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A typological and technological analysis of stone artefacts from the Magubike archaeological site, Iringa Region, southern Tanzania

by

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Abstract

Previous archaeological research in southern Tanzania has focused on Plio-Pleistocene sites documenting early hominid evolution, or alternatively, the late Holocene Later Stone Age and Iron Age sites documenting the transition from foraging to food production. However, recent surveys and test excavations conducted by Dr. Pamela Willoughby in Iringa have revealed the region's potential for also contributing to the study of the Middle Stone Age, the time period and technological system that coincides with the appearance of anatomically modern humans. Analysis of lithics recovered from two 1m^2 test pits during 2006 test excavations at Magubike rockshelter demonstrate the site contains sequences yielding Middle Stone Age, Later Stone Age, and Iron Age materials. Michael Mehlman's lithic typology is used to place the lithics within a relative cultural historical context. Further analysis documents patterns and intensity of lithic reduction, raw material utilization, and other aspects of lithic production at Magubike throughout time.

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Chapter 1: Introduction

Genetic and fossil evidence suggest that anatomically modern *Homo sapiens* emerged in sub-Saharan Africa between 100,000 and 200,000 years before present (BP) (McDougall 2005; Ingman et al. 2000; Hammer et al. 1998; Vigilant 1991; Cann et al. 1987). The archaeological evidence indicates that this speciation event coincides with the onset of a chronological period and technological system known as the Middle Stone Age (MSA) around 200,000 BP. At this time, a shift from hand-held stone implements to multi-component, hafted tools occurs, and the first signs of significant regional variability in technological systems emerge. However, despite this evidence, some researchers believe fully "modern behaviour” emerged only 40,000 to 50,000 BP, with the transition to the Later Stone Age (LSA). Disputes among current researchers over what defines “modern” human behaviour, and how to recognize it in the archaeological record, also confound the issue.

Equatorial East Africa is particularly important for the study of the origins of biological and behavioural modernity. During periods of extreme cold, this region likely served as the largest tropical refugium for human populations, which may have been decimated elsewhere (Ambrose 1998b). Sediments from lake cores from Lake Malawi suggest decreased environment variability and aridity after 70,000 BP, following a period between 135,000 and 70,000 BP in which tropical refugia expanded and collapsed repeatedly due to heightened climate variability (Scholz et al. 2007). During this time, parts of East Africa may still have been habitable. It can also probably be expected to demonstrate the developmental states of technological innovation that contributed to the complex behaviours perceived as behaviourally modern at this time as well as, if not better than, any other part of the African continent (Clark 1988).

Over the last century, extensive archaeological and paleontological fieldwork has been carried out in northern Tanzania at places such as Olduvai Gorge, Mumba, and Laetoli. Dr. Pamela Willoughby's ongoing research (Willoughby 2006a, 2006b, 2005), including test excavations and surveys, reveals that the southern part of the country is rich in archaeological materials as well, and can also provide insight into the Middle Stone Age in this region. In order to contribute to Dr. Willoughby's efforts to establish a localized cultural historical sequence for this area, particularly in regards to the MSA, this thesis analyzes and interprets technological and typological data from lithics recovered from two of three 1m^2 test pits during 2006 test excavations at Magubike, a rockshelter northwest of Iringa City in the Iringa region.

Culture-histories, or spatial-temporal sequences of events, may be discounted as a significant archaeological endeavour in areas where the time depth is shallow, or where such a sheer quantity of data from the study of numerous sites has resolved most major problems in regional sequences (Mabulla 1996). However, the cultural historical approach complements rather than opposes other approaches (Deetz 1988; Cobb 1998). Indeed, these chronologies are a necessary first step for investigating broader anthropological issues, as they provide the database for comparisons, generalizations, and hypotheses testing

(Cobb 1998; Mabulla 1996). As Sutton (1981: 453) states, “Collections of stone tools…may be interesting to look at, but they tell us little unless arranged with a sense of chronology and development.”

No localized cultural historical sequence has yet been established for southern Tanzania. However, this information will shed light on technological adaptations and processes of cultural change over time at Magubike. In particular, implications for hominid behavioural adaptations in this region will be discussed in regard to technological variability within the MSA, as well as within the context of the debate over modern human behavioural origins.

Chapter 2 introduces the research topic and describes the theoretical context of this study. In particular, it provides an overview of East African prehistory and discusses the Middle Stone Age as a chronological designation and technological system, the origins of anatomically modern humans based on genetic and fossil evidence, and the archaeology of behavioural modernity. Chapter 3 describes the study site of Magubike and test excavations there in greater detail. Chapter 4 outlines the typological and technological variables and statistical techniques employed in this study. The typological and technological analyses, with some discussion and interpretation of results, are presented in Chapters 5 and 6. The last chapter, Chapter 7, outlines a cultural historical sequence for Magubike based on the lithic analysis, discusses the implications of the findings in terms of changing cultural and technological adaptations at Magubike, notes problems with this study, and suggests directions for future research.

Chapter 2: Background and Theoretical Context

2.1 The Genetic and Fossil Evidence for Modern Human Origins

Genetic evidence indicates a single, recent African origin for *Homo sapiens.* Analysis of mitochondrial DNA samples from living human populations indicate that the most recent common maternal ancestor, known as "mitochondrial Eve," lived sometime between 143,000 and 288,000 years ago in sub-Saharan Africa (Ingman et al. 2000; Vigilant 1991; Cann et al. 1987). Unlike nuclear DNA, mitochondrial DNA (mtDNA) is not subject to the recombination of genes because it is inherited strictly maternally. In addition, the rate of mutation in mtDNA is faster than that of nuclear NDA, so that small changes in recent populations can be detected, and some of these changes are neutral and have been demonstrated to occur at a steady rate over time (Cann et al. 1987). Thus, mtDNA is ideal for such studies.

Cann et al. (1987) compared observed fragment patterns of purified mtDNA samples from 147 individuals with origins in five different geographical regions. High-resolution mapping of restriction sites was undertaken utilizing 12 restriction enzymes. Approximately 9% of the human mtDNA genome was examined, an average of 370 restriction sites (the specific sequences of nucleotides recognized by restriction enzymes) per individual. Of the sample, 133 distinct mtDNA types were recognized. Seven of the types were found in more than one individual; additionally, the seven types found in more than one individual did not occur in more than one geographic region. Cann et al. then estimated the extent of the nucleotide sequence divergence of each pair of individuals based on the number of restriction site differences. The team then devised a tree demonstrating the most parsimonious possible evolutionary relationship between the types. The samples of African origin exhibit the greatest variation, indicating an African origin for the human mtDNA gene pool. Assuming a constant rate of mutation for mtDNA, they determined the common ancestor of all extant mtDNA types existed 140,000-190,000 years ago.

Although the original study of Cann et al. (1987) has been closely scrutinized and its sample, methods and calibration rates criticized, subsequent studies with more extensive analyses support its conclusions (Stringer 2002; Vigilant et al. 1991). Similar analysis of Y-chromosome variation in present day humans also suggests a recent African origin for *Homo sapiens,* but with a common ancestor of only 60,000 years ago (Hammer et al. 1998).

These findings do not necessarily imply that anatomically modern *Homo sapiens* emerged in Africa at this time; however, they do strongly suggest a recent African origin for the species. Within a year of the original study, paleontologists suggested that paleontological, as well as genetic, evidence indicated a recent African origin for *Homo sapiens*, and this became known as the "Out of Africa" hypothesis, in contrast with the multiregional continuity hypothesis, which purported that gene flow allowed modern humans to evolve from local *Homo* populations throughout the Old World (Klein 2008; Stringer and Andres 1988).

Fossil evidence suggests modern *Homo sapiens* emerged as a species in sub-Saharan Africa between 200,000 and 100,000 BP (Klein 2008; McDougall

2005). Defining anatomical modernity is a contentious matter, but debates over the modernity of certain specimens may be due in part to different approaches to identifying it (Pearson 2008). For example, statistical approaches employ a set of measurements and proportions to define what it means to be modern, whereas biological approaches focus on developmental processes that produce key differences in cranial or skull morphology in various hominids. However, despite different approaches, the general consensus is that rather than a quick speciation event, there may have been a gradual, mosaic transition to *Homo sapiens* over the last 300,000 years in Africa (McBrearty and Brooks 2000), and the species emerged long before the onset of the LSA in sub-Saharan Africa 40,000 BP.

Most studies of modern human origins focus on changes in cranial morphology, though mostly incomplete crania are available for study from African localities (Rightmire 2008). The record of postcranial remains is even sparser (Pearson 2003). However, overall, several dozen specimens have been recovered. Some come from controlled excavations, while others are surface finds for which context can be reasonably inferred (McBrearty and Brooks 2000).

The Kibish Formation at Omo in southern Ethiopia has yielded the oldest well-dated "anatomically modern" human fossils to date (Pearson et. al. 2008; McDougall et al. 2005). Recent discoveries, and the reanalysis of former finds, confirmed the conclusion that the postcranial fragments of Omo I are modern yet differ from the usual anatomy of recent populations in some aspects (Pearson et al. 2008; McDougall et al. 2005). This skeleton preserves many parts of both the appendicular and axial skeleton, albeit in very fragmentary condition. Omo I shares some unusual features with Neandertals, early human fossils from the Middle East, and European Upper Paleolithic humans from the Gravettian period such as a medially facing radial tuberosity, a laterally flaring facet on the talus for the lateral malleolus, and reduced dorsovolar curvature of the base of the metacarpals, suggesting the possibility early modern humans in Eurasia did not necessarily inherit these traits from Neandertals, but from earlier African predecessors such as Omo I. Other traits are similar to those observed among recent humans, such as the large projection of its coronoid process of the right ulna relative to its olecranon. ^{40}Ar/^{39}Ar dating of feldspars from tuffs in Members I and III of the Kibish Formation have provided a minimum age of 104,000 ± 1,000 BP, and maximum age of 196,000 ± 2,000 BP. Geological correlations, isotopic ages of pumice clasts in Member 1, and evidence of rapid deposition of Member 1 further narrow the age estimate to approximately 195,000 ± 5,000 BP. However, the emergence of anatomically modern traits was a gradual process. Omo II is a surface find from the same site determined to be the same age as Omo I by detailed stratigraphic analysis (Brown and Guller 2008; Feibel 2008). However, this nearly complete calvarium exhibits more primitive traits than Omo I (Fleagle et al. 2008). This evidence supports the idea that the evolution of anatomically modern humans was a gradual, mosaic-like process.

2.2 The Middle Stone Age: Chronology and Technology

Goodwin and Van Riet Lowe (1929) first employed the term “Middle Stone Age” to describe South African lithic technology characterized by scrapers, points, and Levallois technology, and it now also refers to the chronological period throughout sub-Saharan Africa beginning approximately 300,000 and ending around 40,000 BP, as well as the technology that is widespread throughout that period. Genetic and fossil evidence highlight the significance of this period of time as that in which anatomically modern humans emerged. It is also during this time that the first technological system to exhibit considerable regional variability appears. This may reflect adaptations to specific environments or even imply ethnic markers with different groups possibly starting to make tools that differ stylistically, but are functionally equivalent, due to social factors.

Although the division of the southern African Stone Age into discrete, time constrained categories makes it difficult to assign certain assemblages to a specific time period as some assemblages clearly fall into an intermediate or transitional zone, the Middle Stone Age is generally characterized by flake-based industries typologically dominated by scrapers and points made on radial and prepared cores. In addition to diagnostic tool types, it can also be technologically defined by the frequency of faceting on flake platforms, which is an indication prepared core and Levallois technology, and the tendency of convergent rather than parallel flaking on dorsal flake surfaces (Allsworth-Jones 1986). According to Clark (1977), it is a Mode 3 technology along with the Middle Paleolithic of Europe, characterized by prepared core surfaces for the production of flakes that are subsequently shaped.

Prepared core technology includes the Levallois technique (Figure 2.1), which became widespread in the MSA. Levallois cores are shaped by the removal of flakes along the core's margins and upper surface, followed by the preparation of a striking platform, to allow for the removal of a large flake that cuts across these preparation flake scars (Inizan et al. 1999; Debénath and Dibble 1994). This shaping allows the subsequently removed flake to be used without additional retouching, and these flakes are recognized by the dorsal scar pattern and number of platform facets. Used to produce flakes, blades, and points, it is widely believed that this special preparation of the core is a means of predetermining flake shape (Debénath and Dibble 1994).

However, Dibble (1989) suggests the predetermination of flake size and shape should be visible though greater standardization of flakes compared to those produced by other methods. A comparison of size measurements of Levallois flakes, “normal” flakes, and biface trimming pieces revealed statistical differences between the Levallois and normal flakes in thickness as well as several indices calculated from the measured attributes, including area/thickness, length/width, and width/thickness. However, no difference existed between the Levallois flakes and biface trimming pieces. Although there is no universally accepted definition of the latter, they are sometimes identified by characteristics such as a narrow faceted striking platforms and lipping (Andrefsky 1999). Thus, if the results indicate greater standardization of Levallois flakes, one must also accept greater standardization of biface trimming pieces. Dibble instead suggests that rather than a method of core preparation leading to the production of flakes with predetermined sizes and shapes, it is instead a specific method for production of many flakes from one core; it is a reductive strategy. The standardization of the biface trimming pieces reflects their role in a consistent technology, and indeed, Dibble says the application of such a technology will also produce results that are more conformable. The normal flakes probably show the highest degree of variation because they are most likely the products of different technologies. Inizan et al. (1999) also point out that a degree of predetermination is also involved in other knapping activities. However, they also acknowledge that the Levallois method is the "first well organized, very widespread debitage method to develop before the advent of *Homo sapiens*" (1999:63).

Results of archaeological fieldwork and analysis throughout sub-Saharan Africa have demonstrated spatial and temporal variability within the Middle Stone Age, and interpretations of this variability may provide insight into early modern human behavioural adaptations in the time and place that they evolved. The MSA is preceded by the Acheulean, characterized by hand-axes, cleavers, and other heavy duty tools, and followed by the Later Stone Age (LSA), characterized by small bladelets and backed tools, which are pieces with 90° retouch along at least one edge to facilitate insertion into hafts without cutting the hafting material, and are often microlithic. However, some Middle Stone Age assemblages contain components usually associated with either the Early or Later Stone Age. For example, the Sangoan Industry contains a heavy duty component associated with the Acheulean, including core-axes and picks and may be transitional from the Acheulian to the typical MSA (McBrearty 1988). Others contain elements often recognized as Upper Paleolithic (UP) or LSA. This includes the Lupemban

Industry and Howeisons Poort (e.g., Barham 2001), both of which include backed pieces and geometrics.

Backed tools are described as a statistically minor, but technologically significant feature of the Lupemban Industry of Kalambo Falls and Twin Rivers in Zambia (Barham 2001). At Twin Rivers, these artefacts are bracketed between dates of 400,000 and 140,000 BP by thermal ionization mass spectrometric (TIMS) U-series. Kalambo Falls is presumed to be of a similar age, though this does not mean the sites are contemporaneous (Clark and Brown 2001). The backed pieces are trapezoids shaped by blunt retouch or deliberate snapping of blades to removes butts and distal ends, creating a tapered mid-section with a cutting edge opposite. The backed blades, along with carefully constructed lanceolates and core-axes, as well as blade and prepared core technology, constitute a combination of light and heavy tools. It appears to be restricted to the woodlands of south central Africa and the Congo basin. It may represent the first regionally distinct industry of sub-Saharan Africa, and backed tools indicate this industry included hafted, composite tools. The emergence of this technology in central south Africa at this time parallels, or may even precede, the emergence of anatomically modern humans.

The Howeison's Poort of southern Africa, found at Klasies River, Diepkloof, Sibudu and other sites, is a blade-based industry characterized presence of backed tools and various geometric forms (Lombard 2009) that are more standardized and occur at a higher frequency than those at Kalambo Falls and Twin Rivers (Barham 2002). It includes backed geometric pieces that are usually larger than those of the LSA but are generally referred to as microlithic nonetheless as they are relatively smaller than typical flake and blade tools found elsewhere in the MSA (Soriano et al. 2007; McCall 2006; Minchillo 2006). Flaking efficiency was higher than that observed for the pre- and post-conventional MSA in the region when the edge length to mass value for complete flakes is employed as a proxy for flaking efficiency in assemblages (Mackay 2008). These assemblages, generally dated to between 50,000 and 60,000 BP (Rigaud et al. 2006), resemble LSA technology, and were once thought to be transitional to the LSA, but are now known to precede a return to more conventional MSA technology. This stratification between conventional MSA assemblages indicates Howeison's Poort is unequivocally MSA in age (Harper 1997; McCall 2007; Soriano et al. 2007; Villa et al. 2005).

Many more sites and assemblages exhibit certain elements that differentiate in some way from the "conventional" MSA. It is unclear whether assemblage variability in the MSA can be best attributed to the beginnings of regional cultural identity, or long term ecological adaptations to specific habitats (Mabulla 1996). For example, Clark (1988) suggested that assemblages with a heavy duty component are more often associated with closed vegetation habitats based on faunal analysis, such as coastal evergreen forests, woodland savannas and thickets, whereas more conventional assemblages are associated with open country. However, McBrearty (1983:318) demonstrated that the Sangoan MSA at Simbi in western Kenya, an early industry characterized by its heavy duty component, was associated with more arid conditions as indicated by evidence such as the presence of grazers (grass eaters) in the faunal assemblage, vegetation contents and stable isotope values of the soil. Indeed, it has been suggested such associations are gross simplifications (Rots and Van Peer 2006).

Further spatial variability can be observed in regionally distinctive point forms (Clark 1988; McBrearty and Brooks 2000). As McBrearty and Brooks (2000) note, point design is strongly limited by functional constraints, specifically regarding hafting and aerodynamics, and it is further limited by the sharing and exchange of points within a group. While the archaeological record for the African MSA is not high-resolution enough to deduce detailed local maps demonstrating stylistic boundaries in which abrupt discontinuities in point style correspond with boundaries of ethnic groups within which such points are exchanged, as can be observed in the ethnographic record, McBrearty and Brooks recognize several types on a continent-wide scale (Figure 2.2). For example, they note the Lupemban industry of the Congo basin is characterized by long, thin, and skilfully made lanceolate points, whereas the East African Rift Valley features foliates (leaf-shaped pieces), narrow foliates, and unifacial and bifacial triangular points. However, Dibble (1989:427) warns that the “simplicity” of such industries and raw material and technological constraints imply “extreme caution” should be taken when attributing lithic variation to cultural or stylistic factors.

Although the reasons behind it are little understood, it remains clear that temporal as well as spatial variability exists in the MSA. The scarcity of MSA sites further confounds the problem, as this makes it difficult to attribute lithic technological variability to environmental, cultural, or other factors. Such issues have demonstrated the need for a better developed chronology for sub-Saharan Africa, particularly in this time period. The application of chronometric dating techniques such as thermoluminescense (TL) of burnt flint, optical spin luminescence (OSL) of sediments, electron spin resonance (ESR) of teeth and shells, and uranium series (U-series) (Schwarcz and Grün 1999; Feathers 1996; Wintle 1996; Grün 1993; Schwarcz 1992; Grün and Stringer 1991) have made is possible to better date finds from less than 200,000 BP but more than 40,000 BP, providing greater understand the chronological framework of the MSA.

ESR is a technique applied to materials of biological origin such as tooth enamel, shell, or corals from archaeological and other deposits (Wintle 1996; Schwarcz and Grün 1993). It works on the basis that electrons are trapped in the enamel of teeth or other object from natural radiation in the sample and its surroundings (Wintle 1996). Placing the sample in a magnetic field and measuring the magnetic energy it absorbs allows a date to be calculated, because the number of electrons correlates to its age. Thermoluminescense, originally applied to pottery because it had been fired, is often applied to burnt flint and measures the total natural radiation field to which an object has been exposed since a zeroing event such as exposure to sunlight or heat. OSL is very similar in that a luminescence signal is measured by optical stimulation of the trapped electrons, and is used to date sediments (Wintle 1996).

Despite the refinement of chronological frameworks made possible by techniques like ESR, OSL, TL, and U-series, dates obtained in these methods are based on unproven assumptions rendering them not completely accurate (Millard

2008). For example, the rate at which enamel absorbs radiation is actually unknown. Therefore two models of uptake are calculated with this method: linear uptake (LU) and early uptake (EU). The LU date assumes a steady rate of uranium absorption over the depositional life of the tooth or bone from the surrounding environment, whereas the EU date assumes the initial amount was large at the time of deposition, followed by minimal absorption. The EU is believed to provide a minimal date, but LU dates are closer to other methods of estimating ages (Millard 2008). Also, if an artefact or sediment was reheated to temperatures beyond 400˚ C, perhaps due to fire, its "clock" may be reset and TL or OSL analyses subsequently produces misleading dates. However, as long as these and other limitations are kept in mind, these techniques remain a useful and powerful tool for interpreting the paleontological and archaeological records.

2.3 The Archaeology of "Behavioural Modernity"

Throughout the evolution of hominids, speciation events are accompanied by technological changes. The emergence of anatomically modern humans approximately coincides with the appearance of Middle Stone Age technology. The transition from Early to Middle Stone Age technology is characterized by the replacement of hand-held implements such as hand axes by hafted composite tools such as spears, along with greater standardization of tool types and the beginnings of what can be recognized as regional variability in lithic assemblages.

Tools are only one segment of a larger class of behaviour referred to as “technology”, but they are the aspect of technology that is observable in the archaeological record (Torrence 1989b). Indeed, the largest class of data available to archaeologists is comprised of stone artefacts (Torrence 1989a). Due to the prevalence of stone artefacts in the archaeological record, behavioural models for prehistoric nomadic foragers, including Paleolithic and Stone Age humans, are based almost exclusively on lithics (Riel-Salvatore and Barton 2004). It is essential to remember "tools are not ends in themselves, but used by people as part of a larger strategy for coping with their social and physical environment" (Torrence 1989: 58). But because the morphology of stone implements is a result of prehistoric activity, they can yield useful insight into the behaviour of their makers (Riel-Salvatore and Barton 2004).

Despite the change in technology that occurred approximately around or slightly before the time anatomically modern *Homo sapiens* appeared, the nature of the relationship between anatomical and behavioural evolution in early *Homo sapiens* is highly debated (Willoughby 2007, 2001; Mellars 2005; Henshilwood and Marean 2003; Kusima 2003; Klein 2000, 1992; Wadley 2001; McBrearty and Brooks 2000), and some researchers believe fully modern behaviour emerged only 40,000 to 50,000 BP (Klein 2001, 1992; Wadley 2001; Ambrose 1998a). Confounding the issue are the lack of available sites at which the MSA-LSA transition can be directly studied (Willoughby 2001), as more LSA than MSA sites exist in East Africa, and many MSA sites are not followed by the LSA (Mabulla 1996). The lack of MSA sites may be due to lower population levels prior to the onset of the LSA.

Although anatomically modern *Homo sapiens* emerged in sub-Saharan

Africa between approximately 100,000 and 200,000 BP, they are associated with Middle Stone Age (MSA) technology, largely viewed as analogous to the Middle Palaeolithic (MP) tools produced by Neandertals in Europe, until around 40,000 BP with the onset of the LSA. Some researchers infer that the development of anatomical modernity preceded that of "behavioural modernity" by tens of thousands of years, the latter only coming abruptly at the transition to the Middle-to-Later Stone Age and reflecting the nature of the Middle-to-Upper Palaeolithic transition in Europe. These researchers argue for a punctual event in human evolutionary history characterized by the abrupt appearance of a package of traits indicative of behavioural modernity (Wadley 2001; Klein 2000, 1992).

In this view, technological ingenuity, social formations, and ideological complexity at this time allowed anatomically modern populations to expand and disperse from Africa, and successfully displace other hominid populations outside the continent (Klein 2000). According to Klein, among others, the artefactual contrast between MSA and LSA assemblages denotes significant behavioural differences between the makers of each (1992), despite that both were anatomically modern. Thus, in this view, a discrepancy exists between anatomical and behavioural modernity; behavioural and morphological evolution are decoupled (Stringer 2002).

Mellars (2005) considers the MSA-LSA transition as a dramatic change, a reorganization or "revolution" in behavioural patterns. Klein (2001, 2000) proposed this supposed onset of "behavioural modernity" around 40,000 BP is the product of a significant cognitive change. The only mechanism suggested for such a change is a selectively advantageous genetic mutation. However, such a genetic mutation is difficult to demonstrate anatomically and genetically (Barham and Mitchell 2008; Henshilwood and Marean 2003).

One possible contender is the FOXP2 gene, which has been shown to be relevant to the ability to develop language because of its association with language impairment in living populations (Kraus et al. 2007; Enard et al. 2002). Calculations indicate it appeared within the last 200,000 years, but Neandertals have also been demonstrated to share this variant of FOXP2, indicating it was present in a common ancestral population prior to that time (Kraus et al. 2007). Enard et al. (2002) suggested that some human-specific feature of the gene affect a person's ability to control orofacial movements, and by extension, the ability to develop proficient spoken language. Therefore, the time when this FOXP2 variant became fixed in the human population could be pertinent regarding the development of human language. However, its appearance predates not only the MSA-LSA transition, but also the emergence of anatomically modern humans, and so would not fit the criteria for a highly advantageous neurological change at the onset of the LSA and UP. Thus, it seriously undermines Klein's argument for a recent emergence of behavioural modernity, specifically with regards to the development of syntactic language, in Africa (Barham and Mitchell 2008).

Although proponents of the "human revolution" believe that behaviour prior to 40,000 BP anticipated fully modern behaviour yet was significantly different from it (Klein 2000), the same evidence can also be interpreted as indicating that the emergence of behavioural modernity was a long, gradual process with considerable time-depth in the African MSA (Henshilwood and Marean 2003; McBrearty and Brooks 2000). Indeed, some technological innovations deemed behaviourally modern are present as early as the late Acheulean, albeit sporadic and discontinuous in appearance in time and place.

The widely held indicators of behavioural modernity, traits that are now widespread among LSA hunter-gatherers, probably required time and specific circumstances or pressures in order to be invented and spread (McBrearty and Tryon 2006). Furthermore, cognitive behaviour is an expression of the interaction of inherent potential with knowledge, and a fundamental property of this knowledge is its accretionary nature; thus, instable demographic systems and population crashes during that time may have prevented the continuous accumulation of the technological and symbolic knowledge that is widespread in the LSA (Hovers and Belfer-Cohen 2006).

Equatorial Africa probably served as the largest tropical refugium in periods of extreme cold or environmental instability, when human populations elsewhere were likely greatly decimated, and so may be where such populations were concentrated (Ambrose 1998b). MtDNA studies indicate a demographic expansion of populations within Africa between 40,000 and 75,000 BP (Mountain and Cavalli-Sforza 1997; Watson 1997; Harpending et al. 1993; Sherry et al. 1993), slightly predating the appearance of conventional LSA technology. Decreased environmental variability and aridity following 70,000 BP possibly facilitated successful population expansions and migrations that were simply not possible between 135,000 and 70,000 BP due to heightened climate variability in which tropical refugia expanded and collapsed repeatedly, as suggested by lake cores from Lake Malawi (Scholz et al. 2007). New technological innovations, as well as increased social networking, may have then further contributed to demographic spread and subsequent migrations (Brooks et al. 2006; Ambrose 1998a). Furthermore, the region would have also had the largest reservoir of knowledge upon which to base new innovations (Ambrose 1998a).

However, McCall (2006:431) cautions that “it seems increasingly unwise to view the Middle Stone Age in Africa as constantly ‘improving’ towards the ultimate emergence of the LSA”. Indeed, “progress" in technology, or a unidirectional evolutionary process in which tools become increasingly complex throughout time, is not inevitable (Torrence 1989a, 1989b). This is demonstrated by lithic assemblages that take place long after the question of modern human origins, some of which are characterized by a wide range of amorphous and unstandardized types produced with minimal effort using local raw materials of no specific quality and used expediently (Torrence 1989b).

The expectation, noted by D’Errico and Henshilwood (2007), is that behaviours generally considered to be hallmarks of modernity should be widely present in Middle Stone Age sites, particularly those postdating 100,000 years ago. However, this does not appear to be the case. In some areas, “behaviourally modern” deposits are overlain by typical Middle Stone Age assemblages (Vishnyatsky 1994). Wadley (2001) notes the sporadic, irregular appearance of these traits in the archaeological record, and is wary of what she refers to as a "shopping list" of traits proclaimed to indicate behavioural modernity. It appears that some traits may be only a possible, not obligatory, outcome of the acquisition of behavioural modernity, and that the absence of some traits at Middle Stone Age sites does not signify whether or not the inhabitants were behaviourally modern (d'Errico and Henshilwood 2007; d'Errico 2003; d'Errico et al. 2003).

The sporadic, punctuated (temporally and spatially restricted) occurrences of so-called behaviourally modern traits suggest an inherent capability to produce technology and exploit resources in a manner that is defined as behaviourally modern (Hovers and Belfer-Cohen 2006; Vishnyastky 1994). Hovers and Belfer-Cohen (2006) note that ethnographic data suggests that these innovations will not always be utilized, even in historically known hunter-gatherers who are obviously modern humans both anatomically and behaviourally. The pattern of technological adaptation observable for the African Middle Stone Age suggests that some behaviours will become apparent only when triggered by certain stimuli that are circumstance-dependent. Therefore discrete populations should not be expected to exhibit necessarily similar patterns of behaviour, even if they possess similar cognitive abilities (Hovers and Belfer-Cohen 2006). Paleolithic and Stone Age technology probably constitutes a range of options broadly distributed spatially and temporally, held in common by all contemporaneous hominids, and invoked differently according to context (Clark and Riel-Salvatore 2006).

The problem of distinguishing between the emergence of new behavioural capabilities as opposed to the manifestation of already-inherent cognitive abilities has been referred to as the "sapient paradox" (Renfrew 1996). Although the development of new behavioural patterns might be expected to be linear and gradual, the inherent potential of latent behavioural patterns appears to manifest in a punctuated manner as made necessary by circumstance (Vishnyatsky 1994). That people did not make something does not by necessity imply they were unable to do so, and attempts to assess the cognitive capabilities of early by their stone tools may have validity only with regard to the lower limit of human intelligence (Vishnyatsky 1994).

Malafouris (2008) recently provided an alternative view of human cognitive evolution to one based on ever-increasing sophistication or specialization of a modular mind. He proposes the methodological implications of the changes observed in the material record could be viewed as indicative of possible plastic effects, causing changes in human cognition rather than (or as well as) being simply reflections of pre-existing cognitive or genetic changes. That is, material culture may actually be one of the possible reasons behind cognitive change, rather than simply a product thereof. Thus technology of hominids should be interpreted not only with regards to how it reflects those hominids' cognitive abilities, but also in terms of the effects such technology may have had on cognitive evolution over time.

Contributing to the debate over the origins of behavioural modernity is the contention among researchers regarding what exactly constitutes behavioural modernity. The literature converges on a number of features, including increased artefact diversity, greater standardization of artefact types, blade-based technologies, worked bone, antler and other organic materials, personal ornamentation, structured living spaces, ritualistic behaviour including burial of the dead, economic intensification including the exploitation of fish, fowl or other resources requiring specialized technology, enlarged geographic ranges, and expanded exchange networks. Some researchers believe these traits indicate hominid cognitive capabilities that encompass abstract thinking, planning depth, behavioural and technological innovativeness, and symbolic behaviour (McBrearty and Brooks 2000).

The antiquity and distribution of the material correlates of such behaviours in the empirical record is the focus of many researchers (Willoughby 2007; Henshilwood and Marean 2003). Thus, the identification of behavioural modernity in the archaeological record has often been a matter of determining the presence of absence of a suite of traits. Many of the features found on the so-called modernity checklist occur throughout the MSA. For example, evidence of complex bone industries in the MSA has been uncovered at various sites, including at Katanda in the Democratic Republic of the Congo and Blombos Cave in South Africa (d'Errico and Henshilwood 2007; Henshilwood et al. 2001; Yellen et al. 1995).

However, this "laundry list" approach, in which behavioural modernity is determined by the presence or absence of traits deemed indicative of modernity, rely on the underlying assumption that a given trait is a measure of modernity (Clark and Riel-Salvatore 2006; d'Errico 2003; Henshilwood and Marean 2000; Wadley 2001). The traits, largely based on the European Upper Paleolithic and its contrast with the preceding Middle Paleolithic, rest on the untested assumption that modernity is not present among MP peoples (d'Errico 2003). It does not take into account differences between the LSA and UP, or that the nature of the archaeological record of the MP-UP transition is perhaps a product of the unique situation of rapid colonization of new continents.

Given these limitations, it is possible the only archaeological signatures that may reflect the use of symbolism to organize behaviour can be considered directly indicative of behavioural modernity. Evidence of external symbolic storage include artwork in the form of paintings or engravings that are representational in form; personal ornamentation such as beads and body paintings with pigments like ochre; lithic style; and the social use of space (Henshilwood and Marean 2003; Wadley 2001). While sparse, such evidence has appeared at MSA sites.

Ostrich eggshell beads come from early LSA deposits at sites such as Mumba rockshelter and Kisese II rockshelter in northern Tanzania and Enkapune Ya Muto in central Kenya (Ambrose 1998a). They are also present at some MSA sites. Blombos Cave along the cape of South Africa yielded 41 perforated *Nassarius krasussianus* or tick shell beads (Henshilwood et al. 2004). For 39 of the beads, OSL dating of associated sediments produced a date of 75,600±3,400 BP and TL dating of burnt flints produced a similar date of 77,000±6,000 BP. The additional two beads from the topmost underlying, and still undated, level and may be intrusive. At Sibudu Cave in KwaZulu-Natal, South Africa, five specimens of *Afrolittorina africana*, including three bearing perforations, were recovered from the Still Bay and Howieson Poort MSA levels and may be shell beads (d’Errico et al. 2008).

Such personal adornments may be significant as they may have been used to establish cultural identity (Henshilwood and Marean 2003). Among the present day !Kung San hunter-gatherers of the Kalahari desert, beads are an important item of exchange in a gift-giving system, !hxaro, that serves to strengthen regional social networks which are used as safety nets in times of economic hardship, and thus enhances survival in marginal environments (Ambrose 1998a; Weissner 1986, 1982). The use of social networking systems as an economic fall-back, resulting in socially-mediated risk minimization and social solidarity, may have also been contributed to population stability or expansion. However, the conclusion that personal ornamentation in the form of beads is indicative of language, has been refuted on the basis that proving the intentionality or artefactuality of such beads does not inform on their representational or symbolic status (Malafouris 2008) and the lack of underpinning by empirical theories of what personal ornaments or beads and symbols are, and how these objects are interrelated (Botha 2008).

Additional evidence of symbolic and ceremonial behaviour may be provided by burials in the Levant and Australia that predate any obvious technological transition from the MSA/MP (Mellars 2005). In Africa, evidence of mortuary practices predate even the transition to anatomical modernity. Post-mortem disarticulation and defleshing cutmarks observed on three crania, intermediate between archaic and anatomically modern *Homo sapiens,* from the Middle Awash date to 154,000 and 160,000 BP by the ^{40}Ar/^{39}Ar (Clark et al. 2003). A 600,000 year old *Homo heidelbergensis* cranium from Bodo in the

Middle Awash of Ethiopia also displays possible evidence of mortuary practice/ritual, cannibalism, or both in the form of defleshing cutmarks (White 2000, 1986). The earliest evidence for such practices is similar marks observed on the specimen Stw-53 from Sterkfontein Member 5 in South Africa (Pickering et al. 2000). Though dating for Stw-53 has been problematic, its morphology suggests it represents early *Homo* or even *Australopithecus*, thus predating the Bodo specimen.

These observations can be interpreted as likely reflecting the emergence of a strong symbolic component in human behavioural patterns before any changes in associated lithic and bone technologies at the onset of the Later Stone Age, or even before the appearance of anatomically modern *Homo sapiens* (Mellars 2005; d’Errico 2003). This fits with the idea that behavioural changes often occurs before physical changes (Minichillo 2005).

In addition to evidence of symbolism, the study of ancient technologies has often been the basis of evaluation of hominid cognitive abilities (d’Errico et al. 2003). However, some researchers warn against simplistically linking technological innovations with the emergence of modern behaviours, even if they appear simultaneously (Henshilwood and Marean 2003; Wadley 2001). For example, blade-based technology has often been upheld as a more efficient use of raw material and cutting edge than flake-based technology by researchers such as Klein (1992). Bar-Yosef and Kuhn (1999) criticize this simplistic and assumed correlation between blade technologies, the European UP and behavioural modernity. As Tactikos (2003) demonstrates, the the cutting-edge-to-mass ratios are actually not significantly different between MP and UP stone tools.

However, Bar-Yosef and Kuhn (1999) point out that if it can be shown that specific blade and bladelet technologies are linked to composite tool manufacture, they may reflect novel and significant patterns of social and economic cooperation within human social groups. The use of composite tools may have significant implications regarding cognitive evolution (Ambrose 2001; Brooks et al. 2006; Wadley et al. 2009; Wynn 2009). The innovation of hafting occurs as early as between 220,000 and 180,000 BP based on OSL dates at Sai Island in Sudan, where use-wear analysis provides direct evidence that core-axes were used as hafted implements (Rots and Van Peer 2006). It could even be as early as 400,000 BP at the sites of Kalambo Falls and Twin Rivers in Zambia, where the presence of backed lithic artefacts suggests the use of composite tools (Barham 2002). The production and maintenance of the multiple elements that make up a composite tool require planned sequences of actions that are preformed at different times and places. The complex problem solving and planning suggested by the production and use of composite tools may have influenced the evolution of the frontal lobe, which is involved in speech (Ambrose 2001). Furthermore, the steps required to produce the compound adhesives used to haft stone tools in MSA of South Africa, and perhaps elsewhere, require multitasking and abstract though (Wadley et al. 2009). Brooks et al. (2006) also believe cognitive sophistication is implied by the use of MSA points as hafted elements.

The use of hafted points as hunting weapons also has more direct implications for human subsistence strategies (Lombard 2006). Use-wear analysis at the sites of White Paintings rockshelter in the Tsodilo Hills, Botswana and Sibudu Cave in South Africa indicate that points from both sites exhibit diagnostic impact fractures, which is evidence of their use as stone tips of either throwing or thrusting spears for hunting (Lombard 2005; Donahue et al. 2002). Because it is an innovation that coincides with the emergence of anatomically modern humans, a change of hunting strategies may be associated with this speciation event (Donahue et al. 2002).

The focus of this study is the lithic technological system people employed throughout time at Magubike, a rockshelter in southern Tanzania. Of particular interest are the early humans that inhabited the rockshelter during the Middle Stone Age, given the significance of the MSA as the period in which modern humans emerged and also coincidentally as the first technological system to exhibit considerable regional variability. The analysis of the lithic artefacts recovered from test excavations there strongly indicates the potential contribution of Magubike to the study and understanding of MSA lithic variability.

Figure 2.1 Levallois technique for producing stone tools (adapted from Howell 1965).

