba industry is again present at both Nasera (Levels 8/9-11) and Mumba (Bed V). It is characterized by the presence of large backed tools. The high frequency of backed tools are combined with a low frequency of points. The core types of radial, platform and bipolar are present. Blades and blade fragments are now visible in contrast to the preceding Kisele industry. In the scraper category, sundry side and sundry end scrapers were dominant.

The industry that follows Mumba is termed Nasera industry (as opposed to Mehlman's old name of the Naseran) and is also classified as intermediate MSA/LSA. Again it has an additional term, in this case "proto-LSA" is added. This industry is characterized again by the combination of points and backed tools but the proportions are reversed compared to Mumba. There is a high frequency of points, backed tools are rare and are not close to the size of the Mumba backed tools. The most diagnostic pieces are small retouched points. Scrapers are dominant especially small convex and convex end types. Bipolar core technology is dominant and peripherally worked cores are more plentiful than platform cores.

The Lemuta industry follows the Nasera Industry but it is only present at Nasera (Levels 4 and 5). It is classed as an early LSA or Pleistocene LSA assemblage (the LSA thus incorporates two major geological time periods). There is a moderate frequency (around 30%) of backed tools and this category was dominated by divers backed. In the scraper category, end scrapers and small convex scrapers have the highest frequency. There is a relative balance between the amount of scrapers and backed pieces. Bipolar cores also have a high frequency and the corresponding product an *outil écaillé* is evident.

The Silale industry is again, present only at Nasera (Level 4 and 3b). It is classed as a Holocene LSA industry. Microlithic backed pieces and small convex scrapers dominate the assemblage which Mehlman terms as "typical mid-Holocene LSA" (1989:389). Within the microlith grouping of artifacts, in increasing frequency, are straight-backed points, geometric crescents and curved-backed pieces. There were no trapezes or triangles present. The size of the microliths in the Silale are smaller than that of microliths in the Lemuta.

The Olmoti industry at Nasera and the Oldeani industry at Mumba occur in association with pottery. The presence of pottery signals the end of the comparable levels of Nasera and Mumba to site IdIu22 tp4 as none of test pits 2,3,or 4 had enough diagnostic pottery to use for comparisons. The Oldeani and Olmoti industries are included in the following tables because they still contain lithic artifacts and in fact, the Olmoti is classified as LSA.

Table 3.4 Mumba chronology (adapted from Mehlman 1989: 560-562)

Industry	Stratigraphy	Date	Cultural Designation
Oldeani		±5,000 bp	Mesolithic/pottery
Aceramic	Bed III-upper		
Nasera	Bed III-lower	±23,000-30,000 bp	Intermediate MSA/LSA
Mumba*	Bed V	>30,000-?40,000 bp	Intermediate MSA/LSA
Kisele	Bed VI-A	±50,000-?90,000 bp	MSA
Sanzako	Bed VI-B	±130,000 bp	MSA

* The Lemuta and Silale industries, present at Nasera, are not present at Mumba; there is a gap in the sequence at 10,000 -20,000 bp. It is more evident in Table 3.6.

Table 3.5 Nasera Chronology (adapted from Mehlman 1989: 560-562)

Industry	Stratigraphy	Date	Cultural Designation
Olmoti	Level 3	±5,000 bp	LSA/pottery
Silale	Level 3b	±7,000 bp	LSA
Lemuta	Level 4 & 5	±17,000-21,000 bp	Early LSA
Nasera	Levels 6 & 7	±23,000-30,000 bp	Intermediate MSA/LSA
Mumba*	Level 8/9-11	>30,000-?45,000	Intermediate MSA/LSA
Kisele	Levels 18-25 12-17	±50,000-?90,000 bp	MSA

*The Sanzako industry present at Mumba is not present at Nasera.

Table 3.6 Cultural Chronology of Mumba and Nasera (adapted from Mehlman 1989:560-562)

		Mumba (Lake Eyasi)	**Industry**	**Nasera**
Holocene	0-10,000	Mumba II		Levels 1-3
		Upper Bed III	**Silale**	
Upper Pleistocene	10,000-20,000		**Lemuta**	Level 4
	20,000-30,000	Lower Bed III		Levels 5-7
			Nasera	Level 8/9
		Bed IV Beach		
	30,000-70,000		**Mumba**	Levels 10-11
		Bed V	**Kisele**	Levels 12-17
	70,000-140,000	Bed VI-A		Levels 18-25
		Bed VI-B	**Sanzako** (MSA)	
Middle Pleistocene	140,000 - ?275,000	Eyasi Beds		

McBrearty's (1986) study concerns the Muguruk site in Western Kenya. Her work provides information on the Sangoan-Lupemban and Middle Stone Age assemblages. The Sangoan was, until McBrearty's work, somewhat in limbo. Originally named to indicate a regional industry (previously discussed in Chapter 1) such as Stillbay, Magosian, etc., it was never clearly detailed. It has been described as a intermediate assemblage between the ESA and the MSA, an early MSA assemblage or even a late ESA assemblage. Consequently, McBrearty set out using modern (controlled) archaeological methods, to describe and analyze both the Sangoan and Middle Stone Age assemblages at Muguruk.

McBrearty divided the Muguruk Formation into six members. She documented nine stratigraphic units which contained three occupation levels. The lowest level she termed the Sangoan-Lupemban, the upper two were designated MSA, UCS MSA and RS MSA respectively. Member two contains the Sangoan-Lupemban assemblage although some of the material is located at the junction of member two and three. UCS MSA is contained in Member six and RS MSA is present in Member four. McBrearty interprets Member 6 (UCS MSA) to immediately overlie the Sangoan-Lupemban member (2) and underlie Member four (RS MSA).

All assemblages contain a large percentage of flaking debris (+90%). Flake production being by radial core reduction and there is a significant percentage of Levallois cores, flakes and points. The principal difference between the Sangoan and MSA assemblages is the presence of large bifacial tools in the Sangoan. Other differences are present but they are subtle; presence of more exotic materials in the MSA levels, smaller artifact size in the MSA and bifacial or alternate retouch pieces are significantly less in the MSA levels.

For the LSA, two studies are included here, Brandt (1988) and Kusimba (1999). The theoretical models have been explained earlier, in chapter 1; however, their relevance with respect to the lithic comparisons are pertinent in this section. Brandt's (1988) study is a late Pleistocene/Holocene site, Gogoshiis Qabe rockshelter at Burr Heybe, Somalia. The lithic information, only raw material choices and typological, is from earlier excavations (1935) and the initial dating of the assemblages has since been reevaluated in light of new dating technologies. Regardless, the lithic assemblages are separated into two industries, the Eibian and the Bardaale, both are considered LSA industries (1988:43-44). The Eibian is dated to approximately 12,910±180 BP and the first phase (without pottery) of the Bardaale is dated to 9100-8100 BP. Typologically the Bardaale is comprised of microliths, small scrapers and ground stone implements. This industry is manufactured from local materials, quartz and limestone. The Eibian is also comprised of microliths and small scrapers but includes pressure flaked small points. The stone implements are made on exotic cherts and local quartz. The inclusion of the pressure flaked implements and the proportion of exotic chert to local quartz (30%) are the main differences between the two industries as described by Brandt. He also assumes that function is not affecting the differences between the Eibian and Bardaale.

Kusimba (1999) analyzes the lithic artifacts from five sites at Lukenya Hill, Kenya. Based on dates, she groups three of the sites, GvJm46, GvJm62 and GvJm19 into the older group, group 1 and the remaining two sites, GvJm16 and GvJm22 into the younger group, group 2 at +20,000 BP and 10,000 BP respectively. The two groups are evaluated on the basis of raw material selections, tool types, core types and reduction methods and non-local obsidian. The three main raw material choices for the Lukenya assemblages are chert, obsidian and quartz ; the chert and obsidian are relatively localized while the quartz is plentiful throughout the area. The tool and cores types although not as all inclusive as Mehlman's types are nonetheless comparable. Kusimba's group 1 was determined to be primarily quartz-based. Typologically, group 1 was considered to be scraper-based with an assortment of scraper types. Bipolar reduction of cores occurred more often in this group. Finally, the proportion of non-local obsidian to local obsidian was less in group 1. In contrast, group 2 exhibited a higher proportion of non-local obsidian, bipolar cores were rare and the assemblage was principally microlith-based.

Chapter 4
Typological Analysis and Metrical Data

The metrical data and analysis of the typological elements discussed in Chapter 3 are presented in this chapter. The distribution of raw material types will be presented first, followed by the distribution in the general category. Within the tool category, the distribution of the scraper and backed pieces types, separately and in comparison to each other will be presented immediately following the data on the core types. The statistical data will be presented with test pit 4 considered as a single sample first. In order to determine change by depth test pit 4 will considered as a population of 29 samples (=individual levels).

4.1 Raw Material

Raw material distribution for the test pit, as a whole, is shown in Table 4.1. Quartz is the predominant raw material (47.7%) with quartzite (39.4%) second in frequency; together they represent 87.1% of the total artifacts. Volcanic rocks comprises only 1.5% of the total raw material choices. Tests regarding the flaking quality of the volcanic rocks performed by Miller in 1993 revealed the flakes produced were inferior (Miller 1993:57). It is not surprising then that volcanics are not a frequently occurring raw material, even though it is locally available. There were other raw materials represented in test pit 4, however they were so minimally represented that the contribution to the percent frequency was zero (Table 4.1).

Table 4.1 Raw Material Frequency, IdIu22 test pit 4

	Quartz	Quartzite	Chert	Volcanic	Obsidian	O. Met.	O. Sed	Total
n	10179	8410	2426	329	1	6	7	21358
%	47.7	39.4	11.4	1.5	.0	.0	.0	100

O. met.= other metamorphic
O. sed. = other sedimentary

The amount of quartz in test pit 4 is similar to the frequency of quartz distribution Miller (1993:57) found in the Songwe River surface survey sites (46.2%). The remaining raw material types, are distributed differently however. Miller's quartzite frequency was 15.4%, half of the quartzite frequency in test pit 4, while the frequency of chert was inversed: 25.3 % compared to test pit 4 at 11.4%. Obsidian, other metamorphic and other sedimentary did not contribute to the total percentage in test pit 4 (Table 4.1) whereas Miller's other sedimentary and other metamorphic categories contributed 2.3 % and 2.1% respectively and obsidian contributed .04%.

Mehlman's raw material types were only quartz, quartzite, chert and other but quartz occurred consistently high in every site. The chert and quartzite frequency was variable with each site. For example, at the Mumba VI-A site, upper and lower, the quartzite frequency was 10% while the chert was 5.4. In contrast, at the Mumba Lower III site the quartzite frequency was 5.6 % and the chert was 5.4%. Regardless, the quartzite frequency at any site was never as high as test pit 4. The chert frequency in the MSA sites was higher than test pit 4 although not by much. The LSA sites had less chert than test pit 4.

McBrearty's main raw material at the MSA site at Muguruk, Kenya was overwhelmingly Ombo phonolite and the quartz, quartzite and chert occupied only a very small proportion of the remaining (McBrearty 1986:192, 237, 238, 268). Thus between the differing raw material type and dates of sites, it made raw material comparisons somewhat unnecessary.

The distribution of raw material is seen by Brandt (1988) and Kusimba (1999) to be a reflection of specific subsistence strategies. Both of these studies used quartz and chert which contributes to effective comparisons although Kusimba includes obsidian in her raw material choice. This addition does not reduce the comparability as she considers chert and obsidian similarly (as opposed to quartz). Kusimba's study at Lukenya Hill, Kenya separates her five sites into two groups, 1 and 2, based on dating, thus group 1 is proposed to date "significantly earlier than 20,000 BP" (1999:172), at a time when southern Kenya was less arid, and group 2 to "10,000 year or more" (ibid), a time of high aridity. Both groups have local quartz present; however, group 2 has a higher proportion of non-local raw materials (chert & obsidian) to quartz and only a "moderate" (1999:175). Group 1 had high amounts of quartz, some obsidian and chert but the proportions of quartz to the chert and obsidian was high. Group 2 with its higher proportion on non-local raw material is proposed to represent a subsistence strategy to compensate for patchy resources (food and water). Thus, groups would have moved around frequently to get access to scarce resources and in the process acquire non-local raw materials, chert and obsidian. In contrast, group 1 indicates a time when resources were dependable. This group had a reduced need to travel and so used what was locally available for toolmaking.

A similar situation exists with Brandt's (1988) study at Burr Heybe in southern Somalia although his dates are slightly different and he classifies his lithic artifacts into industries, ±12 kya for the Eibian industry and ±8,000 for the Bardaale industry respectively. The Eibian is dated to the terminal Pleistocene during which time southern Somalia is arid thus resources would be patchy, scarce and undependable. As a consequence, group mobility would be great and there would be a high amount of interaction between groups. Accordingly, the Eibian presents large amounts of local quartz but 30% of the raw materials is comprised of exotic cherts (1988:44). The Bardaale industry, dated to the Holocene, a time where there is more moisture, resources are patchy but more dependable. There is a reduced need to move for resources consequently the lithic artifacts are "almost exclusively from locally available quartz" (ibid).

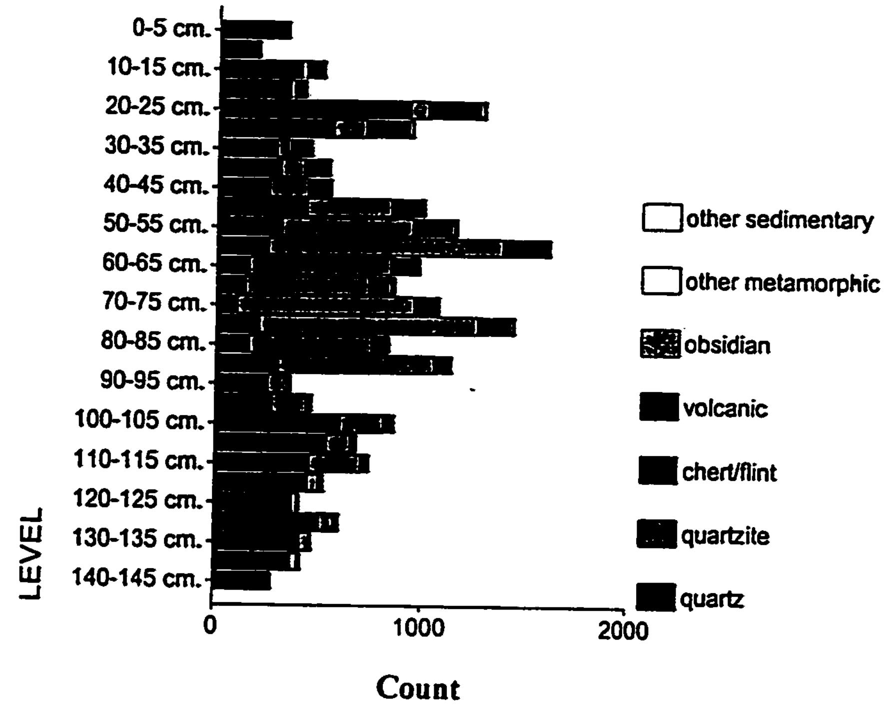
Site IdIu22 tp4 appears to reflect a time then when resources were dependable as the percentage of locally available raw materials, quartz and quartzite and probably most of the chert comprise 98.5 % of the total raw materials.

In order to determine if test pit 4 exhibits any change in raw material by depth, the variable is tested statistically by level. Once the frequency distribution was performed (Table 4.1 and discussed above) it was evident that the categories of obsidian, other metamorphic and other sedimentary (obsidian (n=1); other metamorphic (n=6) and other sedimentary (n=7)) contributed only trace frequencies (Table 4.1) to the distribution of raw material types. The chi-square values were calculated using the statistical package

SPSS. It places all the requested data in a contingency table thus some levels may not have had a particular raw material present (an empty cell). Since this statistic is especially sensitive to empty cells, those categories that contributed trace frequencies were then eliminated from the calculation of the chi square.

The null hypothesis, for this test, was that there was no change in raw material by depth. The chi square value was 8326.76 with 84 degrees of freedom (df= 84) at a probability of less than .000 ($p < .000$) and there were only 2 empty cells (1.2%) (Appendix III). Therefore the null hypothesis must be rejected. There is a relationship between raw material types and the stratigraphic levels. Figure 4.1 shows a bimodal frequency for quartz, quartzite exhibits a corresponding increase and a decrease in chert by depth. Quartz begins low and increases to a maximum at the 20-25 cm level and decreases in frequency to the 70-75 cm level. Until the 35-40 cm level, as the second most frequent raw material, chert is more frequent than quartzite. After this level, quartzite is more frequent than chert regardless of the frequency of quartz. After the 70-75 cm level, quartz increases again, overtaking quartzite by the 90-95 cm level.

Figure 4.1 Raw Material by level, IdIu22 tp4



4.2 General Artifact Categories

The first exploration into typology for test pit 4 is the distribution or frequency of the basic typological categories; tools, cores, debitage and ground stone. The frequencies in each category is presented in Table 4.2 and Figure 4.2. Debitage dominates the total measured artifacts at 88 % (n=18,819), cores comprise 2.6%(n=551) of the total and tools comprise 9.2%(n=1978) of the total. It should be noted that with the exception of ground stone all categories are represented.