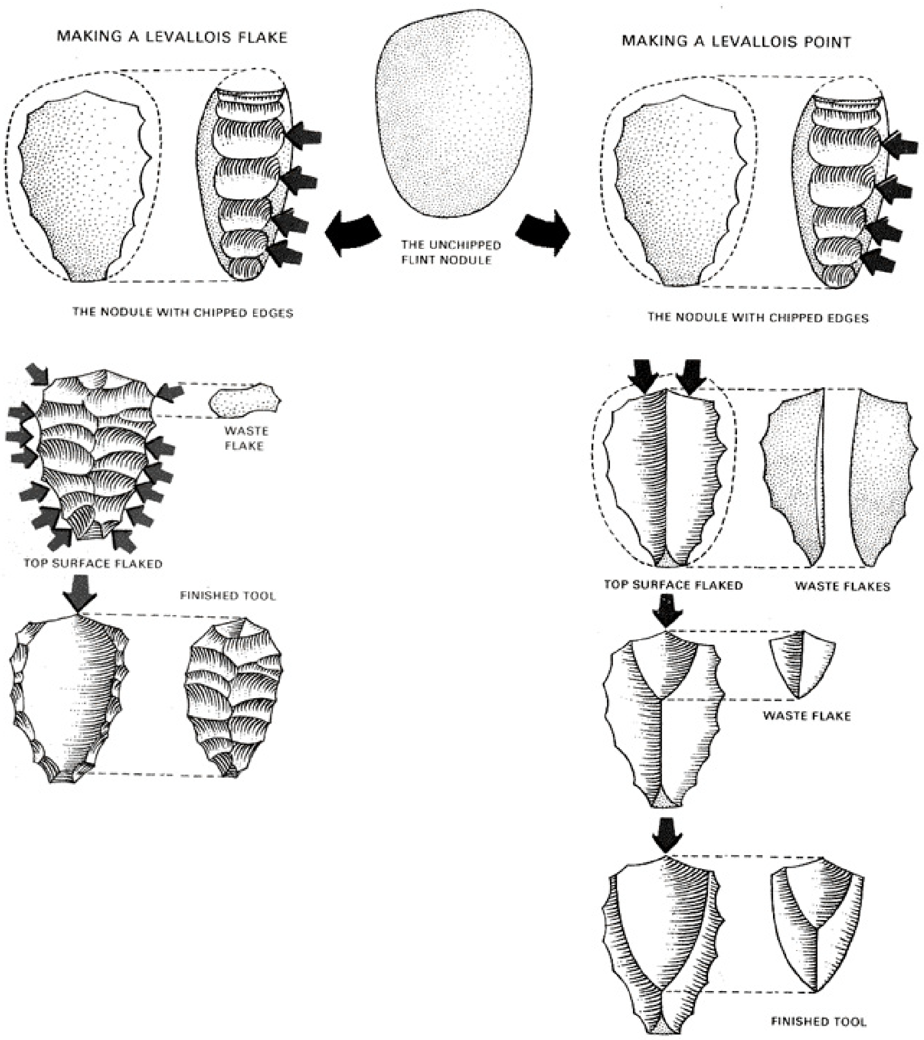
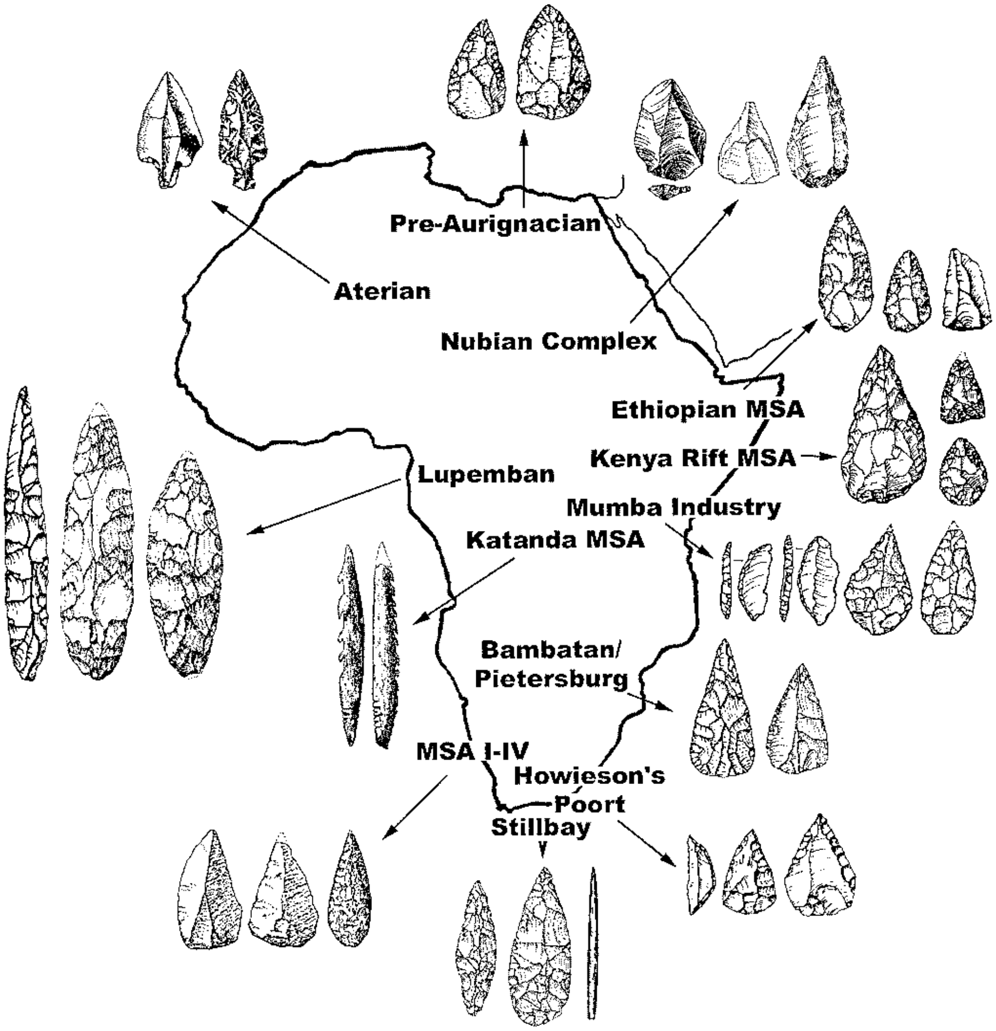


Figure 2.2 Map of distribution of point styles in the African MSA (after Clark, 1993, Figure 1; adapted from McBrearty and Brooks 2000).



Chapter 3: Site History and Description

In 2005, Dr. Pamela Willoughby recorded several sites during an initial visit to the Iringa region. The District Cultural Officer for Iringa Rural, Joyce Nachilima, showed Willoughby a number of rockshelters in the area. All of the rockshelters had archaeological materials exposed on the surface surface (Willoughby 2006a, 2005). These included Magubike, Mlambalasi, and Kitelewasi. Willoughby observed lithics, ceramics, and iron slag on the surface, as well as outside around the sites. At Magubike, a number of stone artefacts diagnostic of the MSA were observed in the surrounding fields. Iron Age pottery, iron slag, bone, and lithics were also observed in the rockshelter.

Mlambalasi and Magubike became the focus of the initial 2006 field season, and her team conducted test excavations at both sites to determine the nature of the archaeological deposits present. Additional fieldwork conducted in 2008 included a survey to identify possible raw material sources in the area, as well as more test excavations outside the main site at Magubike in order to determine the extent of the site.

Magubike rockshelter is located at approximately 7º45.790'S, 35º28.399'E, at an elevation of 1541 m, and lies in close proximity to the village of the same name (Figure 3.1) (Willoughby 2006a). It consists of a large granite rock shelter overlooking agricultural fields (Figure 3.2). The main rock shelter at Magubike was assigned the Standardized African Site Enumeration System (SASES) number of HxJf-01, and the surrounding agricultural field was designated HxJf-03 since there appeared to be many artefacts of different raw materials than those represented within the shelter. At the time, this was considered a possible indication of the presence of a second, open-air site (Willoughby 2005, 2006a); however, subsequent test excavations in 2009 disproved this, as artefacts were only present on the surface of the fields. Two other rock shelters in the vicinity with Iron Age occupations were registered as HxJf-02 and HxJf-04.

3.2 Fieldwork

The test excavations conducted in 2006 were carried out by Willoughby, PhD students Pastory Bushozi and Katie Biittner, and Peter Abwalo from the Tanzania Department of Antiquities. Local hired men aided in digging. Each unit was excavated using 10 cm arbitrary levels and sediment was inspected by hand in large pans. As digging progressed, changes in soil were noted and upon completion, a wall profile was drawn. All ecofacts and artefacts were collected, bagged and tagged by level on-site, and later washed, sorted by material (i.e., lithics, iron slag, pottery, ochre or fauna), then counted, re-bagged and re-tagged. Following the field season, the artefacts were transported to Dar es Salaam and the Department of Antiquities granted Willoughby permission to temporarily house them in Edmonton for study.

The intent of the 2006 field season was to collect surface samples and conduct test excavations in order to determine the cultural sequences at Magubike and another rockshelter in Iringa region, Mlambalasi (HwJf-02) (Biittner et al. 2007; Willoughby 2005, 2006a; Biittner 2006). Surface collection and test excavations resulted in the recovery of thousands of artefacts, including lithics, pottery, red ochre, iron slag, bone, and shell. At Magubike, the team excavated three 1m^2 test pits beneath the overhang in 2006 (Biittner 2006; Willoughby 2006b). TP1 was placed in a side chamber and reached a depth of 180cm. TP2 was placed beneath main overhang, and when bedrock between 50-60cm prevented further excavation, TP3 was placed adjacent to it and reached a depth of 210 cm. These units yielded 18,930 lithic artefacts (Table 3.1).

In Dr. Willoughby's archaeology lab at the University of Alberta in Edmonton, the artefacts were re-washed and individually labelled with test pit, level, and catalogue number. The lithic artefacts were then classified using Mehlman's (1989) typology and entered into a database using the statistical program SPSS. Additional technological variables, including planform, dorsal scar pattern, dorsal scar number, size measurements (length, thickness, breadth, weight), Toth type, retouch angle and intensity, cortex coverage, and raw material were also recorded and entered.

As will demonstrated in later chapters, the first test pit yielded Iron Age deposits (0-50 cm), overlaying a possible Later Stone Age (50-70 cm) and followed by a possible mixed Later Stone Age/Middle Stone Age (70-100 cm) in which the number of artefacts dropped off before picking back up with Middle Stone Age materials around 100cm and continued until bedrock at 180 cm. Unlike in TP1, the Iron Age directly overlays the MSA in TP2 and TP3. The MSA begins at 60 cm and continued until bedrock at 210 cm. Furthermore, the MSA begins much sooner, though the bedrock is at a greater depth. This suggests that despite the close proximity of the test pits, different areas of the site were subject to different taphonomic processes. Additionally, the Stone Age encompasses a huge amount of chronological time; therefore, countless occupations may be represented here.

3.2.1 Test Pit 1

The first 1m^2 test pit was placed in a side chamber on the west side of the rockshelter. The concentration of artefacts on the surface along the edges of the shelter and its low areas suggest the flow of water through the area, possibly indicating the area is in the path of an ephemeral stream. The unit was placed in a high area with a dense surface concentration of artefacts (Biittner 2006) and reached a depth of 180 cm, at which point, bedrock was met. There were 6,575 lithic artefacts recovered (Figure 3.3). The profile of the East Wall is presented in Figure 3.4. Seven stratigraphic units were recognized. The first change in soil was at about 5 cm, where it became greyer, wetter, and less consolidated. Bioturbation in the form of roots was present between 10-40 cm. Lithics, pot sherds, red ochre, shell and bone fragments, iron slag, and some ground stone objects were recovered from these levels. After 40 cm, the soil transitioned to a brownish grey. At this point, the artefact density dropped off, coupled with a high number of gravel and disintegrating rock.

Between 50 cm and 70 cm, the amount of gravel was still high, but the artefact density of lithics drastically increased. Large cores and core fragments in various raw materials were observed, as were a high number of flakes, blades and flake-blades. One piece of iron was recovered at this point.

After 70 cm there was another drop-off in artefact frequency, and no more bone or shell, though a hammerstone/pestle and large cobble-sized core were recovered. The soil abruptly changed to a very distinct, highly visible reddish tone, but still contained considerable quantities of gravel. The next couple levels produced almost no artefacts, just gravel, and a few flakes. At 100-110 cm, the test pit began to yield larger flakes in quartz and basalt, still with a large amount of gravel.

At 110 cm, the density of lithic artefacts very dramatically increased. A high degree of variability in raw material types was observed and continued until 150 cm, where the density dropped off but several pieces continued to be found. This continued until bedrock was hit between 170-180 cm.

3.2.2 Test Pit 2

The second test pit was placed under the main overhang of the rockshelter. It reached a depth of 60 cm, at which point gravel and MSA artefacts appeared, but digging was discontinued to the presence of a large rock. There were 938 lithic artefacts were recovered (Figure 3.5). The profile of the south wall can be seen in Figure 3.6.

The first 10 cm was very soft, gray, ashy soil and contained Iron Age bone, pottery, iron, lithics, and a broken human premolar. This continued in the next ten centimetre level. A modern fire pit was visible in the northwest corner along the west wall. The soil began to change into a reddish brown at 20 cm. Bone, pottery, and lithics continued to be uncovered but less iron than before. A clayish deposit was visible in the west wall. At 40 cm there was a lot blackened/burnt bone and more lithics. The soil was very soft and silty. Around the clayish area, a large rock was uncovered that took up most of the unit.

Between 50-60 cm, attempts were made to dig around the rock, which appeared to be roof fall. There was gravel and large MSA-like artefacts in a variety of types and high in density considering the small area they were coming from, and resembling those in TP1. At this point digging could not continue due to the large rock, so the unit was extended to the east by a meter square.

3.2.3 Test Pit 3

The third test pit was placed adjacent to the east wall of the second test pit under the main overhang. This est pit reached bedrock at 210 cm and yielded 11,417 lithic artefacts (Figure 3.7). The profile of the South wall can be seen in Figure 3.6 and that of the East wall in Figure 3.8.

The first few levels (0-30 cm) were very ashy and contained a lot of charcoal along with iron, pottery, lithics, bone fragments and shell, attributed to the Iron Age. After 30 cm, there was only lithics, shell and bone though the soil continued to be silty.

At 40 cm, the deposit became gravelly, there was a decrease in bone, and lithics were larger than before. At 70 cm the soil was reddish, like that in TP1. A single piece of pottery was found between 70-80 cm, but may be intrusive, having possibly fallen from the wall or surface. Unlike in TP1, bones and shell were present throughout until the bedrock, but the bones were partially to completely fossilized and artefacts had a calcium carbonate rind on them. A total of seven human teeth were recovered: two shovel-shaped incisors were found in level 150-160 cm and an incisor, a canine, and three premolars were recovered from 130-140 cm. An additional broken premolar was found when bone samples were examined in Edmonton. A shell bead was recovered from between 180-190 cm. The bedrock was reached at 210 cm

3.3 Dating

Radiocarbon dates were obtained on *Achatina* shell fragments from the third test pit. The sample from 20-30 cm yielded a calibrated date of 1410-1015 BC (IsoTrace lab number TO-13422) with a 95% confidence interval, within the range of the Iron Age. The sample from 130-140 cm (IsoTrace lab number TO-13423) produced a date range of 41,100-42,480 BP (uncalibrated), and is of particular interest because that places it approximately at the Middle-to-Later Stone Age transition. Because of the limits of radiocarbon dating, it is reasonable to treat age determinations of 40,000 BP or older as minimum, rather than absolute, dates (Phillips 2005).

Initial ESR dates obtained on shells from 120-130 cm differ significantly from the radiocarbon dates for 130-140 cm. A date range of 150,000 to 234,000 BP was determined, most likely indicating an age closest to 150,000 (Skinner, personal communication, 2010). Thus, these deposits probably date to between

41,100 and 150,000 BP; while a very large range, it does place it squarely within the Middle Stone Age.

However, additional work is necessary to refine the dating chronology of Magubike. Some considerations to be made when addressing these results include the mobility of the shell and how it entered the archaeological record- for example, as a living organism burrowing, or alternatively, through the activity of hominids or other animals. In particular, a greater understanding of the stratigraphy and site formation processes would facilitate better interpretations of these dates (Biittner 2006).

3.4 Ongoing research

As previously mentioned, Willoughby returned in 2008 and conducted further test excavations below the site to determine the extent of the cultural history of Magubike and its surroundings. I participated in this fieldwork. HxJf-03 was determined not to constitute a second site, despite the difference observed in the raw material of the lithics from those in the shelter. However, HxJf-01 extends beyond the present-day roof of the rockshelter, out to where it is probable the roof once extended. Most notably, a unit (TP5) placed at the foot of the slope yielded a 2.5 metre complete sequence of the Iron Age, Later and Middle Stone Age. The concentration of LSA artefacts contrasts with the sequences observed within the rock shelter. As of this writing, the analysis of lithics from 2008 is not yet completed, and so this thesis will consider only the data from test excavations in 2006. Data from TP2 is also omitted since it did not yield a complete sequence, limiting its potential for contributing to a construction of the site’s entire cultural historical sequence as well as for providing insight on the MSA in particular.

Table 3.1 Total number of stone artefacts recovered from 2006 test excavations at Magubike by level.

		TEST PIT			**Total**
		1	**2**	**3**	
LEVEL (CM)	0-10	271	43	89	403
	10-20	85	190	211	486
	20-30	84	172	152	408
	30-40	181	136	131	448
	40-50	320	211	191	722
	50-60	419	186	195	800
	60-70	459	0	370	829
	70-80	78	0	728	806
	80-90	18	0	484	502
	90-100	42	0	767	809
	100-110	36	0	657	693
	110-120	436	0	696	1132
	120-130	726	0	825	1551
	130-140	1517	0	902	2419
	140-150	1149	0	365	1514
	150-160	531	0	638	1169
	160-170	215	0	705	920
	170-180	8	0	1160	1168
	180-190	0	0	1278	1278
	190-200	0	0	812	812
	200-210	0	0	61	61
Total		6575	938	11417	18930

Figure 3.1 Map of Tanzania showing location of Magubike and various other Stone Age sites (adapted from Biittner et al. 2007).

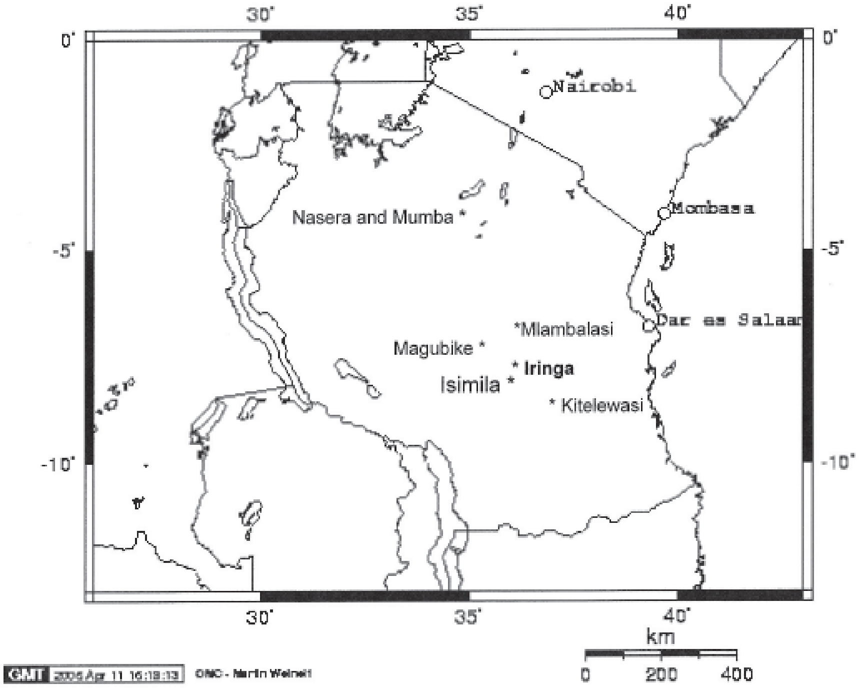


Figure 3.2 View of Magubike rockshelter in 2008 (photograph by author).

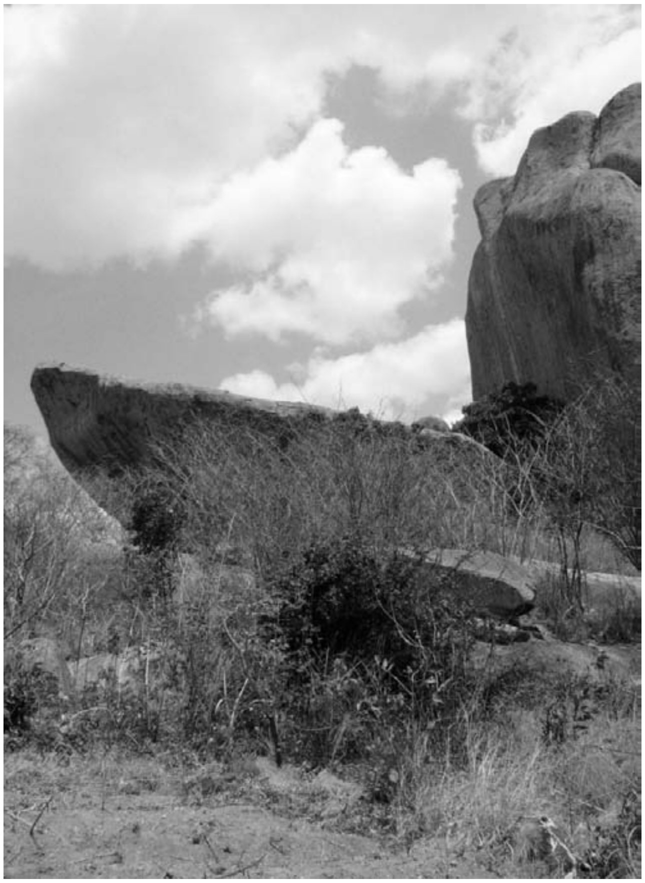


Figure 3.3 Number of stone artefacts by level in TP1.

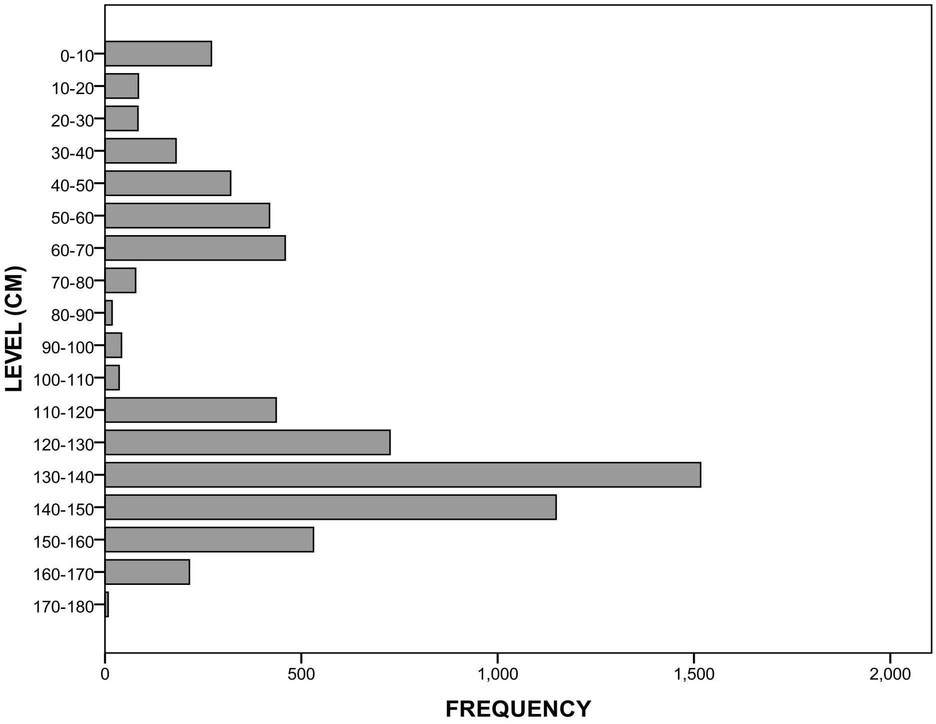
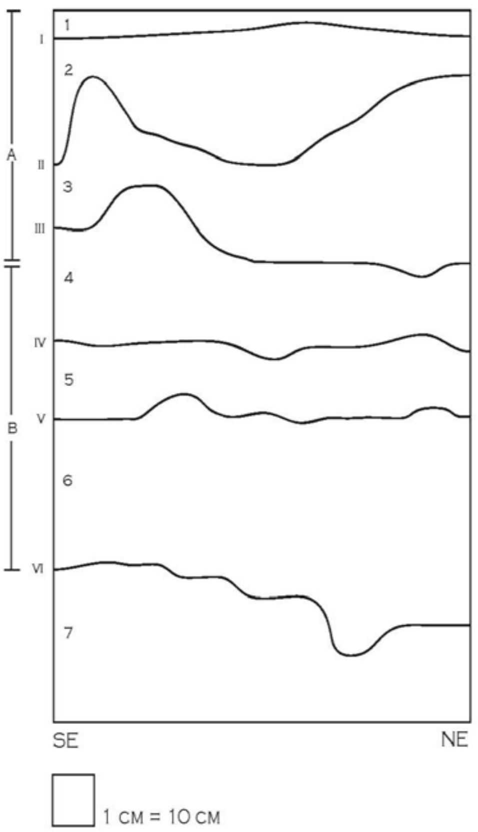


Figure 3.4 Stratigraphic profile of TP1, East wall, at Magubike (drawing by Katie Biittner).



Lithostratigraphic	Allostratigraphic	Ethnostratigraphic
1. silt and sand, moderately sorted, mixed composition, coherence = 2, grey	I. fuzzy contact	A. Iron Age: lithics, pottery, iron slag, ash, charcoal, shell, bone,
2. silt and sand, (less sand than 1), moderately sorted, mixed composition, coherence = 1, darkish grey	II. fuzzy contact	
3. silt and sand (gritty), moderately sorted, mixed composition, coherence = 0, brownish grey	III. fuzzy contact	
4. Gravel sized clasts with silty matrix, poorly sorted, mixed composition, coherence = 1, reddish/orange-ish	IV. fuzzy contact	
5. gravel sized clasts with silty matrix, poorly sorted, mixed composition, coherence = 1, dark brown	V. fuzzy contact	B. Middle Stone Age (MSA): lithics, beads, faunal remains
6. Gravel sized clasts with silty matrix (predominately gravel), poorly sorted, mixed composition, coherence = 1, reddish/orange-ish	VI. distinct contact	
7. Bedrock		

Figure 3.5 Number of stone artefacts by level in TP2.

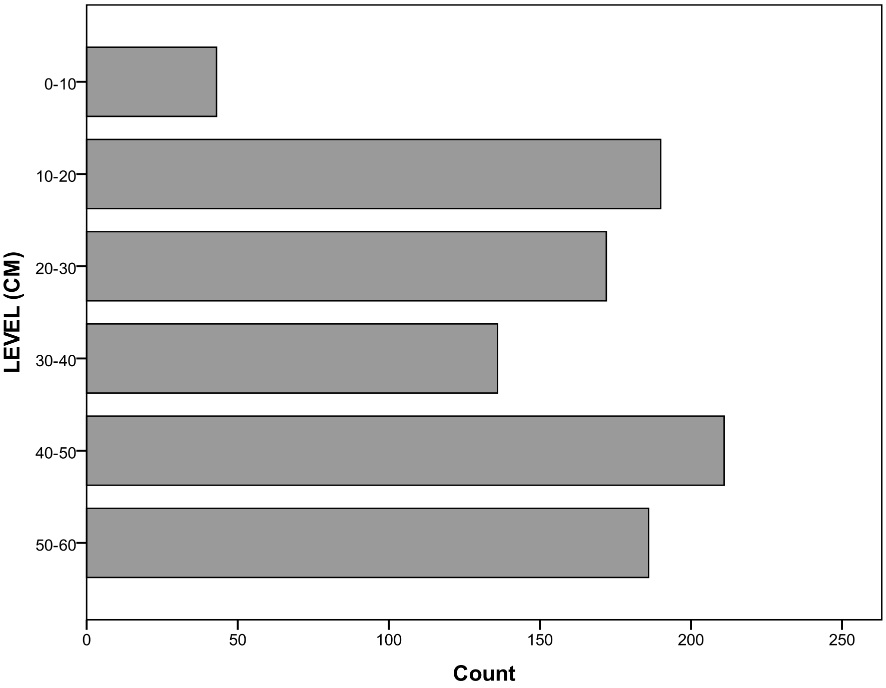
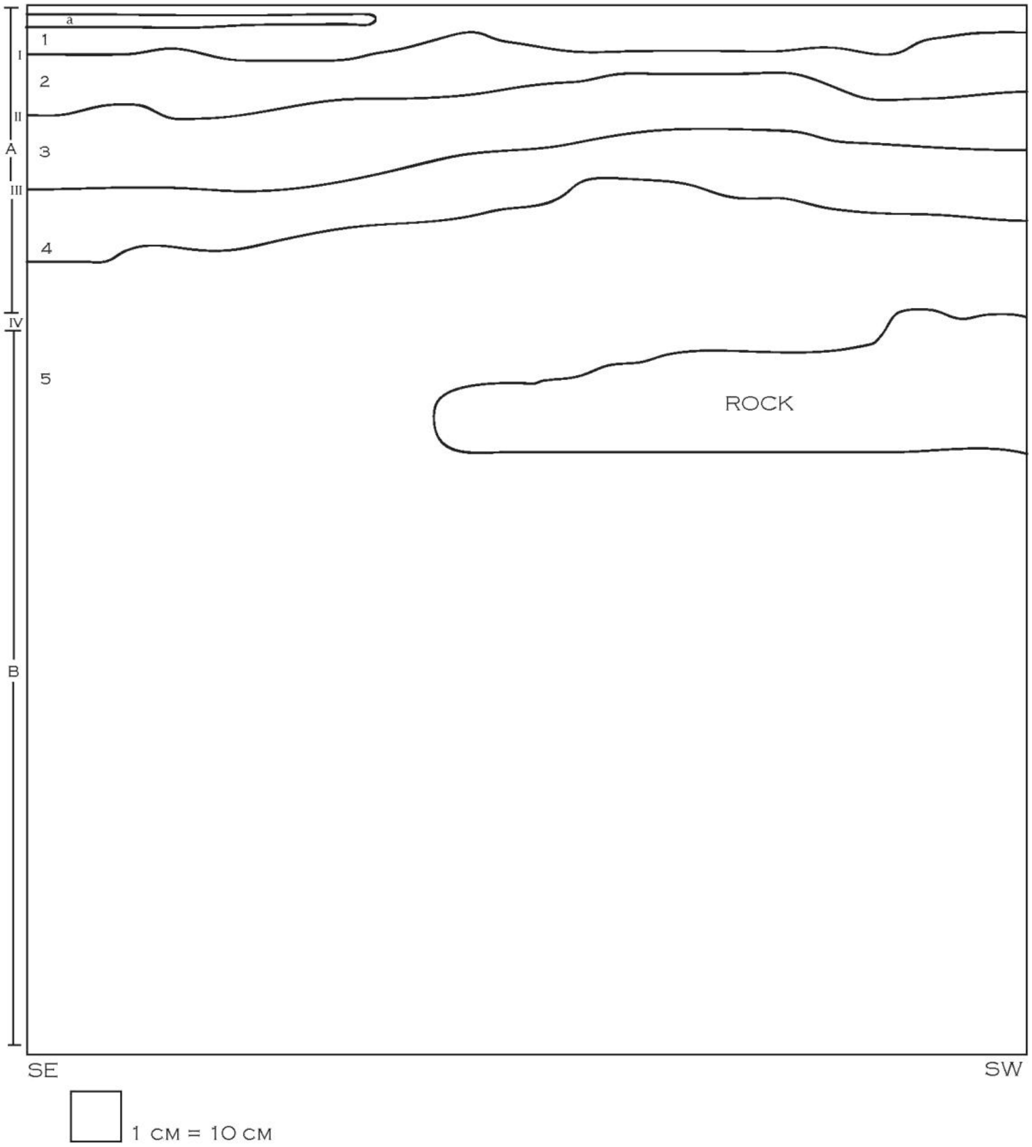
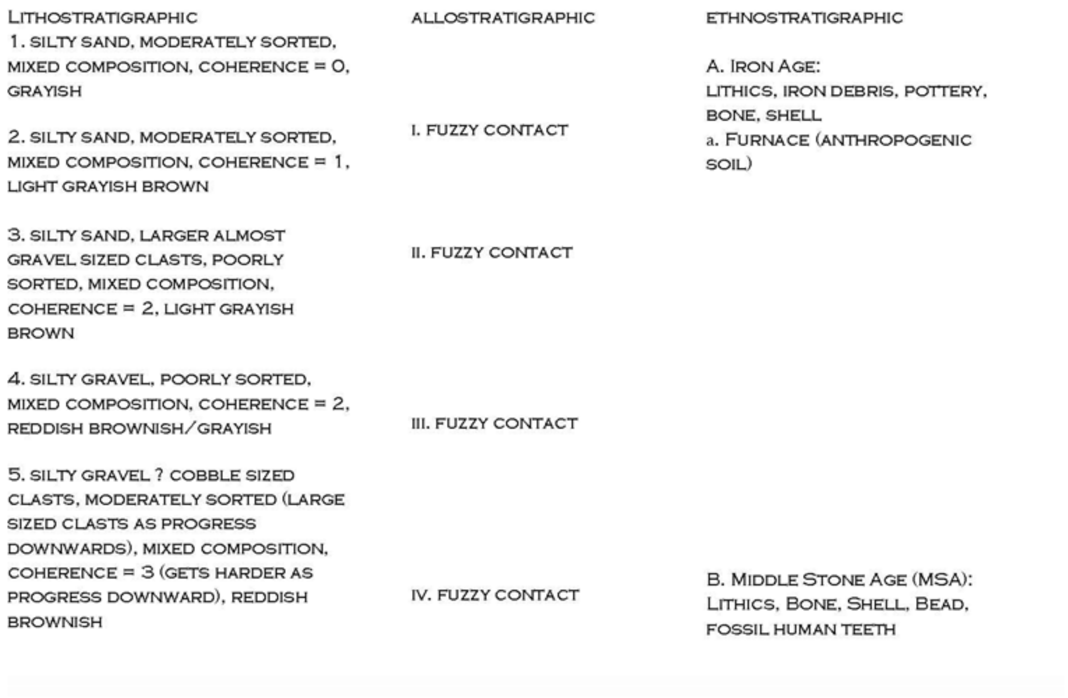


Figure 3.6 Stratigraphic profile of TP2 and 3, South wall, at Magubike (drawing by Katie Biittner).





Lithostratigraphic	allostratigraphic	ethnostratigraphic
1. silty sand, moderately sorted, mixed composition, coherence = 0, grayish		A. Iron Age: lithics, iron debris, pottery, bone, shell a. Furnace (anthropogenic soil)
2. silty sand, moderately sorted, mixed composition, coherence = 1, light grayish brown	I. fuzzy contact	
3. silty sand, larger almost gravel sized clasts, poorly sorted, mixed composition, coherence = 2, light grayish brown	II. fuzzy contact	
4. silty gravel, poorly sorted, mixed composition, coherence = 2, reddish brownish/grayish	III. fuzzy contact	
5. silty gravel ? cobble sized clasts, moderately sorted (large sized clasts as progress downwards), mixed composition, coherence = 3 (gets harder as progress downward), reddish brownish	IV. fuzzy contact	B. Middle Stone Age (MSA): Lithics, Bone, Shell, Bead, fossil human teeth

Figure 3.7 Number of stone artefacts by level in TP3.

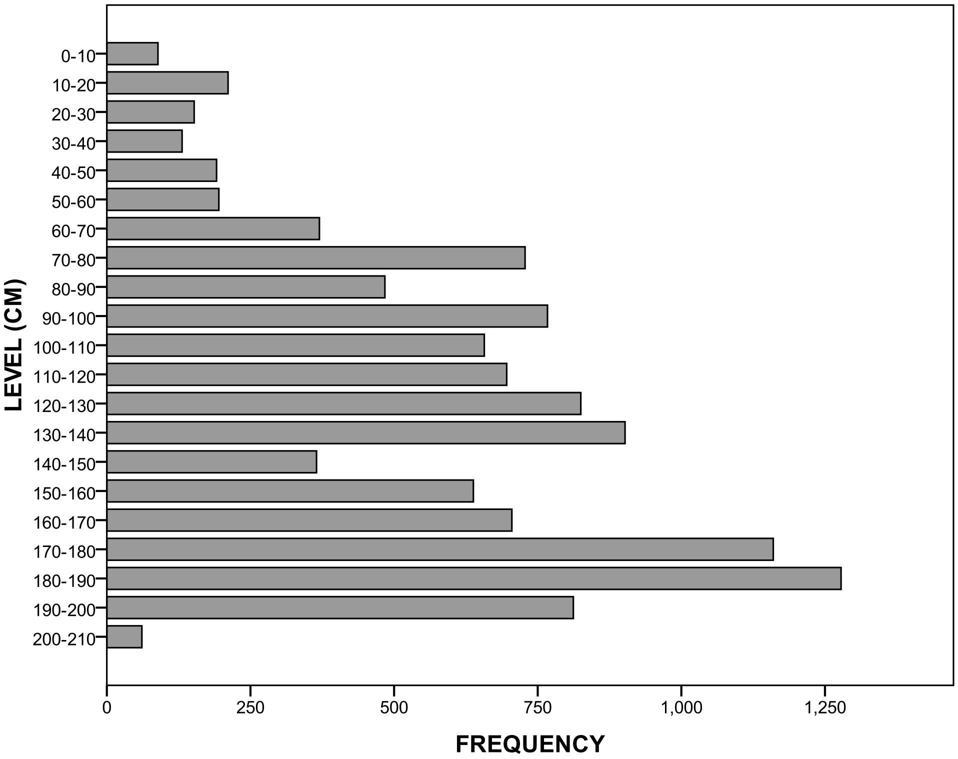
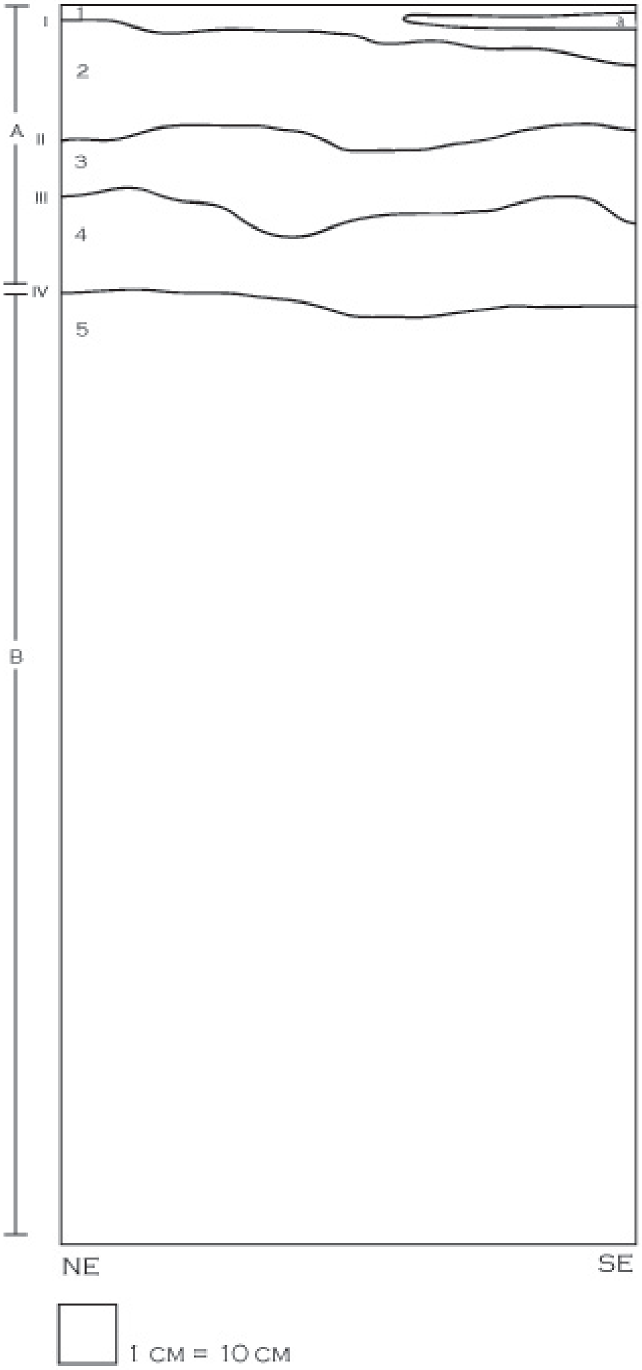


Figure 3.8 Stratigraphic profile of TP3, East wall, at Magubike (drawing by Katie Biittner).



Chapter 4: Methods

4.1 Objectives

The primary objective of this study is to present and analyze the typological and technological data of lithics recovered from 2006 test excavations at the Magubike rockshelter. Typological and technological data are employed to contribute to the development of a culture-historical sequence for this region (Appendix I). Although Clark (1989) believes lithics tell us very little about past human behaviour compared to other single categories of evidence such as faunal remains, they remain the largest class of data available to archaeologists (Torrence 1989a). Also due to this high prevalence of stone artefacts in the archaeological record, behavioural models for prehistoric nomadic foragers, including Paleolithic and Stone Age humans, are based almost exclusively on lithics (Riel-Salvatore and Barton 2004).

The archaeological materials are assigned to certain culture or time periods based on a standardized classification system that facilitates comparisons with other sites. Additionally, the typological and technological data allows for various questions concerning hominid behaviour and decision-making to be addressed. Results will be discussed within the context of the modern human behaviour debate, and also compared with the data from other sites in East Africa.

4.2 Typological variables

Typological classification allows findings to be communicated to other archaeologists in a simplified, understandable fashion (Clarkson and O’Connor

2006). A classification is necessary for the convenience of describing artefacts in groups or classes, as opposed to the impractical alternative of describing an assemblage artefact-by-artefact. The sorting of artefacts into types is not always a simple matter of identification as the artefact's type is not always obvious, but rather a process of recognizing resemblances between given objects and specific type concepts, with the artefact being labelled according to what type concept it most closely resembles. However, providing type definitions ensures a degree of consistency in the communication of information and sorting of artefacts (Adams and Adams 1991). Types are not always defined by concrete boundaries, but rather, often consists of central tendencies from which most specimens deviate in some characteristics and to some degree. In some circumstances, such as with the Middle Paleolithic scrapers, variation is continuous, but even in such cases, arbitrary divisions may be necessary in order to communicate effectively what an assemblage contains (Adams and Adams 1991).

Lithic types do not necessarily reflect divisions recognized by the makers. Through experimentation by killing feral goats with replicated hafted projectile points on spears in North America, Flenniken (1985) demonstrated that important morphological changes resulted from rejuvenation processes despite attempts to maintain morphologically similar end-products. This supports what is known as the "Frison Effect," which demonstrates that what may appear to be different tool types actually simply reflect different stages of rejuvenation and use in the life of a tool (Frison 1968). Dibble (1984, 1987, 1993) applies this idea to the European Middle Paleolithic, and hypothesizes scraper types are a product of different stages in the reduction of flake blanks through re-use and re-modification, rather than emic types that reflect style (Bordes 1973, 1972) or function (Binford and Binford 1969, 1966). In fact, the detailed morphological lithic types often utilized by archaeologists probably merely reflect our biased perceptions of an infinite range of variability (Clark 1989). However, typological classification is still useful for the purpose of description and communication.

Mehlman's typology is divided into four major categories (Table 4.1). Although Willoughby made minor adjustments to Mehlman’s original typology in order to better meet the needs of the present application of the typology, its use facilitates comparison with the materials from Mumba and Nasera rockshelter in northern Tanzania to which Mehlman applied the typology. The general categories and their types are outlined and defined below.

4.2.1 Trimmed pieces

Mehlman (1989:127-140) defines a retouched tool or trimmed piece as any piece with at least one edge of secondary modification. Trimmed pieces encompass ten tool types: scrapers, backed pieces, points, burins, bifacially modified pieces, becs, composite tools, *outils écaillés*, heavy duty tools and other/sundry. Scrapers are pieces with unifacial retouch that forms an edge with an angle between 35˚ and 90˚ degrees, usually ranging between 45˚ and 70˚.

Steeper retouch indicates a core edge or backed piece. Scrapers are subdivided by the location and shape of the retouched edge. Subtypes include small convex scrapers, convex end scrapers, convex double end scrapers, convex end and side scrapers, circular scrapers, nosed end scrapers, convex side scrapers, convex double side scrapers, nosed side scrapers, sundry double end scraper, sundry and side scraper, sundry side scrapers, sundry double side scrapers, concave scrapers, concavities, notches, sundry combination scrapers, convex end and concave combination scrapers, convex side and concave combination scrapers, divers scrapers including microburins, convergent scrapers, and scraper fragments.

Backed pieces exhibit bidirectional retouch (directed from both faces of the flake) forming an edge with an angle averaging over 80˚, and usually approaching 90˚. Backed piece subtypes are crescents, triangles, trapezes, curved back pieces, straight backed pieces, orthogonal truncation, oblique truncation, angle-backed pieces, divers backed, backed awl/drill/perçoir, and backed fragments.

Points are pieces retouched along two convergent sides to form a point or alternatively can be manufactured using Levallois methods. Sides may be uni- or bifacially retouched, forming an angle less than 45˚. Retouch angles are usually low, less than 30˚, forming a cutting edge or a combination of cutting and low angle scraper retouch. Although not formal tools in the traditional sense, Levallois points are included in this type along with the retouched point subtypes of unifacial points/perçoir, alternate face/edge points/perçoir, and bifacial points.

Burins are tools with one or more burin facets, or places where burin spalls have been removed to create a chisel-like end. The burin facts are flake scars produced by striking a usually long, narrow piece (the burin spall) off the side of the flake, blade or bladelet (Tixier 1974). Burin subtypes include dihedral burins, angle burins, and mixed/other burins.

Bifacially modified pieces include any that show some bifacial retouch along an edge but is not readily classified as a point, core or biface/heavy duty tool. These include discoids, point blanks, and bifacially modified pieces.

Becs exhibit two short lines of either unifacial or alternating edge steep retouch intersecting to form a robust spur, projection, or corner on a piece. All becs belong to the subtype of becs.

Composite tools are retouched pieces combining the characteristics of two or more defined tool types. Subtypes are sundry composite tools, burin and other composite tools, backed and other composite tools, and scraper and other composite tools.

Outils écaillés or scalar pieces are flakes that exhibit crushing and stepped flaking restricted to the flake margin on one or more opposing edges are a product of bipolar flaking. All *outils écaillés* belong to the subtype of *outils écaillés*.

Heavy duty tools encompass all large cutting tools and the heavy duty tools of other typologies such as choppers, handaxes, cleavers, and picks. Usually, these pieces possess a greatest dimension of more than 50 mm. These include core/large scrapers, handaxes, core choppers, cleavers, picks, core axes, and other heavy duty tools.

The other/sundry category exists for retouched tools and tools fragments that are otherwise unclassifiable. The subtypes are sundry modified, cutting edge, bulbar thin/talon reduced, and tool fragment.

4.2.2 Cores

Cores are recognized by their chunkiness and flake negatives (scars produced by prior flake removals) of sufficient size to have yielded blanks from which tools could have been made (Mehlman 1989:140-148). There are five core types:

Peripheral cores are those worked on both faces from a single edge which extends around at least a third of the core, and may encircle it entirely. Flakes were removed from a well defined periphery/equator, hence the name. Peripherally worked cores include part-peripheral cores, radial/biconic cores, disc cores, and Levallois cores.

Patterned platform cores range in shape from chunky to subrectangular and subcuboid to tabular. The striking platform often forms close to a 90° angle with the faces bearing the major flake negative scars. This includes classic blade and bladelet cores. Mehlman's subtypes are adjacent double platform core/core scrapers and multiple platform cores.

The intermediate category is for cores which combine the features of two core types. The subtypes are platform/peripheral cores, platform/peripheral core/core scrapers, platform/bipolar cores, platform/bipolar core/core scrapers, and bipolar/peripheral cores.

Bipolar cores are characterized by two opposed edges crushed, battered, or stepped flaked on one or both faces. Additionally, negative flake scars run longitudinally between opposed edges. Some researchers opt to define these as tools rather than cores. Bipolar cores are divided into the subtypes of bipolar cores and core fragments.

Amorphous cores are those that do not fit in any other category. All amorphous cores belong to the subtype amorphous/casual cores.

4.2.3 Debitage

The general category of debitage comprises the by-products of tool making and includes five types:

Flakes encompass all pieces of chipped stone without retouch and preserved platforms, except for blades, specialized flakes, and Levallois flakes. Flake subtypes include whole flakes, trimmed/utilized flakes, flake talon fragments, and trimmed/utilized flake talon fragments.

Blades are defined as flakes with length twice their width. Larger blades with thick, triangular cross sections may be core rejuvenation flakes if the dorsal ridge bears either the obvious edge of a core platform or the edge of a peripheral core. Blades are divided into subtypes of whole blades, trimmed/utilized bladders, blade/talon fragments, and trimmed/utilized blade talon fragments.

Angular fragments are any pieces lacking a platform and without retouch. These include core fragments, angular fragments, trimmed/utilized angular fragments, medial or distal blade segments, and trimmed/utilized blade segments.

Levallois flakes are those produced by the Levallois technique, described in Chapter 2. The subtypes are whole Levallois flakes and trimmed/utilized Levallois flakes.

Specialized flakes are elongated to blade length shapes of small size with triangular cross sections, and include core rejuvenation flake and burin spalls. Subtypes are plain burin spall and tool spall.

4.2.4 Non-flaked

Non-flaked stone implements are pieces showing natural cortex and pecked, crushed, and/or ground surfaces (Mehlman 1989:140-154). There are seven types:

Hammerstones are oblong to sub-hemispherical cobbles with bruised, crushed, or pecked areas usually localized on extremities. The only subtype is hammerstones.

Anvil stones are blocky or flat, slab-like pieces of stone with localized battering, bruising and pecking on one more flat surface. Subtypes are edge anvils, pitted anvils, and edge and pit anvils.

Pestle rubbers are oblong to sub-hemispherical cobble-sized stones with one or more ground facets. Pestle rubbers encompass the subtypes pestle rubbers and dimpled rubbers.

Polished axes are flat, rectangular pieces with a sharp ground bit along one end. Subtypes include lobed axes and other axes.

Stone discs are flat, relatively thin, circular pieces of stone. Stone discs are divided into the subtypes of pecked disc and dimpled discs.

The sundry polished/ground category is for pieces that do not fit in other categories. All items in this type belong in the subtype sundry ground/shaped item.

Manuports are all unmodified stone items which are also non-angular and a result of human introduction to the site assemblage.

4.3 Technological variables

In addition to typological classification, also recorded were a number of technological variables for each artefact (Table 4.2). Toth types, platform breadth, platform length, platform angle, number of platform facets, planform, dorsal flake scar pattern, and number of dorsal scares were recorded for whole and retouched flakes and blades. Tools were not examined for these since trimming can obscure the features requiring observation when it comes to these variables. Flake area and platform area relative to the flake area were calculated. For tools, retouch intensity and angle were recorded. Cortex cover and number of visible flake scares were recorded for cores. Weight, breadth, length and thickness were measured for all artefacts. Ratios for breadth-to-length, thickness-to-breadth, and thickness-to-length were calculated. Degree of abrasion was also recorded for all pieces.

4.3.1 Toth types

Whole flakes were assigned to types based on the location of cortex, or lack thereof, on the dorsal surface and platform (Toth 1982) (Figure 4.1). The amount of cortex on a flake’s dorsal surface indicates the relative stage of production when it was detached (Andrefsky, 1998; Odell, 2004; Dibble, Schurmans et al. 2005). Toth Types provide information on the stage of manufacture as well as flaking methods. These are based on Toth's (1982) study of Oldowan tool production at Koobi Fora, Kenya, which was developed independently but is very similar to a system developed by Paola Villa (1978, as cited in Toth 1982) in her work at Terra Amata in Europe.

Type I exhibits a cortical platform and completely cortical dorsal surface. These are typically the first flake struck from a cobble, and thus indicates the beginning stages of lithic manufacture.

Type II exhibits a cortical platform and a partially cortical dorsal surface. These are typically the second flake to be knocked off the core by unifacial flaking.

Type III exhibits a cortical platform and a completely non-cortical dorsal surface. Type III results from the unifacial flaking if little cortex is left on the surface being worked, or alternatively, from the release of flakes from the ventral surface of another flake with cortex on its dorsal, with that cortical surface becoming the butt of the removed flake.

Type IV exhibits a non-cortical platform and completely cortical surface. Type IV are the first flakes resulting from bifacial flaking, or releasing a flake from the cortical surface of another flake.

Type V exhibits a non-cortical platform and partially cortical surface. Type V is a product of bifacially flaking a cobble, or unifacially working a flake with a cortical dorsal surface.

Type VI exhibits a non-cortical platform and a completely non-cortical dorsal surface. Finally, Type VI represents the later stages of flaking, from cores of flake starting forms with little to no cortex remaining.

Type VII are flakes which cannot be placed in the above categories, either because the platform is too small or because they are missing the platform. Toth (1982) used Type VII for flakes that could not be placed in the previous categories, usually because the platform was too small. However, Willoughby also uses this category to record Toth types for tools, which do not always reatain a platform.

4.3.2 Planform

Whole and utilized flakes were assigned to categories based on overall shape or planform (Figure 4.2). The categories are comprised of (1) convergent, (2) divergent, (3) parallel, (4) intermediate, (5) circular, and (6) unknown (Figure 4.2). Willoughby draws these categories from McBrearty (1986: 198-199), and has added the categories of circular and unknown.

4.3.3 Dorsal Scar Pattern

The scar pattern on the dorsal surface of a flake can indicate what mode of reduction occurred before the detachment of that flakes (Toth 1982; McBrearty

1989). The categories of patterns (Figure 4.3), the first five of which are also drawn from McBrearty's (1989:183) work, are (1) radial, (2) same pattern simple, (3) same pattern parallel, (4) opposed platform, (5) plain, (6) transverse, (7) none, and (8) unknown (Figure 4.3). Radial scar patterns are usually indicative of MSA technology, whereas same pattern, parallel are associated with the LSA. However, plain and same platform, simple are produced by any flake production technique (McBrearty 1986).

4.3.4 Dorsal Flake Scars

The number of dorsal scars on a flake may indicate the degree to which the core was worked prior to the detachment of that flake. A higher number of dorsal flake scars results from more extensive lithic reduction. However, the number of dorsal scars can be a function of other factors such as size of the flake and core or flaking method (Toth 1982).

4.3.5 Platform facets and angle

Where possible, platform facets were counted. Multiple platform facets are a possible indication of core platform preparation. This is produced by the bifacial thinning of handaxes (Newcomer 1971), as well as sometimes with Levallois cores (Bradley 1977, as cited in Toth 1982). A facetted striking platform is considered one of the easiest diagnostic features by which to identify Levallois flakes, although these flakes may still also have a plain platform (Bodes 1947; Van Peer 1992; Tixier 1974). Platform angle was also recorded.

4.3.6 Retouch intensity and angle

Retouch intensity fell into one of three categories: marginal, semi-invasive, and invasive (Figure 4.4). These categories indicate the degree of formal retouch on a tool, that is, how far it extends on the surface, and are taken from Clark and Kleindienst (1974:85).

Retouch angle was also recorded. Different edge angles are known to be more practical for performing specific tasks (Figure 4.5) (Andrefsky 1998). According to Andrefsky (1998), very acute or sharp edges are more effective than wider angles for cutting soft materials, such as meat. However, wider angles approaching 75-90° are ideal for scraping hides, because the scraper can be pulled or pushed over the hide with less risk of cutting the hide. According to Mehlman, scrapers exhibit angles between 35˚ and 90˚ degrees, usually ranging between 45˚ and 70˚ (1989). Very steep retouched edges constitute backing or a core edge, defined by Mehlman (1989) as having an angle greater than 80° and usually more than 90°.

4.3.7 Cortex cover and flake scars

Cortex cover and flakes scars were recorded for cores and indicate the degree of reduction intensity. The percentage of cortex was estimated for each core, and for this study, divided into the following categories based on the amount of cortex: 1 (0-25%); 2 (26-50%); 3 (51-75%); or 4 (76-100%). Cores with little or no cortex and a higher number of scars from flake removals reflect a higher degree of reduction than cores with higher amounts of remaining cortex and fewer flake scars.

4.3.8 Size measurements

Length, breadth and thickness were measured in millimetres for all artefacts. Ratios were calculated for breadth to length and thickness to breadth. These ratios convey how long/short and thick/thin the artefact is in relative terms. (Toth 1982). Flake area was also calculated. Weight was measured in grams. Additionally, platform length and breadth were recorded where possible. From these, platform area was calculated, as was the platform area relative to flake area.

4.3.9 Raw material

Each artefact was also assigned to a broad raw material category: quartzite, quartz, chert/flint, metamorphic, volcanic, obsidian, other sedimentary, and quartz. Although obsidian, rock crystal, and quartzite fall into the larger categories of volcanic, quartz, and sedimentary, respectively, they are recognized separately. A number of African studies count these as separate raw material categories. Raw material is tested against tool types and other variables in order to identify any indications of selective behaviour. The usage of raw materials also provides insight on mobility patterns, territory ranges, and social interactions of hunter-gather groups (Inizan et al. 1999; Barut 1994). Distances to raw material sources may reflect either direct contact with that source, embedded within mobility patterns, or alternatively, exchange networks. When non-local resources are utilized in a stone tool assemblage, the proportion within the assemblage compared to local materials in conjecture with the degree of retouch may indicate territory size and the degree of mobility.

4.4 Comparable Sites in East Africa

Mumba Cave, east of Lake Eyasi in northern Tanzania, is one of the most complete archaeological sequences in East Africa, documenting the MSA through the Iron Age (Mehlman 1989; Prendergast et al. 2007). Enkapune Ya Muto is another site in East Africa with a long Stone Age sequence, located in Kenya (Ambrose 1998a). Because of their long archaeological sequences, these sites provide excellent material for comparison with the lithics from Magubike, particularly Mumba and Nasera Cave as the same typology was used, facilitating easier comparison.

4.4.1 Mumba and Nasera (Tanzania)

Margarit Kohl-Larsen first excavated Mumba in 1934-1936. Mehlman (1989) conducted further research in the 1970s at the site, but also incorporated artefacts from the Kohl-Larsen collections into his study. The site has recently been re-excavated, with implications for Mehlman's findings (Prendergast et al. 2007). Mehlman also conducted excavations at Nasera rockshelter, which is located north of the famous early human site Olduvai Gorge.

Mehlman identified two MSA industries. The earliest of these is the Sanzako Industry in Bed VI-B at Mumba, characterized by a high frequency of bifacially modified pieces and heavy duty tools, and low occurrences of formally retouched points (Mehlman 1989:183-186). The bifacially modified pieces possess point-like planforms but are too chunky in cross-section to be considered points, and the range of scraper types is limited and unstandardized.

The overlying layer VI-A contained the Kisele Industry, also seen in levels 12-25 at Nasera (Mehlman 1989:200-201). The Kisele Industry is characterized by a high frequency of retouched points, bifacially modified pieces, and unstandardized scrapers, whereas heavy tools are relatively infrequent. In the MSA industries, radial core technology was most common, whereas bipolar techniques for core reduction were rare. At both sites, quartz is the dominant raw material. The relatively less frequent use of Levallois technology coupled with a higher number of heavy duty tools at Mumba constitute the main differences between the sites.

Mehlman (1989:272-273) also identified what he believed were two intermediate or transitional assemblages at both sites. These assemblages exhibit characteristics typical of LSA and MSA technology. Bed V at Mumba and Levels 8-11 at Nasera yielded these transitional industries. These assemblages were characterized by large, backed pieces, retouched points, with radial, bipolar, and platform cores all well represented. Lower Bed V at Mumba most resembled what was found at Nasera. Upper Bed V was more LSA–like, with more frequent backed artefacts with less frequent points, and bipolar cores dominant over the still-present radial and platform cores.

The other intermediate industry is found in Lower Bed III at Mumba and levels 6-7 at Nasera (Mehlman 1989:318-321). The reversal of the relative frequency of points to back pieces is the main difference between the sites. At

Nasera, points are more common, and the backed pieces are smaller and more infrequent. Scrapers dominated, with convex side scrapers most common. Bipolar cores were frequent, as were peripheral and platform.

Prendergast et al. (2007) recently carried out further excavations at Mumba Cave, and have pointed out why past excavations there were problematic, including Mehlman's work. Kohl-Larsen utilized poor excavation and recovery methods, and Mehlman relied heavily on Kohl-Larsen's collections, and hastily analyzed his lithics, much of which were sorted in the field. Furthermore, they found that previous geological and archaeological subdivisions of the shelter's deposits needed much revision, which has implications for the industries, including so-called transitional ones, identified by Mehlman.

Mehlman relied on Kohl-Larsen's six-bed division, although he revised it by adding sub-divisions. However, Bed V's composition is much more complex than previously thought, in that it actually crosscuts multiple geological units, none of which lie horizontally (Prendergast et al. 2007). The archaeological and geological levels follow a sloping topography that may have been overlooked by previous researchers, including Mehlman, who may have crosscut them in their own levels.

The results of the Prendergast et al. (2007) study of the archaeological materials suggest that the "intermediate" assemblage of Bed V is typologically, though not technologically, transitional (Prendergast et al. 2007; Diez-Martin et al. 2010). The only clearly discernable changes are the appearance of the geometric forms, and a reduction in artefact size. They classify the assemblage as LSA rather than transitional.

Mehlman identified two LSA industries. The Lemuta Industry was originally defined at Olduvai, and is an early LSA industry that is Pleistocene rather than Holocene in age (Mehlman 1989:368-386). Levels 4 and 5 at Nasera have a LSA industry with few MSA traits. Radial cores, including Levallois technology, were infrequent, as were bifacially and other formally retouched tools. Though the LSA types were present in earlier industries, it is not their presence, but rather their frequency, that helps characterize the assemblage. Mehlman (1989:368) suggests that people developed a technology ideal for working with small, locally available quartz cores, with a focus on the small, mass-produced stone implements that can be inset into handles and arrow shafts.

At Nasera, at 10,000 BP there is a gap in the archaeological record, followed by the Silale Industry, a typical mid-Holocene LSA industry in which microlithic backed pieces and convex side scrapers dominate (Mehlman 1989:139-389). The most common microliths were curved back pieces, geometric crescents, and straight-backed pieces. More than half the cores were bipolar, and others tended to be small platform cores. Overall it exhibits a greater degree of standardization than the Lemuta Industry. The geometric microliths are also 10 mm shorter and 4 mm narrower on average that those from the Lemuta.

Mumba also contained an LSA assemblage of an indeterminate industry due to small sample size and typological attributes (Mehlman 1989:400-404). Two additional LSA industries were recognized, both of which contain Kanysore pottery that is attributed to the Pastoral Neolithic around 5,000 BP (Mehlman 1989). The Olmoti (Mehlman 1989: 404-407) is very similar to the Silale, but displays a different relative proportion of types. Scapers dominate over backed pieces, and of the numerous scrapers, there is a decline in small convex scrapers, and increase in concave scrapers. The Oldeani Industry (Mehlman 1989:418-419), on the other hand, contained an abundance of backed microliths, including a wide range of geometric pieces.

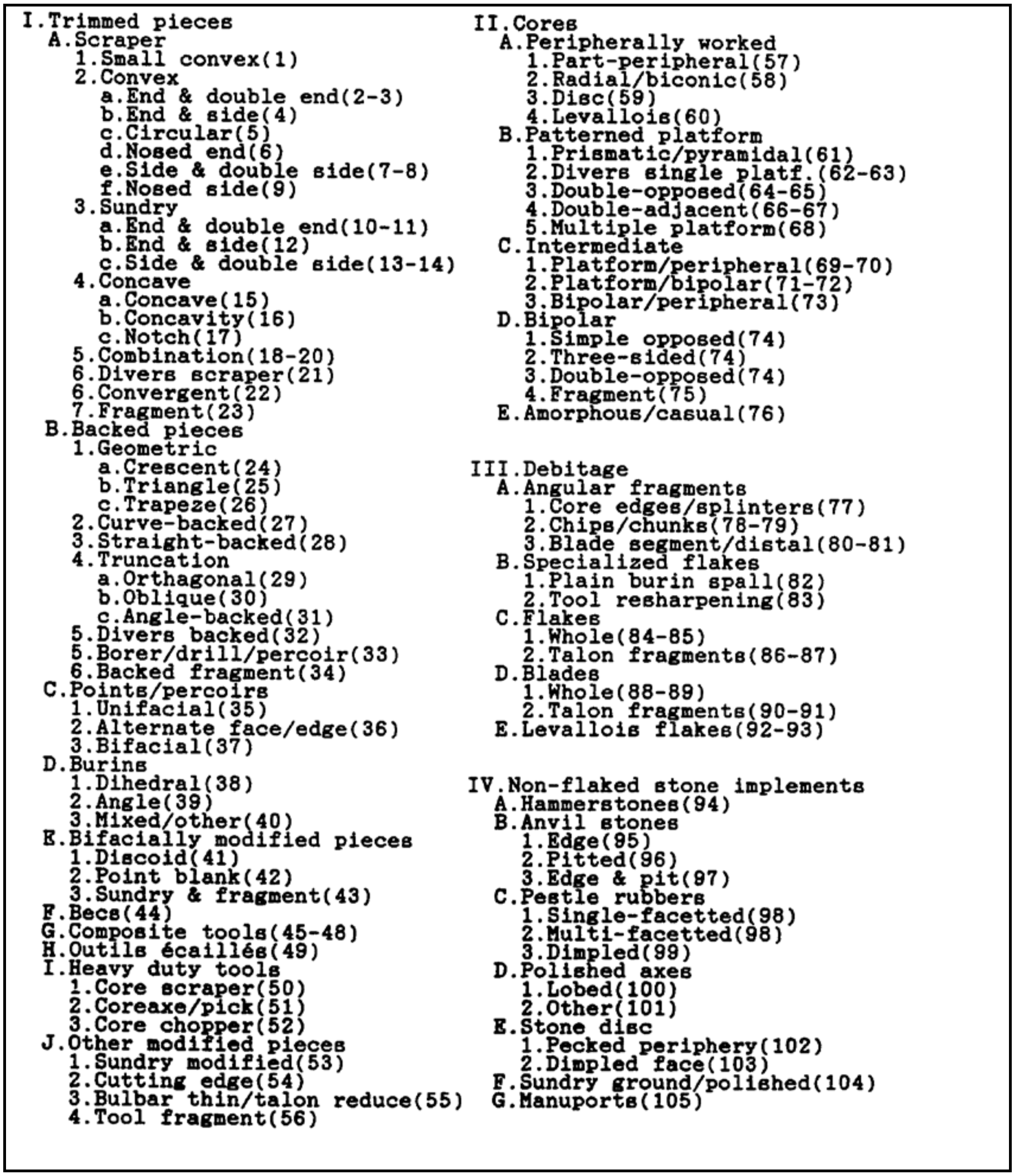
4.5.2 Enkapune Ya Muto (Kenya)

At Enkapune Ya Muto, Ambrose (1998a) recognized a flake-based MSA industry called the Endingi believed to represent a sparse occupation of the site during Oxygen Isotope Stage 3 or 4. It is characterized by flakes with faceted platforms and radial dorsal scar patterns, and dominated tool-wise by *outils écaillés* and scrapers. A large sample of carbonized sediment and decomposed charcoal was radiocarbon dated to 41,400 ± 700 BP. Earlier dates were also obtained, but believed to be contaminated in storage and so unreliable.

Overlying the Endingi is the blade-based Nasampolai Industry, dominated by very large backed blades, geometric microliths, and low frequencies of *outils écaillés*, scrapers and burins (Ambrose 1998a). It is not obviously transitional and differs from the Howiesons Poort of southern Africa in that it lacks evidence of radial core preparation. These levels are characterized by low bone and artefact density, and appear to reflect a long period of ephemeral occupation.

Typical LSA tool types are found in the overlying Sakutiek Industry, including thumbnail scrapers, *outils écaillés*, and low frequencies of backed microliths. Thin, part-bifacially flakes, small knives, flattened discoids, discoidal cores, and facetted platforms on flakes are also present in low frequencies, and Ambrose (1998a) identifies these traits as typical of MSA and intermediate industries. Radiocarbon dating of a charcoal sample suggests a date of 35,800±55BP for these levels, which are abundant with ostrich eggshell beads. One eggshell was also radiocarbon dated, and the results for the exterior of the shell were 37,000 ±100 and for the interior, considered more reliable as it was less contaminated, 39,900±1600 BP. This places the deposit within the MSA-LSA transitional period.

Table 4.1 Mehlman's typology (adapted from Mehlman 1989).



- I.Trimmed pieces
  - A.Scraper
    - 1.Small convex(1)
    - 2.Convex
      - a.End & double end(2-3)
      - b.End & side(4)
      - c.Circular(5)
      - d.Nosed end(6)
      - e.Side & double side(7-8)
      - f.Nosed side(9)
    - 3.Sundry
      - a.End & double end(10-11)
      - b.End & side(12)
      - c.Side & double side(13-14)
    - 4.Concave
      - a.Concave(15)
      - b.Concavity(16)
      - c.Notch(17)
    - 5.Combination(18-20)
    - 6.Divers scraper(21)
    - 6.Convergent(22)
    - 7.Fragment(23)
  - B.Backed pieces
    - 1.Geometric
      - a.Crescent(24)
      - b.Triangle(25)
      - c.Trapeze(26)
    - 2.Curve-backed(27)
    - 3.Straight-backed(28)
    - 4.Truncation
      - a.Orthagonal(29)
      - b.Oblique(30)
      - c.Angle-backed(31)
    - 5.Divers backed(32)
    - 5.Borer/drill/percoir(33)
    - 6.Backed fragment(34)
  - C.Points/percoirs
    - 1.Unifacial(35)
    - 2.Alternate face/edge(36)
    - 3.Bifacial(37)
  - D.Burins
    - 1.Dihedral(38)
    - 2.Angle(39)
    - 3.Mixed/other(40)
  - E.Bifacially modified pieces
    - 1.Discoid(41)
    - 2.Point blank(42)
    - 3.Sundry & fragment(43)
  - F.Becs(44)
  - G.Composite tools(45-48)
  - H.Outils écaillés(49)
  - I.Heavy duty tools
    - 1.Core scraper(50)
    - 2.Coreaxe/pick(51)
    - 3.Core chopper(52)
  - J.Other modified pieces
    - 1.Sundry modified(53)
    - 2.Cutting edge(54)
    - 3.Bulbar thin/talon reduce(55)
    - 4.Tool fragment(56)
- II.Cores
  - A.Peripherally worked
    - 1.Part-peripheral(57)
    - 2.Radial/biconic(58)
    - 3.Disc(59)
    - 4.Levallois(60)
  - B.Patterned platform
    - 1.Prismatic/pyramidal(61)
    - 2.Divers single platf.(62-63)
    - 3.Double-opposed(64-65)
    - 4.Double-adjacent(66-67)
    - 5.Multiple platform(68)
  - C.Intermediate
    - 1.Platform/peripheral(69-70)
    - 2.Platform/bipolar(71-72)
    - 3.Bipolar/peripheral(73)
  - D.Bipolar
    - 1.Simple opposed(74)
    - 2.Three-sided(74)
    - 3.Double-opposed(74)
    - 4.Fragment(75)
  - E.Amorphous/casual(76)
- III.Debitage
  - A.Angular fragments
    - 1.Core edges/splinters(77)
    - 2.Chips/chunks(78-79)
    - 3.Blade segment/distal(80-81)
  - B.Specialized flakes
    - 1.Plain burin spall(82)
    - 2.Tool resharpening(83)
  - C.Flakes
    - 1.Whole(84-85)
    - 2.Talon fragments(86-87)
  - D.Blades
    - 1.Whole(88-89)
    - 2.Talon fragments(90-91)
  - E.Levallois flakes(92-93)
- IV.Non-flaked stone implements
  - A.Hammerstones(94)
  - B.Anvil stones
    - 1.Edge(95)
    - 2.Pitted(96)
    - 3.Edge & pit(97)
  - C.Pestle rubbers
    - 1.Single-facetted(98)
    - 2.Multi-facetted(98)
    - 3.Dimpled(99)
  - D.Polished axes
    - 1.Lobed(100)
    - 2.Other(101)
  - E.Stone disc
    - 1.Pecked periphery(102)
    - 2.Dimpled face(103)
  - F.Sundry ground/polished(104)
  - G.Manuports(105)

Table 4.2 Technological variables.

All Artefacts	Thickness (mm) Breadth (mm) Length (mm) Weight (mm) Abrasion (presence, absence)
Whole and utilized/trimmed flakes	Toth Types (I-VII) Dorsal Scar Pattern (radial; same pattern, simple; same pattern, parallel; opposed; or transverse) Planform (circular; parallel; convergent; divergent; or intermediate) Number of Platform Facets (n) Number of Dorsal Scars (n) Platform Angle (degrees)
Cores	Cortex coverage (percent) Flake scars (n)
Trimmed pieces	Retouch Angle (degrees) Retouch intensity (marginal;, semi-invasive; or invasive)

Figure 4.1 Toth types (adapted from Toth, 1982). Dotted areas indicate cortex.

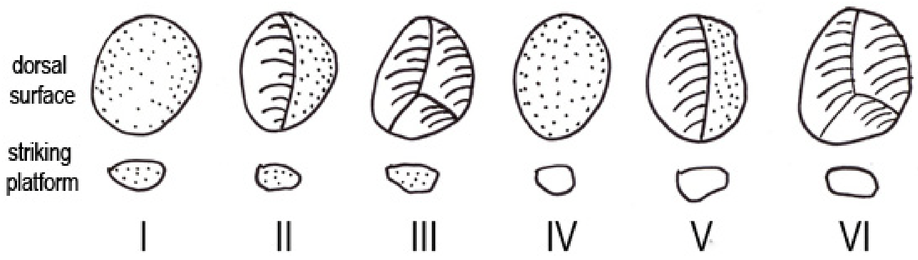


Figure 4.2 Planforms (adapted from Miller 1993; based on McBrearty 1986).

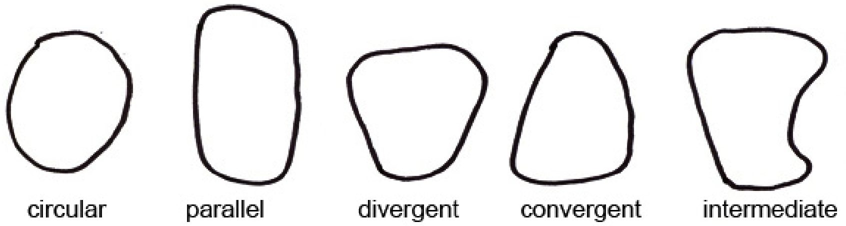


Figure 4.3 Dorsal scar patterns.

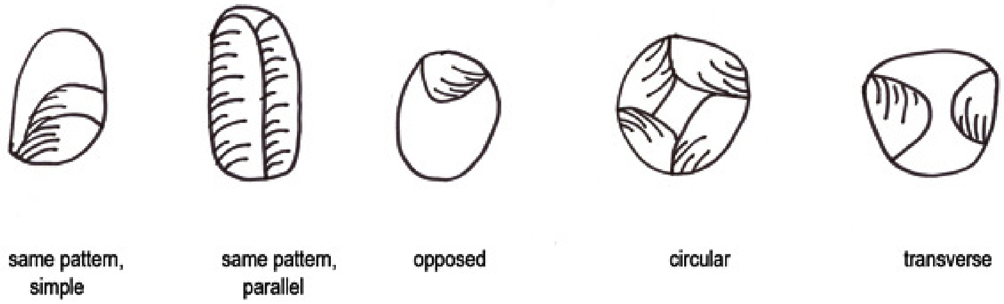
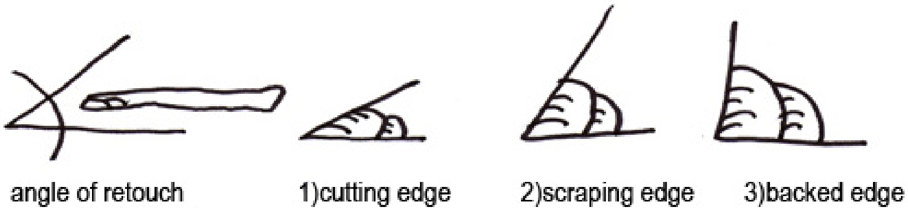


Figure 4.4 Retouch intensity.

Figure 4.5 Angles of retouch.



Chapter 5: Typological Analysis

This chapter presents the typological data for the lithics from test pits 1 and 3 at Magubike. As discussed in previous chapters, the use of Mehlman's typology facilitates comparison with the materials from Mumba and Nasera rockshelter in northern Tanzania, for which Mehlman developed the typology, as well as LSA and MSA material also from southern Tanzania studied by Dr. Willoughby and her former students (Garcin 2006; Sipe 2000; Miller 1993). Mehlman's typology also allows for meaningful comparisons not only between assemblages of the same age, but also those of different chronological periods. Some types allow for a chronological designation because they are diagnostic of a certain technology widespread in a given time period, but the typology also relies on the frequency of different types of tools to differentiate between time periods.

The test pits are examined level by level to note any temporal change, and are compared to each other overall, as well as to the data from Mehlman's (1989) sites in northern Tanzania and Willoughby's previous study area in south western Tanzania (Garcin 2006; Sipe 2000; Miller 1993). Due to the difference in raw material distribution, the test pits are treated as different samples rather than grouped together as one representation of Magubike in order to determine if there are additional typological or technological differences.. The distribution of raw materials is also discussed in this chapter in order to determine any correlations between raw materials and the recognized types.

5.1 Raw Material

A variety of raw materials was utilized for stone tool production at Magubike, including quartz, crypto-crystalline silica, quartzite, metamorphic, and rock crystal. Quartz is the most dominant material in both test pits. However, the distribution of raw material types overall is quite different between the test pits (Table 5.1). Chert/flint and rock crystal are more common in TP1, whereas metamorphic is more common in TP3. Furthermore, in TP1, quartz is more than twice as frequent as the second most common raw material, chert/flint, whereas in TP3, the second most frequent material, metamorphic, very nearly outnumbers quartz. In TP1, quartz accounts for 49.7% (n=3265) of all lithic artefacts, followed by chert/flint at 18.6% (n=1221), volcanic at 12% (n=789), quartzite at 8.3% (n=548), and rock crystal at 11.4% (n=751). Quartz is also the dominant material in TP1 at 39.2% (n=4475) but is very closely followed by metamorphic at 37.7% (n=4306). Chert/flint accounts for 13.6% (n=1552), followed by quartzite at 7.3% (n=829), and rock crystal at 2.2% (n=254). Both test pits also contain a solitary artefact each that belongs to the 'other sedimentary' category.

To examine the distribution of raw materials over depth, a chi-square test was preformed (Appendix II). Because this test is sensitive to empty cells, the ‘other sedimentary’ category was omitted due to its low contribution to the overall distribution, and some 10 cm levels were combined to create 20cm units due to the overall low number of artefacts in those levels. In TP 1, the chi-square value is 1115.612 (df=48, p <.000), and in TP 3, it is 2941.650 (df=68, p <.000), and this indicates there is a statistically significant association between depth and raw material. According to Cramer’s V, this association is slightly stronger in TP3, which has a value of .508 compared to .412 in TP1.

When the distribution of raw materials is examined level by level, a general trend can be observed in both test pits (Figure 5.1). While all raw materials are present throughout both test pits, the use of quartz decreases with depth. In TP1, there are differences in raw material distribution between the levels prior to the break in artefact density at 70-110 cm, and those that follow it. From 0-70 cm, the use of quartz is greater than that of all the other types combined. However, during and especially after the break 70-110cm, metamorphic and chert/flint are utilized at a higher frequency. Before the break, there are also some signs of temporal change. Between 40-70 cm, the use of quartzite is greater than in previous levels, whereas chert/flint is less frequent; in these levels, the number of artefacts per level is also greatly increased compared to previous and subsequent levels.

A similar pattern is especially evident after 70 cm in TP3. From 0 to 70 cm, the use of quartz is greater than all other materials combined. After that point, the use of other materials greatly increases, especially of metamorphic materials, with the exception of 100-110 cm in which it is curiously not present, whereas quartzite occurs in a much higher frequency than other levels. From 110 cm to bedrock with the exception of 180-190 cm, metamorphic is the dominant material in each level. The use of rock crystal, however, declines with depth, being greatest in the top few levels and gradually decreasing. This contrasts with TP1, in which the use of rock crystal does not decline with depth.

These data were compared to that from Mehlman’s sites in northern Tanzania, as well as sites in the Songwe River region (Table 5.2). At Mehlman’s sites, artefacts were classified as quartz, quartzite, chert/flint, or other. As at Magubike, quartz dominates. Also bearing a similarity to the pattern observed at Magubike is the tendency of quartz to be utilized to a greater extent in the later periods of LSA (which may be present in TP1), Pastoral Neolithic (which is not present at Magubike), and Iron Age (present at Magubike) as compared with the MSA. Chert/flint is the second most common material, except within the MSA/LSA “intermediate” assemblages in which it is only slightly less common than quartzite. However, quartz is more frequent in all of Mehlman’s assemblages than what is seen at Magubike. At IdIu22 in Mbeya, quartz is the prevalent raw material in the LSA, followed by quartzite, chert/flint, and then volcanic rocks. Quartz is also the dominant material at MSA surface sites in south western Tanzania, but less so than at IdIu22, and with chert/flint as the second most common material. Volcanic materials are also more common than at IdIu22. But again, the pattern of quartz being more greatly utilized in later periods, specifically the LSA and Iron Age, compared to earlier during the MSA is apparent here.

Although quartz is locally available (<1km) within the vicinity of Magubike, recent surveys in the Iringa and nearby Mbeya regions did not lead to the discovery of possible raw material sources for other types of raw materials, such as the chert/flint and metamorphic. This suggested the possibility that the earlier, MSA inhabitants were utilizing raw material sources from a long distance either via trade or exchange networks, or as a result of their own mobility, in contrast with the later inhabitants who relied more heavily on the locally available quartz. However, microscopic analysis by PhD student Katie Biittner (personal communication, 2010) and a review of geological maps from the area indicate there are likely nearby sources (>10km) of Magubike. Thus, it raises questions about the obvious shift in raw material usage at the site. The transition to utilizing lower quality quartz located within such close proximity of the site may indicate smaller territories and reduced mobility during subsequent periods.

5.2 General Categories

The general categories are trimmed pieces, cores, debitage, and non-flaked stone implements (Table 5.3). Non-flaked stone implements have been omitted from most of the discussion, as they account for less than 0.1% of all recovered stone artefacts. The distribution of general categories is similar for both test pits, with most lithic artefacts classified as debitage. However, although both test pits have about the same percentage of cores compared to other categories, TP3 contains twice the relative frequency of trimmed pieces as TP1, and less debitage.

The overall distribution of the general categories of lithic artefacts in TP1 is as follows: debitage, 45.3% (n=2891); trimmed pieces, 43.1% (n=2837); cores, 11.4% (n=752); and ground stone, 0.1% (n=5). As already mentioned, in TP3, debitage accounts for a far greater percentage of artefacts at 66.5% (n=7592); trimmed pieces account for 22.1% (n=2524); cores, 11.4% (n=1297); and there were four ground stone pieces recovered.

For the chi square test of the relationship between depth and general category distribution (Appendix II), the category of ground stone was omitted since it contributed very little to the overall distribution, and in TP1, two 10 cm levels were combined because of low artefact count. In TP1, the chi square value is 355.196 (df=32, *p* <.000), and in TP3, it is 887.616 (df=40, *p* <.000). These results prompt a closer inspection of the relationship between the distribution of trimmed pieces, cores, and debitage with depth as these variables have a statistically significant association, although this is not a strong association according to Cramer's V (.165 and .197 in TP1 and TP3, respectively).

In both test pits, the percentage of debitage relative to the other categories increases with depth, whereas the percentage of trimmed pieces decreases (Figure 5.2). In TP1, trimmed pieces outnumber debitage until 100 cm, at which point, debitage accounts for a larger portion of the artefacts and continues to do so until the bedrock at 180 cm. There was some fluctuation in the distribution of cores, but they always account for less than either the trimmed pieces or debitage. In TP3, the percentage of debitage again increases with depth. However, unlike in TP1, even in the upper levels it outnumbers trimmed pieces in frequency in many cases. This is not surprising, considering that, as can be observed in the overall distribution frequencies, debitage accounts for more of the total assemblage in TP3 than TP1. Debitage accounts for less than half of each level until 110 cm, but after 130 cm, it accounts for more than 70%. Cores account for more of the assemblage in the upper levels, then become less frequent overall, yet are about even with trimmed pieces starting at 160 cm and outnumber them in the last two levels, 190-210 cm.

The pattern observed at Magubike, in which the percentage of debitage increases over time, is reverse that observed by Mehlman; at Mehlman's sites, the amount of debitage relative to cores and trimmed pieces decreases over time (Table 5.4). This pattern is also observed when considering the LSA at IdIu22 and various MSA surface sites in the Songwe River Valley of southwest Tanzania; at IdIu22, 80.8% of the LSA assemblage is debitage, compared to only 57.8% at MSA surface sites.

A chi-square test was also calculated to help determine the nature of the relationship between the distributions of raw materials and general categories (Appendix II). In TP1, this value is 647.042 (df=8, p<.000) and in TP3, 1247.073 (df=8, p<.000), indicating a statistically significant relationship does exist between these variables. In both test pits, quartz accounts for more than half of all cores and trimmed pieces, and less than half of the debitage. This may be due to the fact that the debitage occurs in highest frequency in the lower levels, in which quartz is less frequent than it is above. However, in TP1, even though it accounts for less than half of the debitage, more of the debitage is still made on quartz than any other raw material, followed by chert/flint and then metamorphic; but in TP3, most debitage is made on metamorphic followed by quartz, perhaps because metamorphic materials almost outnumber quartz in TP3.