Table 4.2 General Category, IdIu22tp4

	Tools	Cores	Debitage	Ground Stone	Total
n	1978	551	18819	10	21358
%	9.3	2.6	88.1	0.00	100%

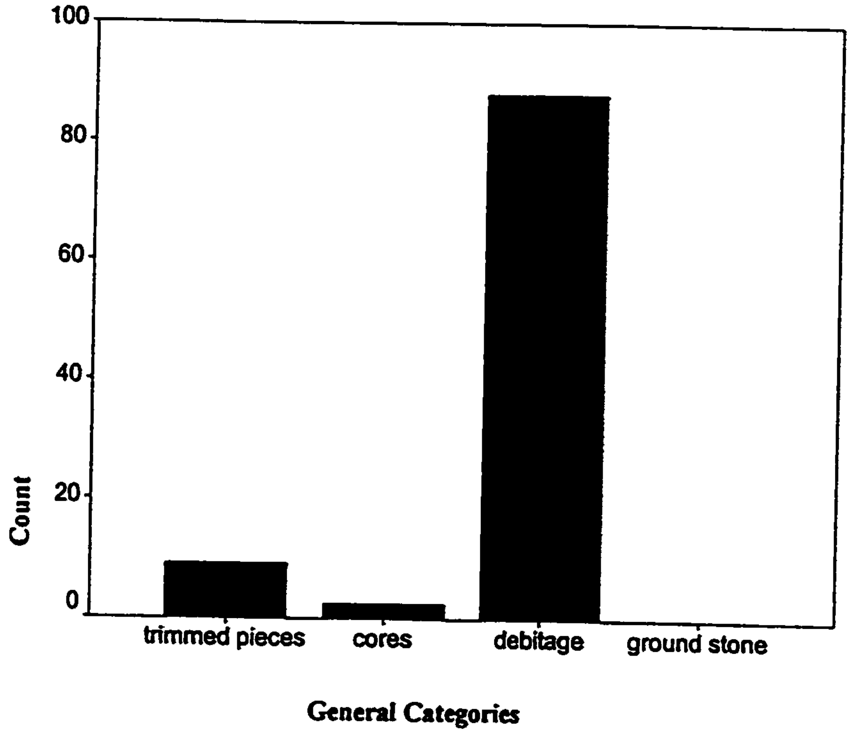
A high percentage of debitage is usual because debitage is composed of everything not considered a tool or a core namely whole flakes and blades, trimmed and utilized (whole) flakes and blades, parts of flakes and blades, etc. as well as angular fragments and core fragments. Miller's surface survey collections resulted in an average of 57.7% debitage in contrast to the debitage for test pit 4 (88.1%) which is also less than test pit 1 (n=9892, 93.6%).

The tool percentage is high (9.3%, n=1978) compared to the percentage of tools in test pit 1 (n=408, 3.8%). In Miller's Songwe River collections his "trimmed pieces" category comprised 25.5% of the total artifacts.

The number of cores is nearly the same between tp1 and tp4, 2.5% and 2.58% respectively. In comparison to Miller's sample, cores in tp4 comprised 2.58% as opposed to an average of 16.7% (1993:89).

The averages used in the general categories of Miller's surface collections do not reflect the range in the distribution of tools, cores and debitage at all of the sites in Willoughby's research area (for example, debitage ranges from 43.5% at IcIu2t1 to 98.9% at IcIu9tp1); they are simply an average of his samples. Further, the table below (Table 4.3) compares the distribution between the general categories at relevant sites in sub-Saharan Africa and seems to support the distribution of the general categories in test pit 4.

Figure 4.2 General Categories IdIu22 tp4



The chi-square statistical test for the distribution of these general categories by level was performed. It resulted in a chi-square value of 137.187 (df=56, p<.000) (Appendix III). No cells had less than expected counts thus the distribution of tools, cores and debitage throughout test pit 4 can be considered significant. The ground stone category was eliminated in the statistical test because of its low contribution to the total distribution. Figure 4.3, presented below, is the graphical representation of the general categories by level.

Figure 4.3 General Categories by level, IdIu22 tp4

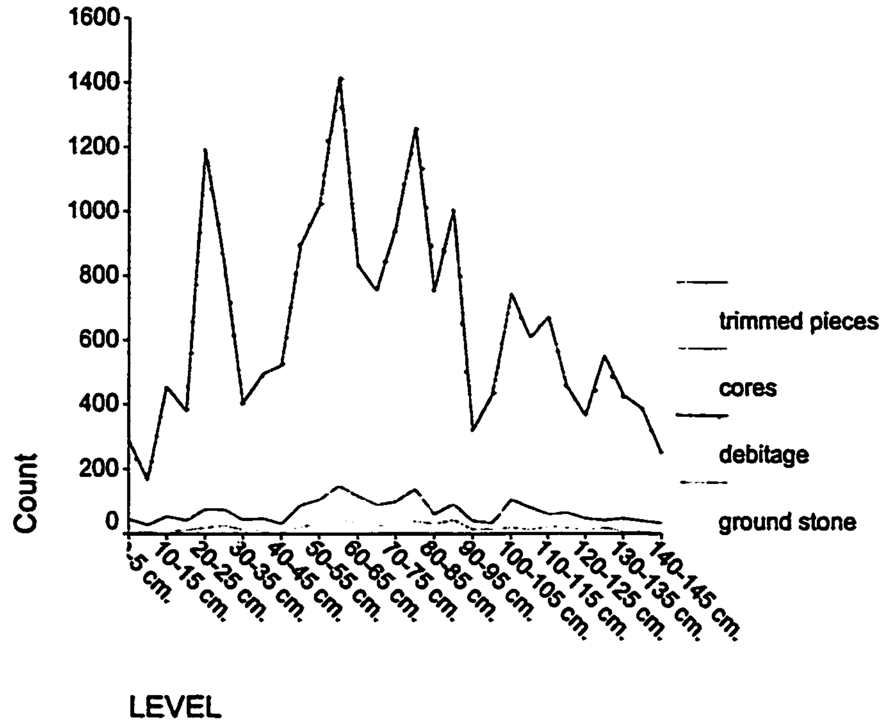


Table 4.3 General Categories, comparison sites

%	Test pit 1	Test pit 4	Miller*	McBrearty[a]	Mehlman[a]	Mehlman[b]
Tools	3.8	9.3	25.5	2.1	3.6	10.1
Cores	2.5	2.6	16.7	1.1	7.9	15.2
Debitage	93.6	88.1	57.7	95.3	88.6	74.7

* indicates surface collections and are an average in each category of all of his samples
a, The figures in this column are an average of McBrearty's 3 members; 2, 4 & 6.
b, The figures in this column are an average (no weighting) of Mehlman's five sites that are dated by him as MSA/LSA Intermediate and later: Nasera, levels 6 and 7; Mumba Lower III; Nasera levels 4 and 5 (Lemuta Industry); Nasera level 3b (Silale Industry) and Mumba Middle III. The Olmoti Industry (Nasera level 3) is not included as that industry includes pottery which IdIu22 test pits 1, 2, 3 and 4 also did not.
c, These figures are an average of Mehlman's MSA sites: Kisele Industry at Nasera 12-25, Mumba VI-A Upper and Lower and the Sanzako Industry at Mumba VI-B

In addition, testing was performed between raw materials, general categories and levels to determine if there was any pattern. The crosstabulation testing was performed three times: with the ground stone category included, without the ground stone category but with raw material categories, quartz, quartzite, chert/flint and volcanic and finally without ground stone and only the raw materials, quartz, quartzite and chert/flint. The ground stone category and the volcanic raw material were eliminated because of their minimal contribution to the frequency. In all cases, a chi-square statistic was determined by depth. In all levels, there were less than expected cell counts (empty cells) therefore the resulting chi-square statistics were considered inconclusive (Appendix III). It could not be concluded that general categories showed any raw material pattern by level.

Further, each general category was tested individually by the major raw material types (quartz, quartzite, chert/flint and volcanic) by level to determine if there was any tendency to choose a particular raw material for a specific category, for example, the better quality raw material chert/flint for tools. In all cases, the chi-square test was inconclusive and again there was a high percentage of empty cells (Appendix III).

4.3 Core types

The majority of the cores in test pit 4 is patterned platform (73.3%). Peripheral cores are the second most frequent core type but it is considerably less frequent at 13.5%. Bipolar cores are the third most frequent core type at 10.2% (Table 4.4).

Table 4.4 Core Frequencies, IdIu22 tp4

	Peripheral	**Pat. Platform**	**Intermediate**	**Bipolar**	**Amorphous**	**Total**
n	74	404	3	56	14	551
%	13.5	73.2	.5	10.2	2.6	100

In Miller's (1993) distribution of core types, peripherally worked cores were overwhelmingly the most frequent core type at all sites in his sample. This was followed by patterned platform, again at all sites. It varied by site with the remaining core types (1993:89).

Figure 4.4 Core Distribution, IdIu22 tp4

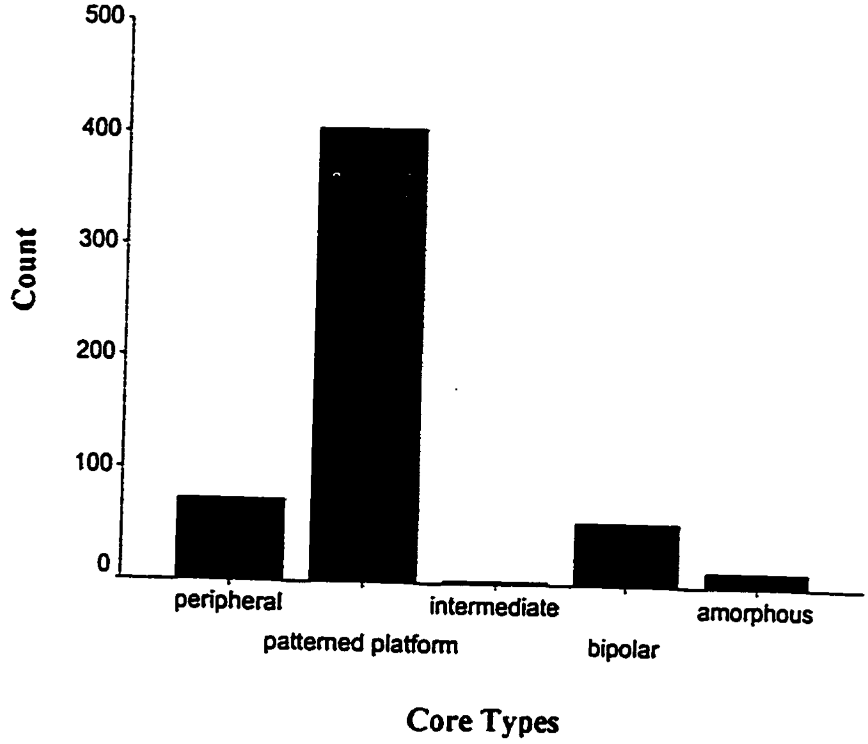
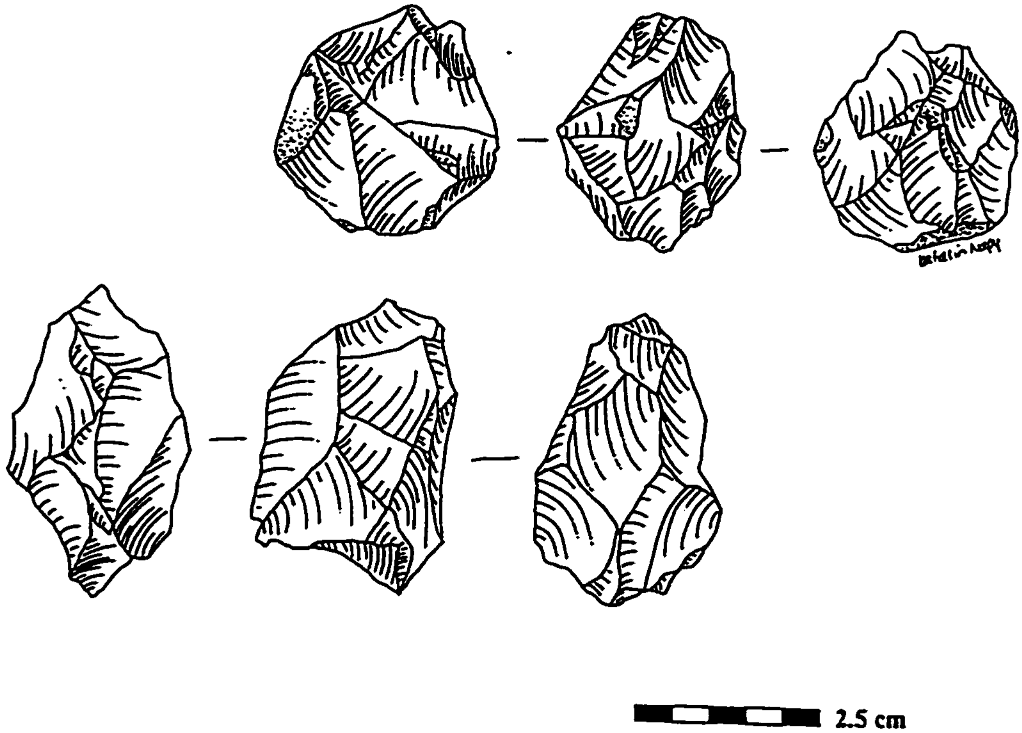
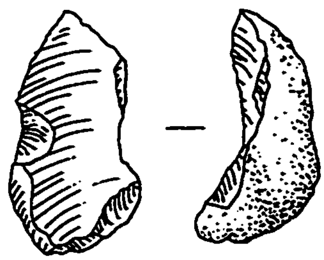


Figure 4.5 Core Artifacts, IdIu22tp4

a) Multiple Platform Core



b) Bipolar Core



Miller classifies his Songwe River collections as MSA. Patterned platform cores and bipolar cores, although more prevalent in the LSA are not absent in the intermediate MSA (Mehlman 1989:368). Nor, are they absent either in "unquestionable MSA assemblages" (Mehlman 1989:200).

Peripheral cores are somewhat different. Although they are present in varying frequencies at his sites, Mehlman does state with respect to the Lemuta Industry (early LSA) that "radial/Levallois core technology (= peripheral core type) has disappeared" (Mehlman: 368). Nonetheless the frequency of patterned platform cores and peripheral cores do indicate a temporal shift. Table 4.5 presents the core types at Mehlman's sites. The sites range in time from the "unquestionable MSA assemblage", the Kisele Industry, to the Holocene LSA assemblage, the Silale Industry.

Table 4.5 Core Types, Mehlman's sites

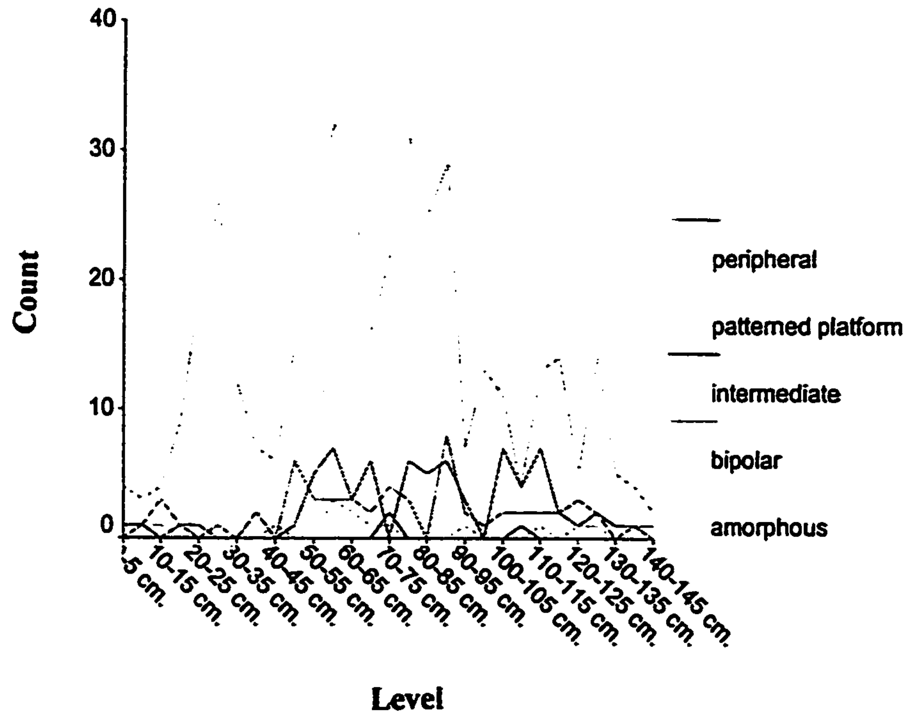
%	1	2	3	4	5	6	7	8
A	12.4	8.5	4.0	5.4	25.5	16.2	36.6	36.5
B	2.8	2.5	24.0	9.9	20.3	47.8	37.4	55.3
C	61.3	66.9	56.0	64.9	34.0	20.2	4.3	0

A, patterned platform core; B, bipolar; C, peripheral
1, Kisele Industry (MSA), Mumba VI-A Upper; 2; Sanzako Industry (MSA), Mumba VI-B Lower; 3, Kisele Industry (MSA) Nasera 12-17; 4, Kisele Industry (MSA), Nasera 18-25; 6 MSA/LSA Intermediate;
5, Mumba III Lower; Nasera 6 & 7; 7, Lemuta Industry (early LSA, Pleistocene), Nasera 4 & 5
8, Silale Industry (Holocene LSA), Nasera 3b

McBrearty's excavations at the MSA Muguruk site are also consistent with Mehlman's MSA sites although more extreme. She has no bipolar cores in any archaeological levels (members) and the percentage of radial cores ranges from 77% to 91%. The platform cores range from 10% to 14% (McBrearty 1986: 181, 225, 260).

Statistically, the $\chi^2=153.2$, df=112, $p<.006$ with 81.4% of the cells with less than expected counts. Consequently, the variability in core types by level is insignificant (Appendix III). Graphically it is represented in Figure 4.5 (below).

Figure 4.6 Core types by level



4.4 Tool Types

In the tool category this study will deal primarily with two groups, scrapers and backed pieces. It will be remembered from chapter 3 that these two groups, as a whole, were considered by Mehlman to be more indicative of change and there are types within these two larger categories (subtypes) that will also be discussed. In addition, Mehlman points out in his MSA assemblages what he observed to be diagnostic markers; bifacially modified pieces, points and heavy duty tools (1989: 183, 201) consequently the presence and frequency of these types idea will also be explored.

4.4.1 Backed Pieces

The backed pieces variable consists of: crescents, triangles, trapezes, curved backed pieces, straight backed pieces, orthagonal truncations, oblique truncations, angle backed pieces, divers backed, backed awls/drills/percoirs and backed fragments (Figure 4.7). The distribution of the various types of backed pieces throughout test pit 4 is shown in Table 4.6. Backed pieces (n=1312) comprised 66.13% of the tool category. This is a 10% difference from test pit 1. Backed pieces comprised 56.13% of the total tools in IdIu22 tp1 (n=229).

Table 4.6 Backed Pieces, IdIu22 tp4

Backed Pieces	n	%
crescent	117	8.9
triangle	84	6.4
trapeze	98	7.5
curved backed	252	19.2
straight backed	203	15.5
orthagonal truncation	92	7.0
oblique truncation	226	17.2
angle backed	27	2.1
divers backed	194	14.8
awl/percoir/drill	14	1.1
backed fragment	5	.4
Total	1312	100

Curved and straight backed, oblique truncations and divers backed pieces appear to dominate test pit 4. Divers backed pieces are almost all microburins, the debitage from producing microliths (crescents, triangle and trapezes). The microburin technique, explained in chapter 2 (Figure 2.3, p.36), is a special technique that produces specific tool types. This is Mehlman's category of divers backed (Table 4.6). Thus, if there are microliths present and they are being manufactured at the site, there will also be microburins present.

The microliths thus need to be considered as a group when comparing their frequency to divers backed. Divers backed pieces then do not occur more frequently than microliths. Microliths become the most frequently occurring backed pieces at 22.8% with curved backed pieces (4), straight backed pieces (5) and divers backed pieces (9) occurring at 19.2%, 15.5% and 14.8% respectively.

The distribution of divers backed pieces does change by level (Figure 4.6a, raw data Appendix III). Microburin frequency does decrease with depth as do crescents, triangles and trapezes (Figure 4.6). Both diverse backed pieces and the grouping of crescents, trapezes and triangles have a high frequency at the top of test pit 4 and taper off towards the bottom of test pit 4, almost disappearing at the 140-145 cm level.

Curved backed (#4) and straight backed pieces (#5) are the two highest occurring backed piece categories. The presence and frequencies of these two groups, the angle backed (#8 in Table 4.6) and the divers backed category discussed above in IdIu22 tp4 resemble the Silale industry.

Figure 4.7 Divers Backed, Trapeze, Crescents and Triangles by level, IdIu22 tp4

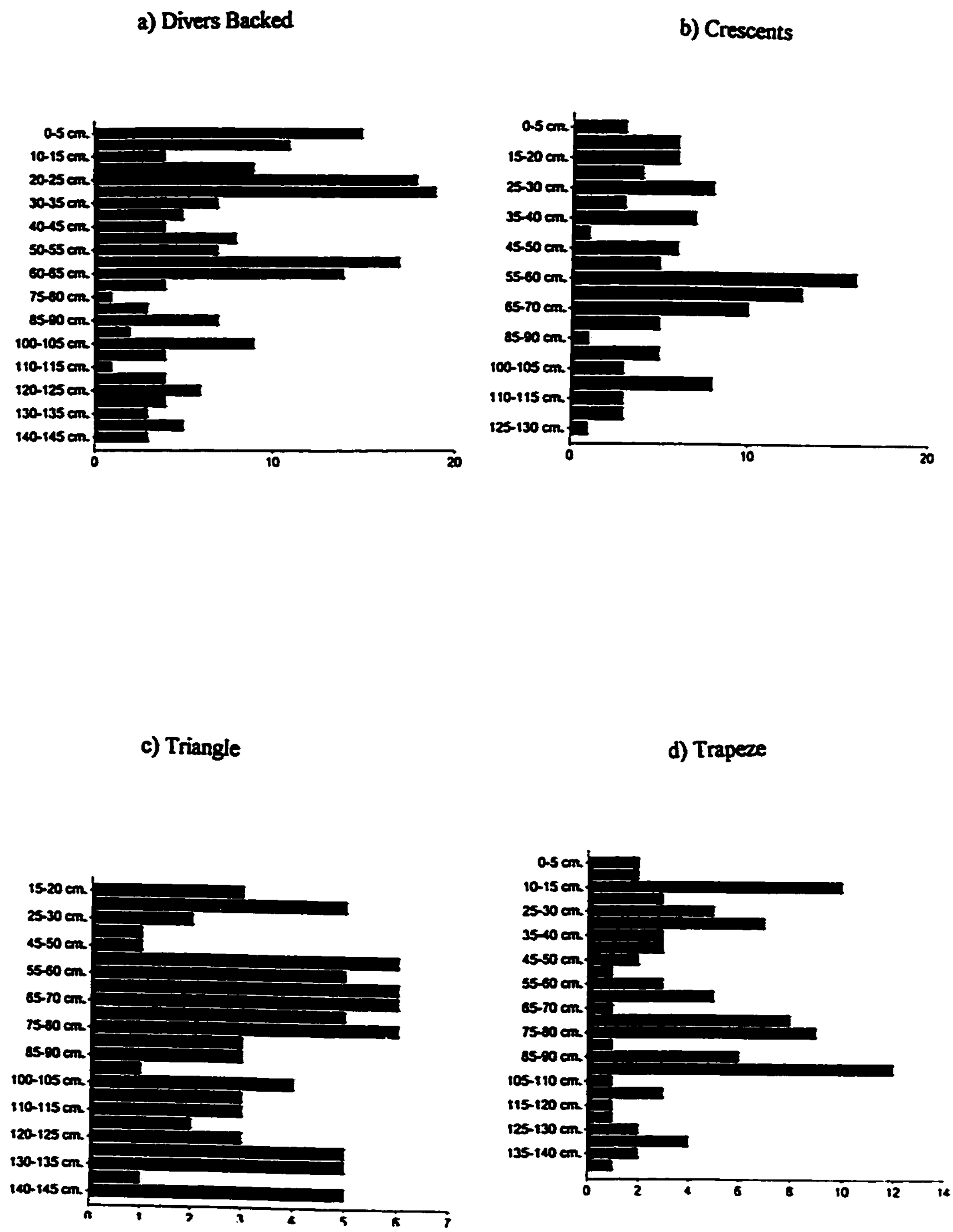
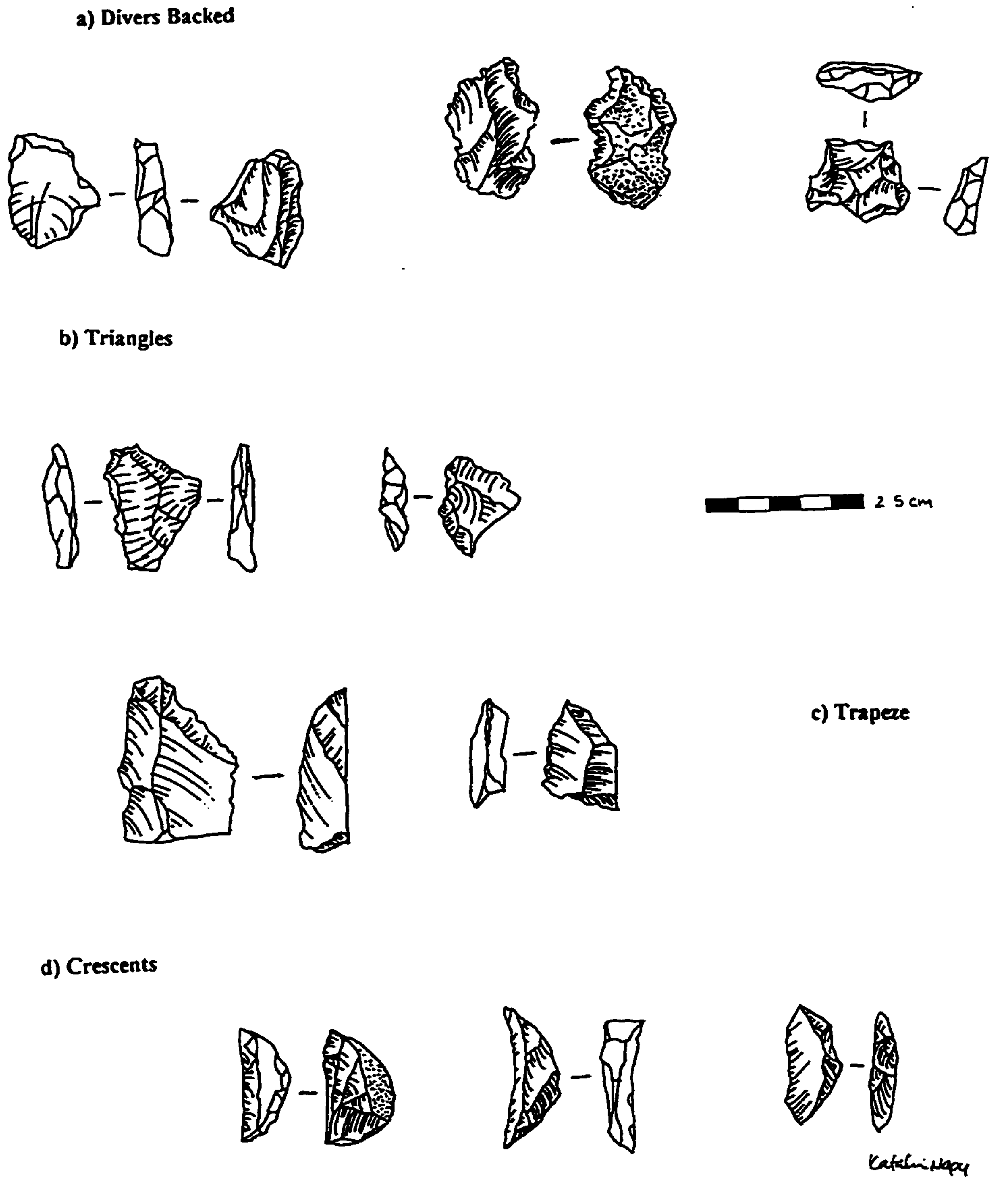


Figure 4.8 Backed Artifacts, IdIu22 tp4



4.4.2 Scrapers

Mehlman's typology has 23 different types, only 20 of which are present in test pit 4 (Table 4.7). There were no convex double end scrapers (#3), sundry double end scrapers (#11) and divers scrapers (#21) present. The next most frequent scraper occurrence is the circular scraper at 23.8%, followed by concave scrapers (19.3%) then sundry side scrapers (13.1%). These three types combined comprise over half of the total scraper types (56.2%). Figure 4.8 displays the scraper type distribution; raw data are included in Appendix III.

It is interesting to observe that circular scrapers are the largest category, as they are typically diagnostic of MSA assemblages. The sites that have these scrapers, Nasera levels 12-17 and Mumba Lower VI-A, are Mehlman's MSA sites (Table 4.8). It is also interesting to note that he includes circular scrapers in the end scraper group when the data are presented. The distribution of the circular scrapers in test pit 4 is randomly distributed through the levels. Only four of the levels have no circular scrapers, 5-10 cm, 95-100 cm, 120-125 cm and the deepest level 140-145 cm. Small convex scrapers which Mehlman found to "dominate tool assemblages" from the early LSA (Lemuta Industry) (1989:368) occur in test pit 4 only .4% (n=2).

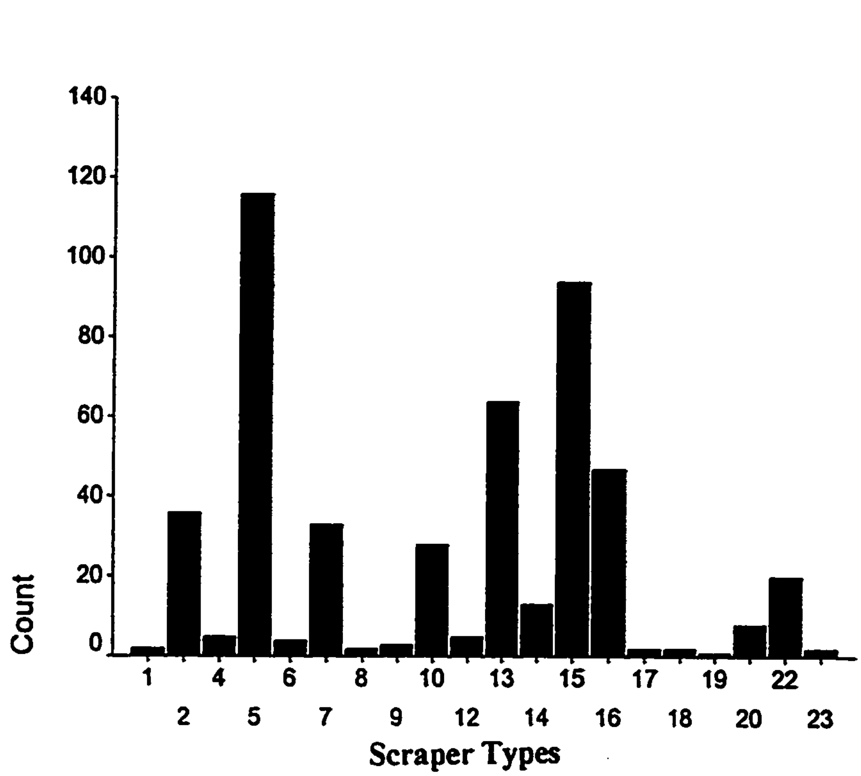
Table 4.7 Scraper Frequencies, IdIu22 test pit 4

Scraper Types	n	%
small convex scraper	2	.4
convex end scraper	36	7.4
convex end and side	5	1.0
circular	116	23.8
nosed end	4	.8
convex side	33	6.8
convex double side	2	.4
nosed side	3	.6
sundry end	28	5.7
sundry end and side	5	1.0
sundry side	64	13.1
sundry double side	13	2.7
concave	94	19.3
concavity	47	9.7
notch	2	.4
sundry combination	2	.4
convex end and concave combination	1	.2
convex side and concave combination	8	1.6
convergent	20	4.1
scraper fragment	2	.4
Total	487	100

Table 4.8 Scraper Frequency, Mehlman's sites (Mehlman 1989)

	small convex	end	side	concave	combination	divers	convergent	circular
Sanzako	0.0	7.5	60.0	22.5	5.0	5.0	0.0	0.0
Nasera 12-17	0.0	41.2	41.2	5.9	0.0	0.0	5.9	5.9
Nasera 18-25	0.0	32.4	51.4	2.7	2.7	2.7	0.0	0.0
Mumba Lower VI-A	0.0	25.8	43.9	16.7	6.1	1.5	3.0	3.0
Mumba Upper VI-A	0.7	30.9	44.6	16.5	5.0	0.0	2.2	0.0
Nasera 6 & 7	14.4	30.1	27.4	13.0	2.7	7.5	4.8	0.0
Mumba III Lower	6.7	32.5	35.0	18.3	4.2	2.5	0.8	0.0
Nasera 4 & 5 (Lemuta)	19.0	25.9	22.4	18.1	0.9	12.1	1.7	0.0
Nasera 3b (Silale)	51.2	18.6	16.3	14.0	0.0	0.0	0.0	0.0
Mumba III Middle	57.7	42.3	0.0	0.0	0.0	0.0	0.0	0.0