5.2.1 Trimmed pieces

As discussed in the preceding chapter, the trimmed pieces category includes any piece having at least one edge of secondary modification. Within this category, there are ten tool types: scrapers, backed pieces, points, burins, bifacially modified pieces, becs, composite tools, *outils écaillés*, heavy duty tools and other/sundry. The proportion of backed pieces to scrapers can indicate whether an assemblage belongs to the MSA or a later period such as the LSA. The production of backed microliths is associated with the LSA and continues in the Iron Age. Although backed pieces are sometimes part of MSA assemblages, scrapers are the dominate tool type. Furthermore, according to Mehlman, points, bifacially modified pieces, and heavy duty tools are also more common in the MSA (1989). Backed pieces and scrapers will be discussed further below, as will the distribution of other various tool types.

Backed pieces are the most dominant tool type at Magubike, followed by scrapers (Table 5.5). In TP1, backed pieces account for 78.1% (n=2216) of all trimmed pieces, followed by scrapers at 13.9% (n=395), and points and bifacially modified pieces, both at 1.8% (n=50 and 52, respectively) (Appendix III). All other tool types account for less than 0.1% each of all trimmed pieces. In TP3, backed pieces and scrapers still dominate, but there is a higher frequency of other tool types present. Backed pieces amount to 60.7% (n=1533), and scrapers, 23.4% (n=590); however, points, *outils écaillés*, and burins all outnumber bifacially modified pieces. The distribution of these types is as follows: points, 7.2% (n=182); *outils écaillés*, 3.7% (n=94); burins, 2.2% (n=56); and finally, bifacially modified pieces, 1.7% (n=42). The remaining types account for 1% or less each of all trimmed pieces in TP3.

Regarding raw materials, quartz dominates as it does overall, accounting for 58.1% of all trimmed pieces in TP1 and 57.5% in TP3. Although overall quartz is 10% more frequent in TP1 than TP3, about the same percentage of trimmed pieces in both test pits is made on quartz. From this point, the distribution of raw materials among trimmed pieces differs considerably between the test pits.

Rock crystal is the next-to-least common material in TP1, yet is the material second most commonly utilized for trimmed pieces in at 15.9% in TP1. Metamorphic materials, on the other hand, are the least utilized at 5.3%, despite being the third most used material overall. Other materials account for trimmed pieces as follows: chert/flint, 13.5%; and quartzite, 7.2%. Whereas the high frequency of trimmed pieces made on quartz can be accounted for by its prominence overall, these data suggests a strong preference for rock crystal for the production of formal tools, notably in the younger levels.

In TP3, although quartz and metamorphic are almost equal in overall frequency, almost three times as many trimmed pieces are made on quartz. However, unlike in TP1, metamorphic materials are used more than any other material besides quartz, at 19.3%. The other materials are utilized at the following frequencies: chert/flint, 12.9%; rock crystal, 5.2%; quartzite, 4.9%. For the most part, this pattern follows the distribution of raw materials overall, with the exception of rock crystal, which accounts for only 2.2% of all artefacts overall, more than 5% less than quartzite, yet also accounts for a higher frequency of trimmed pieces than quartzite. Again, rock crystal seems to be a preferred material for the production of formal tools.

5.2.1.1 Backed pieces and scrapers

As has already been mentioned, the proportion of scrapers to backed pieces is significant. Backed microlithics are considered the hallmark of LSA and later technology, whereas scrapers are much more prominent in the MSA, with geometric microliths occurring in assemblages rather sporadically. According to Mehlman (1989), backed pieces outnumber scrapers in Holocene LSA assemblages, and in earlier industries, scrapers are the dominant tool type. Indeed, Mehlman's MSA industries yielded three backed pieces, in contrast with his LSA industries in which backed pieces outnumbered scrapers. Even in the "intermediate" MSA/LSA assemblages identified by Mehlman, backed pieces account for only 3.9-8.7% of all trimmed pieces, in contrast with scrapers at 40.8-52.4%.

At Magubike, divers backed and oblique truncations account overwhelmingly for the majority of backed pieces at more than 75% (Figure 5.3). In TP1, 56.5% (n=1251) of backed pieces are divers, and 25.1% (n=557) are oblique truncations. In TP3, the distribution is very similar, with 50.4% (n=773) of all backed pieces categorized as divers, and 26.7% (n=409) as oblique truncations. In both test pits, the third most common subtype is the geometric form trapeze, accounting for 6.7% (n=148) in TP1 and 6.6% (n=101) in TP3. In

TP1, all other subtypes account for less than 3% each of the total backed pieces, and in TP3, less than 5% each. In both test pits, most backed pieces are produced on quartz (Figure 5.4).

The distribution of the most common subtypes of backed pieces, divers backed, oblique truncations, and trapezes, was examined level by level (Figure 5.5). The chi-square test was inconclusive due to the high number of empty cells with expected counts of less than five (Appendix II). However, there does not appear to be much change in the distribution of these subtypes through time. All are present throughout both test pits for the most part. In TP1, there is a drop in divers backed in levels 80-110 cm, but these levels are part of a drop in artefact density and have very few pieces overall. In TP3, oblique truncations do appear to increase in relative frequency at the lowest levels, after 160 cm.

Of scrapers, the most common subtypes are circular, convex end, and concave scrapers (Figure 5.6). Circular subtypes are most frequent in both test pits, account for 27.8% (n=110) of all scrapers in TP1 and 22.5% (n=133) of those in TP3. Convex end scrapers are the second most frequent in TP1 at 15.4% (n=61) followed by concave scrapers, 14.2% (n=56). This relationship is reversed in TP3, with concave scrapers being slightly more frequent than convex end scrapers, at 16.8% (n=99) and 14.9% (n=88), respectively. As with backed pieces, most scrapers are made on quartz, but a higher number of them are made on other materials when compared to backed pieces (Figure 5.4).

The distribution of the most common scraper types of circular, convex end, and concave were examined level by level (Figure 5.7). A chi-square test was preformed but inconclusive due to the high number of cells with expected count less than 5 (Appendix II). However, it appears circular scrapers decrease in relative frequency with depth whereas concave increase in both test pits. This is especially apparent in TP1, in which no concave scrapers were recovered until 40-50cm. In TP1, concave scrapers were found at 10-30 cm, but not 0-10 cm or 30-60cm. They are found at their highest percentage at 110 cm, with a bit of a drop in a couple of levels but remain more or less steady until bedrock. The third most common scraper type, convex end, is present in levels throughout both test pits in varying amounts, with no discernable pattern with depth.

A chi-square test was also performed to determine if there is an association between the distribution of scrapers and backed pieces with depth (Appendix II). The chi square value for TP1 is 85.084 (17df, p<.000) and TP3 has a chi square of 149.432 (df=20, p<.000), with only two cells exhibiting less than the expected count. Thus, the null hypothesis can be rejected as a statistically significant association exists between the distribution of scrapers and backed pieces with depth in both test pits. However, Cramer's V indicates this association is not very strong, with a value of .234 in TP1 and .274 in TP3.

In TP3, it appears backed pieces decrease very slightly in proportion to scrapers with depth, particularly near the bottom of the test pit (Figure 5.8). There is a decrease in average percentage accounted for by backed pieces, and between 170-180 cm, scrapers outnumber backed pieces for the first time; the two types are equal in number in the last 20 cm, 190-210 (though only one of each is found in the level 200-210 cm). In TP1, however, the proportion of backed pieces remains relatively steady and strong compared to the scrapers, although it also features a slight decrease in the number of backed pieces compared to scrapers with depth. The only exception occurs in the break in artefact density 70-110 cm. No backed pieces were recovered from 80-90 cm, but not many pieces were recovered overall; likewise, scrapers outnumber backed pieces 100-110 cm, but only four and three were recovered, respectively.

The high number of backed pieces throughout both test pits presents an interesting question given other possible indicators of cultural change that suggest these oldest layers belong to the MSA, that is, the presence of Levallois technology, which will be discussed below, and the change in raw material distributions. A possibility is that water peculating through the deposit has resulted in the downward movement of these artefacts. Other evidence of water activity, such as concretions that have developed on artefacts in these levels, also indicates the presence of water moving through the deposit. Furthermore, the high amount of gravel and possibly disintegrating bedrock may have contributed to the reworking of artefacts within the deposit. As the bedrock breaks up, the overlying deposits may shift and, consequently, mix. Bioturbation noted in the upper levels during excavation may have also contributed to mixing of deposits. This will be discussed in greater depth in the following chapters.

5.2.1.2 Other tool types

Tool types other than backed pieces and scrapers only constitute a small percentage of the trimmed pieces overall. However, some of these types are still significant as diagnostic markers. Points, bifacially modified pieces, and heavy duty tools are more common in the MSA than later periods, according to Mehlman (1989), and these have a clear distribution in the lower levels of Magubike (Figure 5.9). As such, these tool types will be discussed here, although heavy duty tools, a common component in certain MSA industries, were incredibly rare at Magubike.

Points include unifacial, alternate face/edge, bifacial and Levallois points. (while not formally retouched tools, these points have been included in the point category in order to group all points together) (Figure 5.10). In TP1, some points were recovered from 0-10 cm, and then not found again until 110 cm, at which point they occur in every level until 160 cm. In TP3, such a pattern is less clear; points are found in almost every level. However, Levallois points have a very clear distribution limited to the lower levels of the site; in TP1, the 25 Levallois points recovered, comprising 50% of the points overall, were found between 130-170cm. And in TP3, in which Levallois points account for 69.2% (n-126) of all those recovered, they were found between 30-40 cm and then 50-200 cm.

Bifacially modified pieces included discoids, point blanks, and bifacially modified pieces (which share their name with the tool type). These are distributed throughout both test pits, coming from almost every level in both test pits. Thus there is no discernable distribution pattern.

Only two heavy duty tools were recovered, both from the last recognized natural stratigraphic unit overlying the bedrock: a core/large scraper from 100-120 cm and a biface/pick from 160-160 cm, both in TP3.

5.2.2 Cores

The five core types are peripheral, patterned platform, intermediate, bipolar, and amorphous. As mentioned previously, cores are recognized by their chunkiness and flake negatives of sufficient size to have yielded blanks from which tools could have been made. Because of different methods of lithic reduction that are associated with different time periods and technological systems, some core types, like some tool types, are most common in a certain time period. Peripheral cores are most associated with the MSA as they are products of the radial flaking methods utilized widely in that time, but bipolar and platform cores are also found in MSA assemblages. However, platform cores are generally indicative of LSA technology. These cores are usually associated with the classic blade and bladelet technology of the LSA. Bipolar technology is not as diagnostic chronologically, often instead reflecting raw material constraints.

At Magubike, bipolar cores dominate throughout each test pit (Table 5.6). Roughly half of these have been categorized specifically as core fragments on the sub-type level, so they are probably slightly over represented, but even with this considered, it is apparent bipolar technology was heavily utilized at Magubike throughout all time periods. In TP1, 84.3% (n=634) of cores are bipolar. In TP3, this number is 92.1% (n=1193).

Following bipolar cores in frequency are peripheral cores, accounting for 10.9% (n=82) of all those in TP1 and 5% (n=65) in TP3 (Appendix III). More than half of these are part-peripheral cores, 58.5% (n=48) in TP1 and 52.3% (n=34) in TP3. Radial/biconic cores are the second most frequent subtype of peripheral cores present in either test pit, 17.1% (n=14) in TP1 and 26.2% (n=17) in TP3, followed by Levallois cores, 13.4% (n=11) in TP1 and 16.9% (n=11) in TP3. Disc cores are also present, 11% (n=9) in TP1 and 4.6% (n=3) in TP3.

Patterned platform cores are the third most common core type in each test pit, 3.3% (n= 25) of those in TP1 and 2.9% (n=37) in TP3. Additionally, two "intermediate" cores (.3%) and nine amorphous cores (1.2%) were recovered from TP1. The intermediate cores all show indications of being utilized peripherally as well as by the bipolar technique.

Chi square tests were performed to look at the relationship between depth and distribution of core types (Appendix II). Amorphous and intermediate cores were omitted due to their low contribution to the overall distribution, but due to the high number of cells exhibiting less than expected counts, the results are still inconclusive. When examining the distribution of core types level-by level, it is readily apparent that in TP1, bipolar cores are present throughout (Figure 5.11). However, the amorphous cores are found between 60 cm and bedrock. Peripheral cores are not found between 10-50 cm, account for less than 10% of all cores between 50-70 cm, but account for more than 20% of the cores 70 cm-130 cm with the exception of 90-100 cm from which only five bipolar cores were recovered. At that point, they drop in relative frequency but still account for more than 10% of the cores until 170 cm. There is no discernable pattern in distribution of core types in TP3. However, Levallois cores, a subtype of peripheral, are not present until 60 cm in TP3 and 110 cm in TP1. The other types of peripheral cores are present throughout, but the distribution of this sub-type is noteworthy since Levallois technology is characteristic of the MSA.

In contrast to the pattern observed at Magubike, Mehlman's data shows a clear shift in methods of lithic reduction through time (Table 5.7). Peripheral cores clearly dominate in the MSA, followed by amorphous cores, platform cores, and finally, bipolar cores. An interesting observation is that amorphous cores are most common in Mehlman's MSA assemblages, and at Magubike, these cores, though few in number, are not found until 60 cm. In the LSA, bipolar cores dominate followed by platform and amorphous cores, with very few peripheral cores present. A similar pattern is seen in the Songwe River Valley; the LSA at IdIu22 is dominated by platform, followed by bipolar, cores, whereas MSA surface sites suggest a preference for peripheral flaking during that time period.

A chi square test was also calculated to look at the relationship between core type and raw material (Appendix II), but the results are inconclusive for this test as well due to the high number of cells with expected counts less than five. In TP1, as with trimmed pieces, metamorphic materials account for the lowest number of cores, at only 5.9%, despite being more common than both rock crystal and quartz (Table 5.8). Quartz accounts for 63.8%; chert/flint, 13.3%; quartzite, 10.9%; and rock crystal, 6.4%. Although rock crystal is the second most frequent material for tools, it is second to least frequent for cores.

In TP3, the raw material distribution of cores reflects that observed overall, but with some differences in frequency. Most notably, as with trimmed pieces, although metamorphic and quartz are similar in frequency, when it comes to cores there are almost three times as many produced on quartz compared to metamorphic, 61.8% and 20.8%, respectively. The other raw materials are represented at frequencies close to their representation overall: chert/flint, 9.42%; quartzite, 6.1%; and rock crystal, 1.9%.

5.2.3 Debitage

As reviewed in the previous chapter, debitage consists of the following tool types: flakes, blades, angular fragments, Levallois flakes, and specialized flakes (Table 5.9). Most lithic artefacts belong in this category, as it includes any product of the tool-making process other than cores and trimmed pieces.

Levallois flakes are of particular interest, because they are a product of a specific method of lithic reduction that is widespread during the MSA. Levallois flakes were recovered from every 10 cm level between 60-200 cm in TP3, and between 100-170 cm in TP1 (Appendix III). A total of 35 were recovered from TP1, ranging in frequency per level from 1 to 14, and 121 were recovered from TP3, ranging from 1 to 20 per level. The distribution of raw materials among Levallois products- cores, points, and flakes- does not completely resemble that overall. In TP1, half of the pieces were made on metamorphic materials, 50.6% (n=130), followed by quartz at 21.8% (n=56). They were also made on chert./flint, at 19.5% (n=50); quartzite, 6.6% (=17); and rock crystal, 1.6% (n=4). In TP3, metamorphic was also the dominant material for Levallois products, but accounted for a lower percentage of the assemblage at 33.3% (n=23), and was followed not by quartz, but by chert/flint at 29.4% (n=20). Quartz accounted for

23.5% (n=16) of the Levallois pieces; rock crystal, 8.8% (n=6); and quartzite, 4.4% (n=3). The shift in raw material usage combined with the very clear distribution of Levallois products indicates directional change at the site of Magubike. In the particular, the presence of Levallois products indicates the lower levels of the site contain MSA materials.

Table 5.1 Overall distribution of raw materials.

		RAW MATERIAL TYPES						
TEST PIT		quartz	quartzite	chert/ flint	meta-morphic	other sedimentary	rock crystal	**Total**
1	N	3265	548	1221	789	1	751	6575
	%	49.7	8.3	18.6	12.0	.0	11.4	100.0
3	N	4475	829	1552	4306	1	254	11417
	%	39.2	7.3	13.6	37.7	.0	2.2	100.0
Total	N	7740	1377	2773	5095	2	1005	17992
	%	43.0	7.7	15.4	28.3	.0	5.6%	100.0

Table 5.2 Comparison with raw material distribution of other sites (%).

	Quartz	**Quarzite**	**Chert/flint**	**Volcanic**	**Rock Crystal**	**Other**	**Meta-morphic**
Magubike TP1	49.7	8.3	18.6	-	11.4	-	12
Magubike TP3	39.2	7.3	13.6	-	2.2	-	32.7
Mehlman-MSA	79.8	5.6	9.3	-	-	5.3	-
Mehlman-MSA/LSA	89.9	4.3	4.1	-	-	1.7	-
Mehlman-LSA	94.1	4.8	4.8	-	-	.7	-
Garcin, Sipe- LSA	60.8	24.4	13.3	1.5	-	.08	-
Miller-MSA	46.2	15.4	25.3	8.5	-	4.4	-

Table 5.3 Overall distribution of general categories.

		GENERAL CATEGORIES				
TEST PIT		trimmed pieces	cores	debitage	ground stone	Total
1	N	2837	752	2981	5	6575
	%	43.1	11.4	45.3	.1	100.0
3	N	2524	1295	7594	4	11417
	%	22.1	11.3	66.5	.0	100.0
Total	N	5361	2047	10575	9	17992
	%	29.8	11.4	58.89	.1	100.0

Table 5.4 Comparison with distribution of general categories at other sites.

	Trimmed Pieces	Cores	Debitage
Magubike TP1	34.1	11.4	45.3
Magubike TP3	22.1	11.3	66.5
Mehlman- MSA	9.8	14.9	75.3
Mehlman- MSA/LSA	4	12.7	83.3
Mehlman- LSA	2.2	3.6	94.2
Garcin- LSA	15.6	3.6	80.8
Miller- MSA	22.5	16.7	57.8

Table 5.5 Overall distribution of trimmed pieces.

			TEST PIT		
			1	**3**	**Total**
TOOL TYPE	scraper	N	395	590	985
		%	13.9	23.4	18.4
	backed pieces	N	2216	1533	3749
		%	78.1	60.7	69.9
	points	N	50	182	232
		%	1.8	7.2	4.3
	burins	N	26	56	82
		%	.9	2.2	1.5
	bifacially modified pieces	N	52	42	94
		%	1.8	1.7	1.8
	becs	N	13	24	37
		%	.5	1.0	.7
	composite tools	N	1	0	1
		%	.0	.0	.0
	outils ecailles	N	84	94	178
		%	3.0	3.7	3.3
	heavy duty tools	N	0	2	2
		%	.0	.1	.0
	other tools	N	0	1	1
		%	.0	.0	.0
Total		N	2837	2524	5361
		%	100.0	100.0	100.0

Table 5.6 Overall distribution of cores.

			TEST PIT		
			1	**3**	**Total**
TOOL TYPE	peripheral	N	82	65	147
		%	10.9	5.0	7.2
	pattered platform	N	25	37	62
		%	3.3	2.9	3.0
	intermediate	N	2	0	2
		%	.3	.0	.1
	bipolar	N	634	1193	1827
		%	84.3	92.1	89.3
	amorphous	N	9	0	9
		%	1.2	.0	.4
Total		N	752	1295	2047
		%	100.0	100.0	100.0

Table 5.7 Comparison of distribution of cores at other sites.

	Peripheral	Patterned Platform	Intermediate	Bipolar	Amorphous
Magubike TP1	10.9	3.3	.3	84.3	1.2
Magubike TP3	5	2.9	-	92.1	-
Mehlman- MSA	63.9	7.8	-	4.3	24
Mehlman- MSA/LSA	28.9	18.6	-	47.8	15.9
Mehlman- LSA	4.6	32.9	-	48.7	13.9
Garcin- LSA	11.8	56.2	.8	38.9	2.4
Miller- MSA	61.5	24.5	1.8	4.0	2.4

Table 5.8 Distribution of cores by raw material.

TEST PIT				RAW MATERIAL					Total
				quartz	quartzite	chert/flint	meta-morphic	rock crystal	
1	**TOOL TYPE**	peripheral	N	41	8	17	13	3	82
			%	50.0	9.8	20.7	15.9	3.7	100.0
		patterned platform	N	7	4	9	4	1	25
			%	28.0	16.0	36.0	16.0	4.0	100.0
		intermediate	N	1	1	0	0	0	2
			%	50.0	50.0	.0	.0	.0	100.0
		bipolar	N	431	65	71	23	44	634
			%	68.0	10.3	11.2	3.6	6.9	100.0
		amorphous	N	0	4	1	4	0	9
			%	.0	44.4	11.1	44.4	.0	100.0
	Total		N	480	82	98	44	48	752
			%	63.8	10.9	13.0	5.9	6.4	100.0
3	**TOOL TYPE**	peripheral	N	31	10	6	17	1	65
			%	47.7	15.4	9.2	26.2	1.5	100.0
		patterned platform	N	15	5	7	9	1	37
			%	40.5	13.5	18.9	24.3	2.7	100.0
		bipolar	N	754	64	109	243	23	1193
			%	63.2	5.4	9.1	20.4	1.9	100.0
	Total		N	800	79	122	269	25	1295

Table 5. 9 Overall distribution of debitage.

			TEST PIT		
			1	**3**	**Total**
SUB TYPE	core fragment	N	799	1556	2355
		%	33.9	66.1	100.0
	angular fragment	N	684	2019	2703
		%	25.3	74.7	100.0
	blade segment-medial or distal	N	73	131	204
		%	35.8	64.2	100.0
	plain burin spall	N	46	58	104
		%	44.2	55.8	100.0
	whole flake	N	551	1509	2060
		%	26.7	73.3	100.0
	trimmed/utilized flake	N	344	523	867
		%	39.7	60.3	100.0
	flake talon fragment	N	364	1388	1752
		%	20.8	79.2	100.0
	whole blade	N	27	86	113
		%	23.9	76.1	100.0
	blade talon fragment	N	58	203	261
		%	22.2	77.8	100.0
	Levallois flake	N	32	120	152
		%	21.1	78.9	100.0
	trimmed/utilized Levallois flake	N	3	1	4
		%	75.0	25.0	100.0
Total		N	2981	7594	10575
		%	28.2	71.8	100.0

Figure 5.1 Distribution of raw material by level.

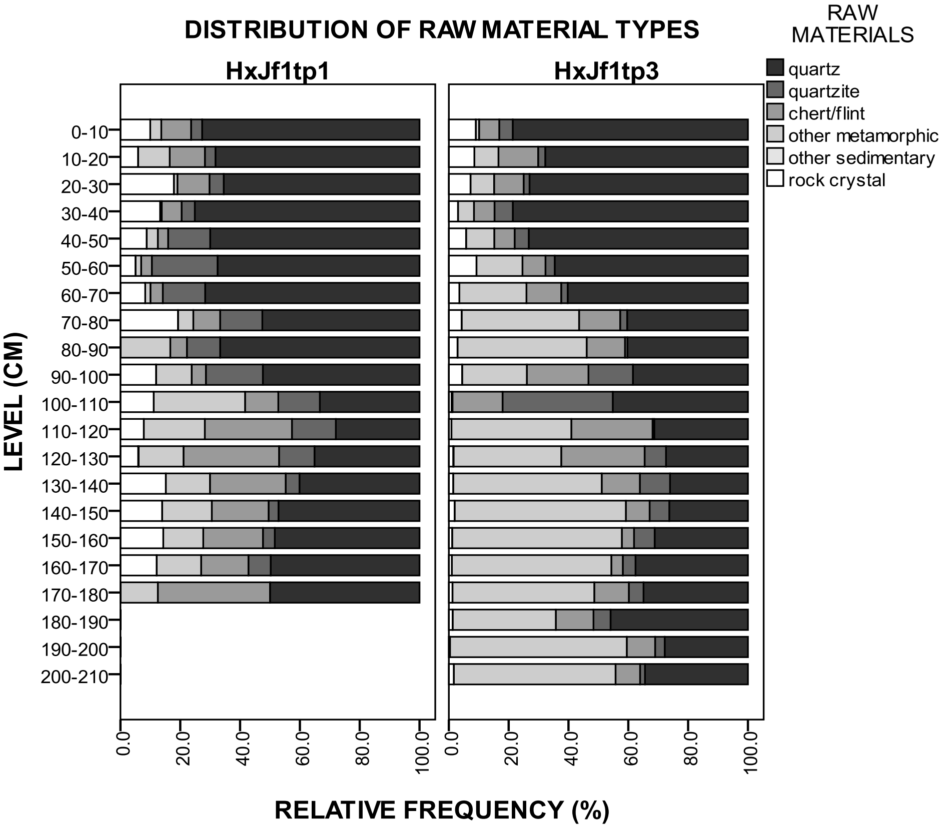


Figure 5.2 Distribution of general categories by level.

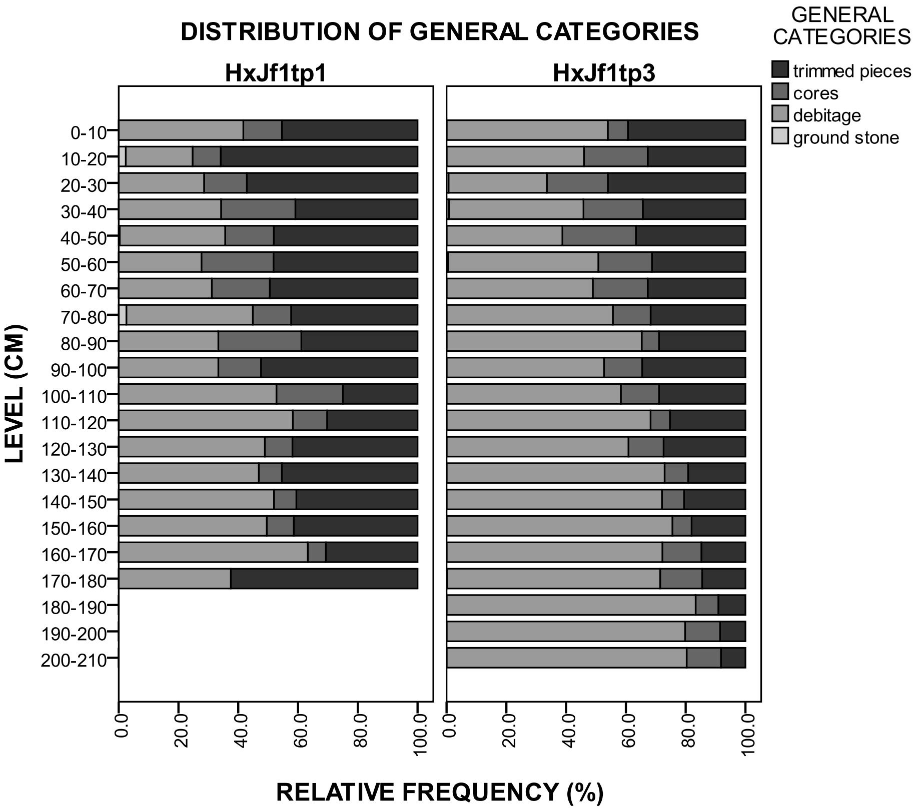


Figure 5.3 Overall distribution of backed piece subtypes.

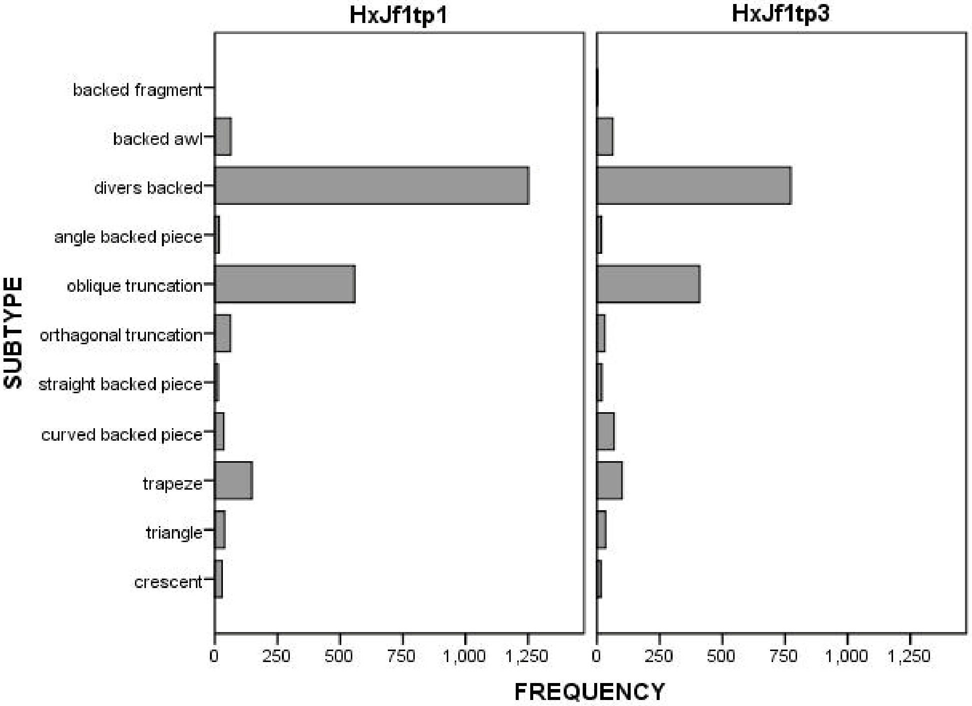


Figure 5.4 Distribution of raw materials among backed pieces and scrapers.

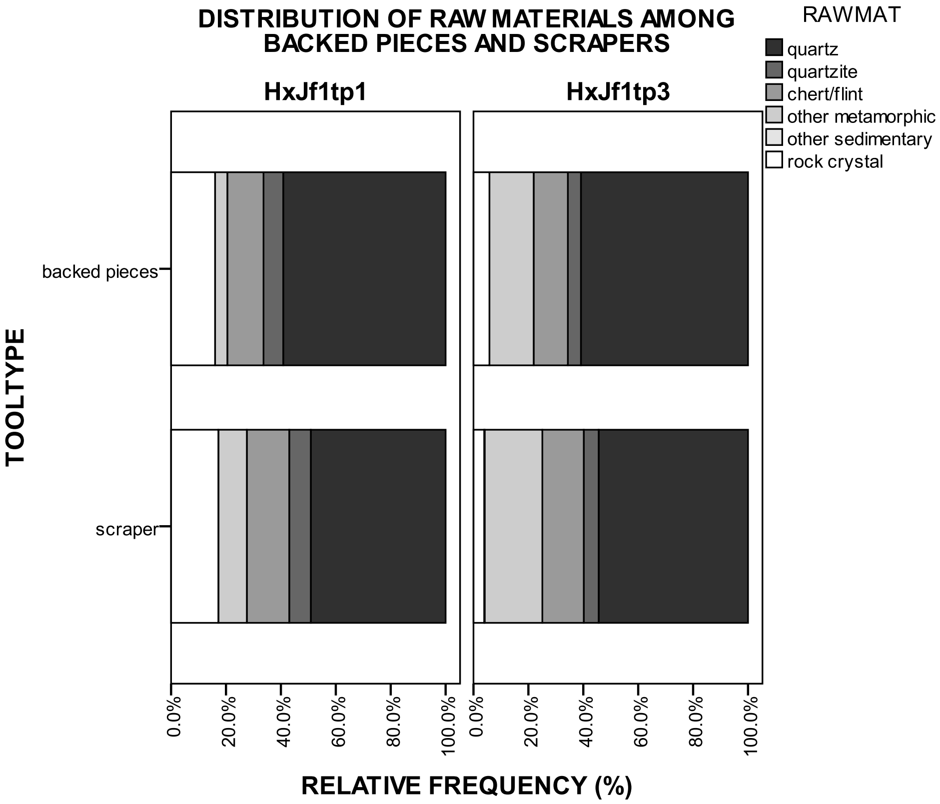


Figure 5.5 Distribution of backed piece subtypes by level.

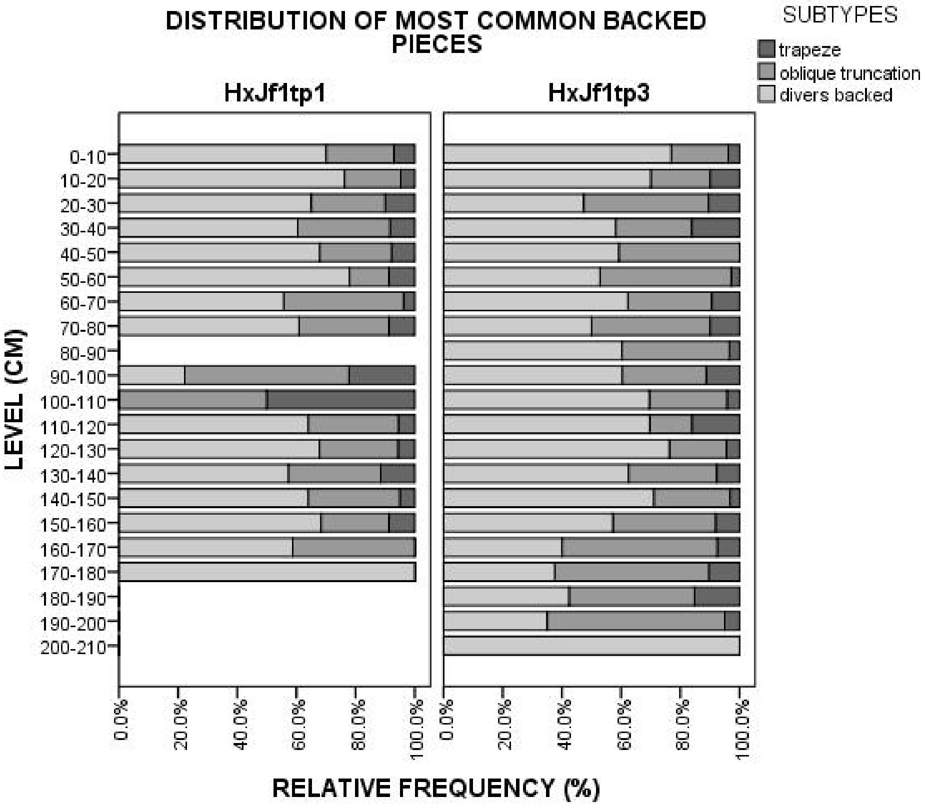


Figure 5.6 Overall distribution of scraper subtypes.

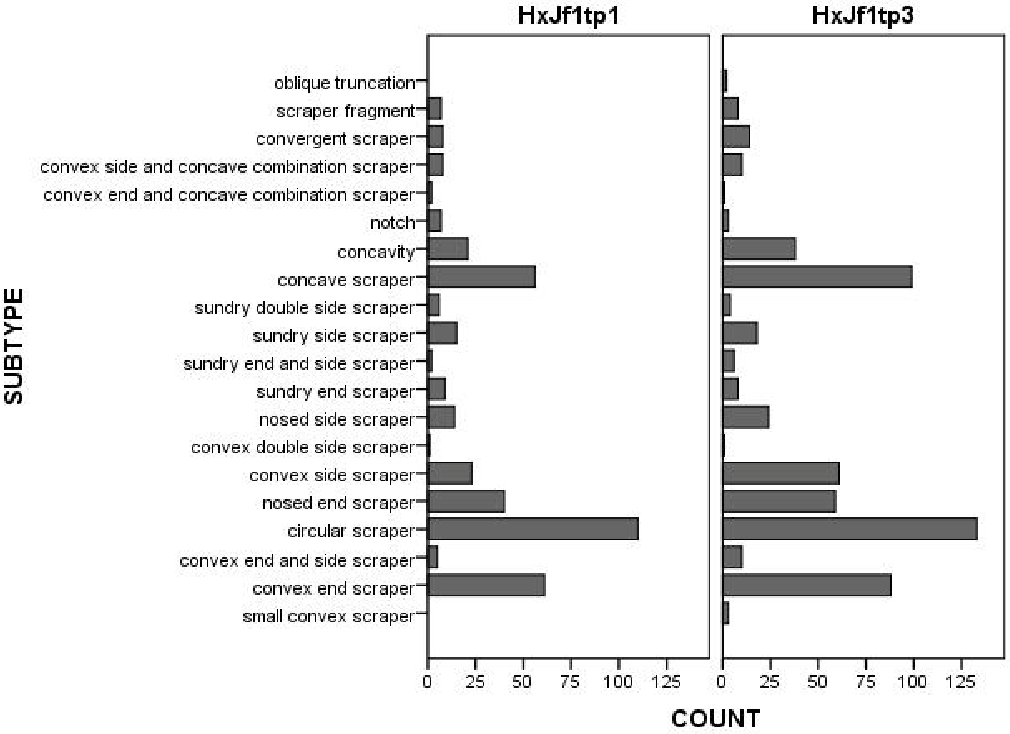


Figure 5.7 Distribution of most common scraper subtypes by level.

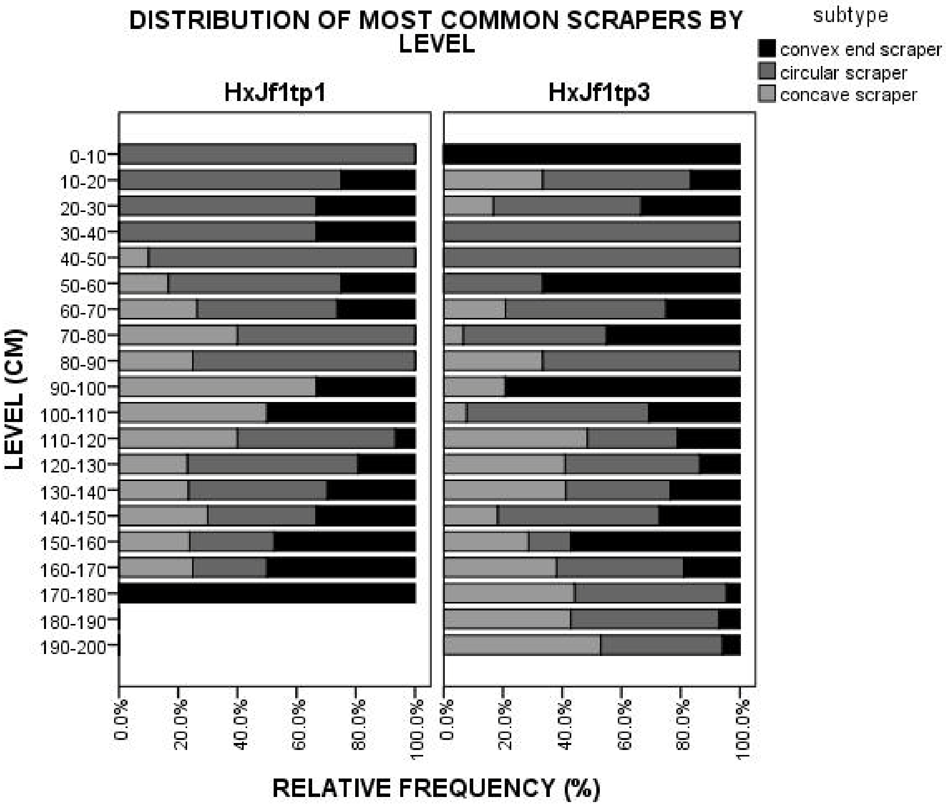


Figure 5.8 Proportion of backed pieces to scrapers by level.

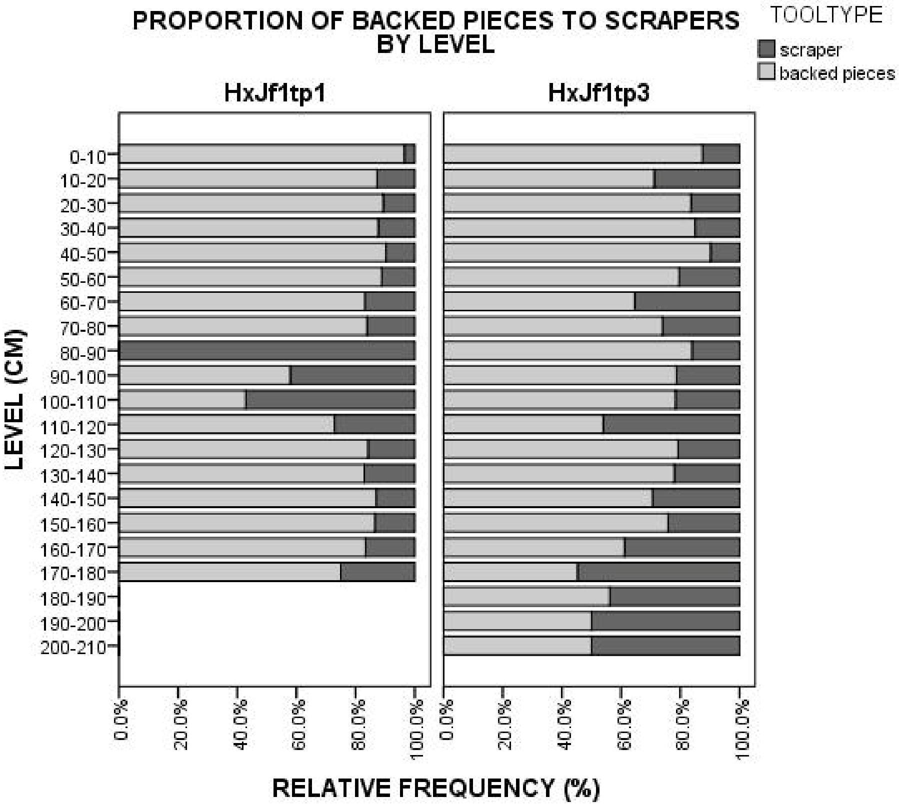


Figure 5.9 Distribution of points, bifacially modified pieces, and heavy duty tools by level.