Figure 4.9 Scraper Frequencies, IdIu22 tp 4

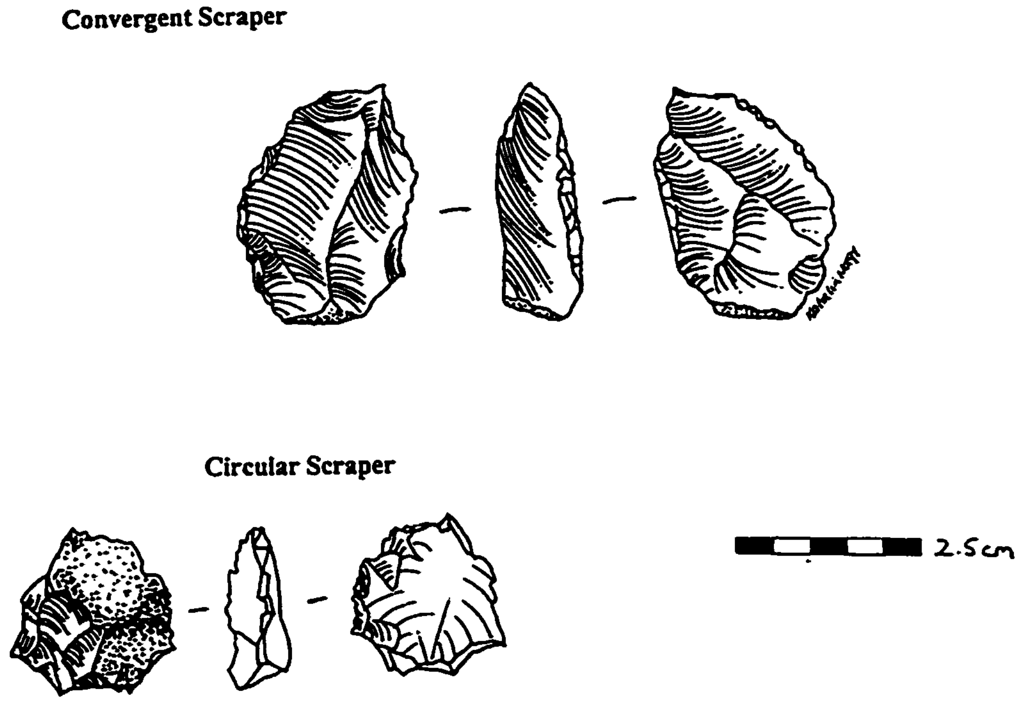


1=small convex; 2=convex end; 4=convex end and side; 5=circular; 6=nosed end; 7=convex side; 8=convex double side; 9=nosed side; 10=sundry end; 12=sundry end and side; 13=sundry side; 14=sundry double side; 15=concave; 16=concavity; 17=notch; 18=sundry combination; 19=convex end and concave side; 20=convex side and concave end; 22=convergent; 23=scraper fragment

The frequency of scraper types with at Muguruk site (McBrearty 1986) site was difficult to evaluate as the categories used for classification were not always the same as Mehlman's. She also did not group her scraper frequencies at the morphological level which made it difficult to pull out comparable information. This should be expected to some degree; the sites and the industries are different. Consequently, McBrearty's assemblages were not included here.

Scraper type frequency was compared to the excavation levels to determine if there was any pattern in the types of scrapers by level. The result was no relationship exists between scraper types and levels (χ^2=735.75, df=532, p<.000 and 97.9% of the cells had less than expected counts, Appendix III).

Figure 4.10 Scraper Artifacts, IdIu22 tp4



4.4.3 Comparison of Backed Pieces to Scrapers

Backed pieces seem to outnumber scrapers in Holocene LSA assemblages, before pottery (Mehlman 1989:386) therefore the proportions of scrapers and backed pieces categories, relative to each other are considered. In all of McBrearty's assemblages there were no backed pieces (McBreary 1986: 203,277). The Lemuta Industry, an LSA industry but not Holocene and Merrick's Olduvai assemblages, backed pieces and scrapers generally balance each other (Table 4.9). Mehlman's Silale Industry, a Holocene LSA industry, would appear to support Mehlman's conclusion. The proportions of backed piece to scrapers is not balanced. IdIu22 tp4 would also appear to exhibit similar proportions.

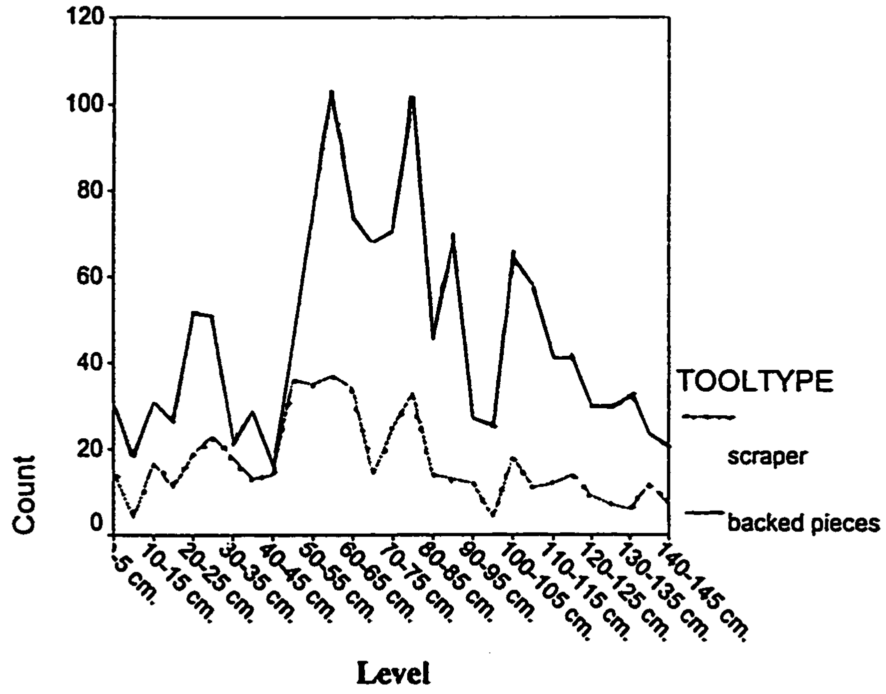
Table 4.9 Distribution of scrapers and backed pieces

%	Test Pit 4	Merrick	Lemuta (P-LSA)	Silale (H-LSA)
scrapers	28	39	39	27
backed pieces	73	37	31	57

Kusimba's study at Lukenya Hill, also analyzed the distribution of scrapers and microliths. In her group 1, the earlier group, the industry was scraper-based (1999:176) and her group 2, the later group was microlith-based. Although she was not specific about the distribution of the types within the scrapers and microliths (in this study, at least) she did list the types and they were similar to the categories used here.

The chi-square test for the distribution of scrapers and backed pieces by level for test pit 4 resulted in χ^2=57, df=28, p<.001 and no empty cells (Appendix III) thus the distribution of backed pieces and scrapers by level is non-random. Backed pieces in test pit 4 consistently outnumber scrapers in all levels (Figure 4.10).

Figure 4.11 Scraper and Backed Pieces by level



4.4.4 Bifacially modified pieces, points and heavy duty tools

These three types within the tool category are considered to be diagnostic of MSA assemblages according to Mehlman (1989:183, 201). A simple count revealed 25 bifacially modified pieces, eight heavy duty tools and five points. They contributed 1.3%, .4% and .3% respectively to the tool category.

As well, the distribution of these three types in the test pit levels were explored to determine if they occurred in the lower levels or were randomly distributed. The points, of which there was only one subtype (unifacial) were at the 35-40 cm, 60-65 cm, 120-125 cm and 140-145 cm levels. Bifacially modified pieces had only three subtypes; discoids, point blanks and bifacially modified pieces. The distribution of this group had no statistical significance but the bifacially modified pieces subtype were located only in the 5-50 cm levels. The discoids were distributed throughout the test pit and the point blank subtype of which there was only one was located in the 105-110 cm level.

The heavy duty tools tool type has three subtype occurrences: core/large scraper, biface/pick and core chopper. All three subtypes were represented in test pit 4 although they accounted for only .03% of the tools. There was no concentration of any of the three subtypes in test pit level although seven of the tools were throughout the 105 cm levels and deeper. The remaining heavy duty tool, a core chopper was located in the 50-55 cm level.

Points were another diagnostic marker for the MSA according to Mehlman, as stated in the beginning of this chapter. In this tool type there are three subtypes: unifacial point, alternate face/edge point and bifacial point. There was only one type of point present in test pit 4 and that was the unifacial point subtype. Throughout test pit 4 only 5 unifacial points were documented and they were dispersed throughout the test pit; at 35-40 cm, 60-65 cm, 120-125 cm and 140-145 cm.

Chapter 5

Technological Analysis and Metrical Data

This chapter presents the metrical data and conclusions from the technological attributes studied in this thesis. A discussion of the technology variables are presented in Chapter 3 but recapped again here for convenience are: Toth type, shape of piece (planform), scar pattern, number of dorsal scars and artifact size measurements. The format will be similar to Chapter 4 in which the data for IdIu22 tp4 as a single sample is presented first, followed by the data compared for the 29 levels .

For the analysis in this section only whole flakes and trimmed/utilized flakes are used (n=6337) for this portion of the analysis because these artifacts exhibit the variables criteria in as pristine condition as is possible. In most cases, the tools have had retouch applied to them which could possibly obscure the variable under analysis.

5.1 Toth Type for whole flakes

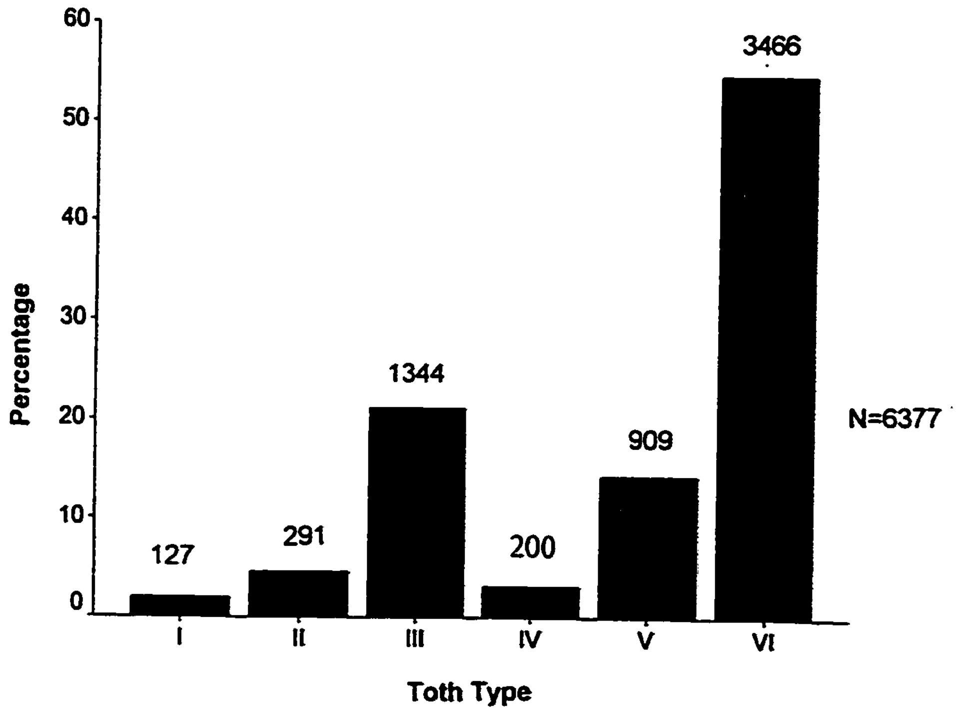
The distribution of Toth numbers (Table 5.1) shows that over half (54.7%) are at stage VI (no cortex on dorsal surface, no cortex on platform, also see Figure 3.1). The next most frequent occurrence is stage III at 21.2% and stage V at 14.4%. Nick Toth proposed that a high amounts of stages IV, V and VI represented the later stages of core reduction, i.e. the cortex and outer flakes had already been removed (Toth 1982:73). Therefore 72.2% of the flakes show the later stages of core reduction.

However, the frequency of stage III is also high. This stage has cortex only on the platform, none on the dorsal surface (Figure 3.1) and usually indicates bipolar technology. It is an economic use of small cores and it is a core reduction strategy especially well suited to small quartz cores (Mehlman 1989:368).

Table 5.1. TothType, IdIu22 test pit 4

	I	II	III	IV	V	VI	Total
n	127	291	1344	200	909	3466	6337
%	2.0	4.6	21.2	3.2	14.3	54.7	100

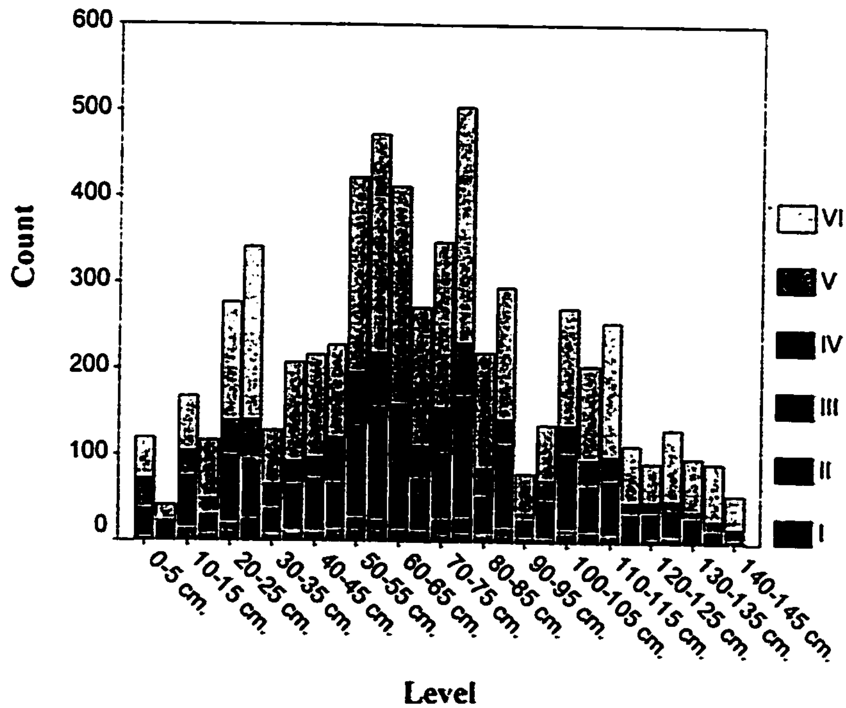
Figure 5.1 Frequency of Toth Type, IdIu22 tp4



Toth proposed from his sites and replication experiments that sites with a high frequency of late stage core flaking was a result of : (1) initial flaking of the core elsewhere possibly testing the core for quality, (2) selective removal of stage 1-3 by stone age peoples, (3) depositional processes, and/or (4) intensive use of raw materials. All scenarios are possible as well for IdIu22 testpit 4.

When Toth type was explored by individual levels to determine any patterning, the chi-square test resulted in a χ^2 value of 305.75, with 140 degrees of freedom at a probability of less than .000 with 20.7% cells with less than the expected count (Appendix III). Graphically, Toth types by level are presented in Figure 5.2. Even though there is not a significant result, the two areas which stand out are stage VI and stage III.

Figure 5.2 Toth type by level, IdIu22 tp4



The concentration on bipolar technology (= stage III) may be an indication of raw material size and requires further statistical testing to verify this idea. Stage IV may represent traditional flake removal strategies (i.e. not bipolar reduction technology) on small cores. Again, further testing will be required but experimenting with small cores to see if this is even possible is an additional idea. Regardless, Toth VI indicates the final stage of tool production and unless the site is temporary, all stages of tool production should be present at an intensively occupied site which IdIu22 appears to be.

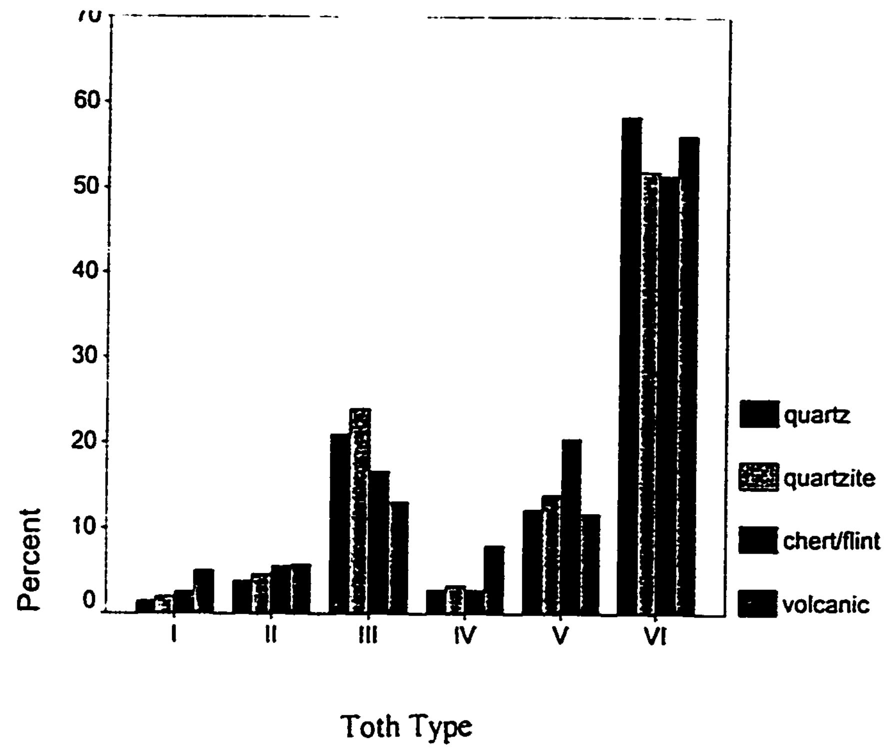
As a further exploration into the data, Toth type for whole flakes and trimmed/utilized flakes (n=6325) was compared to raw material to determine if there were any patterns. Only the most common raw materials raw material types were used: quartz, quartzite, chert/flint. Other metamorphic and other sedimentary were not selected for this analysis because they were contributed only .1% to the total and the chi-square statistic is sensitive to empty cells. The chi-square test resulted in a value of 106.2 (df=15, p<.000) with 2 cells (8.3%) having less than expected counts (Appendix III). Cramer's V was .075 (p<.000) (where a value of 0 = no association, 1 or $^{-}1$ = a perfect relationship) (Shennan 1997:115) which indicates that the strength of association between raw material and Toth type is weak. The chi square would seem to indicate a relationship between raw material and Toth type but the Cramer's V measure of the strength of the relationship is weak. However, because the sample size is large even a weak relationship can be considered significant (Shennan 1997:115). The results are presented below graphically in Figure 5.1. and they reflect the ambiguity of the statistical tests.

Toth VI is the most common, which has already been mentioned and quartz is the most common raw material for that Toth number. This may be simply a combination of factors; a reflection of the most common raw material for the test pit (chapter 4, Table 4.1) and the area.

However, quartz is not the most common for any of the other Toth types. For the other two most numerous Toth types; Toth V, chert/flint is the most common raw material, and Toth III, quartzite is the most common raw material. The chert available to stone age peoples in the area is generally in tabular form although there are lenses of chert present in some of the volcanic rock. In the tabular form there is more cortex surface area compared to the inner material and this may be what Toth stage V actually reflects.

Stage III, Toth type, as a reflection of bipolar reduction technology, is an economical use of small pebbles (Kusimba 1999; Mehlman 1989). Quartzite is the most common raw material at this stage. Quartzite pebbles are locally available but it is also grainy and has a preferred cleavage and these qualities lend well to stage III. In conclusion, there would seem to be a subtle pattern in raw material choice and the stage of flake removal reflected by the Toth type.

Figure 5.3 Raw Material by Toth type, IdIu22 tp4



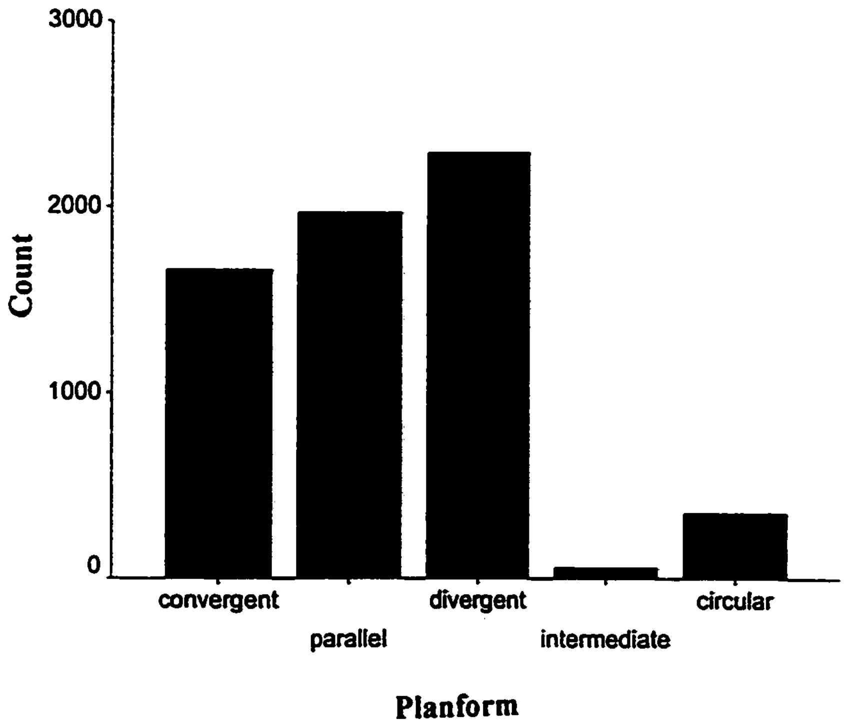
5.2 Planform

The table below, Table 5.2 and the graph, Figure 5.2 represent the frequencies of the planform of the whole and trimmed/utilized whole flakes for IdIu22 tp4 as a single sample. Convergent, parallel and divergent had the most frequent occurrence at 26.2, 31.1 and 36.2 %, respectively and were relatively evenly distributed. The circular planform is indicative of radial flake removal and it is consistent with MSA technology. IdIu22 test pit 4 exhibits only 5.6% of this pattern.

Table 5.2. Planform, IdIu22 test pit 4

	Convergent	Parallel	Divergent	Intermediate	Circular	Total
n	1663	1971	2292	58	353	6337
%	26.2	31.1	36.2	0.9	5.6	100

Figure 5.4. Bar Graph, Planform, IdIu22 test pit 4



These results are somewhat different to McBrearty's (1986) Sangoan-Lupemban sample; test pit 4 has more convergent flakes, 26.2 % versus 14.2%. As well, for some reason McBrearty does not have a circular variable in the planform variable for an assemblage which she concluded to be MSA. For both McBrearty's sample and Miller's (1993) sample there is a relatively even distribution between convergent, divergent, parallel and intermediate. Miller (1993) had a circular choice and it was also evenly distributed with the just mentioned planform choices. The situation with IdIu22 tp4 shows a definite preference as can be seen from the bar chart (Figure 5.2.).

Again, to fulfill one of the research goals, of any technological change, the technological variable, in this case planform, is compared to the levels to determine if there is any patterning. The chi-square statistic was 626.60, df=112, p<.000 and there were 22.1% of the cell with less than the expected count (Appendix III). It must be concluded that there is no change in the technological variable, planform in IdIu22 tp4.

5.3 Scar Pattern

Values for pattern of the flake scars on the dorsal surface were taken from McBrearty (1986:183). This variable has six possible states: radial; same platform, simple; same platform, parallel; opposed platform; transverse and none. The radial scar pattern reflects a radial flaking technique which is diagnostic of the MSA. No scar pattern, can be produced by any flaking technique (McBrearty 1986: 182) and thus cannot be considered diagnostic of any period. Platform scar patterns (simple and parallel) indicate at the very least, transitional MSA/LSA, or LSA technology (Mehlman 1989:311). Merrick did not consider Lukenya Hill, Nakuru Basin or Olduvai Gorge to have transitional industries but he did consider the platform scar pattern to be representative of the LSA.

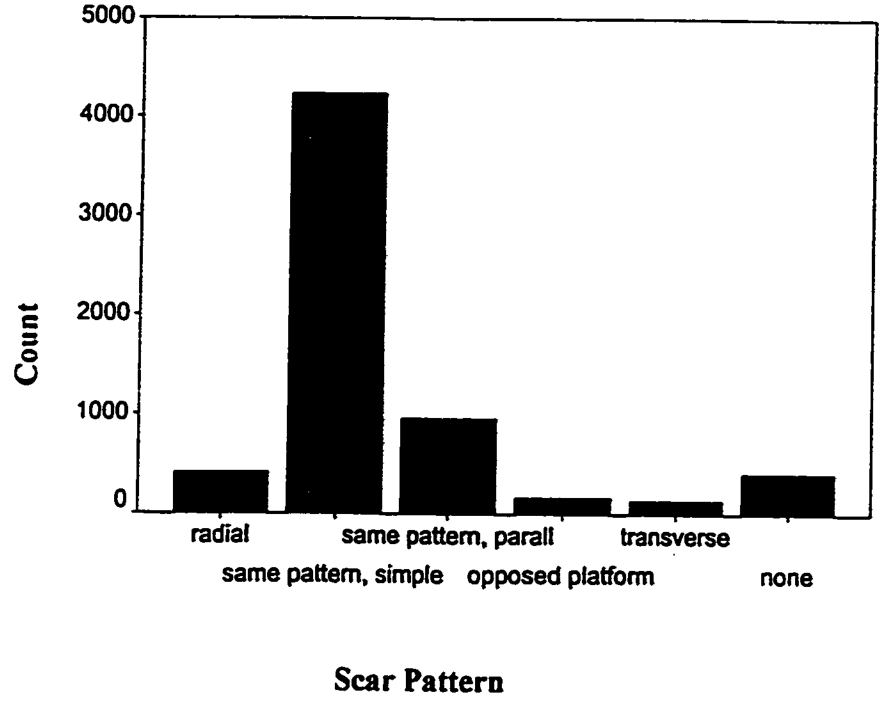
Table 5.3. Scar pattern, IdIu22 test pit 4

	radial	s.p. simple	s.p. parallel	opposed platform	transverse	none	Total
n	417	4240	961	168	139	412	6337
%	6.6	66.9	15.2	2.7	2.2	6.5	100

The frequency of scar pattern in test pit 4 (Table 5.3.) yielded same platform, simple as the major type of dorsal scar pattern at 66.9% (n=4240) and same platform, parallel as the second most frequent occurrence (15.2%). These two choices, both indicative of transitional MSA/LSA, at least, flaking techniques combine to make up 82.1% of the total choices. The radial scar pattern only makes up 6.6% of the total. In McBrearty's Muguruk Sangoan-Lupemban sample, a MSA assemblage, the radial scar pattern makes up 49.4% of the total. The two same platform choices only represent 20% of her total. Miller's (1993) results were similar to McBrearty's.

The frequency of the dorsal scar pattern was compared to levels in test pit 4 to determine if there were any patterns. The chi-square statistic was 688.89, df=140, p<.000 and 19.5% of the cells had a less than expected count of .92. Consequently, the null hypothesis, that there was a pattern in dorsal scar pattern by level, was rejected. It was concluded there was no pattern in the scar pattern variable by level.

Figure 5.5 Scar pattern frequency, IdIu22 test pit 4



5.4 Number of Dorsal Flake Scars

The distribution of the number of dorsal scars for IdIu22 tp4 is presented below in Table 5.4. The most frequent occurrence is only one scar at 39.6% (n=2507) with 2 scars the next most frequent at 38.0%. Together they comprise 77.6% of the total with three or more dorsal scars comprising the remaining distribution . The dorsal scar variable is a measure of the intensity of reduction and from the results it would appear to indicate a less intense stage of reduction.

Table 5.4 Dorsal Scars, IdIu22 test pit 4

	0	1	2	3	4	5	6	7	8+	Total
n	412	2507	2407	660	176	120	43	10	2	6337
%	6.5	39.6	38.0	10.4	2.8	1.9	0.7	0.2	0.0	100

However, the number of dorsal scars may also be considered a reinforcement of the results of the dorsal scar pattern variable. In the frequency distribution of this variable, same pattern, simple and same pattern, parallel were the most frequent occurrences at 66.9% and 15.2%, respectively. It is unlikely that more than two flake removals can be present for either of these two scar patterns to be present. With this line of reasoning it also follows that a radial scar pattern should have multiple flake scars. The results of the frequency distributions of both dorsal scars and scar pattern reinforce this conclusion. The radial scar pattern exhibited only 6.6% occurrence and as stated earlier in this section all the choices that comprise three or more dorsal scars make up only 22.4%

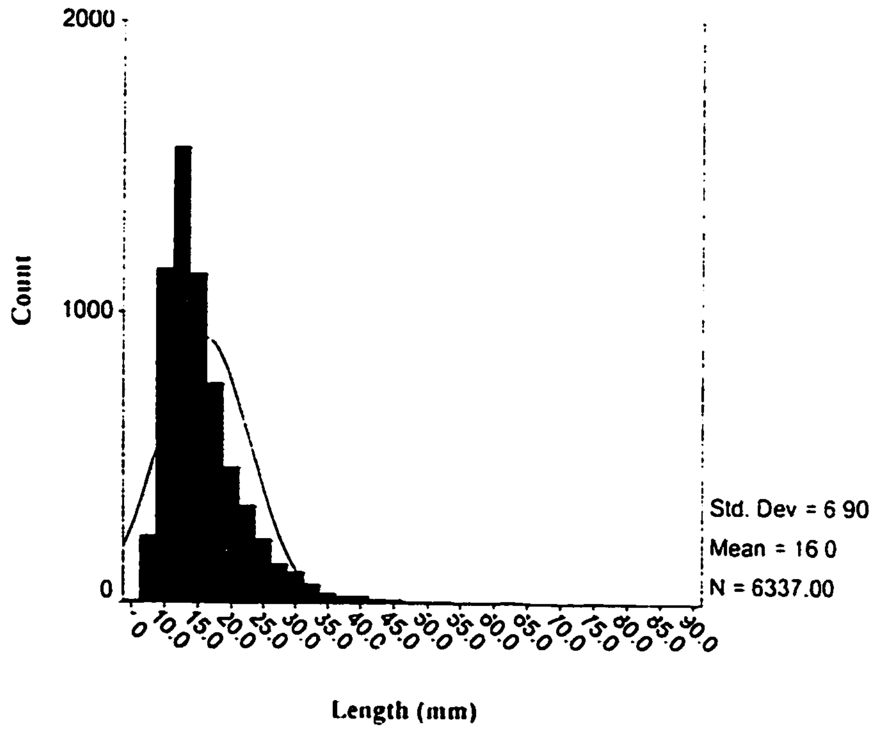
5.5 Flake length, breadth, thickness and weight measurements

The length, breadth and thickness measurements were taken in millimetres and the weight measurements were taken in grams. This section will not include an analysis of the artifact size variable on a level by level scale. The computer program used to perform these analyses was too unwieldy and thus the analyses were limited to IdIu22 tp4 as a single sample.

5.5.1 Flake Length

The flake length for Idlu22tp4 had a mean length of 16.0 mm and a standard deviation of 6.90. The bar graph for length of whole and trimmed/utilized flakes is shown in Figure 5.4

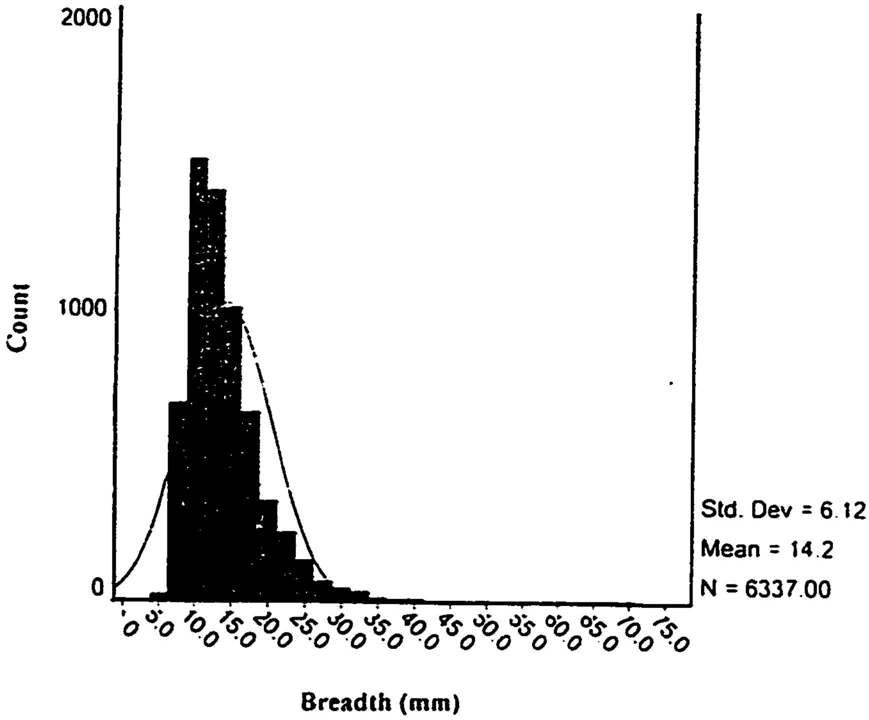
Figure 5.6 Flake length



5.5.2 Flake Breadth

The flake breadth had a mean width of 14.2 mm and a s.d. of 2.91. The histogram shows a slight right skew indicating the whole and trimmed/utilizedflake category is weighted towards smaller pieces (Figure 5.5).