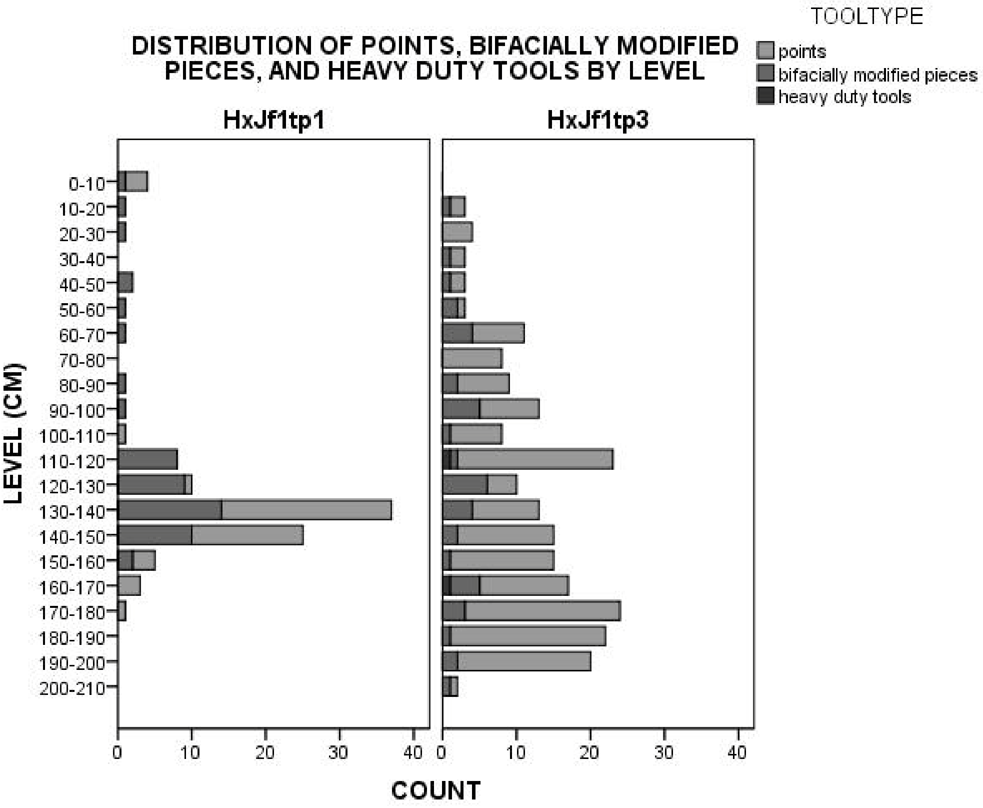


Figure 5.10 Distribution of point subtypes by level.

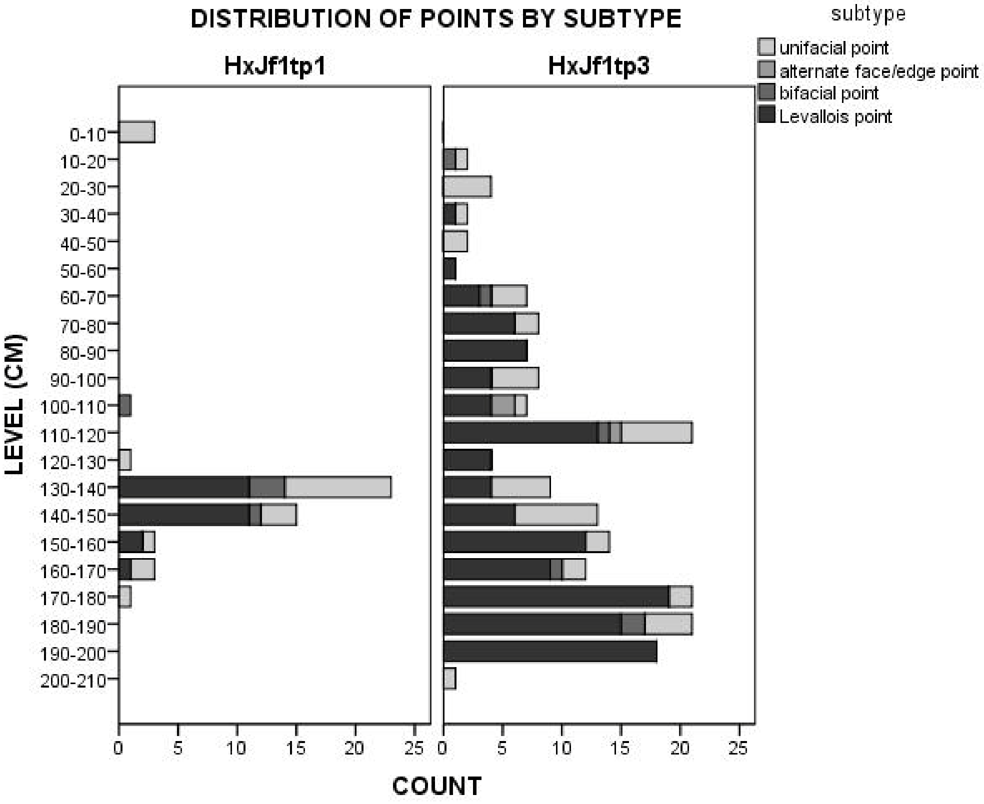
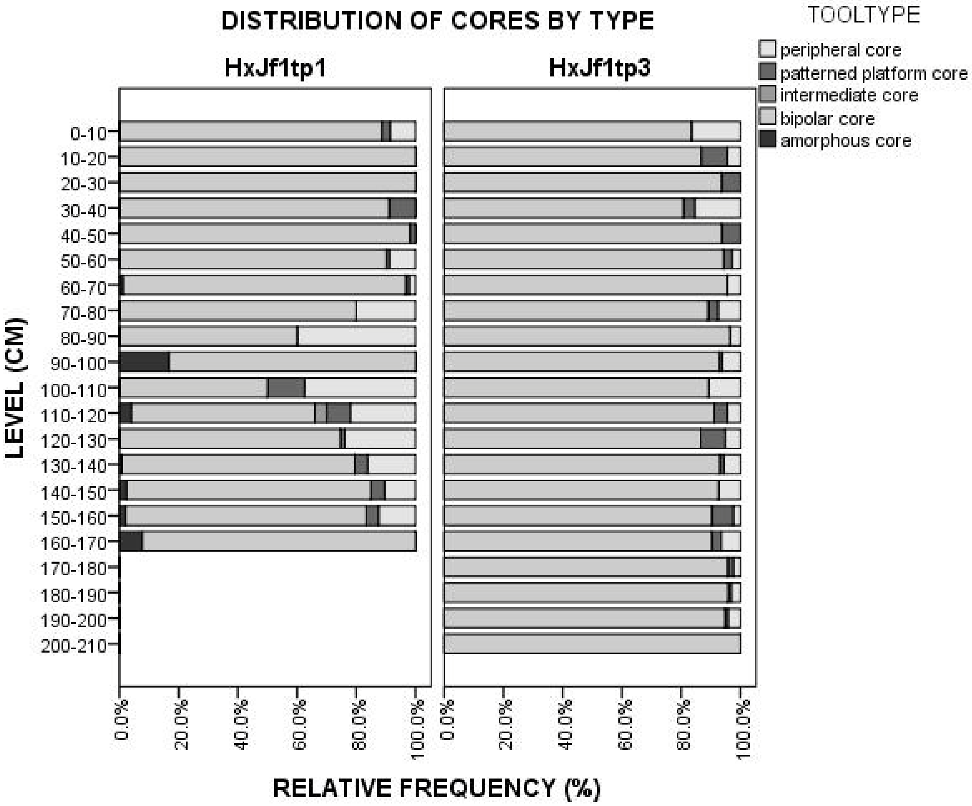


Figure 5.11 Distribution of core types by level.



Chapter 6: Technological Analysis

Assessment of various technological attributes provides additional information on aspects of lithic production, raw material use, site use and mobility. For whole and utilized flakes, the variables of Toth types, platform breadth, platform length, platform angle, number of platform facets, planform, dorsal flake scar pattern, and number of dorsal scares were recorded. Flake area and platform area relative to the flake area were also calculated. For tools, retouch intensity and angle were also recorded. And for cores, cortex cover and number of visible flake scares were recorded. Weight, breadth, length and thickness were measured for all artefacts. Ratios for breadth-to-length and thickness-to-breadth were calculated. Degree of abrasion was also recorded for all pieces. The rationale behind these variables was discussed in Chapter 4.

6.1 Debitage

6.1.1 Toth Types

The presence of all Toth Types among whole and utilized/trimmed flakes at Magubike indicates that each phase of lithic reduction took place to some degree. However, some types are far more common than others (Table 6.1). Types VI and V are most frequent, and account for more than half of all whole and utilized flakes, whereas Types I and II are the least common. In TP1, all whole and trimmed/utilized flakes (n=895) were examined for Toth Type. Type VI is most common, and includes 68.4% (n=377) of the total sample, followed by

Type V which accounts for 22.9% (n=126). As in TP3, the other types account for less than 10%, in the following order: Type III, 4.7% (n=26); Type IV, 2.2% (n=12); Type II, 1.6% (n=9), and Type I, .9% (n=1). The pattern of distribution in TP3 reflects that of TP1. The most prevalent Toth Type is Type VI, represented by 61.8% (n=933) of the total 2032 whole and trimmed/utilized flakes for which this variable was recorded. Type V was second most frequent at 28.7% (n=433) of the sample. As in TP1, the other types together constituted less than 10% of the total sample, in the following order: Type III, 3.6% (n=55); Type IV, 2.4% (n=32); and Types I and II, both1.9% (n=28).

The chi-square results are inconclusive (Appendix II) due to the high number of cells with expected counts of less than five in both test pits, but little change seems to occur over time as the percentage of the types is fairly consistent with depth (Figure 6.1). Type VI dominates not only overall, but also throughout each test pit, and accounts for over half of all whole and utilized flakes in almost every level. The prevalence of Type V as second most common in nearly every level of each test pit also reflects the overall pattern. However, minor changes can be observed. In TP1, between 80-110 cm, at the point at which artefact density drops off to very low numbers, there are more Type Vs than Type VIs. Also, Type VIs appear to very slightly decrease in relative frequency over time in TP3, but very slightly increase in TP1. Very generally speaking, Type III occurs at higher frequencies in higher levels in both test pits. In TP1, Type III accounts for more than 10% of all flakes in the levels of 10-20 cm (12.5%; n=1), 20-30 cm (16.7%; n=1), and 40-50 cm (21.2%; n=7), compared to just once after the break in artefact density 70-110 cm at 160-170 cm. In TP3, Type IIIs occur at higher than 10% in levels 10-30 cm and 40-50 cm, and then once more above the bedrock at 160-170 cm.

The relationship between Toth Types and raw materials was also examined (Table 6.2). A chi-square test proved inconclusive due to the high number of cells with expected counts less than 5 (Appendix II). However, in both test pits, Types V and VI are most likely to be made on metamorphic (and chert/flint in TP1), whereas Type III flakes are more likely to be made on quartz. For the other types, the distributions differ, with quartz most common for Types I and II as well in TP1, and quartzite for Type IV; in TP3, metamorphic most common for Types I, II, and IV. This reflects the higher percentage of metamorphic raw materials found in TP3.

As discussed previously, Toth types provide information on flaking methods as well as degree of lithic reduction. The most common, Type VI, are those with a non-cortical platform and non-cortical dorsal surface, indicate intensive reduction and the later stages in the flaking process, when little to no cortex remains on the core (Toth 1982). In contrast, those types representing the initial stages of reduction are very low in numbers, which indicates earlier stages of flaking occurred away from the site in all time periods, and may possibly reflect the testing of raw materials at their source prior to transport to the site (Toth 1982). However, the second most prevalent, Type V, are those with a non-cortical platform and partially cortical dorsal surface, and these types are the first ones to come off when unifacially working a flake with a cortical surface, removing flakes from that surface, or bifacially flaking a cobble, and this indicates that although they were worked, cores were not intensely reduced prior to transport to the site. Type III has been suggested to be indicative of bipolar technology (Sipe 2001), yet such flakes are curiously absent at Magubike, despite the abundance of bipolar cores, which further supports the possibility that initial reduction took place away from Magubike, perhaps at the local quarry sites.

6.1.2 Planform

Convergent, divergent, parallel, and circular planforms were identified for whole and utilized flakes. The overall distribution for each test pit was very similar (Table 6.3). Divergent planforms account for about half of all whole and utilized flakes, at 48.7% (n=690) in TP1 and 50.6% (n=1203) in TP3. Second most frequent were convergent planforms at 20.4% (n=289) in TP1 and 21% (n=498) in TP3, followed by circular planforms, 17.3% (n=245) in TP1 and 14.8%(n=351) in TP3, and parallel planforms, 13.7% (n=194) in TP1 and 13.6% (n=324), in TP3.

An examination of the distribution of planforms level-by-level shows that each type is found throughout each test pit (Figure 6.2). Chi-square test results testing the relationship between planform distribution and depth were inconclusive (Appendix II). In TP1, in levels 10-40 cm circular flakes are absent, while parallel flakes are slightly higher in number compared to other levels. Circular flakes are again absent from 70-110 cm, the levels that reflect a break in artefact density. 70-80 cm yielded all types except circular; 80-90cm did not yield circular or parallel flakes; and 90-110 cm contains only divergent flakes. The last level, 170-180 cm, also contains only divergent and convergent flakes. In TP3, all levels yielded flakes exhibiting each planform, with the exception of 40-50 cm from which no circular flakes were recovered.

As with depth and planform distribution, the chi-square preformed to determine if there is a statistically significant relationship between planform and raw material (Appendix II). For TP1, the relationship is not statistically significant as indicated by a chi-square value of 15.181 (df=15, p<.438). However, in TP3, the chi-square value is 24.127 (df=12, p<.020), so there is a statistically significant relationship between raw material and plan, although the Cramer's V of .109 indicates it is not a strong association. In both test pits, metamorphic is the most likely raw material for planform except parallel flakes in TP1, which are dominated by quartz (Table 6.4); however, TP3 differs from TP1 in that more than half of flakes of convergent, divergent and circular planforms are made on metamorphic, and almost half of all parallel flakes are. In contrast, the highest percentage for any raw material for any planform in TP1 is only 34. 6% for metamorphic, convergent flakes.

A chi-square was also calculated to test for any statistically significant relationship between planform and whether a flake was trimmed or utilized, to see if there was a preference for particular flakes shapes for use (Appendix II). Although the chi-square value of 2.666 (df=3, p<.446) indicates no such relationship exists in TP3, the results in TP1 of 9.740 (df=3, p<.021) indicate that the relationsip between planform and whether a flake is whole or trimmed/utilized is statistically significant. However, Cramer's V of .021 indicates the relationship is weak. In TP3, approximately three quarters of flakes of each planforms are whole, whereas a quarter are trimmed/utilized (Figure 6.3). Thus, there does not appear to be a preference for utilizing flakes of a particular planform. But in TP1, a higher percentage of flakes overall are trimmed/utilized. The distribution of parallel planforms most closely matches that of TP3, with 71% of parallel flakes whole and 29% trimmed/utilized; however, this is still slightly higher than the percentage for trimmed/utilized flakes for any planform in TP3. That for convergent is slightly higher, with 33.5% of those flakes trimmed/utilized; for divergent and circular, the percentage of trimmed/utilized flakes among all flakes with those planforms is 42.1% and 41.8%, respectively. Thus, it appears there may have been preference for utilizing those divergent and circular planforms.

6.1.3 Dorsal flake scar pattern

The distribution of dorsal scar patterns for whole and utilized flakes is similar for TP1 and TP3 (Table 6.5), with same pattern, simple most prevalent at 69.3% (n=983) and 67.2% (n=1596), respectively. Radial dorsal scars patterns are second most frequent, accounting for 15.9% (n=225) in TP1 and 14.8% (n=353) in TP3, followed by same pattern, parallel, 10.9 (n=155) and 13% (n=310). No pattern was observed on 2.8% (n=40) and 3.7% (n=87); these flakes are cortical and so do not exhibit dorsal flake scars from which a pattern can be discerned. Opposed platform and transverse patterns were also recorded at a very low number.

The chi-square test examining the relationship between dorsal scar pattern and raw material was also inconclusive for the same reason (Appendix II). Of the most common scar patterns of same pattern, simple; radial; and same pattern, parallel, each is most likely to be made on metamorphic raw materials in both test pits with the exception of same pattern, parallel in TP1, in which chert/flint dominates (Table 6.6). However, in TP3, in which metamorphic is the most utilized material for that scar pattern, quartz is utilized more often than chert/flint, and this reflects the overall raw material distributions in which chert/flint is more prevalent in TP1. Also reflecting the overall raw material distribution is the higher frequency of pieces on metamorphic for these three scar patterns in TP3; for each type, metamorphic accounts for approximately 50% of all pieces, compared to just over 30% for each in TP1.

6.1.4 Dorsal Scar Number

Between 0-7 previous flake removals were identified on the dorsal surfaces of whole and utilized flakes. The distribution of the number of dorsal scars is very similar between the test pits (Table 6.7). The most frequent number of dorsal scars is two. Just under half the flakes display this number, 47.5% (n=673) in TP1 and 49.6% (n=1179) in TP3. The second most frequent number of dorsal scars is 1, 27% (n=383) and 25.5% (n=607) in TP1 and TP3, respectively, followed by 3, 14.3% (n=203) and 13.4% (n=319). The cortical flakes, which do not have any previous flake removals on the dorsal surface hence the presence of cortex, account for 2.9% (n=41) and 3.7% (n=87). Those with four and five account for between 5.3%-2.4%, and those with 6-7 account for less than 1% each

The chi-square results testing the relationship of distribution of number of dorsal scars by depth are inconclusive due, as was that examining dorsal scar number and raw material (Appendix II).

Likely, the number of dorsal scars is a reflection of reduction method more so than reduction stage (Table 6.8). More dorsal scars can indicate the flake was struck from the core late in the process, hence the scars from several previous removals. However, other factors such as raw material type, size, flaking pattern, and the type of artefact being produced can affect the number of dorsal scars observed as well. This relationship was tested with chi-square, but the results were inconclusive due to the high number of cells with expected counts less than five (Appendix II). However, it can be noted that in TP1, the majority of lithics with radial scar patterns have 3-6 dorsal flake scars, though some have two. Same pattern, simple have between 1-6 but 1-2 in highest frequency. Same pattern, parallel have between 0-3 but mainly 1-2. In TP3, the patterns are similar. Radial dorsal scar patterns have between 2-7 flake scars, with the majority exhibiting 3-5. Same pattern, simple have between 1-5, mainly 1-2. And same pattern, parallel have between 1-5 as well, and mainly 1-2. Thus, in general, a greater number of flake scars is associated with radial dorsal scar patterns, and so is likely a function of reduction technique (radial) rather than stage of reduction (late). However, this does not necessarily mean these flakes are not the product of later stages of reduction as well.

6.1.5 Platform Facets

The distribution of platform facet number among whole and utilized flakes was similar between the test pits (Table 6.9). In both, the vast majority exhibited one platform facet: 92.3% (n=825) in TP and 92.1% (n=1972) in TP3. Less than 10% possessed more than one platform facet, which is indicative of prepared platform technology such as the Levallois technique utilized in the MSA. In TP1, 7% (n=63) had two platform facets and .6% (n-5) had 3; in TP3, 7.3% (n=148) had 2, and .6% (n=12) had three. TP1 also yielded a single flake with four platform facets.

A chi-square test was not preformed due to the low number of flakes with facetted platforms. However, scientific significance is not always correlated with statistical significance. Although flakes with one or two platform facets are found throughout both test pits, those with three are not found within the upper levels (Figure 6.6). In TP1, the few flakes that exhibit three or more platform facets are found between 130-160 cm. In TP3, the first is found at 40-50 cm, and the rest between 60-140 cm. Also, in both test pits, the more platform facets a flake has, the more likely it was made on metamorphic materials, which reflects the raw material distribution of the test pits (Table 6.10).

Given the prevalence of bipolar lithic reduction, in contrast with prepared core technology like the Levallois method, the low number of flakes with facetted platforms is expected. However, their presence in the lower levels of the deposit is an indication of directional change. Earlier occupants of Magubike were more likely to prepare cores than the later occupants.

6.1.6 Size Measurements

The average measurements for length, breadth, thickness, and weight (Figure 6.7) among debitage subtypes are presented in Table 6.11. With some exceptions, the average size of debitage slightly increases overtime (Figures Figure 6.8). In TP1, however, it peaks around the break in artefact density and then drastically decreases in size again. This may reflect vertical disturbance along with the high number of backed pieces, as it could represent small pieces that have winnowed downward in the deposit.

6.2 Cores

6.2.1 Cortex coverage

The majority of cores, 58.7% (n=440) in TP1 and 57.6% (n=742) in TP3, exhibit minimal cortex of 0-25% (Table 6.12). Most other cores feature 26-50% total cortex coverage; this accounts for 26.8% (n=201) of the cores in TP1 and 26.9% (n=347) in TP3. Slightly more cores in TP3, 14.7% (n=189) feature 51-75% cortex coverage compared to 13.5% (n=101) of all cores in TP1. Finally, less than 1% of all cores yielded by both test pits feature more than 76% cortex coverage. This evidence, along with the high number of flakes with non-cortical platforms and dorsal surfaces as indicated by Toth Types, indicate intensive reduction and the later stages in the flaking process. This suggests that in general, cores were initially flaked away from the site.

The relationship between cortex coverage and level could not be tested due to the high number of cells with expected counts of less than 5. However, although the amount of cortex on cores overall fluctuates in TP1 with no discernable pattern, in TP3 the number of cores with less than 25% cortex coverage appears to increase with time, with the exception of 120-140 cm, until the last levels in which it gradually decreases (Figure 6.9).

Overall, the distribution of cortex coverage among core types is very similar between test pits (Table 6.13). Even with amorphous and intermediate cores omitted due to their low contribution to cores overall, the chi square test examining cortex coverage and core types in TP1 was inconclusive due to the high number of cells with expected counts of less than five. However, in TP3, the chi-square value is 35.520 (df=6, *p* <.000), the relationship is statistically significant although weak according to Cramer's V of .166. Most bipolar cores in both test pits exhibit 0-25% cortex coverage: 61.5% (n=388) in TP1 and 59.3% (n=704) in TP3. This is also the case for patterned platform and peripheral cores in TP1, 56% (n=14) and 43.9% (n=36), respectively. However, in TP3, most peripheral and patterned platform cores have between 26-50% cortex coverage, 55.4% (n=36) and 43.2% (n=16), respectively. Both intermediate cores in TP1 have less than 25%, but all except one of the amorphous cores has more than 50%.

With rock crystal omitted because it contributed little to the overall distribution of raw materials among cores, chi-square tests indicate a statistically significant relationship between cortex coverage and raw material in TP1, which has a chi-square value of 85.277 (df=9, *p* <.000), as well as TP3, in which the chi-square value is 118.327 (df=9, *p* <.000), with Cramer's V of .348 and .305, respectively. In both test pits, quartz cores are more likely to have less cortex compared to cores of other raw materials, particularly metamorphic and quartzite cores, which account for the majority of cores with 50% or more cortex coverage (Table 6.14). Chert/flint cores also follow this pattern in TP3. However, the vast majority of cores of all materials exhibit less than 50% cortex coverage. Thus, this supports the evidence provided by the Toth Type distribution among whole and trimmed/utilized flakes that initial flaking of cores occurred away from the site.

6.2.2 Core flake scars

On average, cores in TP1 have a slightly higher number of flake scars than those in TP3. In TP1, intermediate (peripheral/bipolar) cores feature the most, with an average of 11 flake scars. However, there are only two such cores throughout all of the test pit. Peripheral cores have an average of 10 flake scars each, followed by patterned platform cores at nine. Bipolar cores have an average of five flake scars. The few (n=9) amorphous cores present average only four flake scars each. In TP3, the pattern is very similar. Peripheral cores average the most at nine, followed by patterned platform cores with an average of eight and bipolar cores with an average of six.

This pattern suggests that the number of flake scars may reflect the method of reduction. For example, bipolar cores have a low average of flake scars relative to other types, but this may due to the nature of bipolar flaking, in which pieces are smashed up.

6.2.3 Size measurements

Data for length, breadth, thickness, and weight are presented in Figure 6.10. Bipolar cores are, on average, smaller in length, breadth, thickness, and weight than other core types in both test pits (Table 6.14), followed by peripheral cores and patterned platform cores. In TP1, the amorphous and intermediate cores, which contribute little to the overall number of cores, are by far the largest. Regarding change over time for all size measurements, there is some slight fluctuation but no discernible pattern in TP3 (Figure 6. 11). In TP1, the change reflects that observed in debitage; cores increase in average size until the break at 70-110 cm, at which they are their largest, and then decrease steadily in size with depth.

6.3 Trimmed Pieces

6.3.1 Retouch intensity

Retouch intensity and angle were observed for retouched artefacts. Retouch intensity fell into one of three categories: marginal, semi-invasive, and invasive. The vast majority of tools recovered from Magubike exhibit marginal retouch, 99.3% (n=2793) in TP1 and 99.7% (n=2388) in TP3 (Table 6.15). The remaining tools feature semi-invasive retouch. As Garcin (2006) notes, typically marginal retouch would not constitute classification as a “formal” tool; however, Mehlman (1989) states that flakes with marginal retouch may also be subjectively classified as tools if they exhibit what appears to be distinctive retouch scarring.

Because of the low number of tools with semi-invasive retouch, chi square tests were not preformed to test the relationship between retouch intensity and depth, tool type, or raw material. However, it is interesting to note the distribution of the semi-invasive tools in both test pits. In TP1, all 19 pieces are from between 120-150 cm. In TP3, all 8 pieces were recovered from 60-90 cm and 120-140 cm.

In TP1, 11 bifacially modified pieces constitute the majority of the semi-invasive retouched tools, followed by two scrapers, two points, and one *outil écaillés.* In TP3, semi-invasive retouched tools include four bifacially modified pieces and four scrapers. Bifacially modified pieces account for a small percentage of tools overall, but are more likely to exhibit more intense retouch than other tool types, given that these number represent 20.2% and 10.3% of all bifacially modified pieces in each test pit, respectively (Table 6.14).

Regarding raw material, in TP1, with the exception one piece on metamorphic, about half were made on quartz, and the other half on rock crystal (Table 6.16) This is quite different from the pattern in TP3, in which the majority are made on quartz, in addition to one each on quartzite, rock crystal, and chert/flint. This is interesting given that most semi-invasive pieces are found in the levels were metamorphic is more common that quartz, and furthermore, quartz is of lower quality than the alternatives of metamorphic and chert/flint; however, even in those levels, most tools are made on quartz.

6.3.2 Retouch angle

Retouch angle was recorded in addition to retouch intensity. Very steep retouched edges constitute backing or a core edge, defined by Mehlman (1989) as angles greater than 80°. Scrapers, on the other hand, typically have an angle of retouch between 30° and 70°. The average angle of retouch for a trimmed piece is 79.9% in TP1 and 72.2% in TP3 (Table 6.17). These numbers are high due to the prevalence of backed pieces, which have an average angle of retouch of 90° in TP1 with a standard deviation of 0 and 89.9° in TP3 with a standard deviation of 808. Scrapers average 31.8° with a standard deviation of 15.229 and 30.4° with a standard deviation of 15.916, respectively.

6.3.3 Size measurements

Size measurements for trimmed pieces are presented in Figure 6.12 and Table 6.18. Overall, trimmed pieces in TP3 are slightly larger on average than those in TP1. Over time in TP3, there appears to be a slight increase in average tool size (Figure 6.13). However, the pattern in TP1 is quite different, and reflects that of cores and debitage in TP1. Size peaks with the spare levels, and then decreases; however, although it decreases again, it remains very steady.

Table 6.1 Overall distribution of Toth Types.

			TEST PIT		Total
			1	3	
TOTH TYPE	I	N	5	35	40
		%	.6	1.7	1.4
	II	N	12	33	45
		%	1.3	1.6	1.5
	III	N	45	70	115
		%	5.0	3.4	3.9
	IV	N	18	43	61
		%	2.0	2.1	2.1
	V	N	203	601	804
		%	22.7	29.6	27.5
	VI	N	612	1250	1862
		%	68.4	61.5	63.6
Total		N	895	2032	2927
		%	100.0	100.0	100.0

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Table 6.2 Distribution of raw materials among Toth Types.

				TOTH TYPE						Total
				I	II	III	IV	V	VI	
TP1	**RAW MATERIAL**	quartz	N	2	5	22	2	40	132	203
			%	40.0	41.7	48.9	11.1	19.7	21.6	22.7
		quartzite	N	1	2	5	7	31	42	88
			%	20.0	16.7	11.1	38.9	15.3	6.9	9.8
		chert/flint	N	0	3	13	5	53	187	261
			%	.0	25.0	28.9	27.8	26.1	30.6	29.2
		meta-morphic	N	2	1	1	3	79	185	271
			%	40.0	8.3%	2.2%	16.7	38.9	30.2	30.3
		other sedimentary	N	0	0	0	0	0	1	1
			%	.0	.0	.0	.0	.0	.2	.1
		rock crystal	N	0	1	4	1	0	65	71
			%	.0	8.3	8.9	5.6	.0	10.6	7.9
	Total		N	5	12	45	18	203	612	895
			%	100	100	100	100	100	100	100
TP3	**RAW MATERIAL**	quartz	N	3	7	26	5	59	242	342
			%	8.6	21.2	37.1	11.6	9.8	19.4	16.8
		quartzite	N	4	4	11	4	80	106	209
			%	11.4	12.1	15.7	9.3	13.3	8.5	10.3
		chert/flint	N	7	10	17	3	100	239	376
			%	20.0	30.3	24.3	7.0	16.6	19.1	18.5
		meta-morphic	N	21	12	16	31	360	651	1091
			%	60.0	36.4	22.9	72.1	59.9	52.1	53.7
		rock crystal	N	0	0	0	0	2	12	14
			%	.0	.0	.0	.0	.3	1.0	.7
	Total		N	35	33	70	43	601	1250	2032
			%	100	100	100	100	100	100	100

Table 6.3 Overall distribution of planforms.

			TEST PIT		**Total**
			1	**3**	
PLANFORM	convergent	N	188	435	623
		%	21.0	21.4	21.3
	parallel	N	124	288	412
		%	13.9	14.2	14.1
	divergent	N	413	1029	1442
		%	46.1	50.6	49.3
	circular	N	170	280	450
		%	19.0	13.8	15.4
Total		N	895	2032	2927
		%	100	100	100

Table 6.4 Distribution of planforms by raw material.

				PLANFORM				Total
				convergent	parallel	divergent	circular	
TP1	**RAW MATERIAL**	quartz	N	39	33	88	43	203
			%	20.7	26.6	21.3	25.3	22.7
		quartzite	N	15	13	42	18	88
			%	8.0	10.5	10.2	10.6	9.8
		chert/flint	N	57	34	122	48	261
			%	30.3	27.4	29.5	28.2	29.2
		metamorphic	N	65	27	131	48	271
			%	34.6	21.8	31.7	28.2	30.3
		other sedimentary	N	0	0	1	0	1
			%	.0	.0	.2	.0	.1
		rock crystal	N	12	17	29	13	71
			%	6.4	13.7	7.0	7.6	7.9
	Total		N	188	124	413	170	895
			%	100.0	100.0	100.0	100.0	100.0
TP3	**RAW MATERIAL**	quartz	N	73	67	145	57	342
			%	16.8	23.3	14.1	20.4	16.8
		quartzite	N	47	23	110	29	209
			%	10.8	8.0	10.7	10.4	10.3
		chert/flint	N	83	57	186	50	376
			%	19.1	19.8	18.1	17.9	18.5
		metamorphic	N	230	137	580	144	1091
			%	52.9	47.6%	56.4	51.4	53.7
		rock crystal	N	2	4	8	0	14
			%	.5	1.4	.8	.0	.7
	Total		N	435	288	1029	280	2032
			%	100.0	100.0	100.0	100.0	100.0

Table 6.5 Overall distribution of dorsal flake scar patterns.

			TEST PIT		Total
			1	3	
DORSAL SCAR PATTERN	radial	N	138	292	430
		%	15.4	14.4	14.7
	same pattern, simple	N	639	1352	1991
		%	71.4	66.5	68.0
	same pattern, parallel	N	93	281	374
		%	10.4	13.8	12.8
	opposed platform	N	2	19	21
		%	.2	.9	.7
	transverse	N	1	11	12
		%	.1	.5	.4
	none	N	22	77	99
		%	2.5	3.8	3.4
Total		N	895	2032	2927
		%	100.0	100.0	100.0

Table 6.6 Distribution of dorsal scar patterns by raw material.

				RAW MATERIAL						
				quartz	quartzite	chert/ flint	meta- morphic	other sedi- mentary	rock crystal	**Total**
TP1	**DORSAL SCAR PATTERN**	radial	N	27	13	41	48	1	8	138
			%	19.6	9.4	29.7	34.8	.7	5.8	100
		same pattern, simple	N	152	55	186	195	0	51	639
			%	23.8	8.6	29.1	30.5	.0	8.0	100
		same pattern, parallel	N	19	11	29	22	0	12	93
			%	20.4	11.8	31.2	23.7	.0	12.9	100
		opposed platform	N	1	1	0	0	0	0	2
			%	50.0	50.0	.0	.0	.0	.0	100
		transverse	N	0	0	0	1	0	0	1
			%	.0	.0	.0	100.0	.0	.0	100
		none	N	4	8	5	5	0	0	22
			%	18.2	36.4	22.7	22.7	.0	.0	100
	Total		N	203	88	261	271	1	71	895
			%	22.7	9.8	29.2	30.3	.1	7.9	100
TP3	**DORSAL SCAR PATTERN**	radial	N	40	37	66	149		0	292
			%	13.7	12.7	22.6	51.0		.0	100
		same pattern, simple	N	223	136	245	740		8	1352
			%	16.5	10.1	18.1	54.7		.6	100
		same pattern, parallel	N	67	25	48	136		5	281
			%	23.8	8.9	17.1	48.4		1.8	100
		opposed platform	N	3	2	3	10		1	19
			%	15.8	10.5	15.8	52.6		5.3	100
		transverse	N	1	0	4	6		0	11
			%	9.1	.0	36.4	54.5		.0	100
		none	N	8	9	10	50		0	77
			%	10.4	11.7	13.0	64.9		.0	100
	Total		N	342	209	376	1091		14	2032
			%	16.8	10.	18.5	53.7		.7	100

Table 6.7 Distribution of dorsal scar number.

			TEST PIT		
			1	**3**	**Total**
NUMBER OF DORSAL SCARS	0	N	23	77	100
		%	2.6	3.8	3.4
	1	N	264	524	788
		%	29.5	25.8	26.9
	2	N	410	1012	1422
		%	45.8	49.8	48.6
	3	N	129	267	396
		%	14.4	13.1	13.5
	4	N	40	95	135
		%	4.5	4.7	4.6
	5	N	25	47	72
		%	2.8	2.3	2.5
	6	N	4	7	11
		%	.4	.3	.4
	7	N	0	3	3
		%	.0	.1	.1
Total		N	895	2032	2927
		%	100.0	100.0	100.0

Table 6.8 Distribution of dorsal scar number by dorsal scar patterns.

				DORSAL SCAR PATTERN						
				radial	same pattern, simple	same pattern, parallel	opposed platform	transverse	none	**Total**
TP1	**NUMBER OF DORSAL SCARS**	0	N	0	0	1	0	0	22	23
			%	.0	.0	1.1	.0	.0	100.0	2.6
		1	N	1	246	14	2	1	0	264
			%	.7	38.5	15.1	100.0	100.0	.0	29.5
		2	N	14	323	73	0	0	0	410
			%	10.1	50.5	78.5	.0	.0	.0	45.8
		3	N	68	57	4	0	0	0	129
			%	49.3	8.9	4.3	.0	.0	.0	14.4
		4	N	31	9	0	0	0	0	40
			%	22.5	1.4	.0	.0	.0	.0	4.5
		5	N	21	3	1	0	0	0	25
			%	15.2	.5	1.1	.0	.0	.0	2.8
		6	N	3	1	0	0	0	0	4
			%	2.2	.2	.0	.0	.0	.0	.4
	Total		N	138	639	93	2	1	22	895
			%	100.0	100.0	100.0	100.0	100.0	100.0	100.0
TP3	**NUMBER OF DORSAL SCARS**	0	N	0	0	0	0	0	77	77
			%	.0	.0	.0	.0	.0	100.0	3.8
		1	N	0	436	68	14	6	0	524
			%	.0	32.2	24.2	73.7	54.5	.0	25.8
		2	N	19	798	186	5	4	0	1012
			%	6.5	59.0	66.2	26.3	36.4	.0	49.8
		3	N	145	97	24	0	1	0	267
			%	49.7	7.2	8.5	.0	9.1	.0	13.1
		4	N	79	14	2	0	0	0	95
			%	27.1	1.0	.7	.0	.0	.0	4.7
		5	N	41	5	1	0	0	0	47
			%	14.0	.4	.4	.0	.0	.0	2.3
		6	N	5	2	0	0	0	0	7
			%	1.7	.1	.0	.0	.0	.0	.3
		7	N	3	0	0	0	0	0	3
			%	1.0	.0	.0	.0	.0	.0	.1
	Total		N	292	1352	281	19	11	77	2032
			%	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Table 6.9 Overall distribution of number of platform facets.

			TEST PIT		
			1	**3**	**Total**
NUMBER OF PLATFORM FACETS	1	N	825	1872	2697
		%	92.3	92.1	92.2
	2	N	63	148	211
		%	7.0	7.3	7.2
	3	N	5	12	17
		%	.6	.6	.6
	4	N	1	0	1
		%	.1	.0	.0
Total		N	894	2032	2926
		%	100.0	100.0	100.0

Table 6.10 Distribution of number of platform facets by raw material.

				NUMBER OF PLATFORM FACETS				
				1	2	3	4	**Total**
TP1	**RAW MATERIAL**	quartz	N	195	7	0	0	202
			%	23.6	11.1	.0	.0	22.6
		quartzite	N	80	8	0	0	88
			%	9.7	12.7	.0	.0	9.8
		chert/flint	N	241	19	1	0	261
			%	29.2	30.2	20.0	.0	29.2
		metamorphic	N	238	28	4	1	271
			%	28.8	44.4	80.0	100.0	30.3
		other sedimentary	N	1	0	0	0	1
			%	.1	.0	.0	.0	.1
		rock crystal	N	70	1	0	0	71
			%	8.5	1.6	.0	.0	7.9
	Total		N	825	63	5	1	894
			%	100.0	100.0	100.0	100.0	100.0
TP3	**RAW MATERIAL**	quartz	N	324	17	1		342
			%	17.3	11.5	8.3		16.8
		quartzite	N	192	15	2		209
			%	10.3	10.1	16.7		10.3
		chert/flint	N	344	31	1		376
			%	18.4	20.9	8.3		18.5
		metamorphic	N	998	85	8		1091
			%	53.3	57.4	66.7		53.7
		rock crystal	N	14	0	0		14
			%	.7	.0	.0		.7
	Total		N	1872	148	12		2032

Table 6.11 Mean size measurements for debitage.

	TOOLTYPE		**Length (mm)**	**Breadth (mm)**	**Thickness (mm)**	**Weight (g)**
TP1	angular fragment	Mean	17.544	11.492	5.330	1.250
		N	1556	1556	1556	1556
		Std. Deviation	6.1402	3.9171	2.4756	1.7513
	specialized flake	Mean	17.776	7.922	4.359	.522
		N	46	46	46	46
		Std. Deviation	4.0860	2.0536	1.4914	.3346
	flake	Mean	23.042	23.132	6.725	4.955
		N	1259	1259	1259	1259
		Std. Deviation	10.1158	9.4807	3.1720	9.1846
	blade	Mean	30.491	15.647	5.973	4.293
		N	85	85	85	85
		Std. Deviation	14.5352	7.3421	2.6513	6.4675
	Levallois flake	Mean	31.554	34.823	10.237	11.426
		N	35	35	35	35
		Std. Deviation	12.1304	11.5348	3.8844	11.2100
	Total	Mean	20.403	16.745	5.980	3.010
		N	2981	2981	2981	2981
		Std. Deviation	9.0796	9.2610	2.9254	6.6345
TP3	angular fragment	Mean	19.590	13.274	5.032	1.594
		N	3705	3705	3705	3704
		Std. Deviation	6.1982	4.5387	2.2714	1.7234
	specialized flake	Mean	19.150	8.260	4.402	.729
		N	58	58	58	58
		Std. Deviation	3.7264	1.7166	1.4827	.4112
	flake	Mean	24.177	24.452	6.769	5.447
		N	3421	3421	3421	3421
		Std. Deviation	10.3462	9.3105	3.2150	8.9577
	blade	Mean	31.213	17.087	6.359	5.118
		N	289	289	289	289
		Std. Deviation	12.2401	7.0830	2.9355	7.5468
	Levallois flake	Mean	30.346	33.030	9.140	10.520
		N	121	121	121	121
		Std. Deviation	8.6696	7.7468	2.7223	9.7379
	Total	Mean	22.267	18.731	5.926	3.600
		N	7594	7594	7594	7593

Table 6.12 Overall distribution of amount of cortex coverage.

			CORTEX COVERAGE				Total
			1 (0-25%)	2 (26-50%)	3 (51-75%)	4 (76-100%)	
TP1	**TOOL TYPE**	peripheral	36	30	16	0	82
		patterned platform	14	10	1	0	25
		intermediate	2	0	0	0	2
		bipolar	388	160	79	4	631
		amorphous	0	1	5	3	9
		Total	440	201	101	7	749
TP3	**TOOL TYPE**	peripheral	23	36	6	0	65
		patterned platform	15	16	6	0	37
		bipolar	704	295	177	11	1187
		Total	742	347	189	11	1289

Table 6.13 Distribution of cortex coverage by raw materials

			CORTEX COVERAGE				**Total**
			1 (0-25%)	2 (26-50%)	3 (51-75%)	4 (76-100%)	
TP1	**RAW MATERIAL**	quartz	312	117	48	1	478
		quartzite	24	31	25	2	82
		chert/flint	50	35	10	2	97
		volcanic	16	13	13	2	44
		rock crystal	38	5	5	0	48
	Total		440	201	101	7	749
TP3	**RAW MATERIAL**	quartz	540	181	76	2	799
		quartzite	24	31	20	3	78
		chert/flint	50	42	28	2	122
		volcanic	108	90	64	4	266
		rock crystal	20	3	1	0	24
	Total		742	347	189	11	1289

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Table 6.14 Mean size measurements for core types.