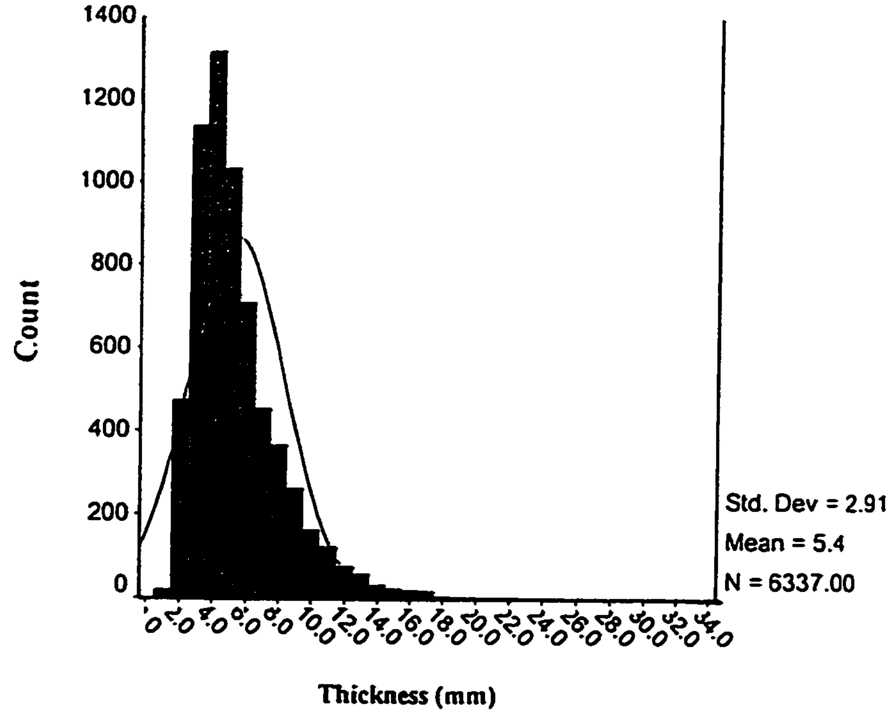
Figure 5.7 Flake Breadth



5.5.3 Flake Thickness

Flake thickness has a mean of 5.4 mm with a s.d. of 2.91. Again, the histogram below describes a skew to the right indicating a tendency to thinner flakes.

Figure 5.8 Flake Thickness



The three measurements of artifact size, length, width, and breadth all describe a smaller artifact. Artifact size has been a criterion to establish a position in a time period. It is generally accepted (Ambrose 1998, Mehlman 1989) that the smaller an artifact is the more recent it is dated (although it does depend of the raw material to some extent). The logic for this is based on increasing technological skill enabled toolmakers to produce smaller and smaller stone implements. The general premise is observed when comparing the size of stone artifacts from the ESA (large) through to the LSA (small and usually microlithic). The measurements of the artifacts in IdIu22 test pit 4 appear to indicate LSA assemblages.

Although Miller uses an artifact size range in his analysis of artifact measurements as opposed to a computer generated frequency in this study, it is still possible to compare these two studies. The mean flake length for IdIu22 tp4 (16.0 mm) would fall in his category 2 (1993: 64); his category 3 (20.1 mm- 30.0 mm) is the mean for flake debitage indicating flake length for IdIu22 tp4 is less. The upper limit for most frequent flake length in test pit four is 20.0 mm (Figure 5.6) whereas Miller's largest categories for flake length begin at 20.1 mm and end at 50.0 mm.

In the breadth category, the mean for test pit 4 is 14.2 mm which is equivalent to Miller's category 2 (1993:64). His most frequent occurrences are from 20.1 mm - 40.0 mm (categories 3 and 4). Again the upper limit of the most frequent occurrence of the flake breadth measurement for IdIu22 tp4 is 20.0 mm.

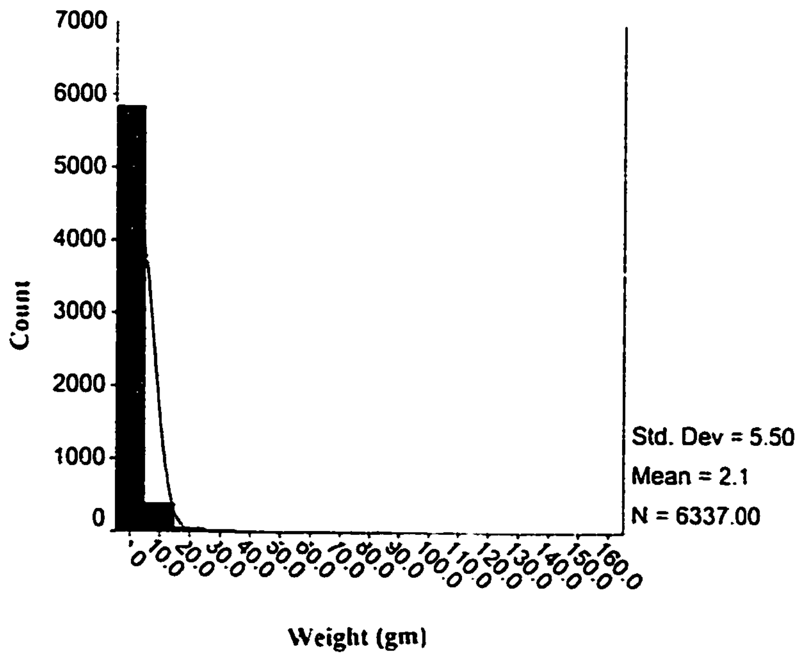
Finally, in the thickness measurement, the mean for IdIu22 tp4 is 5.4 mm with the most frequent occurrences end at 7.0 mm. The two largest categories in Miller's thickness analysis (1993:65) are category 2 (5.1 mm -10.0 mm) and category 3 (10.1 mm-15.0 mm). There is a slight overlap in this measurement but it is nonetheless apparent that the artifacts in Miller's study are "fatter" than the flakes in IdIu22 tp4.

There is some overlap with all of these above measurements; IdIu22 tp4 has occurrences in the above 20.0 mm size ranges but in all cases Miller's size measurements show a normal distribution, IdIu22 tp4's describe an asymmetrical distribution with a skew to the right.

5.5.4 Flake Weight

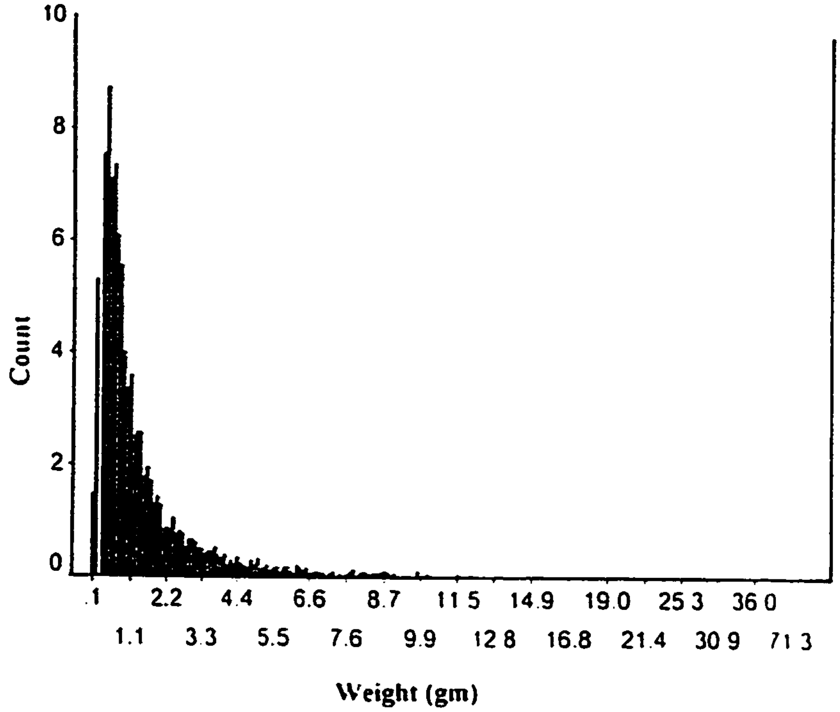
The mean weight for whole and trimmed/utilized flakes is 2.1 grams with the largest amount in the 0.0-5.0 gram range. The histogram below, with the standard deviation shows the normal curve superimposed on the distribution of the flake weights.

Figure 5.9 Flake Weight, histogram



The bar chart for this distribution was more descriptive for this variable consequently it is included as well.

Figure 5.10 Flake Weight, bar chart



In comparison to Miller (1993:65) his two largest occurring categories are: 2 (5.1-10.0 gm) and 3 (10.1-15.0 gm) whereas in test pit 4 the most frequent occurrence is in the 0.0-5.0 gm range (Miller's category 1). Miller does have a large category 1 so there is some overlap but it is still less than category 3. Additionally, the flake weights continue in decreasing amounts up to category 16 (75.1 gm through to highest) in Miller's sample. In IdIu22 tp4 the frequency drops sharply at the mean (2.1 gm) and is virtually invisible at 50.0 gm. Thus overall, whole flakes and trimmed/utilized whole flakes in test pit 4 are smaller and lighter than Miller's MSA surface collection of whole and trimmed/utilized whole flakes.

Chapter 6

Summary and Conclusion

This study has set out to accomplish a number of goals. The stated research goals were, (1) to determine if IdIu22 test pit 4 showed any evidence of change over time, (2) to ascertain if there was an MSA level or a MSA/LSA transitional level at this site and (3) to understand the nature of LSA technology in this area and what it might say about behaviour. Ultimately though, this study is one of information exploration. What types of stone artifacts were in test pit 4? Could the type of technology used to make the stone artifacts be determined? Was there even a "type" of technology? For any of these questions, were there any patterns discernible in test pit 4?

In addition to the stated research goals, an ancillary goal of this study is to attempt to date IdIu22 test pit 4 from the archaeological material, especially in the absence of reliable chronometric data. The soil samples taken for OSL dating have not been processed at the time of writing but once received will hopefully provide solid reinforcement of the conclusions in this study. Regardless, the goal of dating the lithic material, in some respects, were facilitated by the stated research goals: the exploration into the typological and technological elements present in IdIu22 tp4.

Several studies were used for comparative purposes. Mehlman's (1989) work in northern Tanzania, on whose typology this research project is based provided the primary comparison. Mehlman's site is the longest sequence available for East Africa. Similar variables were recorded in both Mehlman's study and Willoughby's research project.

Comparison to other research were further enhanced because Mehlman incorporated other studies into his work. Finally the chronological control of his sites and his thorough work on numerous sites in northern Tanzania ranging in age from the MSA to Holocene LSA was the backbone of this study. Behavioural interpretations based on Mehlman's work are limited as his dissertation focus was a development of the culture-history of northern Tanzania. Accordingly, the comparison of IdIu22 tp4 to Mehlman's data was limited to typology and what information could be discerned from the data.

Miller's (1993) thesis allowed comparisons for material from the same area. Since he was involved in the original research project under Willoughby, he also used the same research parameters which contributed to the comparability of the two studies. Finally, McBrearty's dissertation (1986) at the Muguruk site in Kenya added MSA information to Mehlman's work. For the most part, her sites pre-date Mehlman's consequently by incorporating the information from both authors the research project is the better for it.

Interpretations based on analogy of similar data are somewhat limited as behavioural interpretations are just now emerging in the published literature for this area. Nonetheless, where it was available, comparable and obtainable it was used, such is the case with Brandt (1988), Kusimba (1999)and Ambrose (1998). Even then, their interpretations are environmentally based and it appears from the sparse environmental data available (see Chapter 1, Adams and Faure 1998) that southern Tanzania, if not all of Tanzania did not experience similar severe conditions as Somalia and Kenya. In the case of Kusimba, her use of the South African !Kung, modern hunter-gatherers for analogy to stone age hunter-gatherers behaviour may be considered controversial although she did assume that the !Kung groups she was comparing were in similar environments.

The variables analyzed in this study were separated into typological and technological elements simply for organizational and analytical purposes. The typological and technological elements are usually so interdependent that the researcher generally has to artificially separate the two. Both technology and typology were studied to determine if test pit 4 exhibited any change and thus a stratigraphic sequence. The transition from MSA to LSA in southwestern Tanzania is somewhat of an unknown consequently during the analysis MSA elements and technology, if present, were also assessed. It was hoped this study could uncover any pattern relating to these concerns.

The typological elements studied were distribution of the general artifact categories: tools cores, debitage and ground stone. Then within the tool category, the frequency and distribution of backed pieces and scrapers, the relation between these two types and the frequency of bifacially modified pieces, heavy duty tools and points. Within the core category this study concentrated on the frequency and distribution of peripheral, patterned platform and bipolar cores. These particular types were isolated from their specific general artifact category because they were proposed by Mehlman to be chronologically diagnostic.

The technological elements studied were the Toth type, planform, scar pattern, number of dorsal scars and flake artifact measurements. As with the typological variables a variable was assessed with test pit 4 treated as a single sample and then as a population of 29 samples (=number of levels).

6.1 Problems during analysis

Like any other project this study was not without its problems. The sample size was huge (n=21,358 not counting a few angular fragments in each level which were too small to number and measure. These were weighed as a bulk amount, counted and recorded as such). The test pit was excavated in 5 cm levels which resulted in 29 levels. Ascertaining statistical significance with nominal data and several variables over 29 levels was frustrating. In actuality this type of statistical testing results in a multiple variable (this was usually not less than 4) x 29 contingency table. In most of the analyses patterns did exist for IdIu22 tp4 when the test pit was considered as a single sample or if specific types of stone tools were isolated from their stylistic group. When the test pit was considered, however, as a population of 29 samples (the number of levels) in many instances no significant result was recorded. Although the excavation strategy was changed from 10 cm arbitrary levels in 1995 to 5 cm levels in 1997 to hopefully obtain a better resolution, in many cases, statistical significance was not achieved. It is my opinion that if the levels were collapsed into 10 cm levels statistical significance would be more evident.

6.2 Discussion regarding change over time

The primary method for assessing change in this study was to perform a chi-square test for the variable in question by the 29 levels in test pit 4. In most cases the results were inconclusive (Appendix III). This may be a consequence of the excavation and discussed in the preceding section. However, when the frequency of single variables (the most diagnostic variables) were run by level, a pattern became more visible in some variables

Divers backed pieces (microburins) when considered as simply one category within the entire backed pieces group gave no statistical significance. The same was true with the products of microburin technique. However, once the divers backed piece category was isolated from the backed piece group, there was a decrease in numbers with depth and statistical significance.

An interesting observation also emerged from the test pit when this type of frequency was performed. There is a "hiccup", a change in frequency, that occurs at the 70-75 cm and 75-80 cm level but it only occurs with some variables. In the divers backed pieces this abrupt change occurs at the 75-80 cm; in the raw material category, quartz is at its lowest frequency at the 70-75 cm level. The change is also noticeable in the frequency of raw material compared to whole flakes but not tools or cores at the 70-75 cm level. The whole flake to raw material change may be simply related to the change in quartz frequency but it should also appear in the tool and core categories as quartz was the dominant raw material in all the general artifact categories.

6.3 Discussion regarding dating

The choice of raw material is seen by Steve Brandt (1988) as a temporal indicator. A change in the proportions of quartz to exotic cherts to exclusively local quartz at his LSA site in southern Somalia indicates the change from the terminal Pleistocene to the Holocene. A similar situation occurred at Lukenya Hill, in Kusimba's study (1999). All of the sites, with the exception of McBrearty's, used for comparison in this study and including IdIu22 are comprised primarily of quartz. Mehlman and Merrick showed no significant change between sites in raw materials. The raw material variable by level was one area that had a significant result but IdIu22 did not, or the information was not available, have much non-local raw material therefore the bimodal distribution of quartz is rather confusing.

Scrapers and backed pieces were present throughout Mehlman's sites and he proposes that the proportion of these two groups to each other help date a site. He concludes more backed pieces than scrapers indicate a Holocene LSA assemblage. Throughout test pit 4, backed pieces consistently outnumber scrapers, which would seem to indicate a Holocene date.

The backed pieces category (Mehlman's term and the term this research project follows) is loosely synonymous with microliths. The presence of microliths, according to Ambrose (1998), Merrick (1975) and Mehlman (1989) assigns an assemblage to the LSA. Backed pieces are present throughout the IdIu22 test pit 4.

Located within the backed pieces category are microburins, Mehlman's divers backed category. The presence of this type of backed piece can date a site or level within the LSA, Holocene LSA, according to Stan Ambrose. Although they do not disappear there is a definite decline in the frequency of divers backed pieces from the upper to the lower levels (Figure 4.4a).

The scraper category presented some interesting challenges for dating. The small convex scraper, Mehlman uses to date his LSA levels/sites. This scraper type (and backed pieces) "dominate the subassemblages" (Mehlman 1989: 368). Test pit 4 only had two small convex scrapers throughout the entire test pit and they were located in the same level, the 90-95 cm level. Instead circular scrapers, a MSA type, are present in the highest frequency.

Convergent scrapers are present in McBrearty's MSA assemblages and in Mehlman's assemblages that are assigned from the MSA to the early LSA. Mehlman's frequency does decreases sharply between the Nasera and Mumba MSA/LSA and the Pleistocene LSA but the frequency of convergent scrapers in test pit 4 is most similar to the Nasera MSA/LSA site.