	TOOLTYPE		**Length (mm)**	**Breadth (mm)**	**Thickness (mm)**	**Weight (g)**
TP1	peripheral	Mean	38.559	32.390	17.174	32.152
		N	82	82	82	82
		Std. Deviation	14.4577	11.0685	7.4508	46.4962
	patterned platform	Mean	40.932	28.436	19.484	36.784
		N	25	25	25	25
		Std. Deviation	14.4564	10.0052	9.4252	68.0581
	intermediate	Mean	51.400	36.250	19.200	31.350
		N	2	2	2	2
		Std. Deviation	5.5154	4.7376	1.5556	3.1820
	bipolar	Mean	27.519	19.172	11.741	7.024
		N	634	634	634	634
		Std. Deviation	8.0893	5.6876	3.4896	6.3944
	amorphous	Mean	64.444	47.811	34.867	177.211
		N	9	9	9	9
		Std. Deviation	18.8025	12.2294	10.7652	109.2090
	Total	Mean	29.675	21.309	12.888	12.855
		N	752	752	752	752
		Std. Deviation	10.9858	8.5597	5.5487	30.9157
TP3	peripheral	Mean	38.757	32.234	16.338	25.058
		N	65	65	65	65
		Std. Deviation	8.6347	6.5318	4.3955	17.8944
	patterned platform	Mean	41.997	29.503	21.049	36.920
		N	37	37	37	37
		Std. Deviation	13.0088	12.3446	8.5867	41.9488
	bipolar	Mean	29.328	20.744	11.825	8.571
		N	1193	1193	1193	1193
		Std. Deviation	7.8888	5.8777	5.2239	9.2303
	Total	Mean	30.164	21.571	12.315	10.208
		N	1295	1295	1295	1295
		Std. Deviation	8.6070	6.8054	5.6000	13.3127

Table 6.15 Distribution of retouch intensity by tool types.

				RETOUCH INTENSITY		
				marginal	semi-invasive	**Total**
TP1	**TOOL TYPE**	scraper	N	390	5	395
			%	98.7	1.3	100.0
		backed pieces	N	2216	0	2216
			%	100.0	.0	100.0
		points	N	23	2	25
			%	92.0	8.0	100.0
		burins	N	26	0	26
			%	100.0	.0	100.0
		bifacially modified pieces	N	41	11	52
			%	78.8	21.2	100.0
		becs	N	13	0	13
			%	100.0	.0	100.0
		composite tools	N	1	0	1
			%	100.0%	.0	100.0
		outils ecailles	N	83	1	84
			%	98.8	1.2	100.0
	Total		N	2793	19	2812
			%	99.3	.7	100.0
TP3	**TOOL TYPE**	scraper	N	586	4	590
			%	99.3	.7	100.0
		backed pieces	N	1533	0	1533
			%	100.0	.0	100.0
		points	N	61	0	61
			%	100.0	.0	100.0
		burins	N	54	0	54
			%	100.0	.0	100.0
		bifacially modified pieces	N	35	4	39
			%	89.7	10.3	100.0
		becs	N	24	0	24
			%	100.0	.0	100.0
		outils ecailles	N	93	0	93
			%	100.0	.0	100.0
		heavy duty tools	N	1	0	1
			%	100.0	.0	100.0
		other tools	N	1	0	1
			%	100.0	.0	100.0
	Total		N	2388	8	2396
			%	99.7	.3	100.0

Table 6.16 Distribution of retouch intensity by raw material.

				RETOUCH INTENSITY		**Total**
				marginal	semi-invasive	
TP1	**RAW MATERIAL**	quartz	N	1632	9	1641
			%	99.5	.5	100.0
		quartzite	N	201	0	201
			%	100.0	.0	100.0
		chert/flint	N	377	0	377
			%	100.0	.0	100.0
		metamorphic	N	143	1	144
			%	99.3	.7	100.0
		rock crystal	N	440	9	449
			%	98.0	2.0	100.0
Total			N	2793	19	2812
			%	99.3	.7	100.0
TP3	**RAW MATERIAL**	quartz	N	1413	5	1418
			%	99.6	.4	100.0
		quartzite	N	116	1	117
			%	99.1	.9	100.0
		chert/flint	N	310	1	311
			%	99.7	.3	100.0
		metamorphic	N	420	0	420
			%	100.0	.0	100.0
		other sedimentary	N	1	0	1
			%	100.0	.0	100.0
		rock crystal	N	128	1	129
			%	99.2	.8	100.0
Total			N	2388	8	2396
			%	99.7	.3	100.0

Table 6.17 Mean angle of retouch of tool types.

	TOOLTYPE	**Mean**	**N**	**Std. Deviation**
TP1	scraper	31.78	395	15.299
	backed pieces	90.00	2216	.000
	points	34.60	25	17.376
	burins	90.00	26	.000
	bifacially modified pieces	31.92	52	15.344
	becs	47.31	13	25.869
	composite tools	90.00	1	.
	outils ecailles	86.55	84	11.998
	Total	79.96	2812	22.815
TP3	scraper	30.36	590	15.916
	backed pieces	89.97	1533	.808
	points	32.81	57	23.811
	burins	90.00	54	.000
	bifacially modified pieces	39.74	39	23.282
	becs	34.58	24	23.309
	outils ecailles	82.42	93	18.306
	heavy duty tools	45.00	1	.
	other tools	30.00	1	.
	Total	72.20	2392	28.599

Table 6.18 Mean size measurements for trimmed pieces.

	TOOLTYPE		**Length (mm)**	**Breadth (mm)**	**Thickness (mm)**	**Weight (g)**
TP3	scraper	Mean	29.022	27.701	8.457	8.192
		N	395	395	395	395
		Std. Deviation	10.1720	8.8334	2.8221	8.7504
	backed pieces	Mean	18.743	15.623	5.157	1.614
		N	2216	2216	2216	2216
		Std. Deviation	5.5791	5.1900	1.9199	1.6990
	points	Mean	32.802	26.218	8.174	7.916
		N	50	50	50	50
		Std. Deviation	11.0815	7.9034	2.9754	8.9532
	burins	Mean	23.085	18.300	5.515	2.454
		N	26	26	26	26
		Std. Deviation	5.6481	3.8372	1.7629	1.6413
	bifacially modified pieces	Mean	29.004	28.775	9.029	8.287
		N	52	52	52	52
		Std. Deviation	7.9413	7.4529	2.4520	5.7990
	becs	Mean	18.300	18.454	5.485	1.731
		N	13	13	13	13
		Std. Deviation	1.6980	4.0775	1.3837	.6395
	composite tools	Mean	40.300	26.400	8.500	10.800
		N	1	1	1	1
		Std. Deviation	.	.	.	.
	outils ecailles	Mean	26.065	20.326	8.601	4.483
		N	84	84	84	84
		Std. Deviation	6.2527	5.5102	1.8268	2.5623
	Total	Mean	20.872	17.913	5.848	2.859
		N	2837	2837	2837	2837
		Std. Deviation	7.8039	7.4876	2.4921	4.6228
TP3	scraper	Mean	27.913	25.259	7.433	6.397
		N	590	590	590	590
		Std. Deviation	8.2902	7.9623	2.7521	6.2864
	backed pieces	Mean	20.196	17.325	5.394	2.125
		N	1533	1533	1533	1533
		Std. Deviation	5.4375	5.2495	1.9110	1.7148
	points	Mean	32.590	26.462	7.695	6.864
		N	182	182	182	182
		Std. Deviation	10.5760	7.8783	2.5537	5.8355
	burins	Mean	27.187	24.396	6.932	5.152
		N	56	56	56	56
		Std. Deviation	6.9342	6.8606	1.9043	3.2598
	bifacially modified pieces	Mean	29.857	29.324	9.902	10.371
		N	42	42	42	42
		Std. Deviation	7.2584	6.7162	3.5372	8.2109
	becs	Mean	23.054	21.975	5.538	2.971
		N	24	24	24	24
		Std. Deviation	5.5306	5.8256	1.5148	1.6817
	outils ecailles	Mean	23.959	20.204	8.131	4.344
		N	94	94	94	94
		Std. Deviation	5.3900	4.8565	1.9630	2.5307
	heavy duty tools	Mean	45.300	42.150	14.450	77.500
		N	2	2	2	2
		Std. Deviation	21.2132	30.9006	13.0815	104.9346
	other tools	Mean	38.600	24.800	7.800	4.500
		N	1	1	1	1
		Std. Deviation	.	.	.	.
	Total	Mean	23.404	20.369	6.257	3.821
		N	2524	2524	2524	2524
		Std. Deviation	8.0028	7.4369	2.5124	5.3337

Figure 6.1 Distribution of Toth Types by level.

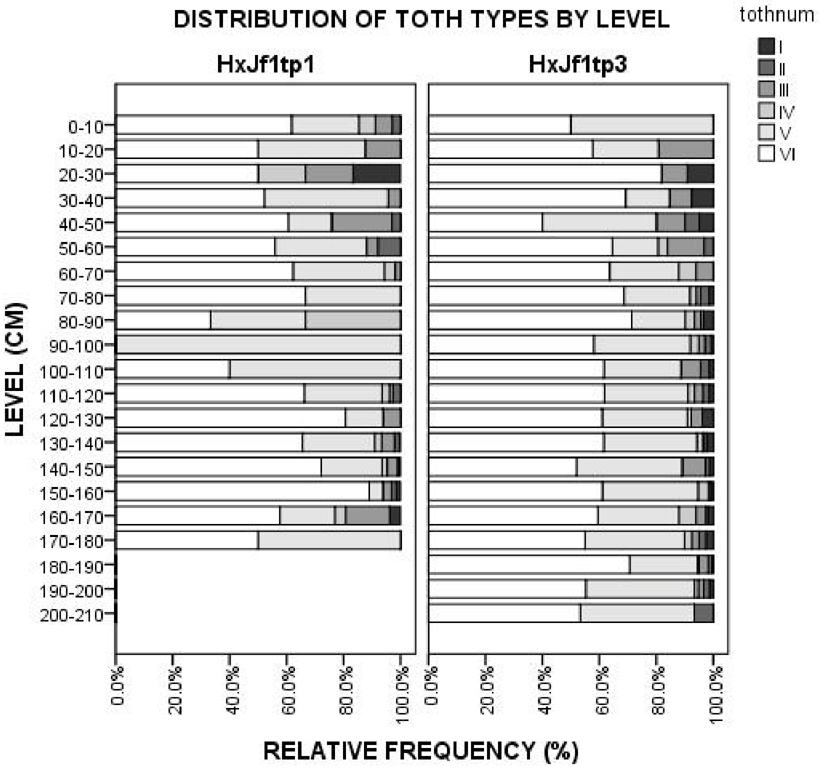


Figure 6.2 Distribution of planforms by level.

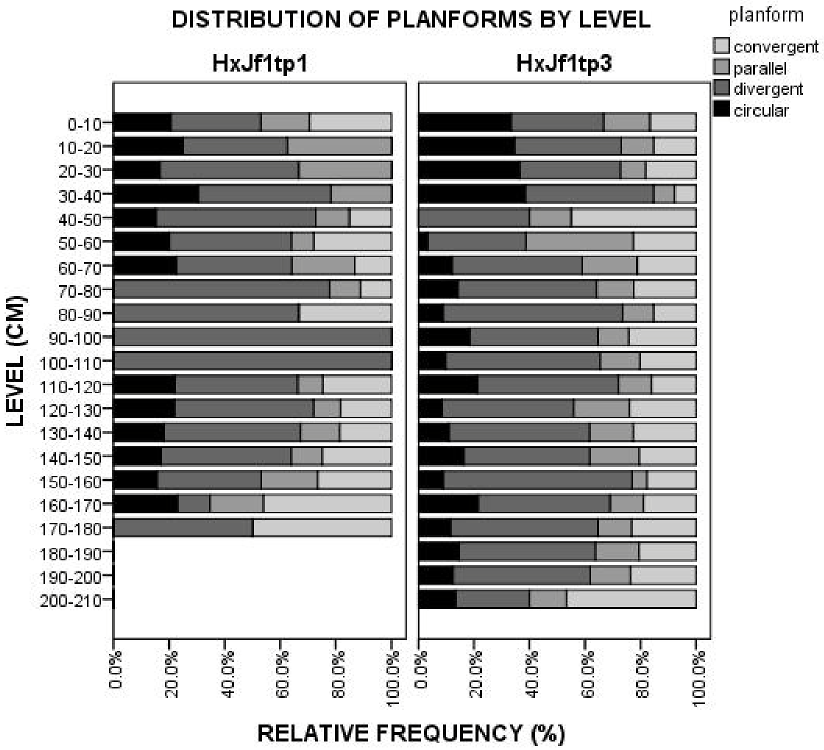


Figure 6.3 Distribution of planform among trimmed and whole flakes.

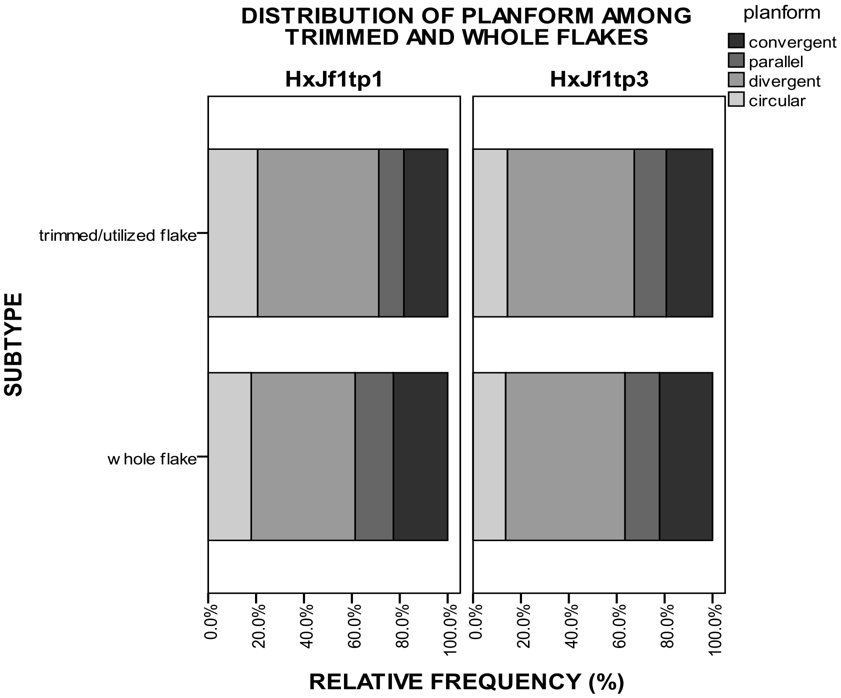


Figure 6.4 Distribution of dorsal scar patterns by level.

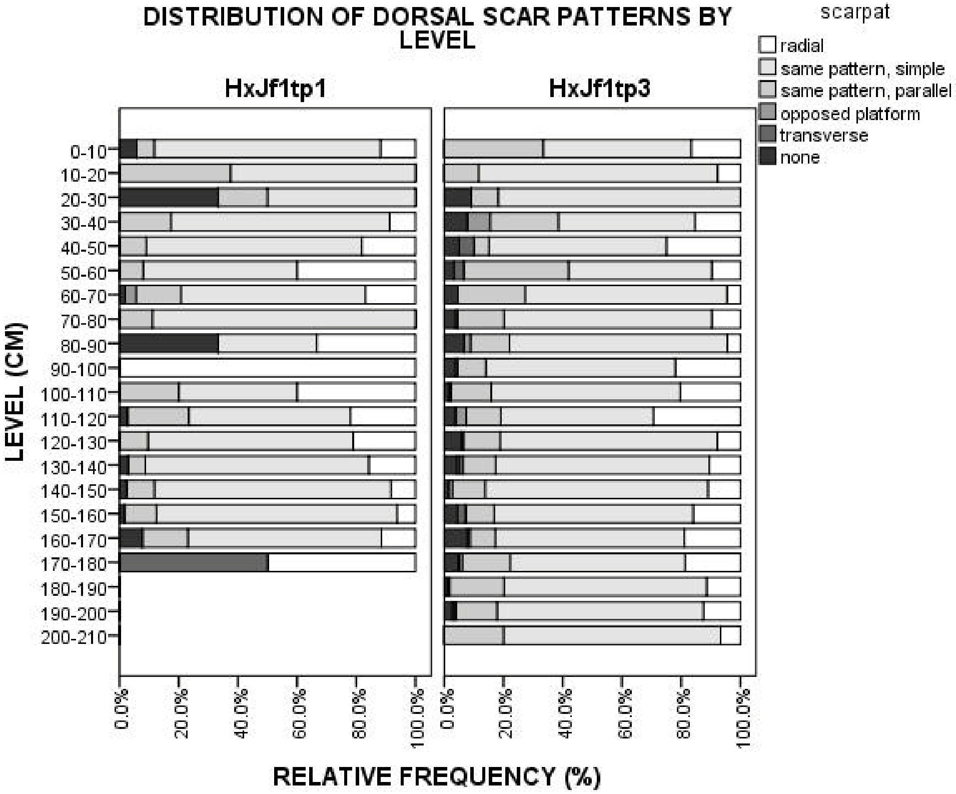


Figure 6.5 Distribution of dorsal scar number by level.

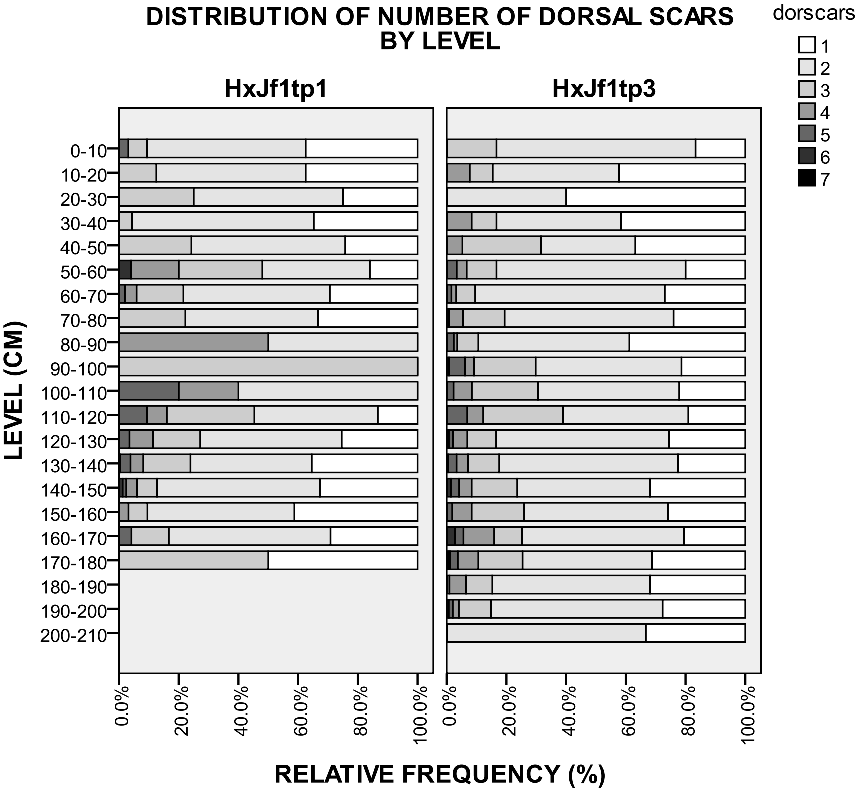


Figure 6.6 Distribution of number of platform facets by level.

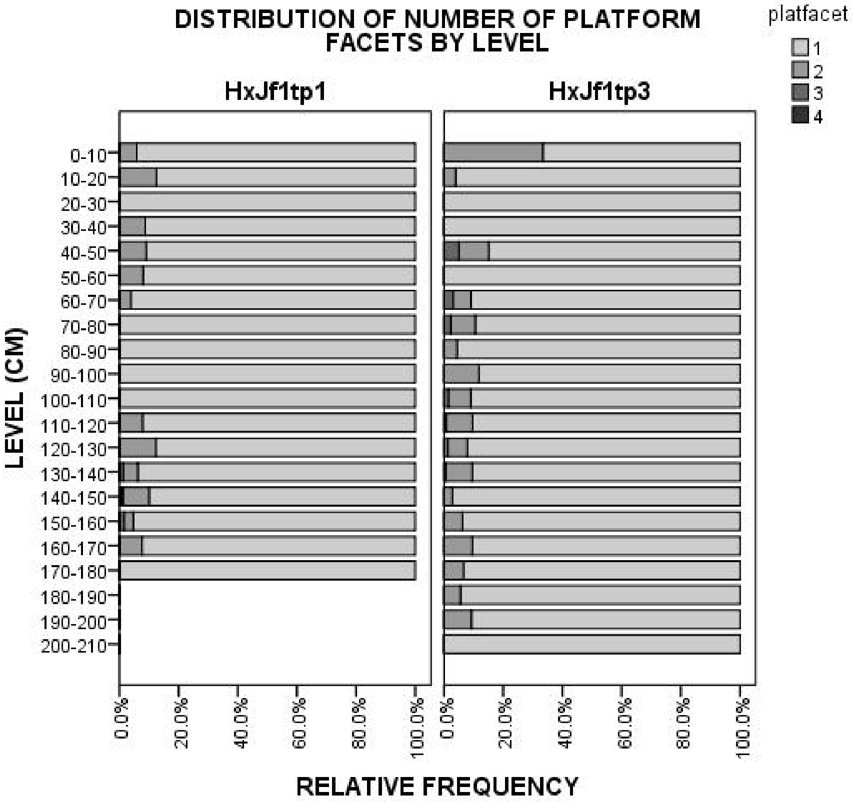
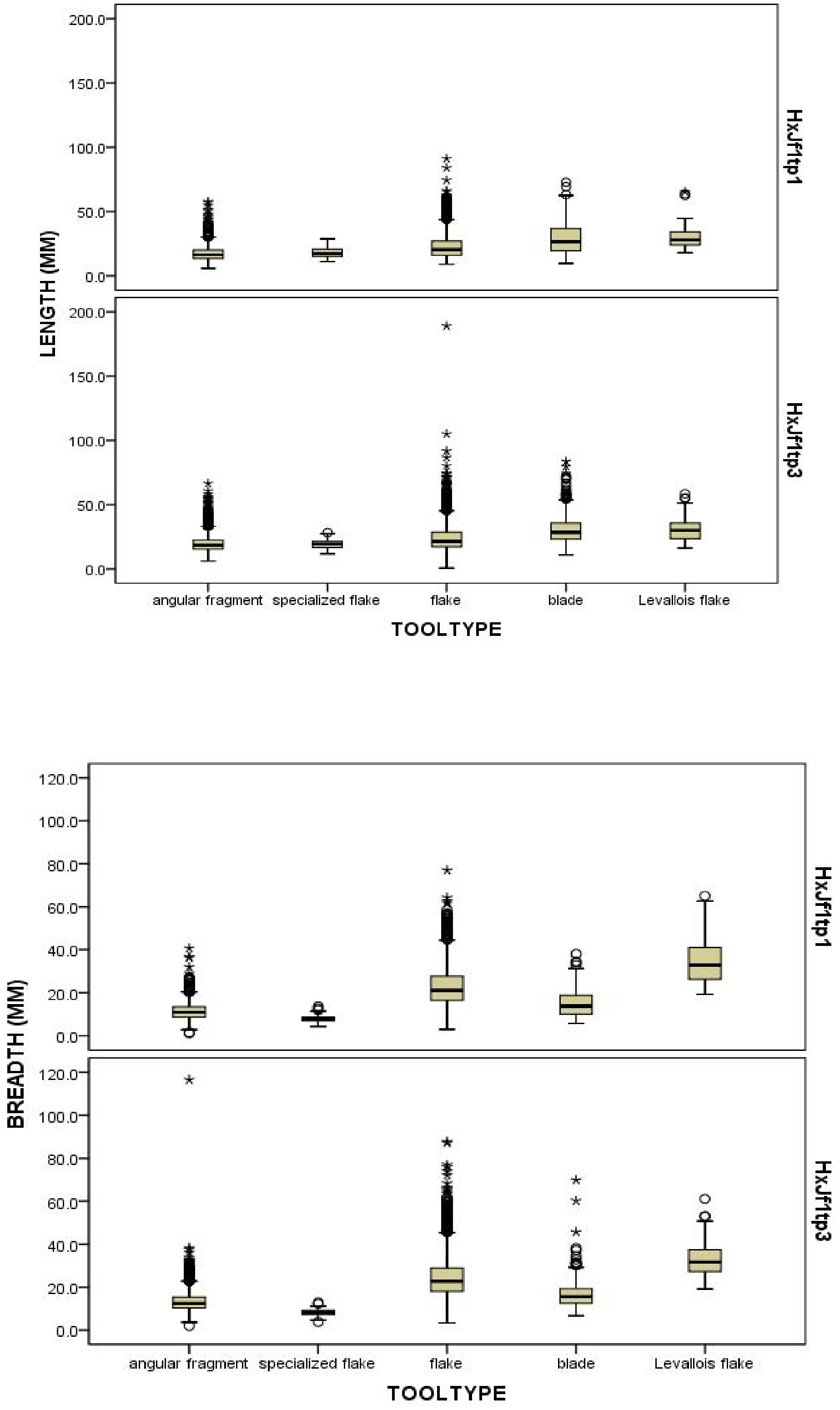
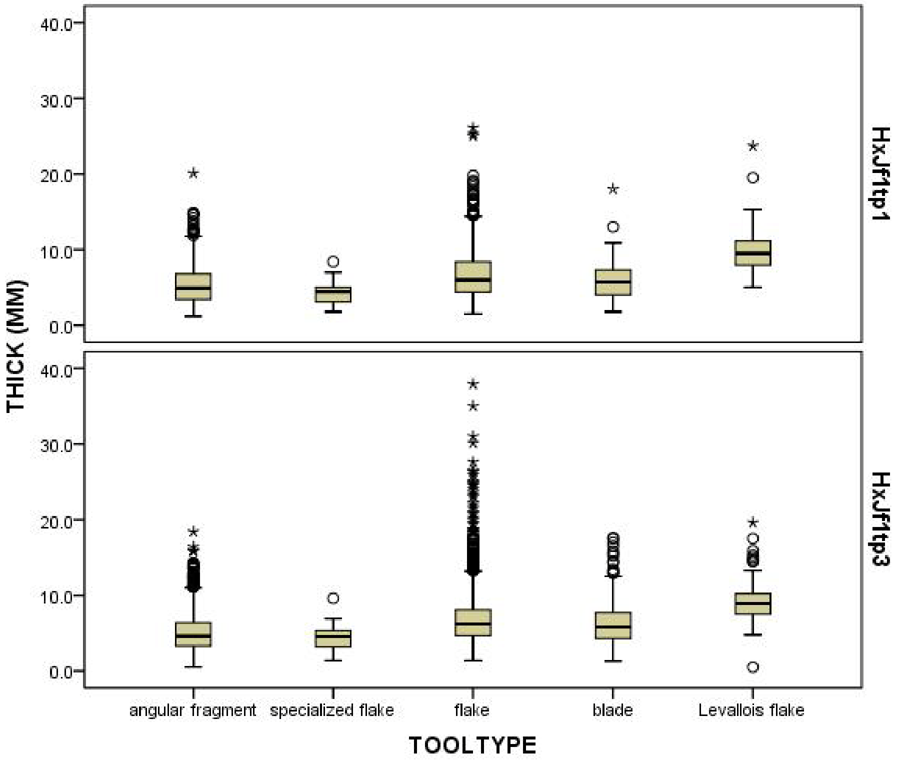


Figure 6.7 Size measurements for debitage.




THICK (MM)
40.0
30.0
20.0
10.0
0.0
HxJf1tp1
HxJf1tp3
angular fragment
specialized flake
flake
blade
Levallois flake
TOOLTYPE

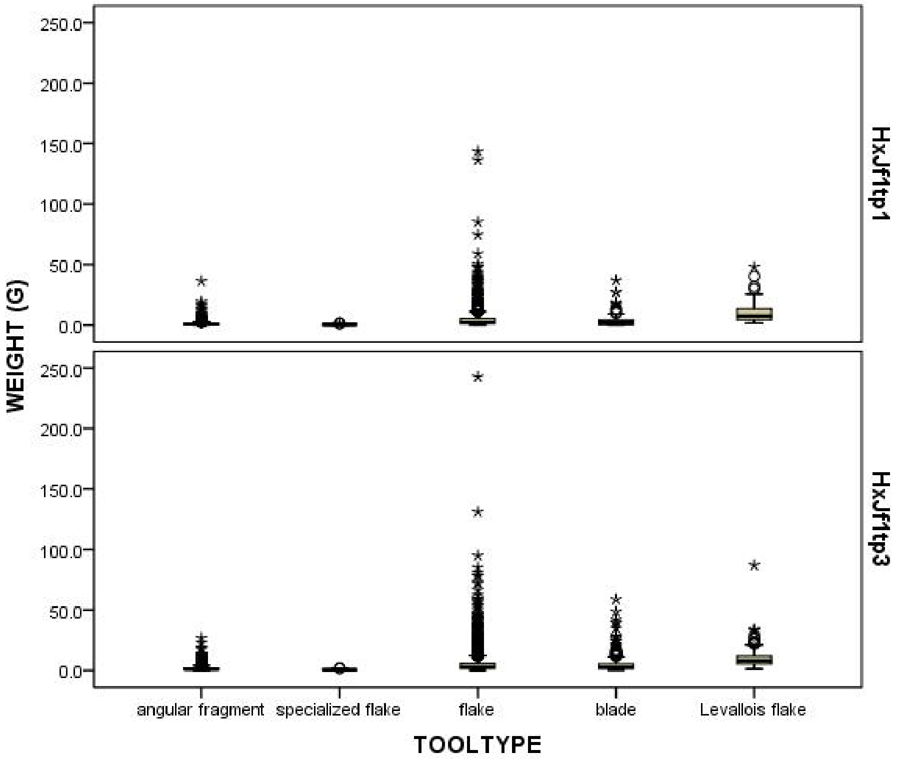
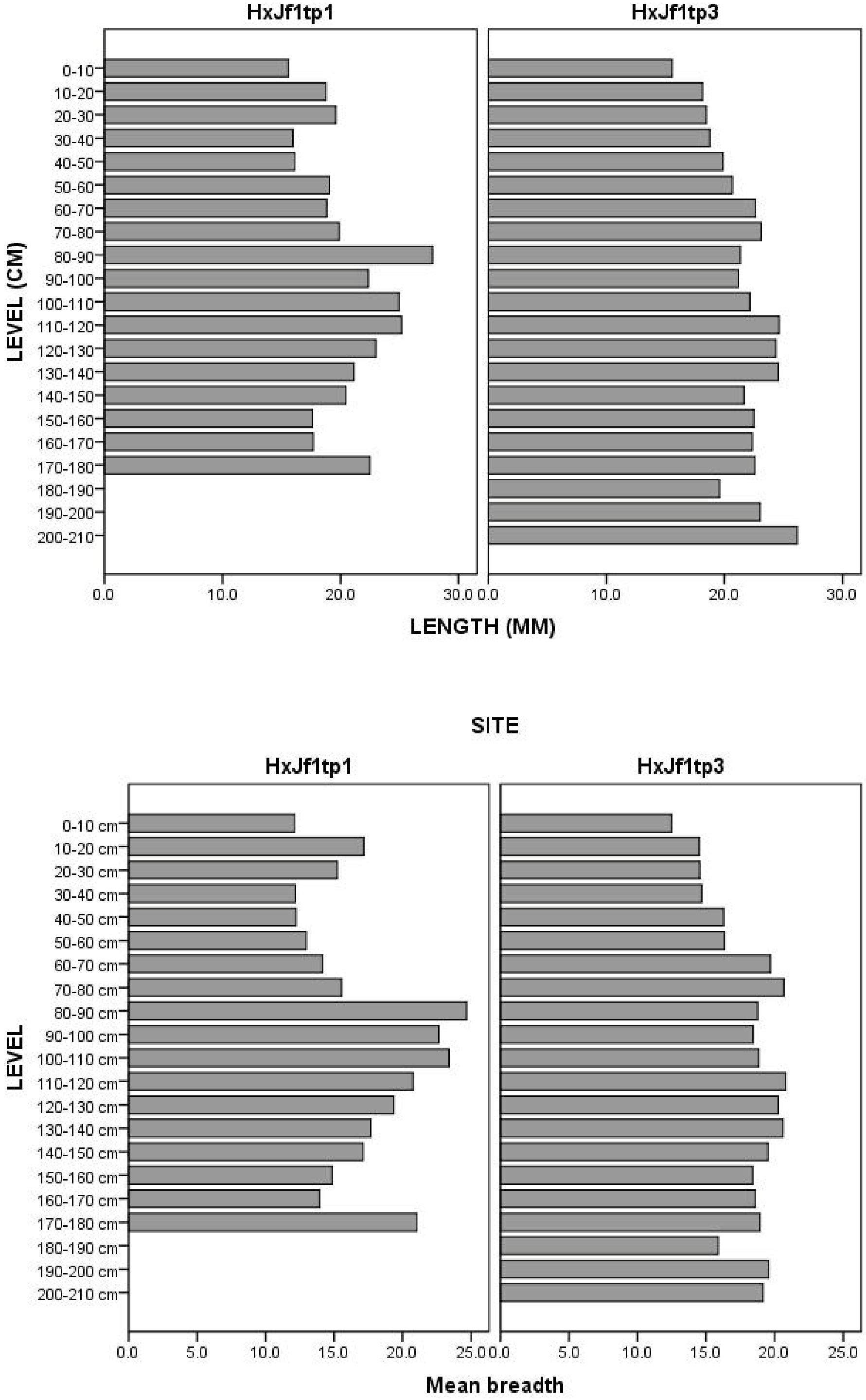
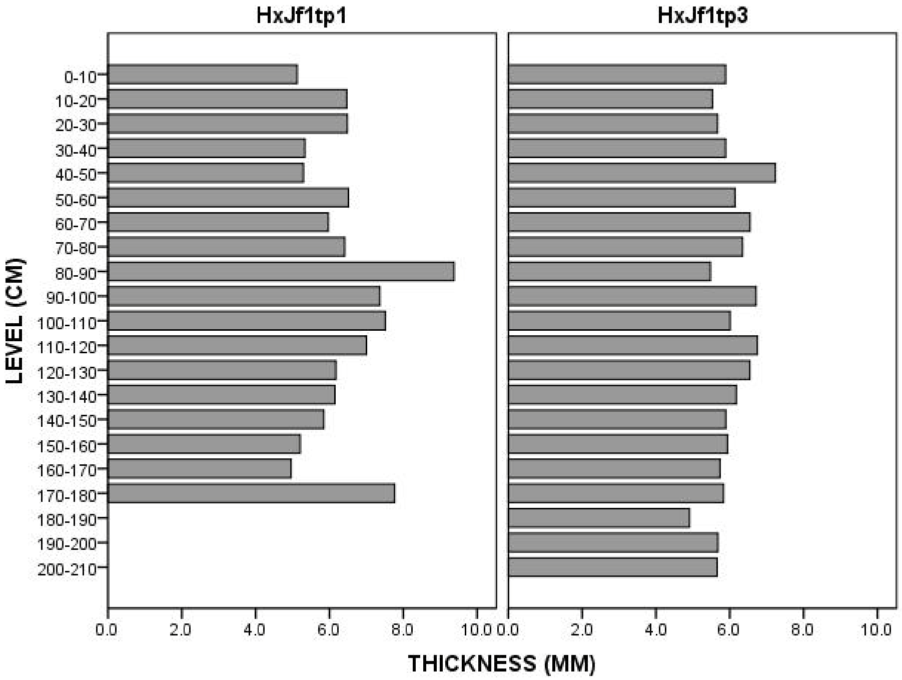

WEIGHT (G)
250.0
200.0
150.0
100.0
50.0
0.0
HxJf1tp1
HxJf1tp3
angular fragment
specialized flake
flake
blade
Levallois flake
TOOLTYPE

Figure 6.8 Mean size measurements for debitage by level.




HxJf1tp1
HxJf1tp3
LEVEL (CM)
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
100-110
110-120
120-130
130-140
140-150
150-160
160-170
170-180
180-190
190-200
200-210
0.0
2.0
4.0
6.0
8.0
10.0
THICKNESS (MM)

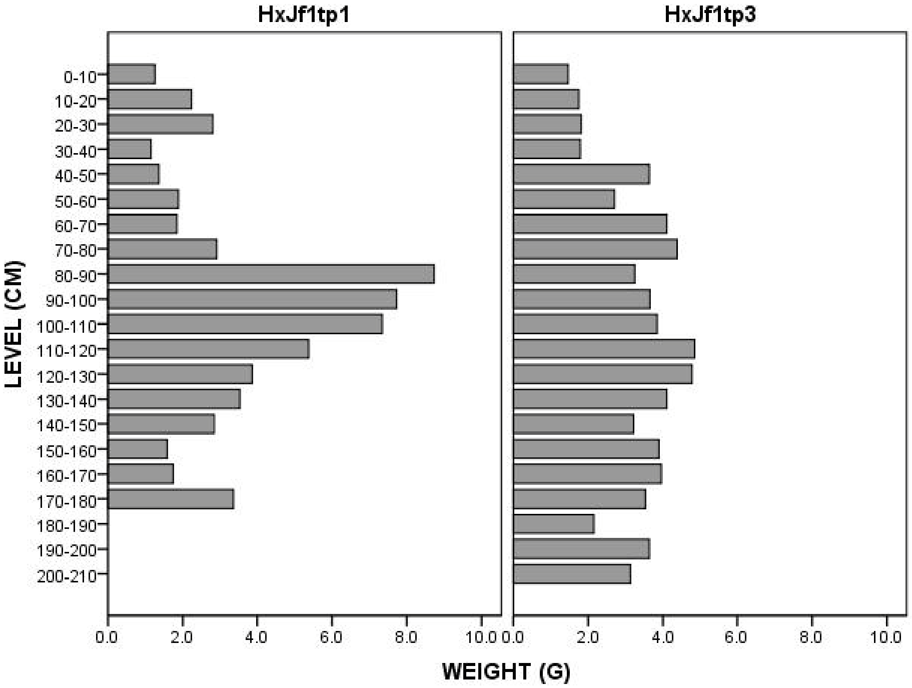

HxJf1tp1
HxJf1tp3
LEVEL (CM)
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
100-110
110-120
120-130
130-140
140-150
150-160
160-170
170-180
180-190
190-200
200-210
0.0
2.0
4.0
6.0
8.0
10.0
WEIGHT (G)

Figure 6.9 Distribution of cortex coverage by level.

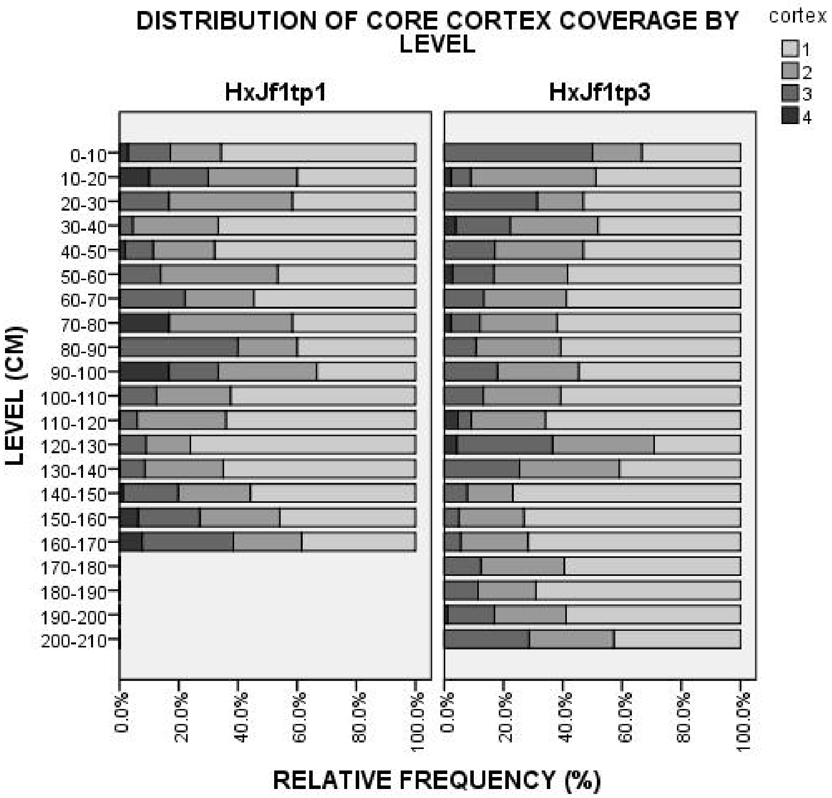
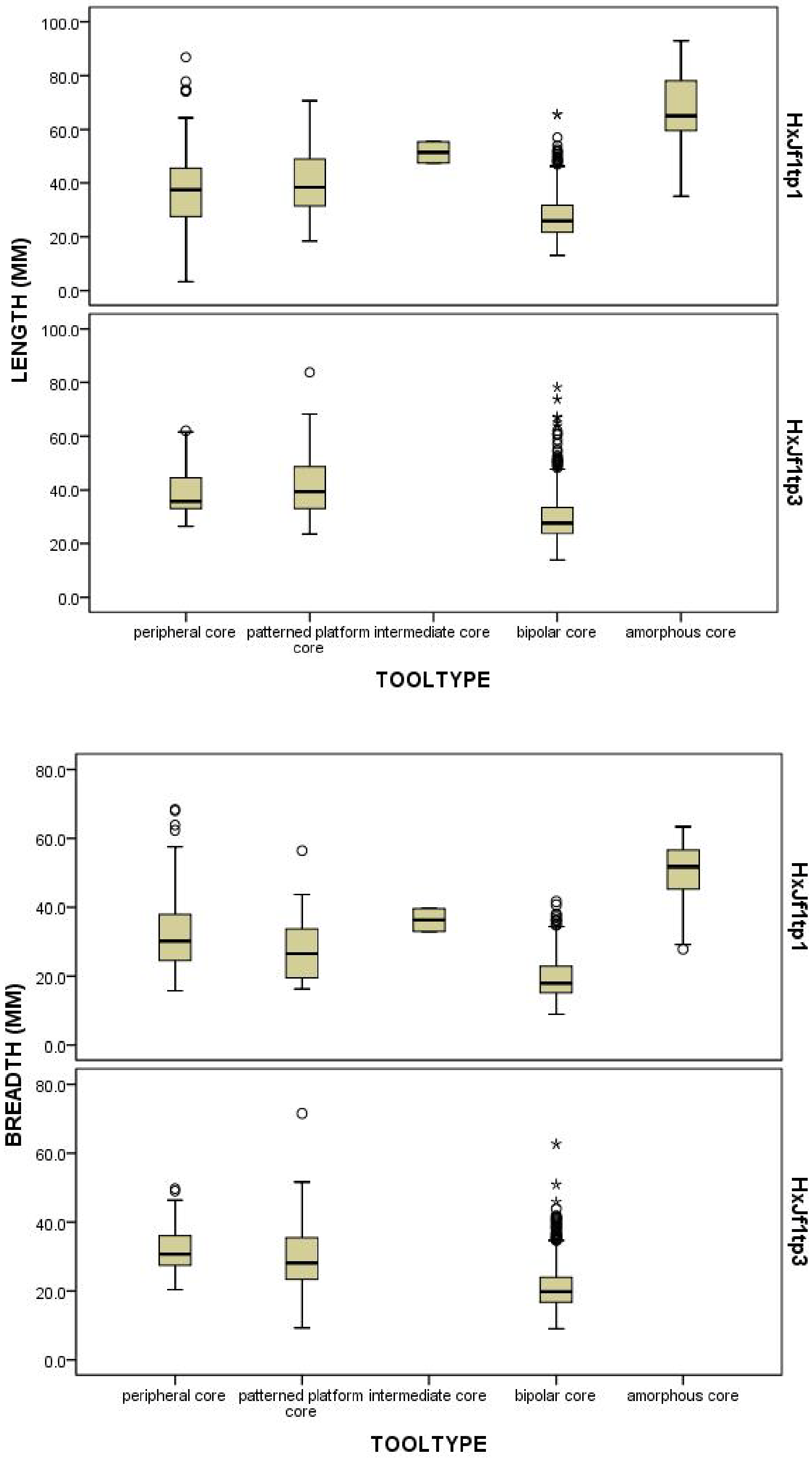
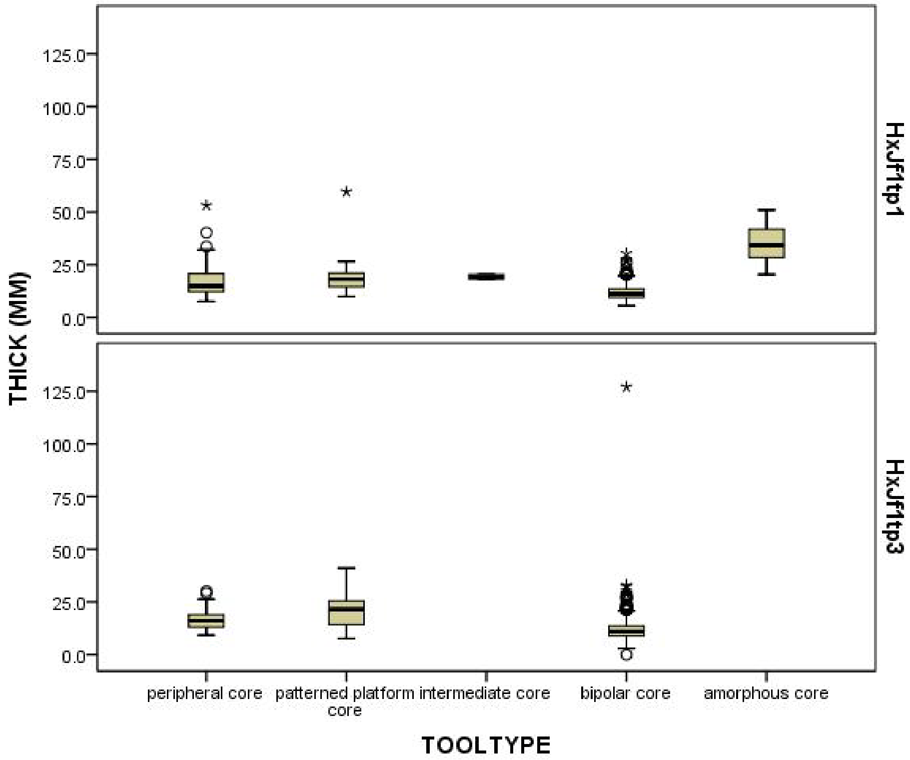


Figure 6.10 Size measurements for cores.




THICK (MM)
125.0
100.0
75.0
50.0
25.0
0.0
HxJf1tp1
HxJf1tp3
peripheral core
patterned platform core
intermediate core
bipolar core
amorphous core
TOOLTYPE

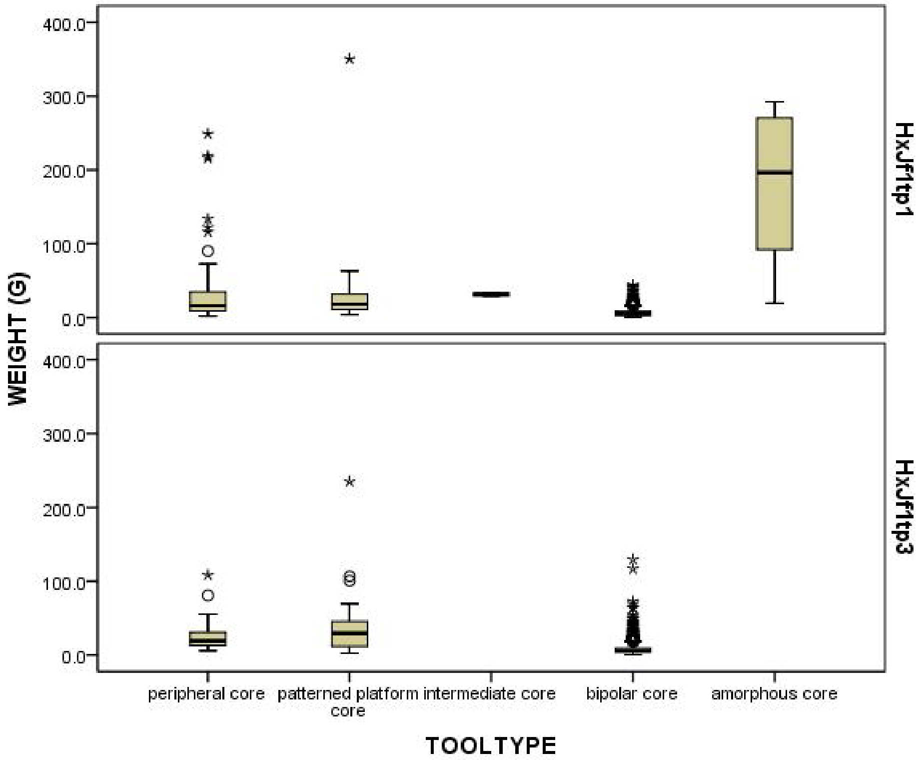
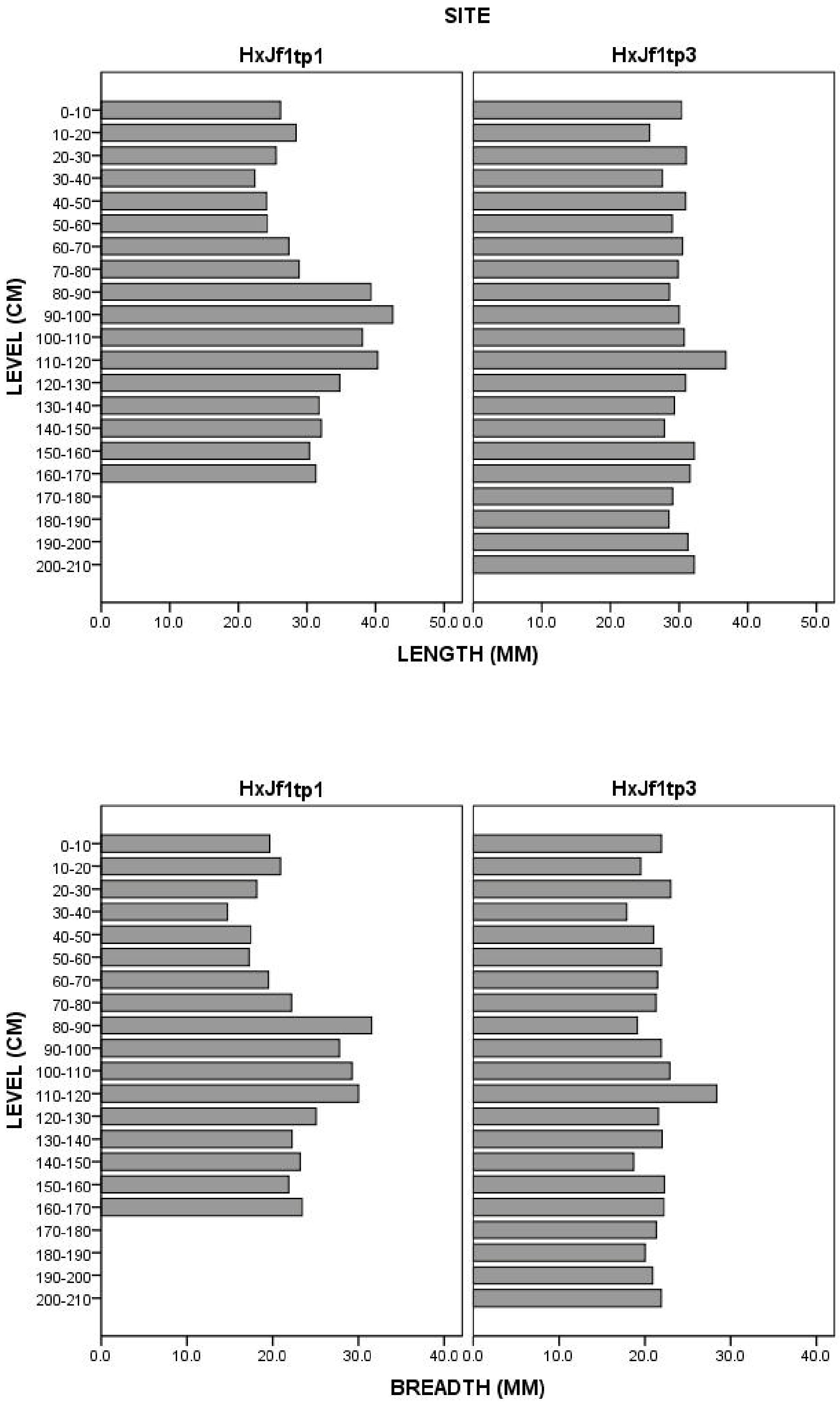
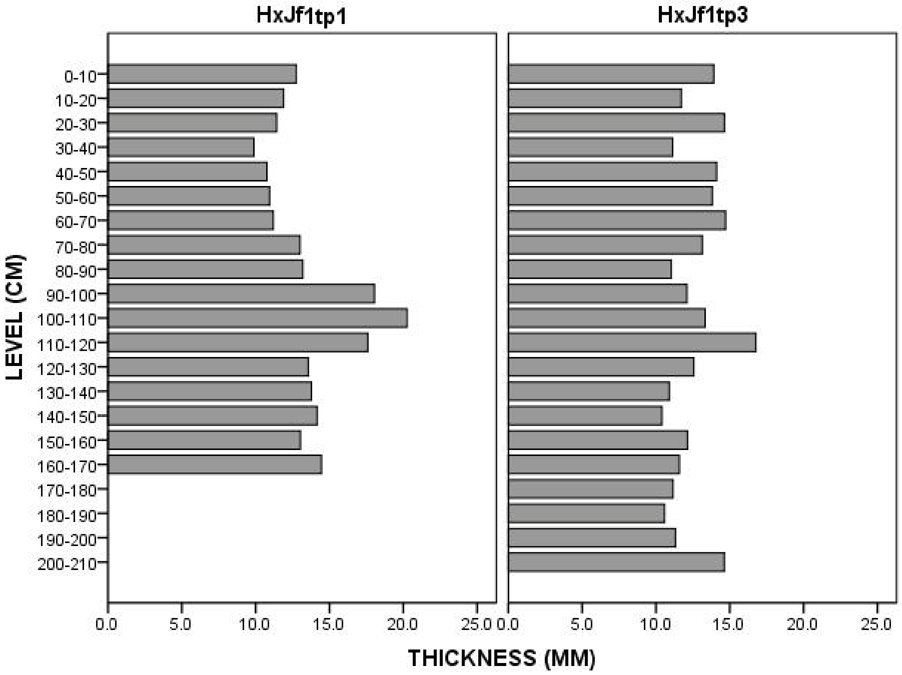

WEIGHT (G)
400.0
300.0
200.0
100.0
0.0
HxJf1tp1
HxJf1tp3
peripheral core
patterned platform core
intermediate core
bipolar core
amorphous core
TOOLTYPE

Figure 6.11 Mean size measurements for cores by level.




HxJf1tp1
HxJf1tp3
LEVEL (CM)
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
100-110
110-120
120-130
130-140
140-150
150-160
160-170
170-180
180-190
190-200
200-210
0.0
5.0
10.0
15.0
20.0
25.0
THICKNESS (MM)

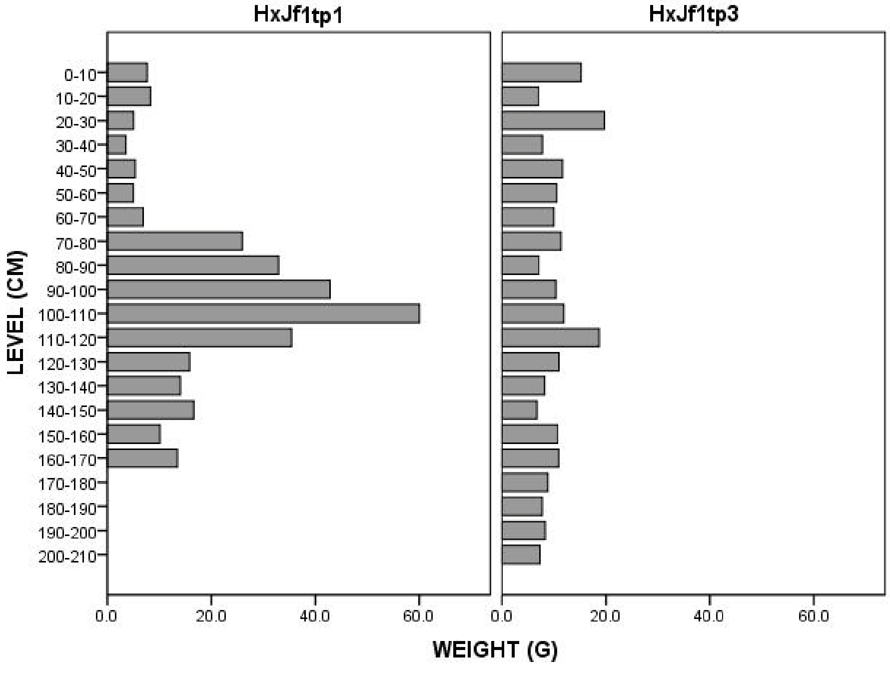
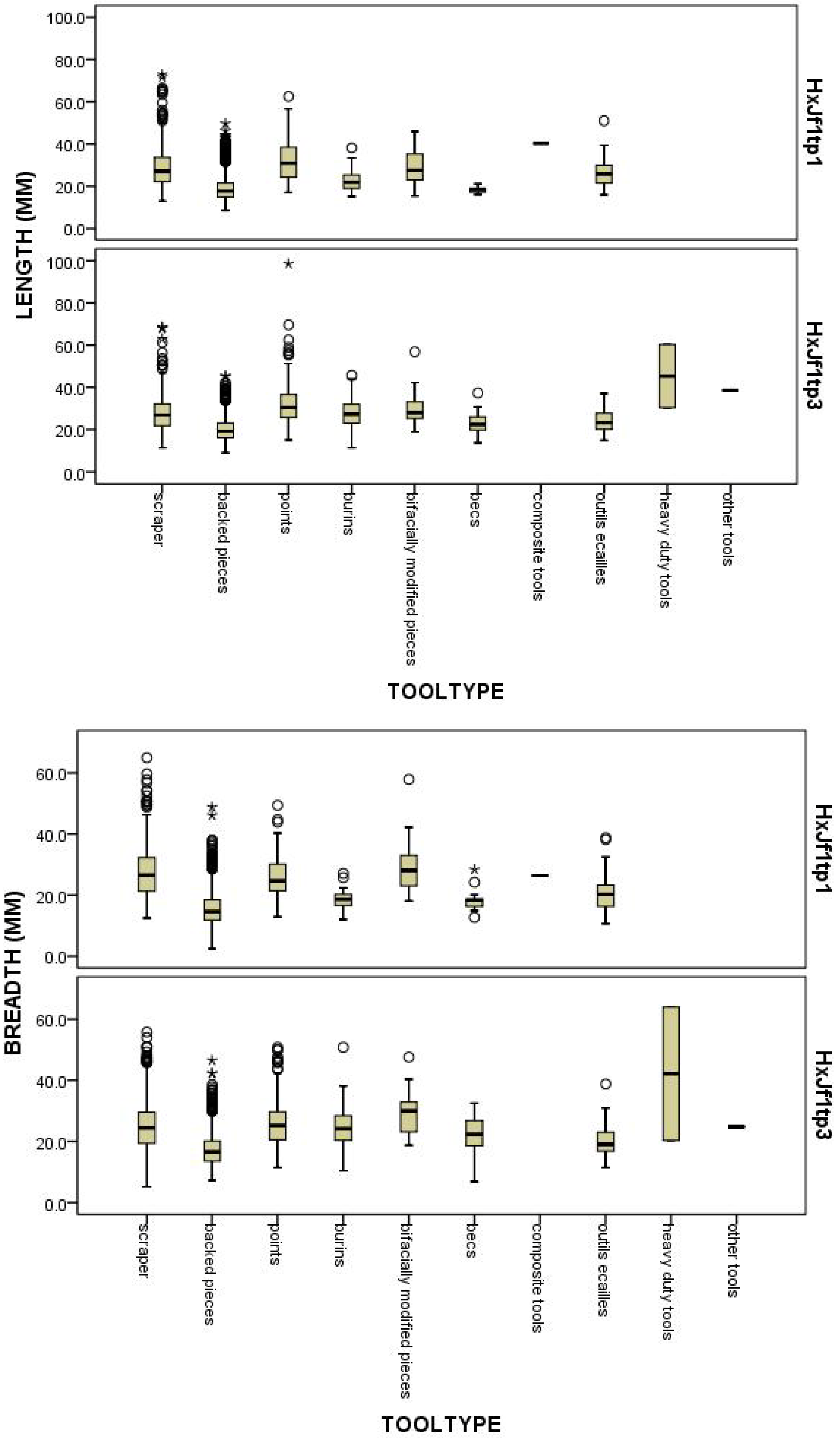
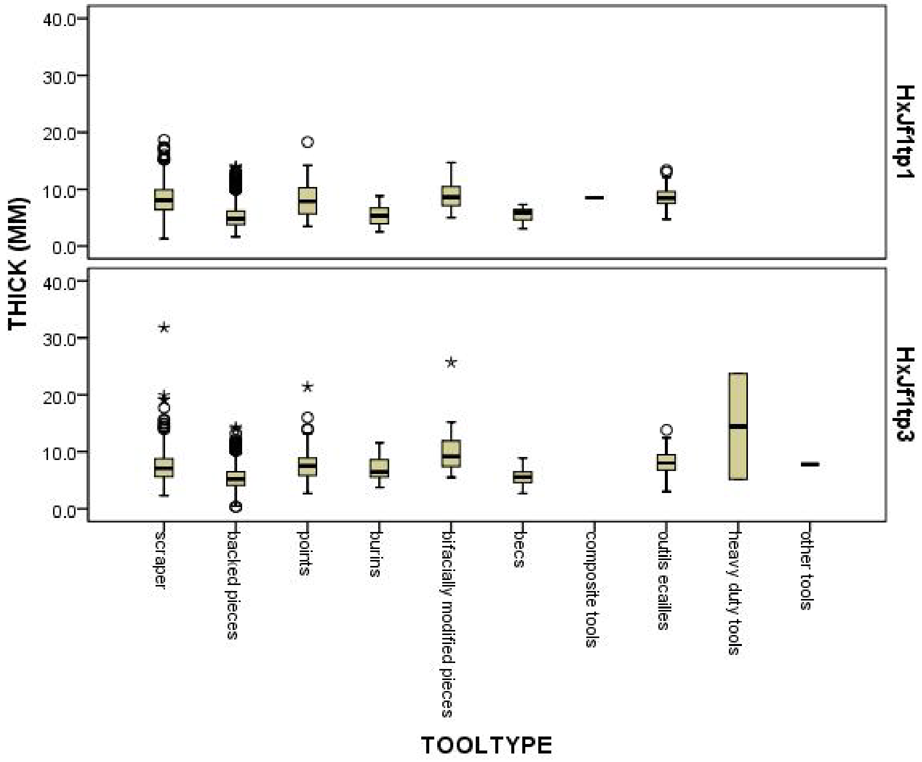

HxJf1tp1
HxJf1tp3
LEVEL (CM)
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
100-110
110-120
120-130
130-140
140-150
150-160
160-170
170-180
180-190
190-200
200-210
0.0
20.0
40.0
60.0
WEIGHT (G)

Figure 6.12 Size meausurements for trimmed pieces.




THICK (MM)
0.0
10.0
20.0
30.0
40.0
HxJf1tp1
HxJf1tp3
scraper
backed pieces
points
burins
bifacially modified pieces
becs
composite tools
outils ecailles
heavy duty tools
other tools
TOOLTYPE

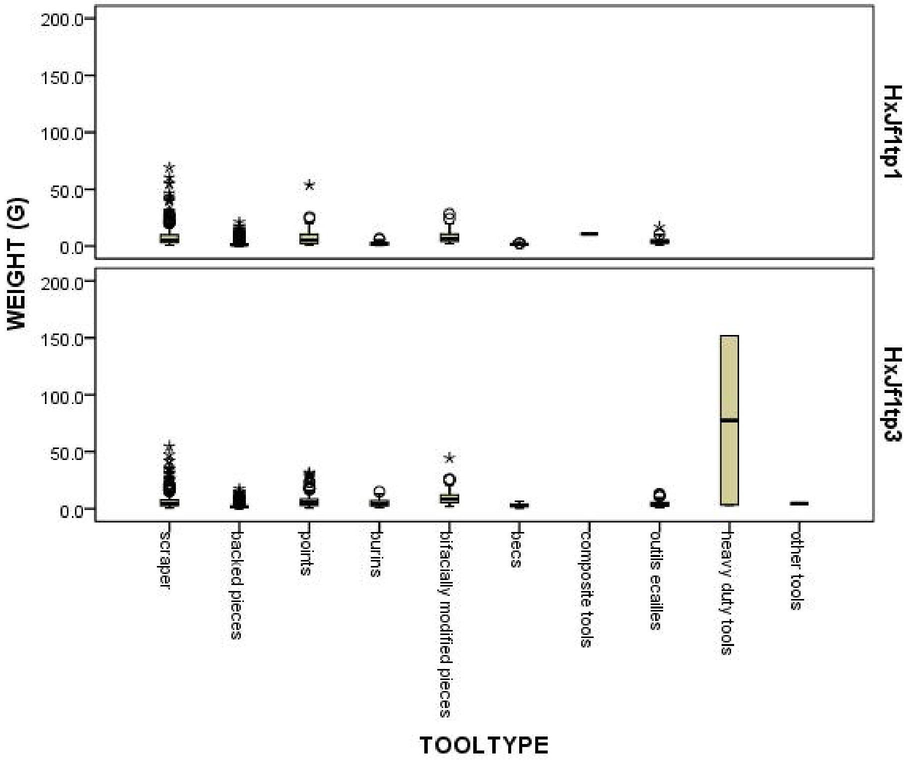
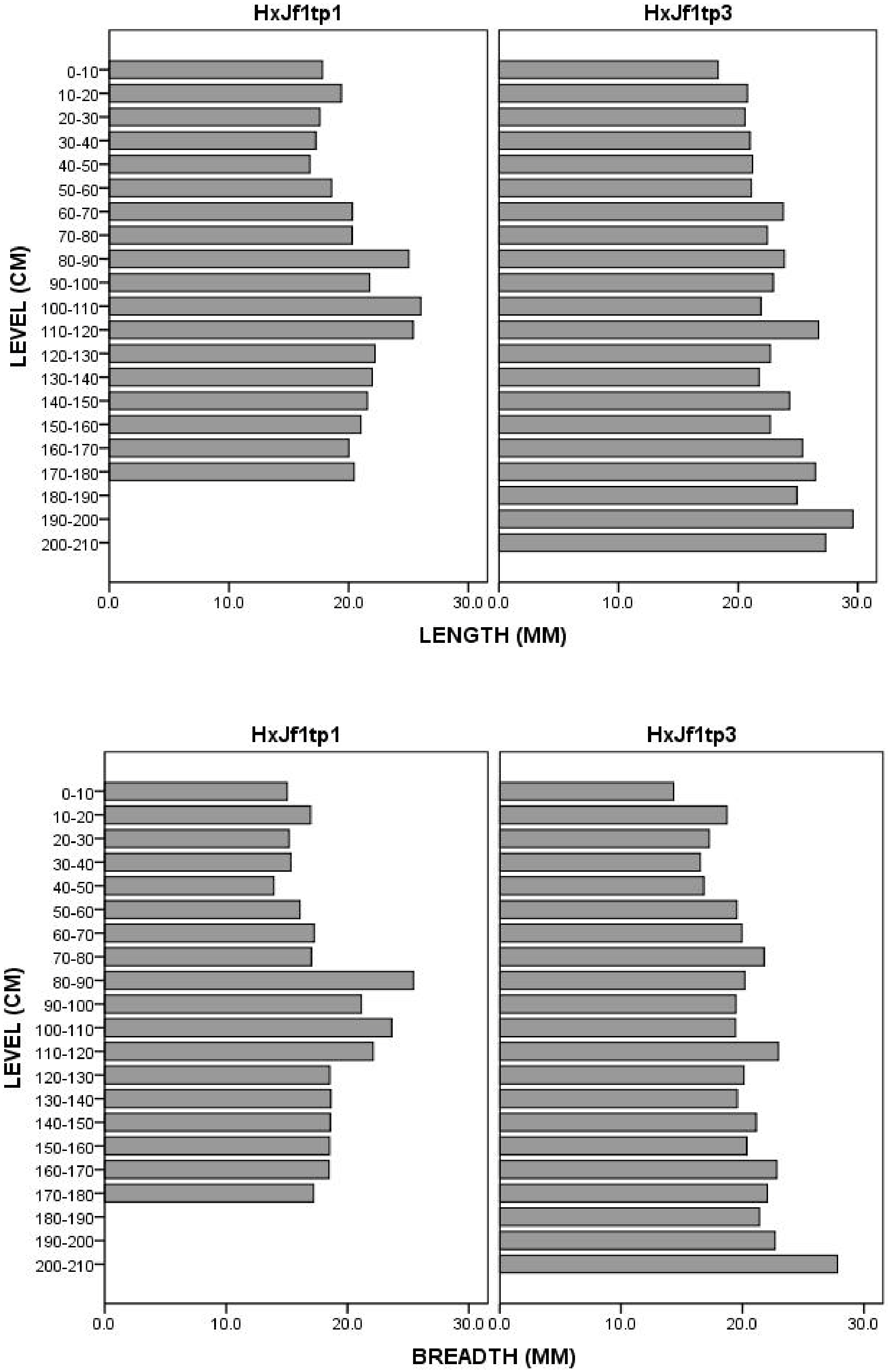
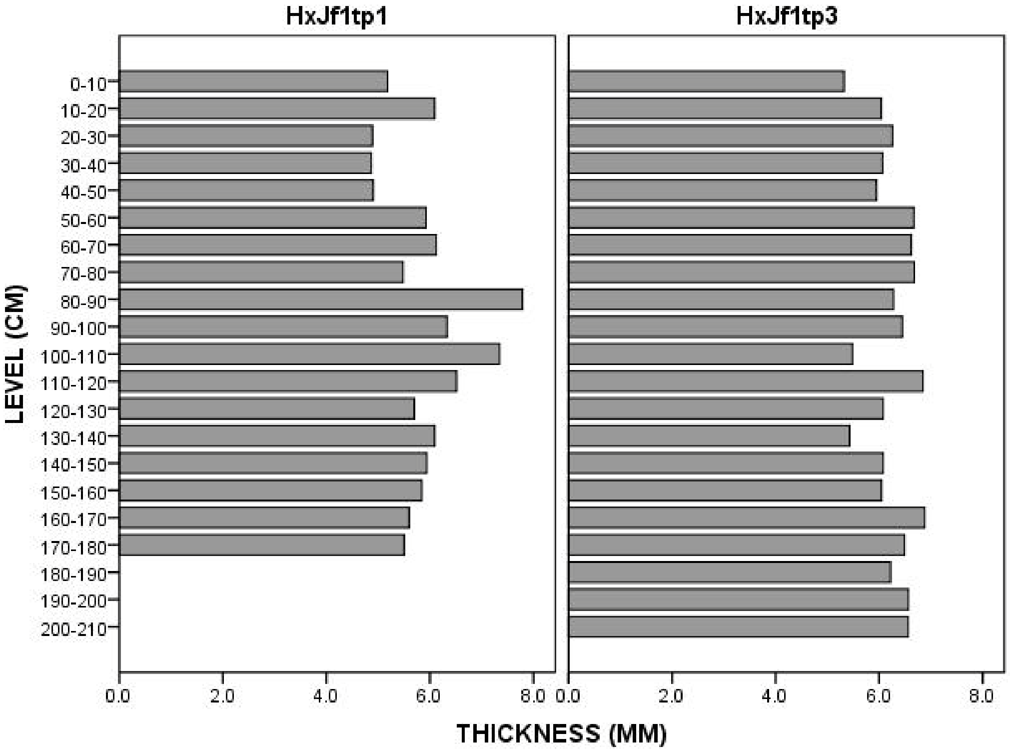
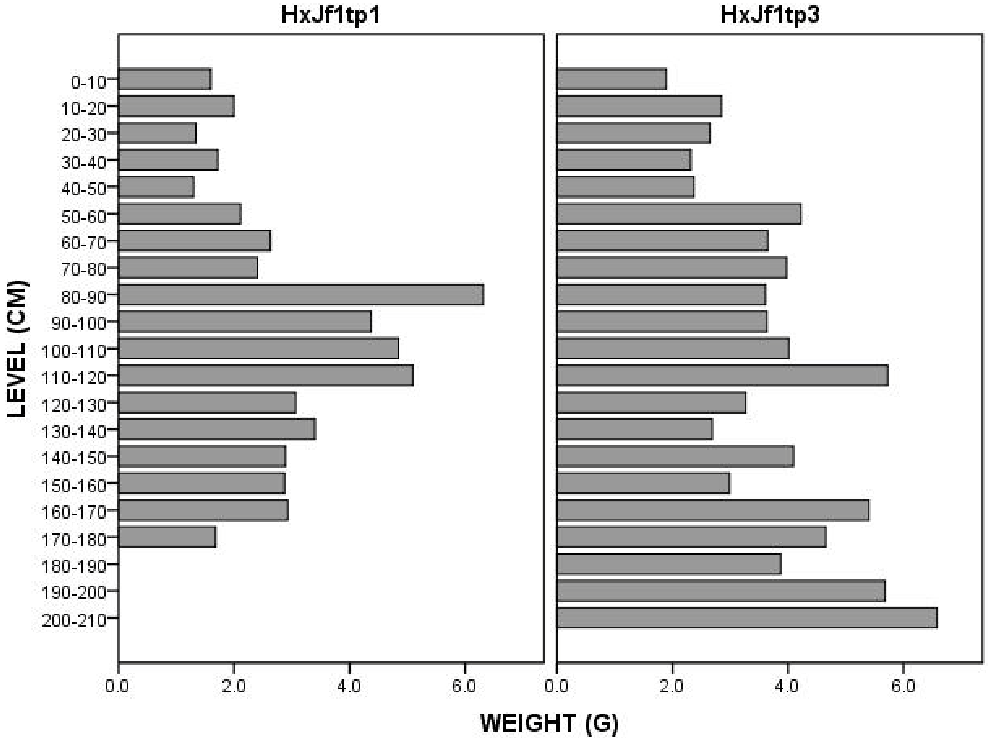

WEIGHT (G)
0.0
50.0
100.0
150.0
200.0
HxJf1tp1
HxJf1tp3
scraper
backed pieces
points
burins
bifacially modified pieces
becs
composite tools
outils ecailles
heavy duty tools
other tools
TOOLTYPE

Figure 6.13 Mean size meausrements for trimmed pieces by level.




HxJf1tp1
HxJf1tp3
LEVEL (CM)
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
100-110
110-120
120-130
130-140
140-150
150-160
160-170
170-180
180-190
190-200
200-210
0.0
2.0
4.0
6.0
8.0
THICKNESS (MM)


HxJf1tp1
HxJf1tp3
LEVEL (CM)
0-10
10-20
20-30
30-40
40-50
50-60
60-70
70-80
80-90
90-100
100-110
110-120
120-130
130-140
140-150
150-160
160-170
170-180
180-190
190-200
200-210
0.0
2.0
4.0
6.0
WEIGHT (G)

Chapter 7: Discussion and Conclusion

This thesis presents and analyzes typological and technological data for lithics from 1m^2 test pits at Magubike excavated in the 2006 field season. The goal of the work is two-fold: first, to develop a localized, tentative cultural historical sequence based on the Magubike data, and second, to use the data to understand the lithic technological systems people employed at Magubike, particularly in the Middle Stone Age. The MSA is critical in paleoanthropology as the time and technology associated with the emergence of anatomically modern humans, and the MSA of the Iringa region has not been documented prior to Willouhby's efforts (Willoughby 2006a, 2006b, 2005), except at the Isimila Stone Age site. Technological and typological attributes were examined overall and by excavation level to determine any changes in the technological adaptations over time, to identify chronologically diagnostic occurrences that allow for a localized cultural historical framework to be constructed. The typology employed was designed by Mehlman (1989) and is based on previous typologies used in East Africa. It was used in order to facilitate comparisons between the data presented here and the data from Mehlman's sites in northern Tanzania. Technological variables provided additional information that allowed for basic assessment of site use and mobility. Magubike yielded archaeological materials including lithics, pottery, fauna, shell, iron and ochre (Table 7.1). The lithics and associated materials provide evidence that these deposits belong to the Middle Stone Age, possible mixed Later Stone Age/Middle Stone Age, Later Stone Age, and Iron Age in TP1 and Middle Stone Age and Iron Age in TP3 (Figure 7.1).

7.1 Culture History at Magubike

Density patterns of artefacts with depth may indicate the length or frequency of occupation. However, prior to inferring occupational intensity from artefact densities, sedimentation rates and site formation processes must be thoroughly investigated (Barut 1994). Factors affecting preservation are not only cultural, biological or chemical in nature, but also include time (Behrensmeyer and Kidwell 1985). Furthermore, the sedimentation process varies widely through time and space (Stern 1993). However, Stern (1993) states that time-averaging can be estimated through the application of standard geological methods to archaeology-bearing sediments. Currently, the temporal resolution of Magubike is unknown, but generally, rockshelters feature very low resolution due to repeated and variable episodes of occupation and mixing due to anthropogenic and natural causes combined with low sedimentation rates (Balet and Galanidou 2009). G.A. Clark (1988: 30) states, “Pleistocene archaeological sites…are never ‘little Pompeiis’ where site contextual resolution and integrity are high enough so that identity-conscious social units could theoretically be identified.” Despite this, archaeological data from deposits with low resolution are still useful as an indicator of generalized, long-term trends or average tendencies (Balet and Galanidou 2009).

The Iron Age is indicated by the presence of pottery, iron slag, ochre, and perseveration of organic materials such as bone and shell. In TP1, pottery was recovered from between 0-30 cm, and iron from 0-10 cm. Bone and shell were recovered from 0-70 cm. Ochre was recovered sporadically from levels between 0-70 cm. In TP3, pottery was recovered from between 0-30 cm, as well as 0-40 cm and 50-60 cm in the adjoining TP2, the lithics of which were not included in the analysis presented in this thesis. The levels 0-30 cm and 40-50 cm in TP2 and 0-40 cm in TP3 also yielded iron slag. During this time, the raw material of choice for lithic production is quartz locally available within 1 km of the site.

Between 50-70 cm, not many changes occur in the lithics besides an increase in the utilization of quartzite. The lithics are no longer associated with ceramics and iron slag, although bone and shell is still present, suggesting these levels probably reflect the LSA. This is followed by a significant decrease in artefact density, which may reflect mixed MSA/LSA or MSA, at 70-110 cm. This contrasts starkly with the sequence in TP 3, in which the Iron Age directly overlies the MSA with no LSA or LSA/MSA levels in between. Despite their proximity, this evidence indicates TP1 possibly underwent different formation processes than TP2 and TP3, and this is further supported by the differential organic preservation at the site, which will be addressed below.

The MSA appears around 110 cm in TP1 and continues until bedrock at 180 cm. In TP3, the MSA begins around 60 cm, and continues until bedrock at 210 cm. TP3 featured organic preservation throughout, in contrast with TP1 which only yielded organic material in the top 70 cm. Despite this difference, these levels in both test pits are characterized by the presence of Levallois technology, a higher frequency of points and scrapers, and the use of a greater variety of raw materials , including those of higher quality, than can be observed in later periods, particularly metamorphic and chert/flint. In particular, Levallois technology has a very clear distribution in TP1 and TP3 at Magubike (Figure 7.2). In TP1, products of Levallois technology- points, flakes, and/or cores- are found in every level between 100-170 cm. That is, Levallois technology appears at 100 cm, and remains until the next-to-last level before hitting the bedrock. In TP3, it is also found throughout the MSA deposits.

However, throughout all time periods present, the primary mode of lithic reduction is the bipolar technique. Bipolar reduction, in which a core is placed on an anvil and then struck with a handheld hammer (Debénath and Dibble 199), is found throughout all regions of the world during all times (Andrefsky 1998). It can be employed as an expedient technology on local materials, and it is also a means of conserving non-local, high-quality materials. Bipolar reduction facilitates full use of any small, intractable raw materials at the expense of reduced control over flake morphology, since it produces a lot of shatter with high morphological variability (Barut 1994; Barham 1987; Andrefsky 1998). This may explain why there is no strongly discernible pattern in variation in the size of flakes over time. Although preferences for tool types changed, the initial process of creating flakes to make those tools displays continuity. Bipolar reduction is also utilized in the making of small tools as a response to the poor quality (and perhaps small nodule sizes) of locally available raw material, such as quartz (Barut, 1994).

Despite this continuity in lithic reduction method through time, it appears the MSA deposits in TP1 and TP3 differ in noteworthy ways. While both feature the use of a greater variety of raw materials than overlying deposits, the relative frequencies of these raw materials differ considerably. In TP1, with the exception of quartz, chert/flint is the most common raw material followed by metamorphic materials. However, in TP3, this relationship is reversed, and furthermore, quartz contributes less to the overall distribution compared to TP1. Not only this, but the abundant metamorphic materials appear visibly different. In TP1, they are very light coloured, in stark contrast to the dark coloured rocks from TP3, even though both materials are metamorphic. Although this information is not visible in the data presented here, it is an important and interesting fact that will be addressed in a future study (PhD dissertation by Katie Biittner) that will provide an in-depth analysis of the raw materials in order to source them. The MSA encompasses tens of thousands of years, and it is quite possible these reflect different occupations within the MSA. In fact, each of these deposits likely reflects many different occupations and thousands of years. For example, although what is found between 60-210 cm in TP3 is very similar for the most part, the 100-110 cm level is noteworthy for a drop in the use of metamorphic materials which are prevalent throughout the rest of the deposit. This could reflect a period of time in which these raw materials were perhaps not available, so quartzite was utilized to a greater extent instead, due to perhaps a change in mobility patterns in which the source was no longer embedded..

However, while it is clear that MSA lithics are present at the site, it is unclear how intact these deposits are. The high number of backed pieces, normally associated with LSA assemblages, suggests the possibility of vertical disturbance. Also, even in the lower levels, most trimmed pieces are made of quartz despite it not being the dominant material, particularly backed pieces that dominate younger lithic assemblages; even though quartz accounts for most scrapers, a higher frequency of other raw materials was utilized in making them compared to backed pieces.

Other evidence, such as the location of TP1 in the path of a possible ephemeral stream and the concretions formed on the surface of many of the artefacts associated with the MSA, indicate possible post-depositional disturbance such as the presence of water moving down through the deposit, perhaps contributing to the downward movement of smaller artefacts such as small backed pieces. Furthermore, the gravel in TP1 appears to be disintegrating bedrock, and as the bedrock breaks down, artefacts may be moving down through the unconsolidated gravel. Bioturbation may have also played a role in displacing artefacts as well, as many roots were observed in the upper levels of TP1. Another possibility is that the artefacts were periodically reworked in place while accumulating. It must be kept in mind that these layers are obviously very compacted.