Concave scrapers in test pit 4 are in similar percentages to Mehlman's sites that are from the MSA/LSA transition to early LSA. Mehlman does have concave scrapers in his Holocene LSA site but they occur less frequently than test pit 4.

The people who produced the artifacts at IdIu22 tp4 had a definite preference for patterned platform cores which would indicate an LSA assemblage but the low occurrence of bipolar cores is somewhat surprising, especially compared to peripheral cores. The presence of peripheral cores and in a frequency greater than bipolar cores may indicate an earlier LSA assemblage rather than a later one. One consideration supporting this statement is the Silale Industry which is dated by Mehlman to Holocene LSA and the

Lemuta Industry, dated as Pleistocene early LSA (has 4.3 % peripheral cores). Mumba III, middle level, which is classed as indeterminate LSA has no peripheral cores at all (Mumba III also has no cores at all.). It therefore must be excluded from this particular discussion.

All of this information from the typological analysis would seem to point to a MSA/LSA transitional date for some of the test pit. Mehlman's diagnostic MSA elements, bifacially modified pieces, heavy duty tools and points contributed less than 2% of the total tools. None of the MSA elements just discussed were distributed in any discernable pattern.

Finally, from the technology portion of the analysis, scar pattern and planform are the two variables which give the most information about dating. The scar pattern frequency of single platform, simple (66.9%) indicates at least the transitional MSA/LSA industry. When combined with single platform, parallel scar pattern (15.2%), a definite LSA technology, the frequency rises to 82.1%. And, compared to the frequency of radial flake removals (6.6%) the conclusion would seem to indicate that test pit 4 is LSA and possibly early LSA. Further, there was no concentration of the radial scar pattern to indicate an MSA level.

The planform variable had a low frequency of the circular form and the convergent, parallel and divergent forms were relatively evenly distributed. The circular form is indicative of radial flaking and is consistent with MSA technology. Therefore from this information, and the fact that there was no patterning of any of the variables, it would seem to indicate test pit 4 does not have an MSA level.

Based on the enormous number of artifacts retrieved not only from test pit 4 but also test pits, 2 and 3 and the location of site IdIu22 in a rockshelter, it is the opinion of this author that IdIu22 was an intensively occupied site for the purposes of manufacturing tools. This site must have had some advantage, or advantages, for tool making. There is presently no evidence of a home based occupation (eg. hearth areas or separate areas for different functions), few organic remains, no fire, nothing that would indicate stone age peoples lived there.

6.4 Conclusions

Many of the conclusions presented in this document must be considered tentative until the remaining test pits in site IdIu22 are analyzed. Test pit 4 was bordered by test pit 2 to the north and test pit 3 to the south. Although test pit 6 does not border test pits 2, 3, or 4, it is further down the slope in direct line to test pits 2, 3 and 4. Consequently any conclusions must take into consideration the data from the other excavated material.

The problem was first, to identify an LSA sequence and compare it to those from elsewhere using a standardized typology (Mehlman's) and second, to examine the methods of manufacturing the LSA tools (technology). Combining all of the lithic evidence, it is clear to this writer that this test pit belongs to the LSA. The time frame may be further refined to propose the early LSA at the lower levels changing to mid- to late LSA below the plough zone. I do not consider any of the levels MSA although there are MSA artifact types and some MSA technology present. Regardless of the somewhat ambiguous results, there is still enough evidence to warrant further excavation. More information can only help contribute to a chronology in this area and resolve the culture historical problems.

This study was not meant to be all encompassing, however, because East African seems to be the nexus for human origins and changes in lithic technology, research here is important. Southwestern Tanzania, as part of East Africa can contribute to the cultural chronology of the region, a region that may have been occupied (albeit probably sporadically) early in human history.

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Appendix I
CODEBOOK: Stone artifact analysis
Dr. Pamela R. Willoughby

Variables for Stone Age of Lake Rukwa Archaeological Project

Variable #	Var. Name	Values=Labels	Min/Max	Field	Location
1	Site	(00) not defined	1/90	2	1-2
	1989:	(01) IcIu1			
	1990:	(02) IcIu2t1 Mjele 1 terrace 1			
		(03) IcIu2t2 Mjele 1 terrace 2			
		(04) IcIu2E Mjele 1 east			
		(05) IcIu2W Mjele 1 west			
		(06) IcIu3E Mjele 2 east			
		(07) IcIu3W Mjele 2 west			
		(08) IcIu3S Mjele 2 south			
		(09) IcIu4 Mjele 3			
		(10) IcIu4tp1 Mjele 3 test pit 1			
		(11) IcIu4tp2 Mjele 3 test pit 2			
		(12) IcIu4tp3 Mjele 3 test pit 3			
		(13) IcIu5 Mjele 4			
		(14) IcIu6 Mjele 5			
		(15) IcIu7 Galula 1; 7A and 7B			
		(16) IcIu8 Mjele 6			
		(17) IcIu9 Mjele 7			
		(18) IcIu9tp1 Mjele 7 test pit 1			
		(19) IcIu9tp2 Mjele 7 test pit 2			
		(20) IcIu10 Mjele 8			
		(21) IcIu10E east of IcIu10			
		(22) IcIu11 Mjele 9			
		(23) IcIu11n1 north of Mjele 9 #1 fossil site			
		(24) IcIu11n2 north of Mjele 9 #2 fossil site			
		(25) IcIu12 Chibwawa 1			
		(26) IdIu1			
		(27) IdIu1S S of IdIu1			
		(28) IdIu3			
		(29) IdIu3NE NE of IdIu3			
		(30) IdIu3S S of IdIu3			
		(31) IdIu4			
		(32) IdIu5			
		(33) IdIu5N N of IdIu5			

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
1	Site		1/90	2	1-2
		(34) Nanyala Nanyala near IdIu5			
		(35) IdIu6			
		(36) Mbozi Mbozi side gorge			
		(37) IdIu10			
		(38) IdIu11 Songwe 1			
		(39) IdIu12N Njelenje 1			
		(40) IdIu13 Njelenje 2			
		(41) IdIu13N N of IdIu13			
		(42) IdIu14 Njelenje 3			
		(43) IdIu15 Njelenje 4			
		(44) IdIu16 Njelenje 5			
		(45) IdIu17 Njelenje 6			
		(46) IdIu17cl close to IdIu17			
		(47) IdIu1617 close to IdIu16 and 17			
		(48) IdIu18 Njelenje 7			
		(49) IdIu18N N of IdIu18			
		(50) IdIu19 Njelenje 8			
		(51) IdIu20 Songwe brickworks			
		(52) IdIu21 Songwe 2			
		(53) IdIv1 Mbalizi 1			
		(54) IdIv2 Mbalizi 2			
		(55) IdIv12N north of Mbalizi 1 and 2			
		(56) IdIx1W Chamoto Hill west side			
		(57) IdIx1E Chamoto Hill east side			
		(58) HxIo1 Mkamba			
		(59) IaIo3 Milanzi			
		(60) IdIu18SE SE of IdIu18			
		(61) IdIu12 Njelenje 1			
		(62) Galula walk around Galula			
	1995:	(63) Galula bone site			
		(64) IcIu13			
		(65) IcIu14			
		(66) IcIu15			
		(67) IcIu16			
		(68) IdIu17-95 Njelenje 6, 1995			
		(69) IdIu17tp1 test pit 1			
		(70) IdIu17tp2 test pit 2			
		(71) IdIu19-95 Njelenje 8, 1995			
		(72) IdIu22			
		(73) IdIu22tp1 test pit 1			

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
1	Site		1/90	2	1-2
	1995:	(74) Mapogoro-95 collection around rockshelters			
		(75) IcIu11N-95			
	1997:	(76) IcIu17			
		(77) IcIu18			
		(78) IdIu23			
		(79) IdIu24			
		(80) IdIu25			
		(81) Mapogoro-97			
		(82) IdIu26			
		(83) IdIu19-97			
		(84) IdIu3-97			
		(85) IdIu22-97			
		(86) IdIu22tp2			
		(87) IdIu22tp3			
		(88) IdIu22tp4			
		(89) IdIu22tp5			
		(90) IdIu22tp6			
		(99) missing			
2	Case # (for each site)	0001-n	1/n	4	3-6
3	Level	(00) surface	0/43	2	7-8
		(01) 0-10 cm. depth			
		(02) 10-20 cm.			
		(03) 20-30 cm.			
		(04) 30-40 cm.			
		(05) 20-40 cm.			
		(06) 40-60 cm.			
		(07) 60-80 cm.			
		(08) 80-100 cm.			
		(09) 40-50 cm.			
		(10) 50-60 cm.			
		(11) 60-70 cm.			
		(12) 70-80 cm.			
		(13) 80-90 cm.			
		(14) 90-100 cm.			
		(15) 0-5 cm.			
		(16) 5-10 cm.			

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
3	Level	(17) 10-15 cm. (18) 15-20 cm. (19) 20-25 cm. (20) 25-30 cm. (21) 30-35 cm. (22) 35-40 cm. (23) 40-45 cm. (24) 45-50 cm. (25) 50-55 cm. (26) 55-60 cm. (27) 60-65 cm. (28) 65-70 cm. (29) 70-75 cm. (30) 75-80 cm. (31) 80-85 cm. (32) 85-90 cm. (33) 90-95 cm. (34) 95-100 cm. (35) 100-105 cm. (36) 105-110 cm. (37) 110-115 cm. (38) 115-120 cm. (39) 120-125 cm. (40) 125-130 cm. (41) 130-135 cm. (42) 135-140 cm. (43) 140-145 cm. (99) missing	0/43	2	7-8
4	Cultural Designation (Culture)	(00) not known (01) ESA (02) MSA (03) LSA (04) Neolithic (05) Iron Age (06) ESA + MSA (07) MSA + LSA	0/12	2	9-10

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
4	Cultural Designation (Culture)	(08) LSA + Neolithic	0/12	2	9-10
		(09) LSA + Iron Age			
		(10) Neolithic + Iron Age			
		(11) LSA, Neolithic + Iron Age			
		(12) MSA, LSA, Neolithic + Iron Age			
		(99) missing			
5	stone raw material (Rawmat)	(1) quartz	0/7	1	11
		(2) quartzite			
		(3) chert/flint			
		(4) volcanic but not obsidian			
		(5) obsidian			
		(6) other metamorphic			
		(7) other sedimentary			
		(9) missing			

Note: v6 to v8 from Mehlman 1989:111-157

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
6	stone artifact general category (Gencat)	(1) trimmed pieces=tools	0/4	1	12
		(2) core			
		(3) debitage			
		(4) non flaked stone (inc. ground stone)			
		(9) missing			
7	tool type (subset of v6) (Tooltype)		01/27	2	13-14
		TRIMMED PIECES			
		(01) scraper			
		(02) backed pieces			
		(03) points/perçoirs			
		(04) burins			
		(05) bifacially modified pieces			
		(06) becs			

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
7	tool type (subset of v6) (Tooltype)	TRIMMED PIECES (07) composite tools (08) outils écaillés (09) heavy duty tools (10) others CORES (11) peripherally worked core (12) patterned platform (13) intermediate (14) bipolar (15) amorphous DEBITAGE (16) angular fragments (17) specialized flakes (18) flakes (19) blades (20) Levallois flakes NON-FLAKED TYPES (21) hammerstone (22) anvil stone (23) pestle rubbers (24) polished axes (25) stone disc (26) sundry ground/polished (27) manuport	01/27	2	13-14
8	tool subtype (subset of v7) (Subtype) SCRAPERS (01)	(000) not applicable (001) small convex scraper (002) convex end scraper (003) convex double end scraper (004) convex end and side scraper (005) circular scraper (006) nosed end scraper (007) convex side scraper (008) convex double side scraper	001/105	3	15-17

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
8	tool subtype	(009) nosed side scraper	001/105	3	15-17
	(subset of v7)	(010)sundry end scraper			
	(Subtype)	(011) sundry double end scraper			
		(012) sundry end and side scraper			
		(013) sundry side scraper			
		(014) sundry double side scraper			
		(015) concave scraper			
		(016) concavity			
		(017) notch			
		(018) sundry combination scraper			
		(019) convex end + concave combination scraper			
		(020) convex side + concave combination scraper			
		(021) divers scraper			
		(022) convergent scraper			
		(023) scraper fragment			
	BACKED PIECES	(024) crescent			
	(02)	(025) triangle			
		(026) trapeze			
		(027) curved backed piece			
		(028) straight backed piece			
		(029) orthagonal truncation			
		(030) oblique truncation			
		(031) angle-backed piece			
		(032) divers backed			
		(033) backed awl/drill/perçoir			
		(034) backed fragment			
	POINTS	(035) unifacial point/perçoir			
	(03)	(036) alternate face/edge pt/perçoir			
		(037) bifacial point			
	BURINS	(038) dihedral burin			
	(04)	(039) angle burin			
		(040) mixed/other burin			
	BIFACIALLY MODIFIED	(041) discoid			
	PIECES	(042) point blank			
	(05)	(043) bifacially modified piece			

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
8	tool subtype (Subtype)		001/105	3	15-17
	BECS (06)	(044) becs			
	COMPOSITE TOOLS (07)	(045) sundry composite tool (046) burin + other composite tool (047) backed + other composite tool (048) scraper + other composite tool			
	OUTILS ECAILLES (08)	(049) outils écaillés			
	HEAVY DUTY TOOLS (09)	(050) core/large scraper (051) biface/pick (052) core chopper			
	OTHER (10)	(053) sundry modified (054) cutting edge (055) bulbar thin/talon reduced (056) tool fragment			
	CORES				
	PERIPHERALLY WORKED (11)	(057) part-peripheral core (058) radial/biconic core (059) disc core (060) Levallois core			
	PATTERNED PLATFORM (12)	(061) pyramidal/prismatic single platform core (062) divers single platform core (063) single platform core/ core scraper (064) opposed double platform core (065) opposed double platform core/ core scraper (066) adjacent double platform core (067) adjacent double platform core/ core scraper (068) multiple platform core			

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
8	tool subtype (Subtype)		001/105	3	15-17
INTERMEDIATE (13)		(069) platform/peripheral core			
		(070) platform/peripheral core/ core scraper			
		(071) platform/bipolar core			
		(072) platform/bipolar core/ core scraper			
		(073) bipolar/peripheral			
BIPOLAR (14)		(074) bipolar core			
		(075) bipolar core fragment			
AMORPHOUS (15)		(076) amorphous/casual			
DEBITAGE					
ANGULAR (16)		(077) core fragment			
		(078) angular fragment			
		(079) trimmed/utilized angular fragment			
		(080) blade segment-medial or distal			
		(081) trimmed/utilized blade segment			
SPECIALIZED FLAKES (17)		(082) plain burin spall			
		(083) tool spall			
FLAKES (18)		(084) whole flake			
		(085) trimmed/utilized flake			
		(086) flake talon fragment			
		(087) trimmed/utilized flake talon fragment			
BLADES (19)		(088) whole blade			
		(089) trimmed/utilized blade			
		(090) blade talon fragment			
		(091) trimmed/utilized blade talon fragment			

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location	
8	tool subtype (Subtype)		001/105	3	15-17	

LEVALLOIS FLAKES (20)	(092) Levallois flake (093) trimmed/utilized Levallois flake
NONFLAKED STONE	
HAMMERSTONES (21)	(094) hammerstones
ANVIL STONES (22)	(095) edge anvil (096) pitted anvil (097) edge and pit anvil
PESTLE RUBBERS (23)	(098) pestle rubber (099) dimpled rubber
POLISHED AXES (24)	(100) lobed axe (101) other axe
STONE DISC (25)	(102) pecked disc (103) dimpled disc
SUNDRY (26)	(104) sundry ground/shaped item
MANUPORTS (27)	(105) manuports
	(999) unknown

<u>For all stone pieces measure</u>:

9	length (L)(mm.)	none	0/?	4	18-21	1 decimal place
10	breadth (B)(mm.)	none	0/?	4	22-25	1 decimal place
11	thickness (mm.) (T)(thick)	none	0/?	4	26-29	1 decimal place

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location	

for cores: length ≥ breadth ≥ thickness

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location	
12	weight (gm.)	none	0/?	5	30-34	1 decimal place
13	ratioBL (B ÷ L)	none	0/1	3	35-37	2 decimal places
14	ratioTB (T ÷ B)	none	0/1	3	38-40	2 decimal places
15	ratioTL (T ÷ L)	none	0/1	3	41-43	2 decimal places
16	abrasion/ rolling (Abrasion)	(1) fresh (2) worn (9) missing	1/2	1	44	

<u>For cores or core tools measure</u>

For non-cores: put in value of 9 in each column for missing data (not applicable) for variables 17 to 18.

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
17	cortex (%)	none (999) missing	0/100	3	45-47
18	# flake scars (Flakscar)	none (99) missing	0/n	2	48-49

<u>For whole flakes and blades, as well as blade and flake tools, measure</u>:

For others, put in value of 9 in each column for missing data (not applicable) for variables 19 to 30.

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
19	Toth flake # (Tothnum) (Toth 1982:73-75)	(1) I (2) II (3) III (4) IV	1/7	1	50

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location	
		(5) V (6) VI (7) VII (includes missing) (9) missing				
20	platform length (mm.)(PL) (Platleng)	none (999.9) missing	0/?	4	51-54	1 decimal place
21	platform breadth (mm.) PB (Platbred)	none (999.9) missing	0/?	4	55-58	1 decimal place
22	platform area (mm²) (Platarea) (PB x PL)	none (9999.9) missing	0/?	5	59-63	1 decimal place
23	platform angle (platangl) (to ventral)	none (999) missing	0/?°	3	64-66	
24	# platform facets (plafacet)	(0) none (1) 1 (2) 2 (3) 3 (4) 4 (5) 5 (6) ≥6 (7) unknown (9) missing	1/7	1	67	
25	flake area (B x L) (mm²)(Flakarea)	none	0/n	5	68-72	1 decimal place
26	platform area ÷ flake area (relarea)(%)	none (9.99) missing	0/1	3	73-75	2 decimal places
27	# dorsal flake scars (dorscars)	(0) none (1) 1 (2) 2	0/8	1	76	

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
		(3) 3			
		(4) 4			
		(5) 5			
		(6) 6			
		(8) 8 or more	0/8	1	76
		(9) missing			
28	dorsal scar pattern (scarpat) (McBrearty 1986:183)	(0) unknown	1/7	1	77
		(1) radial			
		(2) same platform, simple			
		(3) same platform, parallel			
		(4) opposed platform			
		(5) transverse			
		(6) plain			
		(7) none			
		(9) missing/not applicable			
29	planform (McBrearty 1986:198-199)	(1) convergent	1/6	1	78
		(2) parallel			
		(3) divergent			
		(4) intermediate			
		(5) circular			
		(6) unknown			
		(9) missing/not applicable			

<u>For retouched tools only:</u>

Variable #	Variable Name	Values=Labels	Min/Max	Field	Location
30	angle of retouch (angireto) (to side retouch released from)	none (score >90° as 91)	0/90°?	2	79-80
		(99) missing			

31	type of retouch (retouch) (Clark and Kleindienst 1974:85)	(1) marginal (2) semi-invasive (3) invasive (9) none/missing	1/3	1	81

Appendix II
Raw Data

Backed Pieces by level for IdIu22 tp4

Level (cm)	crescent	triangle	trapeze	curved backed	straight backed	orthagonal truncation
0-5 n row %	3 9.7	0 0.0	2 6.5	5 16.1	4 12.9	2 6.5
5-10 n row %	0 0.0	0 0.0	2 10.5	3 15.8	2 10.5	0 0.0
10-15 n row %	6 19.4	0 0.0	10 32.3	4 12.9	2 6.5	0 0.0
15-20 n row %	6 23.1	3 11.5	0 0.0	4 15.4	2 7.7	0 0.0
20-25 n row %	4 7.7	5 9.6	3 5.8	7 13.5	6 11.5	5 9.6
25-30 n row %	8 15.7	2 3.9	5 9.8	7 13.7	7 13.7	0 0.0
30-35 n row %	3 13.6	0 0.0	7 31.8	2 9.1	2 9.1	0 0.0
35-40 n row %	7 24.1	0 0.0	3 10.3	6 20.7	2 6.9	0 0.0
40-45 n row %	1 6.3	1 6.3	3 18.8	5 31.3	1 6.3	0 0.0
45-50 n row %	6 13.3	1 2.2	2 4.4	17 37.8	11 24.4	0 0.0
50-55 n row %	5 7.4	6 8.8	1 1.5	18 26.5	13 19.1	1 1.5
55-60 n row %	16 15.2	5 4.8	3 2.9	24 22.9	16 15.2	5 4.8
60-65 n row %	13 17.8	6 8.2	5 6.8	12 16.4	15 20.5	0 0.0
65-70 n row %	10 14.7	6 8.8	1 1.5	19 27.9	13 19.1	4 5.9
70-75 n row %	0 0.0	5 7.0	8 11.3	17 23.9	15 21.1	5 7.0

Backed Pieces, continued

Level (cm)	crescent	triangle	trapeze	curved backed	straight backed	orthagonal truncation
75-80 n row %	5 5.0	6 6.0	9 9.0	19 19.0	23 23.0	6 30.0
80-85 n row %	0 0.0	3 6.7	1 2.2	12 26.7	6 13.3	4 8.9
85-90 n row %	1 1.4	3 4.3	6 8.7	16 23.2	14 20.3	5 7.2
90-95 n row %	5 18.5	0 0.0	0 0.0	4 14.8	3 11.1	4 14.8
95-100 n row %	0 0.0	4 6.3	0 0.0	4 16.0	8 32.0	6 24.0
100-105 n row %	3 4.7	3 5.2	12 18.8	10 15.6	7 10.9	4 6.3
105-110 n row %	8 13.8	3 7.3	1 1.7	6 10.3	15 25.9	10 17.2
110-115 n row %	3 4.3	2 4.9	3 7.3	10 24.4	6 14.6	5 12.2
115-120 n row %	3 4.3	3 10.0	1 2.4	8 19.5	6 14.6	4 9.8
120-125 n row %	0 0.0	5 16.7	1 3.3	2 6.7	1 3.3	9 30.0
125-130 n row %	1 3.3	5 16.7	2 6.7	5 16.7	5 6.7	3 10.0
130-135 n row %	0 0.0	5 15.6	4 12.5	5 15.6	1 3.1	3 9.4
135-140 n row %	0 0.0	1 4.3	2 8.7	1 4.3	0 0.0	4 17.4
140-145 n row %	0 0.0	5 25.0	1 5.0	0 0.0	0 0.0	3 15.0
Column Total	117 8.9	84 6.4	98 7.5	252 19.2	203 15.5	92 7.0

Backed Pieces, continued

Level (cm)	oblique truncation	angle backed	divers backed	backed awl	backed fragment	Row Total
0-5 n row %	0 0.0	0 0.0	15 48.4	0 0.0	0 0.0	31 100
5-10 n row %	1 5.3	0 0.0	11 57.9	0 0.0	0 0.0	19 100
10-15 n row %	1 3.2	2 6.5	4 12.9	0 0.0	2 6.5	31 100
15-20 n row %	2 7.7	0 0.0	9 34.6	0 0.0	0 0.0	26 100
20-25 n row %	2 3.8	0 0.0	18 34.6	2 3.8	0 0.0	52 100
25-30 n row %	0 0.0	2 3.9	19 37.3	0 0.0	1 2.0	51 100
30-35 n row %	1 4.5	0 0.0	7 31.8	0 0.0	0 0.0	22 100
35-40 n row %	6 20.7	0 0.0	5 17.2	0 0.0	0 0.0	29 100
40-45 n row %	0 0.0	1 6.3	4 25.0	0 0.0	0 0.0	16 100
45-50 n row %	0 0.0	0 0.0	8 17.8	0 0.0	0 0.0	45 100
50-55 n row %	14 20.6	2 2.9	7 10.3	1 1.5	0 0.0	68 100
55-60 n row %	13 12.4	5 4.8	17 16.2	1 1.0	0 0.0	105 100
60-65 n row %	6 8.2	2 2.7	14 19.2	0 0.0	0 0.0	73 100
65-70 n row %	10 14.7	1 1.5	4 5.9	0 0.0	0 0.0	68 100
70-75 n row %	18 25.4	3 4.2	0 0.0	0 0.0	0 0.0	71 100

Backed Pieces, continued

Level (cm)	oblique truncation	angle backed	divers backed	backed awl	backed fragment	Row Total
75-80 n row %	30 30.0	1 1.0	1 1.0	0 0.0	0 0.0	100 100
80-85 n row %	15 33.3	0 0.0	3 6.7	1 2.2	0 0.0	45 100
85-90 n row %	14 20.3	1 1.4	7 10.1	2 2.9	0 0.0	69 100
90-95 n row %	8 29.6	0 0.0	0 0.0	2 7.4	0 0.0	27 100
95-100 n row %	3 12.8	0 0.0	2 8.0	1 4.0	1 4.0	25 100
100-105 n row %	12 18.8	2 3.1	9 14.1	1 1.6	0 0.0	64 100
105-110 n row %	9 15.5	1 1.7	4 6.9	1 1.7	0 0.0	58 100
110-115 n row %	9 22.0	1 2.4	1 2.4	0 0.0	0 0.0	41 100
115-120 n row %	13 31.7	0 0.0	4 9.8	0 0.0	0 0.0	41 100
120-125 n row %	8 26.7	0 0.0	6 20.0	0 0.0	0 0.0	30 100
125-130 n row %	5 16.7	2 6.7	4 13.3	0 0.0	1 3.3	30 100
130-135 n row %	10 31.3	0 0.0	3 9.4	1 3.1	0 0.0	32 100
135-140 n row %	8 34.8	1 4.3	5 21.7	1 4.3	0 0.0	23 100
140-145 n row %	8 40.0	0 0.0	3 15.0	0 0.0	0 0.0	20 100
Column Total	226 17.2	27 2.1	194 14.8	14 1.1	5 0.4	1312 100

	subtype						
	small convex scraper	convex end scraper	convex end and side scraper	circular scraper	nosed end scraper	convex side scraper	convex double side scraper
LEVEL 0-5 cm.				2		3	
5-10 cm.							
10-15 cm.			2	2		3	
15-20 cm.				3			
20-25 cm.		2		3		1	
25-30 cm.		2		2		2	
30-35 cm.			1	6	1		
35-40 cm.		1		1		1	
40-45 cm.		1		2		1	
45-50 cm.		2		7		2	1
50-55 cm.		3		13			
55-60 cm.		5		7	2	4	
60-65 cm.				8		3	
65-70 cm.		2		5		2	
70-75 cm.		1	1	4		3	
75-80 cm.		2	1	10		3	
80-85 cm.				1	1		
85-90 cm.		1		2		1	
90-95 cm.	2	1		4			
95-100 cm.						2	
100-105 cm.		1		11		1	
105-110 cm.				4			
110-115 cm.		3		6			
115-120 cm.		3		4		1	
120-125 cm.							
125-130 cm.				4			
130-135 cm.		2		1			
135-140 cm.				4			1
140-145 cm.		4					
Total	2	36	5	116	4	33	2

scrapers, continued

		subtype						
		nosed side scraper	sundry end scraper	sundry end and side scraper	sundry side scraper	sundry double side scraper	concave scraper	concavity
LEVEL	0-5 cm.			1	4	1	4	
	5-10 cm.			1			2	
	10-15 cm.		1		1		2	1
	15-20 cm.		1		2		1	3
	20-25 cm.	2	1	1	1		6	1
	25-30 cm.	1	1		3	1	8	2
	30-35 cm.		1		2		3	3
	35-40 cm.				1	1	7	
	40-45 cm.		2		3		1	3
	45-50 cm.		3	1	4	1	8	7
	50-55 cm.		2		6		6	4
	55-60 cm.				9	2	4	1
	60-65 cm.		3		4	2	6	3
	65-70 cm.		1				1	1
	70-75 cm.		3		1	1	6	3
	75-80 cm.		2		10		2	3
	80-85 cm.		1		6	1	4	
	85-90 cm.			1	4		2	
	90-95 cm.						4	
	95-100 cm.				1			1
	100-105 cm.						2	1
	105-110 cm.					1	5	
	110-115 cm.		1					2
	115-120 cm.					1	2	2
	120-125 cm.		3		1	1		3
	125-130 cm.		1					1
	130-135 cm.						2	
	135-140 cm.		1		1		5	
	140-145 cm.						1	2
Total		3	28	5	64	13	94	47

		subtype						
		notch	sundry combination scraper	convex end and concave combination scraper	convex side and concave combination scraper	convergent scraper	scraper fragment	Total
LEVEL	0-5 cm.							15
	5-10 cm.					1		4
	10-15 cm.				2	3		17
	15-20 cm.					1		11
	20-25 cm.					1		19
	25-30 cm.					1		23
	30-35 cm.					1		18
	35-40 cm.					1		13
	40-45 cm.					1		14
	45-50 cm.							36
	50-55 cm.					1		35
	55-60 cm.					3		37
	60-65 cm.				4	1		34
	65-70 cm.				1		1	14
	70-75 cm.	2						25
	75-80 cm.							33
	80-85 cm.							14
	85-90 cm.		1			1		13
	90-95 cm.		1					12
	95-100 cm.							4
	100-105 cm.			1	1			18
	105-110 cm.					1		11
	110-115 cm.							12
	115-120 cm.					1		14
	120-125 cm.						1	9
	125-130 cm.					1		7
	130-135 cm.					1		6
	135-140 cm.							12
	140-145 cm.							7
Total		2	2	1	8	20	2	487

Appendix III
Chi Square Results

* indicates a significant result

Raw Material (Top 4) by Level*

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8326.764[a]	84	.000
Likelihood Ratio	9246.907	84	.000
Linear-by-Linear Association	552.577	1	.000
N of Valid Cases	21344		

a. 2 cells (1.7%) have expected count less than 5. The minimum expected count is 3.07.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.625	.000
	Cramer's V	.361	.000
N of Valid Cases		21344	

General Category by Level

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	165.545[a]	84	.000
Likelihood Ratio	167.936	84	.000
Linear-by-Linear Association	3.392	1	.066
N of Valid Cases	21358		

a. 29 cells (25.0%) have expected count less than 5. The minimum expected count is .09.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.088	.000
	Cramer's V	.051	.000
N of Valid Cases		21358	

Cores by raw material by level

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	153.506[a]	112	.006
Likelihood Ratio	140.107	112	.037
Linear-by-Linear Association	.093	1	.760
N of Valid Cases	549		

a. 118 cells (81.4%) have expected count less than 5. The minimum expected count is .02.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.529	.006
	Cramer's V	.264	.006
N of Valid Cases		549	

Tools by raw material by level

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	383.331[a]	224	.000
Likelihood Ratio	316.465	224	.000
Linear-by-Linear Association	41.451	1	.000
N of Valid Cases	1977		

a. 202 cells (77.4%) have expected count less than 5. The minimum expected count is .03.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.440	.000
	Cramer's V	.156	.000
N of Valid Cases		1977	

Cores by level

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	153.193[a]	112	.006
Likelihood Ratio	140.260	112	.036
Linear-by-Linear Association	.095	1	.758
N of Valid Cases	551		

a. 118 cells (81.4%) have expected count less than 5. The minimum expected count is .02.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.527	.006
	Cramer's V	.264	.006
N of Valid Cases		551	

Scrapers by Level

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	735.750[a]	532	.000
Likelihood Ratio	490.103	532	.903
Linear-by-Linear Association	7.483	1	.006
N of Valid Cases	487		

a. 568 cells (97.9%) have expected count less than 5. The minimum expected count is .01.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	1.229	.000
	Cramer's V	.282	.000
N of Valid Cases		487	

Whole Flakes and Trimmed/Utilized Whole Flakes by raw material by level*

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	131.515[a]	28	.000
Likelihood Ratio	131.401	28	.000
Linear-by-Linear Association	9.405	1	.002
N of Valid Cases	6330		

a. 2 cells (3.4%) have expected count less than 5. The minimum expected count is 3.17.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.144	.000
	Cramer's V	.144	.000
N of Valid Cases		6330	

Planform by level

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	626.595[a]	112	.000
Likelihood Ratio	601.073	112	.000
Linear-by-Linear Association	.079	1	.779
N of Valid Cases	6332		

a. 32 cells (22.1%) have expected count less than 5. The minimum expected count is .38.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.315	.000
	Cramer's V	.157	.000
N of Valid Cases		6332	

Scarpat by level

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	688.891[a]	140	.000
Likelihood Ratio	675.047	140	.000
Linear-by-Linear Association	9.646	1	.002
N of Valid Cases	6332		

a. 34 cells (19.5%) have expected count less than 5. The minimum expected count is .92.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.330	.000
	Cramer's V	.148	.000
N of Valid Cases		6332	

Toth type by level

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	305.746[a]	140	.000
Likelihood Ratio	302.777	140	.000
Linear-by-Linear Association	10.384	1	.001
N of Valid Cases	6337		

a. 36 cells (20.7%) have expected count less than 5. The minimum expected count is .84.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.220	.000
	Cramer's V	.098	.000
N of Valid Cases		6337	

Toth Type by Raw Material (Top 4 raw material types)

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	106.175[a]	15	.000
Likelihood Ratio	98.988	15	.000
Linear-by-Linear Association	5.511	1	.019
N of Valid Cases	6330		

a. 2 cells (8.3%) have expected count less than 5. The minimum expected count is 2.75.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.130	.000
	Cramer's V	.075	.000
N of Valid Cases		6330	

Scraper by Backed Pieces by Level*

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	56.990[a]	28	.001
Likelihood Ratio	56.705	28	.001
Linear-by-Linear Association	15.006	1	.000
N of Valid Cases	1799		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.23.

Symmetric Measures

		Value	Approx. Sig.
Nominal by Nominal	Phi	.178	.001
	Cramer's V	.178	.001
N of Valid Cases		1799	