7.2 Implications for origins of behavioural modernity debate

Initially, it was believed the MSA assemblages at Magubike suggested the possibility that the MSA inhabitants were utilizing raw material sources from a long distance either via trade or exchange networks, or as a result of their own mobility, as opposed to later inhabitants who depended on the locally available quartz. MSA hominids were once thought to rely on more readily available materials than their LSA and later counterparts, and this was believed to be an indication of less sophisticated cognitive skills. However, some sites have contained obsidian artefacts known to originate more than 200 km away, and it is increasingly evident MSA hominids in fact did access lithic raw material resources over long distances. For example, obsidian artefacts at Nasera rockshelter have been sourced to 240 km away, while similar artefacts at Mumba come from a source 305 km away (Merrick et al. 1994).

Although extensive surveying in Iringa and Mbeya regions did not reveal possible raw material sources of the abundant metamorphic materials, geological maps indicate a possible source is within 10 km of the site (Biittner, personal communication, 2010). This leads to the interesting question of why Iron Age and possibly LSA people did not utilize the higher quality material that MSA people preferred, given its close proximity to the site. It may reflect decreased territory sizes and social boundaries, perhaps due to population increases, and subsequent decreased territories and more limiting social boundaries, or a preference for small, sharp quartz tools which were inserted into handles. Although the poor quality of quartz limits control of the material when knapping, it does produce a comparably sharp edge.

The differences observed between the two test pits also provide a point of interest. Temporal and spatial variability has been demonstrated to exist throughout the MSA of sub-Saharan Africa, and here is an instance of intra-site variability, probably reflecting temporal variability at the site of Magubike within the MSA. The raw material distribution may reflect differential access to raw materials at different periods within the MSA, for possible reasons such as different mobility patterns which may be due to environmental or social factors. While the high number of backed pieces may be attributed to vertical disturbance, it is possible some of the pieces are in fact from the MSA, such as macrolithic geometric pieces, which are found in some other MSA assemblages such as the Lupemban Industry.

Perhaps most directly pertinent to the issue of behavioural modernity is the occurrence of a shell bead, recovered from the lower levels of TP1. Such personal adornments may have been used to establish cultural identity. Although only one bead has so far been recovered, and the organic component of the oldest levels was more fragmentary than that of the overlying layers, if Magubike contains additional shell beads it will become an indispensable site for furthering our understanding the origins of behavioural modernity.

7.3 Issues in this study

In order to make the best use of archaeological data, it is necessary to consider various constraints on research, in particular, problems or issues that might affect the collection of data and subsequent interpretations. Some retrospective concerns of this study include the use of arbitrary levels, Mehlman's typology, and the statistical methods employed.

An issue with the arbitrary levels utilized in these test excavations is the possibility of cross-cutting the natural strata, hence ending up with mixed levels. Given the large number of artefacts, it probably did not skew the results of typological and technological characterization of the test pits level by level since this study only provided a very generalized view of the sequence yielded. However, it is certainly something to consider if a full-scale excavation is ever undertaken.

Another concern in this study is the use of Mehlman's typology. Typologies are do not necessarily reflect the emic categories that would have been recognized by the makers, but rather, serve to facilitate communication between archaeologists. Additional revisions to Mehlman's typology might make it more useful in this regard in the future. Some issues seen in this study include Mehlman's decision to group core fragments in the general category of debitage, with the exception of bipolar core fragments, which are grouped with cores rather than debitage. Bipolar reduction produces a considerable amount of shatter with high morphological variability, including some pieces with more than two faces that appear as bipolar cores themselves (Andrefsky 1998). These fragments are included in the general category of cores in Mehlman's typology. Thus, bipolar cores are somewhat over represented, since some pieces probably came from a single core. However, even with this consideration, the bipolar strategy was still by far the predominant means of lithic reduction at Magubike throughout the Middle Stone Age and the Iron Age. Another point of concern is that Mehlman did not include a subtype for denticulate scrapers, which has just been included in the concave scraper subtype. Many archaeologists working on the MSA note the presence of denticulates in their assemblages, but when looking at the data from Magubike, these are invisible, thus hindering the communication of their presence to these archaeologists. In addition, there are no specific categories for the whole range of Acheulean tool types such as cleavers, or for Levallois points, further hindering communication and comparison. However, Willoughby has modified the typology in some of these aspects. For example, she added the sub-type of Levallois points to the point category, as well as additional subtypes for heavy-duty tools like picks and cleavers.

Lastly, chi-square was of only limited use in this study when examining the relationship between various variables. Many of the test results were inconclusive due to high numbers of cells exhibiting less than the necessary expected count of five. Perhaps other statistical methods could prove more useful in future studies.

7.4 Directions for future research

Currently, analysis is ongoing of the materials recovered in the 2008 test excavations. These test excavations revealed that Magubike also contains a considerable LSA component as well as Iron Age and Middle Stone Age materials. A 2.5 m deep sequence exists below the main shelter, where the roof likely once extended, which has a continuous record of all three periods. The 2006 and 2008 test excavations clearly indicate Magubike possibly contains evidence of 200,000 years of human history, and is remarkable for a number of reasons outlined below.

Although there are signs of a possible vertical disturbance, it is noteworthy as one of the few sites in East Africa which contain stratified MSA and LSA deposits, like Mumba in northern Tanzania and Enkapune Ya Muto in Kenya. Thus, it is one of the few sites at which the MSA-LSA transition can be directly studied, and at which one can test Klein's hypothesis that the transition is characterized by an abrupt change to "modern" behaviour, rather than a gradual one with roots in the MSA.

Furthermore, the organic preservation in TP3 is extremely rare for sites in tropical Africa. One shell bead was recovered from 180-190 cm in TP 1. Shell beads, a form of self- adornment or ornamentation, may have been used to establish cultural identity. This test pit also yielded MSA human remains in the form of seven teeth, contributing to the sparse fossil record documenting the transition to *Homo sapiens*. The presence of these items, along with other bits of shell and bone, offers the possibility of recovering additional shell beads and early human remains, since they demonstrate that conditions at the site have allowed for organic preservation.

In addition, the MSA of the two test pits examined here differed in interesting ways, particularly in regards to raw material distribution. This intrasite variability perhaps reflects different periods of occupation within that time in which different raw material sources were more heavily utilized, perhaps due to differences in mobility or other factors influencing access to specific raw materials.

Future work at Magubike should include a full-scale excavation of the remaining deposits with the goals of shedding light onto site formation processes, including the extent of environmental factors contributing to possible vertical disturbances, and the degree of any vertical disturbance. The recovery and analysis of additional lithics will provide a greater understanding of processes of cultural change at the site, particularly when interpreted in conjecture with a strong understanding of the site's depositional history and formation process. Securing additional dates via other techniques, such as ESR and OSL, will also allow for better chronological designation of the cultural deposits. Additional surveying based on the geological maps may allow for the location of raw material sources, and this will provide greater understanding of mobility patterns in which procurement of raw materials was likely embedded. When linked with secure dates and thorough lithic analysis of the site's assemblages, this information will provide a detailed picture of technological adaptation and change at Magubike throughout human history, including the period in which the species emerged and the first signs of significant regional technological variability occurred. Due to its long sequence and preservation of organic material, it is a site with the potential to contribute greatly to our understanding of the emergence of behavioural modernity.

Table 7.1 Materials recovered from each test pit by level.

<table>
<tr><th colspan="7">TEST PIT 1</th></tr>
<tr><th>LEVEL (CM)</th><th>Iron/Slag</th><th>Shell</th><th>Bone</th><th>Ochre</th><th>Ceramics</th><th>Stone</th></tr>
<tr><td>0-10</td><td>X</td><td>X</td><td></td><td>X</td><td>X</td><td>X</td></tr>
<tr><td>10-20</td><td></td><td>X</td><td></td><td></td><td>X</td><td>X</td></tr>
<tr><td>20-30</td><td></td><td>X</td><td></td><td></td><td>X</td><td>X</td></tr>
<tr><td>30-40</td><td></td><td>X</td><td></td><td>X</td><td></td><td>X</td></tr>
<tr><td>40-50</td><td></td><td>X</td><td></td><td></td><td>X</td><td>X</td></tr>
<tr><td>50-60</td><td>X</td><td>X</td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>60-70</td><td></td><td>X</td><td>X</td><td>X</td><td></td><td>X</td></tr>
<tr><td>70-80</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>89-90</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>90-100</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>100-110</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>110-120</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>120-130</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>130-140</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>140-150</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>150-160</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>160-170</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><td>170-180</td><td></td><td></td><td></td><td></td><td></td><td>X</td></tr>
<tr><th colspan="7">TEST PIT 3</th></tr>
<tr><th>LEVEL (CM)</th><th>Iron/Slag</th><th>Shell</th><th>Bone</th><th>Ochre</th><th>Ceramics</th><th>Stone</th></tr>
<tr><td>0-10</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td>X</td></tr>
<tr><td>10-20</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td>X</td></tr>
<tr><td>20-30</td><td>X</td><td>X</td><td>X</td><td></td><td>X</td><td>X</td></tr>
<tr><td>30-40</td><td>X</td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>40-50</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>50-60</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>60-70</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>70-80</td><td></td><td>X</td><td>X</td><td></td><td>X*</td><td>X</td></tr>
<tr><td>80-90</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>90-100</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>100-110</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>110-120</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>120-130</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>130-140</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>140-150**</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>150-160</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>160-170**</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>170-180</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>180-190***</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>190-200</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
<tr><td>200-120</td><td></td><td>X</td><td>X</td><td></td><td></td><td>X</td></tr>
</table>

*possibly intrusive.
**human teeth were also recovered from these levels.
***a shell bead was recovered this level.

Figure 7.1 Cultural designations by level.

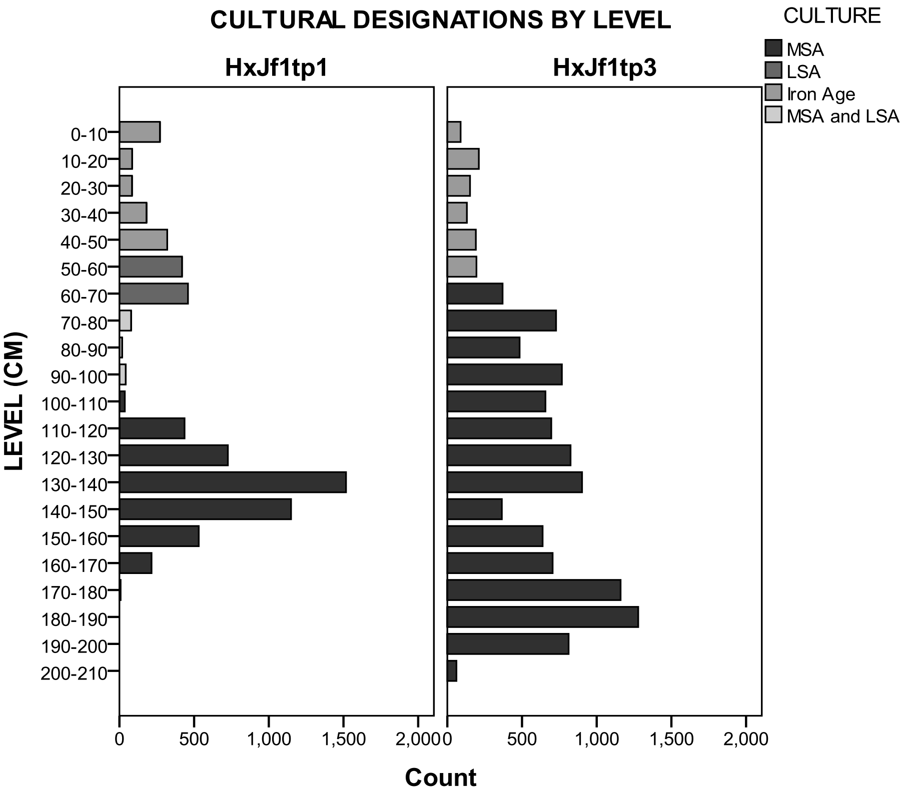
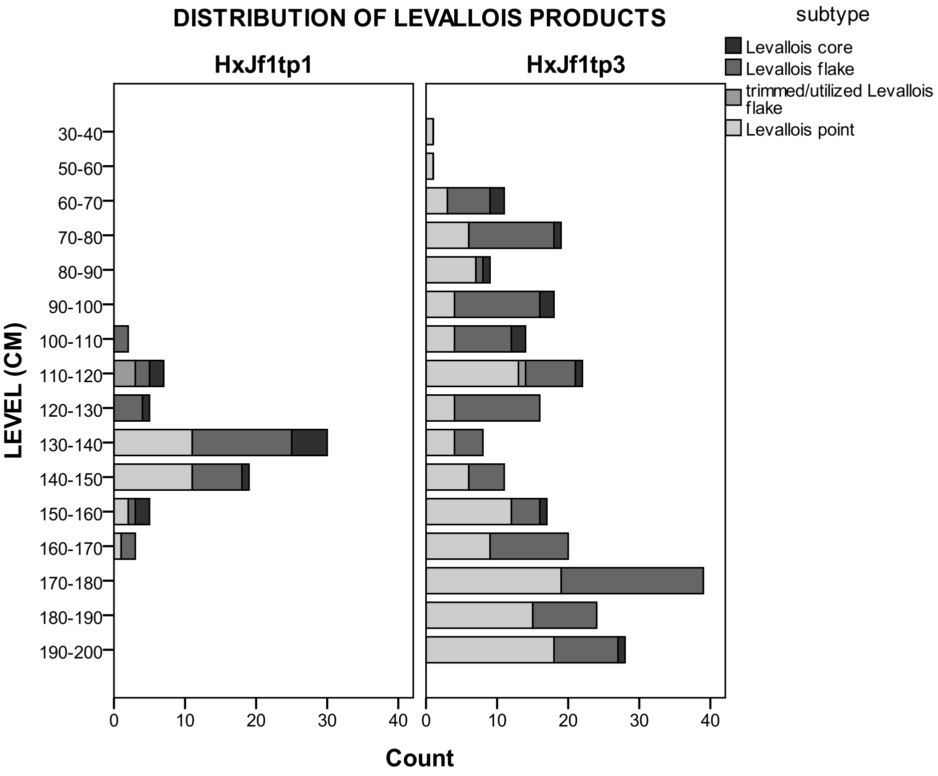


Figure 7.2 Distribution of Levallois products.



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Appendix I

Codebook: Stone artefact analysis (2006)

Variables for Iringa Stone Age Archaeological Project

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
1	Site		100/121	3	1-3
	Mlambalasi	(100) HwJf-2 room 1			
		(101) HwJf-2 room 2			
		(102) HwJf-2 slope			
		(103) HwJf-2 slope and room 1			
		(104) HwJf-2 outside shelter			
		(105) HwJf-2 tp1			
		(106) HwJf-2 tp1 - remove rock at 85 cm			
		(107) HwJf-2 tp1 south wall cleaning			
		(108) HwJf-2 tp1 wall			
		(109) HwJf-2 east of tp1			
		(110) HwJf-2 tp1 rock removal			
		(111) HwJf-2 tp2			
	Magubike	(112) HxJf-1			
		(113) HxJf-1 tp1			
		(114) HxJf-1 tp2			
		(115) HxJf-1 tp3			
		(116) Walk to HxJf-2			
		(117) HxJf-2			
		(118) HxJf-4 (above HxJf-2)			
		(119) Walk back from HxJf-2			
		(120) HxJf-3			
	Kitelewasi	(121) HxJh-1			
		(999) missing			
2	Case # (for each site)	0001 to n	1/n	4	4-7
3	Level	(00) surface	0/62	2	8-9
		(01) 0-5 cm			
		(02) 5-10 cm			
		(03) 0-10 cm			
		(04) 10-15 cm			
		(05) 15-20 cm			
		(06) 10-20 cm			
		(07) 0-20 cm			
		(08) 20-25 cm			
		(09) 25-30 cm			
		(10) 20-30 cm			
		(11) 30-35 cm			
		(12) 35-40 cm			
		(13) 30-40 cm			
		(14) 20-40 cm			
		(15) 40-45 cm			
		(16) 45-50 cm			

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
		(17) 40-50 cm			
		(18) 45-55 cm			
		(19) 50-55 cm			
		(20) 55-60 cm			
		(21) 50-60 cm			
		(22) 60-65 cm			
		(23) 65-70 cm			
		(24) 60-70 cm			
		(25) 70-75 cm			
		(26) 75-80 cm			
		(27) 70-80 cm			
		(28) 80-85 cm			
		(29) 85-90 cm			
		(30) 80-90 cm			
		(31) 90-95 cm			
		(32) 95-100 cm			
		(33) 90-100 cm			
		(34) 100-105 cm			
		(35) 105-110 cm			
		(36) 100-110 cm			
		(37) 90-110 cm			
		(38) 110-115 cm			
		(39) 115-120 cm			
		(40) 110-120 cm			
		(41) 120-125 cm			
		(42) 125-130 cm			
		(43) 120-130 cm			
		(44) 130-135 cm			
		(45) 135-140 cm			
		(46) 130-140 cm			
		(47) 140-145 cm			
		(48) 145-150 cm			
		(49) 140-150 cm			
		(50) 150-155 cm			
		(51) 155-160 cm			
		(52) 150-160 cm			
		(53) 160-165 cm			
		(54) 165-170 cm			
		(55) 160-170 cm			
		(56) 170-175 cm			
		(57) 175-180 cm			
		(58) 170-180 cm			
		(59) 180-185 cm			
		(60) 185-190 cm			
		(61) 180-190 cm			
		(62) 190-195 cm			
		(63) 195-200 cm			
		(64) 190-200 cm			
		(65) 200-205 cm			
		(66) 205-210 cm			
		(67) 200-210 cm			
		(99) Missing			

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
4	Cultural Designation (Culture)	(00) not known (01) ESA (02) MSA (03) LSA (04) Neolithic (05) Iron Age (06) ESA + MSA (07) MSA + LSA (08) LSA + Neolithic (09) LSA + Iron Age (10) Neolithic + Iron Age (11) LSA, Neolithic + Iron Age (12) MSA, LSA, Neolithic + Iron Age (13) MSA and Iron Age (14) MSA, LSA and Iron Age (99) missing	0/12	2	10-11
5	stone raw material (Rawmat)	(1) quartz (2) quartzite (3) chert/flint (4) volcanic but not obsidian (5) obsidian (6) metamorphic (7) other sedimentary (8) rock crystal (9) missing	0/8	1	12

Note: variables 6 to 8 taken from Mehlman 1989:111-157

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
6	stone artefact general category (Gencat)	(1) trimmed pieces=tools (2) core (3) debitage (4) non flaked stone (inc. ground stone) (9) missing	0/4	1	13
7	tool type (subset of v6) (Tooltype)	TOOLS (01) scraper (02) backed pieces (03) points/perçoirs (04) burins (05) bifacially modified pieces (06) becs	01/27	2	14-15

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
			0/27	2	14-15
7	tool type	(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			
		(21) hammerstones			
		(22) anvil stones			
		(23) pestle rubbers			
		(24) polished axes			
		(25) stone discs			
		(26) sundry ground/polished			
		(27) manuports			
8	tool subtype	(000) not applicable	001/105	3	16-18
	(subset of v7)	(001) small convex scraper			
	(Subtype)	(002) convex end scraper			
		(003) convex double end scraper			
		(004) convex end and side scraper			
		(005) circular scraper			
SCRAPERS (01)		(006) nosed end scraper			
		(007) convex side scraper			
		(008) convex double side scraper			
		(009) nosed side scraper			
		(010) sundry end scraper			
		(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			

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
		(022) convergent scraper			
		(023) scraper fragment			
8	tool subtype		001/105	3	16-18
BACKED PIECES (02)		(024) crescent			
		(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 (03)		(035) unifacial point/perçoir			
		(036) alternate face/edge pt/perçoir			
		(037) bifacial point			
BURINS (04)		(038) dihedral burin			
		(039) angle burin			
		(040) mixed/other burin			
BIFACIALLY MODIFIED PIECES (05)		(041) discoid			
		(042) point blank			
		(043) bifacially modified piece			
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			

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
8	tool subtype (Subtype)		001/105	3	16-18

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
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

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
8	tool subtype (Subtype)		001/105	3	16-18

BLADES (19)	(088) whole blade (089) trimmed/utilized blade (090) blade talon fragment (091) trimmed/utilized blade talon fragment
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

For all stone pieces measure:

9	length (L)(mm.)	none	0/?	4	19-22 -1 decimal place
10	breadth (B)(mm.)	none	0/?	4	23-26 -1 decimal place
11	thickness (mm.) (T)(thick)	none	0/?	4	27-30 -1 decimal place

for cores: length ∃ breadth ∃ thickness

12	weight (gm.)	none	0/?	5	31-35 1 decimal place

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
13 `	ratioBL (B) L)	none	0/1	3	36-38 2 decimal places
14	ratioTB (T) B)	none	0/1	3	39-41 2 decimal places
15	ratioTL (T) L)	none	0/1	3	42-44 -2 decimal places
16	abrasion/ rolling (Abrasion)	(1) fresh (2) worn (9) missing	1/2	1	45

<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.

17	cortex (%)	none (999) missing	0/100	3	46-48
18	# flake scars (Flakscar)	none (99) missing	0/n	2	49-50

<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.

19	Toth flake # (Tothnum)	(1) I (2) II (3) III (4) IV (5) V (6) VI (7) VII (includes missing for tools) (9) Missing	1/7	1	51
20	platform length (mm.)(PL) (Platleng)	none (999.9) missing	0/?	4	52-55 1 decimal place
21	platform breadth (mm.) PB (Platbred)	none (999.9) missing	0/?	4	56-59 1 decimal place
22	platform area (mm5) (Platarea) (PB x PL)	none (9999.9) missing	0/?	5	60-64 1 decimal place
23	platform angle (platangl) (to ventral)	none (999) missing	0/?E	3	65-67

Variable #	Variable Name	Value Labels	Min/Max	Field	Location	
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	68	
25	flake area (B x L) (mm5)(Flakarea)	none	0/n	5	69-73	1 decimal place
26	platform area) flake area (relarea)(%)	none (9.99) missing	0/1	3	74-76	2 decimal places
27	# dorsal flake scars (dorscars)	(0) none (1) 1 (2) 2 (3) 3 (4) 4 (5) 5 (6) 6 (7) 7 (8) 8 or more (9) missing	0/8	1	77	
28	dorsal scar pattern (scarpat)	(0) unknown (1) radial (2) same platform, simple (3) same platform, parallel (4) opposed platform (5) transverse (6) plain (7) none (=cortical) (9) missing/not applicable	1/7	1	78	
29	planform (McBrearty 1986:198-199)	(1) convergent (2) parallel (3) divergent (4) intermediate (5) circular (6) unknown (9) missing/not applicable	1/6	1	79	

Variable #	Variable Name	Value Labels	Min/Max	Field	Location
For retouched tools only:					
30	angle of retouch (anglreto) (to side retouch released from)	none	0/90E? (score >90E as 91) (99) missing	2	80-81
31	type of retouch (retouch)	(1) marginal (2) semi-invasive (3) invasive (9) none/missing	1/3	1	82

Appendix II
Statistical test results

*indicates signifigant results
**indicates inconclusive results

Raw material by level*

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	1115.612a	48	.000
	Likelihood Ratio	1221.149	48	.000
	Linear-by-Linear Association	192.331	1	.000
	N of Valid Cases	6574		
HxJf1tp3	Pearson Chi-Square	2941.650a	68	.000
	Likelihood Ratio	2817.804	68	.000
	Linear-by-Linear Association	186.075	1	.000
	N of Valid Cases	11416		

a. 0 cells (0%) have expected count less than 5. The minimum expected count is 6.50.

b. 2 cells (2.2%) have expected count less than 5. The minimum expected count is 4.25.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.412	.000
		Cramer's V	.206	.000
	N of Valid Cases		6574	
HxJf1tp3	Nominal by Nominal	Phi	.508	.000
		Cramer's V	.254	.000
	N of Valid Cases		11416	

General categories by level*

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	358.377[a]	34	.000
	Likelihood Ratio	345.368	34	.000
	Linear-by-Linear Association	79.981	1	.000
	N of Valid Cases	6570		
HxJf1tp3	Pearson Chi-Square	887.616[b]	40	.000
	Likelihood Ratio	914.849	40	.000
	Linear-by-Linear Association	652.809	1	.000
	N of Valid Cases	11413		

a. 6 cells (11.1%) have expected count less than 5. The minimum expected count is .92.

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.92.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.234	.000
		Cramer's V	.165	.000
	N of Valid Cases		6570	
HxJf1tp3	Nominal by Nominal	Phi	.279	.000
		Cramer's V	.197	.000
	N of Valid Cases		11413	

General categories by raw material*

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	647.042a	8	.000
	Likelihood Ratio	656.247	8	.000
	Linear-by-Linear Association	7.113	1	.008
	N of Valid Cases	6569		
HxJf1tp3	Pearson Chi-Square	1247.073b	8	.000
	Likelihood Ratio	1252.432	8	.000
	Linear-by-Linear Association	387.300	1	.000
	N of Valid Cases	11412		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 62.50.

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 28.82.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.314	.000
		Cramer's V	.222	.000
	N of Valid Cases		6574	6569
HxJf1tp3	Nominal by Nominal	Phi	.331	.000
		Cramer's V	.234	.000
	N of Valid Cases		11416	11412

Most common backed piece subtypes by level**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	78.962[a]	32	.000
	Likelihood Ratio	83.116	32	.000
	Linear-by-Linear Association	1.888	1	.169
	N of Valid Cases	1956		
HxJf1tp3	Pearson Chi-Square	95.435[b]	40	.000
	Likelihood Ratio	99.811	40	.000
	Linear-by-Linear Association	1.147	1	.284
	N of Valid Cases	1285		

a. 13 cells (25.5%) have expected count less than 5. The minimum expected count is .15.

b. 17 cells (27.0%) have expected count less than 5. The minimum expected count is .08.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.201	.000
		Cramer's V	.142	.000
	N of Valid Cases		1956	
HxJf1tp3	Nominal by Nominal	Phi	.273	.000
		Cramer's V	.193	.000
	N of Valid Cases		1285	

Most common scraper subtypes by level**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	37.305a	34	.320
	Likelihood Ratio	46.371	34	.077
	Linear-by-Linear Association	.335	1	.563
	N of Valid Cases	227		
HxJf1tp3	Pearson Chi-Square	113.390b	38	.000
	Likelihood Ratio	129.191	38	.000
	Linear-by-Linear Association	22.904	1	.000
	N of Valid Cases	320		

a. 38 cells (70.4%) have expected count less than 5. The minimum expected count is .25.

b. 32 cells (53.3%) have expected count less than 5. The minimum expected count is .28.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.405	.320
		Cramer's V	.287	.320
	N of Valid Cases		227	
HxJf1tp3	Nominal by Nominal	Phi	.595	.000
		Cramer's V	.421	.000
	N of Valid Cases		320	

Backed pieces and scrapers by level*

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	85.084[a]	17	.000
	Likelihood Ratio	73.103	17	.000
	Linear-by-Linear Association	8.250	1	.004
	N of Valid Cases	2611		
HxJf1tp3	Pearson Chi-Square	149.432[b]	20	.000
	Likelihood Ratio	144.592	20	.000
	Linear-by-Linear Association	56.879	1	.000
	N of Valid Cases	2123		

a. 7 cells (19.4%) have expected count less than 5. The minimum expected count is .61.
b. 2 cells (4.8%) have expected count less than 5. The minimum expected count is .56.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.181	.000
		Cramer's V	.181	.000
	N of Valid Cases		6570	2611
HxJf1tp3	Nominal by Nominal	Phi	.265	.000
		Cramer's V	.265	.000
	N of Valid Cases		11413	2123

Core types by level**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	129.641[a]	64	.000
	Likelihood Ratio	113.903	64	.000
	Linear-by-Linear Association	16.761	1	.000
	N of Valid Cases	752		
HxJf1tp3	Pearson Chi-Square	58.241[b]	40	.031
	Likelihood Ratio	59.444	40	.024
	Linear-by-Linear Association	3.487	1	.062
	N of Valid Cases	1295		

a. 61 cells (71.8%) have expected count less than 5. The minimum expected count is .01.
b. 41 cells (65.1%) have expected count less than 5. The minimum expected count is .17.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.415	.000
		Cramer's V	.208	.000
	N of Valid Cases		752	
HxJf1tp3	Nominal by Nominal	Phi	.212	.031
		Cramer's V	.150	.031
	N of Valid Cases		1295	

Core types by raw material**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	175.490[a]	64	.000
	Likelihood Ratio	176.907	64	.000
	Linear-by-Linear Association	10.159	1	.001
	N of Valid Cases	752		
HxJf1tp3	Pearson Chi-Square	289.530[b]	80	.000
	Likelihood Ratio	308.692	80	.000
	Linear-by-Linear Association	50.424	1	.000
	N of Valid Cases	1295		

a. 45 cells (52.9%) have expected count less than 5. The minimum expected count is .29.

b. 49 cells (46.7%) have expected count less than 5. The minimum expected count is .12.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.483	.000
		Cramer's V	.242	.000
	N of Valid Cases		752	
HxJf1tp3	Nominal by Nominal	Phi	.473	.000
		Cramer's V	.236	.000
	N of Valid Cases		1295	

Toth Type by level**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	165.302[a]	85	.000
	Likelihood Ratio	123.855	85	.004
	Linear-by-Linear Association	8.344	1	.004
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	153.849[b]	100	.000
	Likelihood Ratio	151.446	100	.001
	Linear-by-Linear Association	1.329	1	.249
	N of Valid Cases	2032		

a. 81 cells (75.0%) have expected count less than 5. The minimum expected count is .01.

b. 84 cells (66.7%) have expected count less than 5. The minimum expected count is .10.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.430	.000
		Cramer's V	.192	.000
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	.275	.000
		Cramer's V	.123	.000
	N of Valid Cases		2032	

Toth Type by raw material**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	91.792[a]	25	.000
	Likelihood Ratio	107.672	25	.000
	Linear-by-Linear Association	20.586	1	.000
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	87.555[b]	20	.000
	Likelihood Ratio	91.013	20	.000
	Linear-by-Linear Association	1.283	1	.257
	N of Valid Cases	2032		

a. 21 cells (58.3%) have expected count less than 5. The minimum expected count is .01.

b. 8 cells (26.7%) have expected count less than 5. The minimum expected count is .23.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.320	.000
		Cramer's V	.143	.000
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	.208	.000
		Cramer's V	.104	.000
	N of Valid Cases		2032	

Planform by level**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	71.084[a]	51	.033
	Likelihood Ratio	83.544	51	.003
	Linear-by-Linear Association	2.345	1	.126
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	114.696[b]	60	.000
	Likelihood Ratio	107.563	60	.000
	Linear-by-Linear Association	.918	1	.338
	N of Valid Cases	2032		

a. 37 cells (51.4%) have expected count less than 5. The minimum expected count is .28.

b. 20 cells (23.8%) have expected count less than 5. The minimum expected count is .83.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.282	.033
		Cramer's V	.163	.033
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	.238	.000
		Cramer's V	.137	.000
	N of Valid Cases		2032	

Planform by raw material*

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	15.181[a]	15	.438
	Likelihood Ratio	14.950	15	.455
	Linear-by-Linear Association	.595	1	.440
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	24.127[b]	12	.020
	Likelihood Ratio	25.183	12	.014
	Linear-by-Linear Association	.039	1	.842
	N of Valid Cases	2032		

a. 4 cells (16.7%) have expected count less than 5. The minimum expected count is .14.

b. 3 cells (15.0%) have expected count less than 5. The minimum expected count is 1.93.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.130	.438
		Cramer's V	.075	.438
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	.109	.020
		Cramer's V	.063	.020
	N of Valid Cases		2032	

Planform by subtype (whole vs. trimmed/utilized flakes)*

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	9.740[a]	3	.021
	Likelihood Ratio	9.923	3	.019
	Linear-by-Linear Association	4.759	1	.029
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	2.666[b]	3	.446
	Likelihood Ratio	2.694	3	.441
	Linear-by-Linear Association	1.792	1	.181
	N of Valid Cases	2032		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 47.66.

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 72.07.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.104	.021
		Cramer's V	.104	.021
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	.036	.446
		Cramer's V	.036	.446
	N of Valid Cases		2032	

Dorsal scar pattern by level**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	608.326[a]	85	.000
	Likelihood Ratio	127.408	85	.002
	Linear-by-Linear Association	.248	1	.618
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	179.522[b]	100	.000
	Likelihood Ratio	170.178	100	.000
	Linear-by-Linear Association	1.302	1	.254
	N of Valid Cases	2032		

a. 80 cells (74.1%) have expected count less than 5. The minimum expected count is .00.

b. 69 cells (54.8%) have expected count less than 5. The minimum expected count is .03.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.824	.000
		Cramer's V	.369	.000
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	.297	.000
		Cramer's V	.133	.000
	N of Valid Cases		2032	

Dorsal scar pattern by raw material**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	40.132[a]	25	.028
	Likelihood Ratio	33.074	25	.129
	Linear-by-Linear Association	1.425	1	.233
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	39.466[b]	20	.006
	Likelihood Ratio	37.257	20	.011
	Linear-by-Linear Association	1.026	1	.311
	N of Valid Cases	2032		

a. 19 cells (52.8%) have expected count less than 5. The minimum expected count is .00.

b. 11 cells (36.7%) have expected count less than 5. The minimum expected count is .08.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.212	.028
		Cramer's V	.095	.028
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	.139	.006
		Cramer's V	.070	.006
	N of Valid Cases		2032	

Dorsal scar number by level**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	182.851[a]	102	.000
	Likelihood Ratio	156.619	102	.000
	Linear-by-Linear Association	.003	1	.959
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	191.870[b]	140	.002
	Likelihood Ratio	187.163	140	.005
	Linear-by-Linear Association	.163	1	.686
	N of Valid Cases	2032		

a. 93 cells (73.8%) have expected count less than 5. The minimum expected count is .01.

b. 96 cells (57.1%) have expected count less than 5. The minimum expected count is .01.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.452	.000
		Cramer's V	.185	.000
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	.307	.002
		Cramer's V	.116	.002
	N of Valid Cases		2032	

Dorsal scar number by raw material**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	56.695[a]	30	.002
	Likelihood Ratio	53.568	30	.005
	Linear-by-Linear Association	2.908	1	.088
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	40.595[b]	28	.058
	Likelihood Ratio	44.926	28	.022
	Linear-by-Linear Association	.186	1	.666
	N of Valid Cases	2032		

a. 18 cells (42.9%) have expected count less than 5. The minimum expected count is .00.

b. 16 cells (40.0%) have expected count less than 5. The minimum expected count is .02.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.252	.002
		Cramer's V	.113	.002
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	.141	.058
		Cramer's V	.071	.058
	N of Valid Cases		2032	

Dorsal scar number by dorsal scar pattern**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	1342.325[a]	30	.000
	Likelihood Ratio	619.555	30	.000
	Linear-by-Linear Association	233.088	1	.000
	N of Valid Cases	895		
HxJf1tp3	Pearson Chi-Square	3236.982[b]	35	.000
	Likelihood Ratio	1643.940	35	.000
	Linear-by-Linear Association	641.006	1	.000
	N of Valid Cases	2032		

a. 27 cells (64.3%) have expected count less than 5. The minimum expected count is .00.

b. 25 cells (52.1%) have expected count less than 5. The minimum expected count is .02.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	1.225	.000
		Cramer's V	.548	.000
	N of Valid Cases		895	
HxJf1tp3	Nominal by Nominal	Phi	1.262	.000
		Cramer's V	.564	.000
	N of Valid Cases		2032	

Cortex coverage by level**

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	96.451[a]	48	.000
	Likelihood Ratio	77.374	48	.005
	Linear-by-Linear Association	.345	1	.557
	N of Valid Cases	749		
HxJf1tp3	Pearson Chi-Square	129.382[b]	60	.000
	Likelihood Ratio	123.924	60	.000
	Linear-by-Linear Association	4.955	1	.026
	N of Valid Cases	1289		

a. 36 cells (52.9%) have expected count less than 5. The minimum expected count is .05.

b. 31 cells (36.9%) have expected count less than 5. The minimum expected count is .05.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.359	.000
		Cramer's V	.207	.000
	N of Valid Cases		749	
HxJf1tp3	Nominal by Nominal	Phi	.317	.000
		Cramer's V	.183	.000
	N of Valid Cases		1289	

Cortex coverage by tool type*

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	13.816[a]	6	.032
	Likelihood Ratio	14.492	6	.025
	Linear-by-Linear Association	5.910	1	.015
	N of Valid Cases	738		
HxJf1tp3	Pearson Chi-Square	35.520[b]	6	.000
	Likelihood Ratio	32.543	6	.000
	Linear-by-Linear Association	4.399	1	.036
	N of Valid Cases	1289		

a. 4 cells (33.3%) have expected count less than 5. The minimum expected count is .14.

b. 2 cells (16.7%) have expected count less than 5. The minimum expected count is .32.

Symmetric Measures

SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.137	.032
		Cramer's V	.097	.032
	N of Valid Cases		738	
HxJf1tp3	Nominal by Nominal	Phi	.166	.000
		Cramer's V	.117	.000
	N of Valid Cases		1289	

Cortex coverage by raw material*

Chi-Square Tests

SITE		Value	df	Asymp. Sig. (2-sided)
HxJf1tp1	Pearson Chi-Square	85.277a	9	.000
	Likelihood Ratio	76.230	9	.000
	Linear-by-Linear Association	38.389	1	.000
	N of Valid Cases	706		
HxJf1tp3	Pearson Chi-Square	118.327b	9	.000
	Likelihood Ratio	116.758	9	.000
	Linear-by-Linear Association	87.797	1	.000
	N of Valid Cases	1268		

a. 3 cells (18.8%) have expected count less than 5. The minimum expected count is .73.

b. 3 cells (18.8%) have expected count less than 5. The minimum expected count is .74.

Symmetric Measures

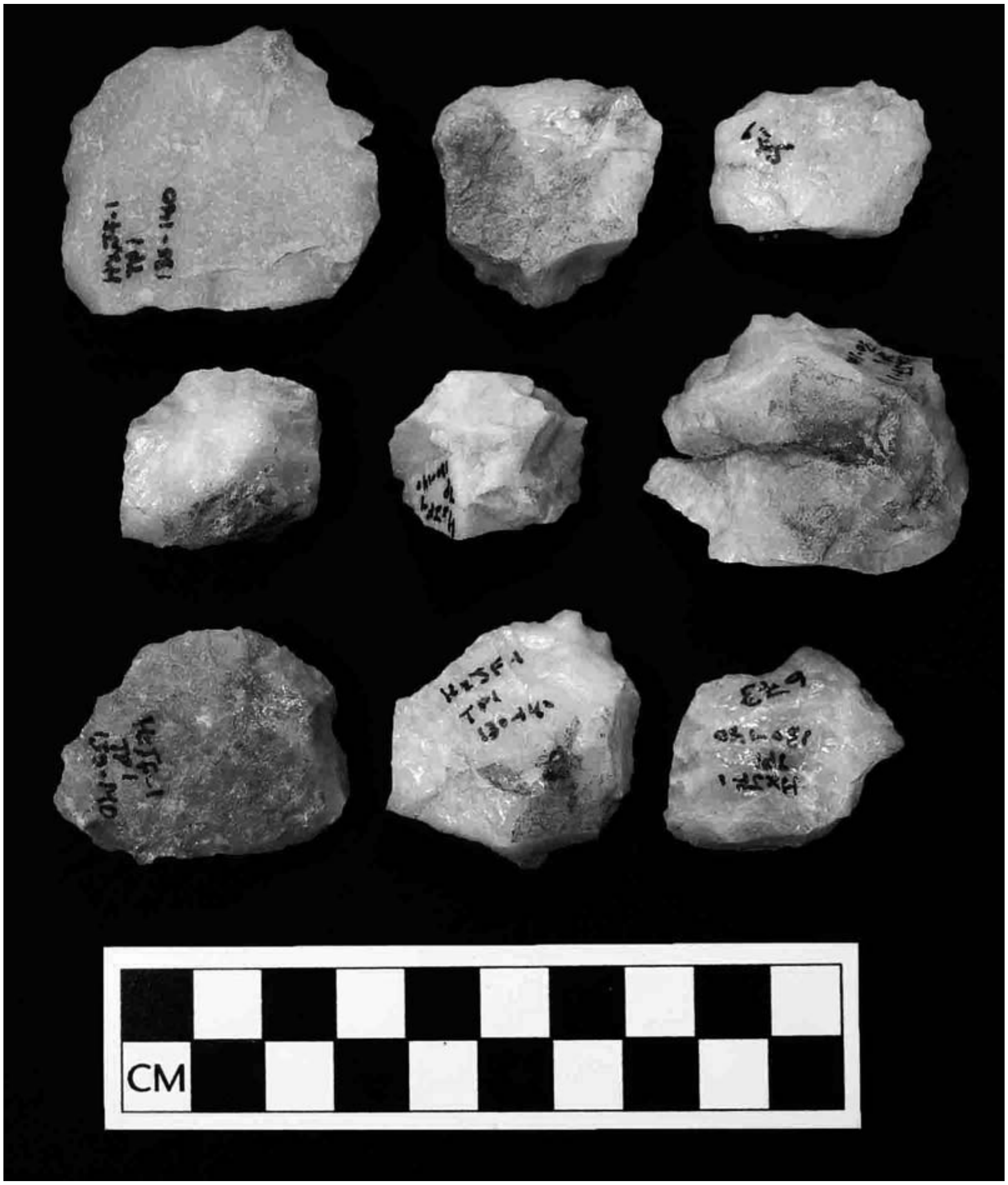
SITE			Value	Approx. Sig.
HxJf1tp1	Nominal by Nominal	Phi	.348	.000
		Cramer's V	.201	.000
	N of Valid Cases		706	
HxJf1tp3	Nominal by Nominal	Phi	.305	.000
		Cramer's V	.176	.000
	N of Valid Cases		1268	

Appendix III
Artefact Photographs

Backed pieces, TP1, 130-140 cm.

Scrapers, TP 1, 130-140 cm.

Peripheral cores, TP 1, 130-140 cm.



Levallois flakes, TP3, 120-130 cm.

Levallois point, TP 3, 130-140 cm.