COMPARATIVE STUDY OF ARCHAEOLOGICAL ASSEMBLAGES IN TWO LAKE BASINS IN KENYA DURING THE LATER STONE AGE PERIOD

by

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DECLARATION

This thesis is my original work and has not been presented for a degree in any other university or any other award.

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DEDICATION

This work is dedicated to my dear parents

Mr. Jason Munene Kirai M’Mbui

and

Mrs. Esther Kirai

You have always believed in me in my most wild ideas even when they made little sense to you.
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OPERATIONAL DEFINATION OF TERMS

**Archaeological assemblage**: A collection of archaeological materials recovered from a single archaeological site found in the same context.

**Lithics**: Composed of stone. i.e. Lithic tools – Stone tools.

**Stone Age**: This is the oldest period of human culture that is characterized by use of stone tools that lasted roughly 3.4 million years, and ended between 6000 and 2000 BC (BCE) with the advent of iron working.

**Early Stone Age**: A period in the history of mankind when he started making stone tools. The Early Stone Age dates back around 2.5 million years ago to about 200,000 years ago.

**Middle Stone Age**: A period in African prehistory between the Early Stone Age and the Middle Stone Age which started around 280,000 years ago to around 50-25,000 years ago.

**Later Stone Age**: A period in African prehistory from 50,000 to 10,000 years ago that is contemporary with European Upper Paleolithic which lasts until historical times. It includes cultures that correspond to Mesolithic and Neolithic in other regions.

**Microlith**: A small stone tool made on flint, obsidian or chert which is about one centimeter long and half a centimeter wide.

**Debitage**: All the material produced in the process of chipping stone.

**Bone harpoon**: A small spear made on bone used to catch aquatic organisms such as fish, crocodiles etc.
LIST OF ABBREVIATIONS

L.S.A.: Later Stone Age

M.S.A.: Middle Stone Age

E.S.A: Early Stone Age

B.P.: Before Present

M.Y.A: Million Years Ago

Ar.: Argon
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ABSTRACT

Researchers working on the Later Stone Age period have studied individual sites on their own making little effort in comparing the archaeological collection from two or more sites. Where this has been done, they have compared collections of different ages in sites separated from each other by a few meters. This study looks compares archeological collections excavated in two different sites, one FxJj12 located in Lake Turkana Basin and the other GxJi 4 located in Lake Magadi Basin. The two sites are approximately 650 km apart and date 10,000 BP. The aim of the study were to reconstruct the cultural sequence of LSA in Kenya using Lake Turkana and Lake Magadi findings, investigate the differences and similarities on the lithic tool and raw material use, investigate the differences in fauna record to establish what wildlife were exploited for food by the site occupants and lastly, examine the differences and similarities in the ecology of the two sites. Cultural ecology theory and behavioral ecology theoretical frameworks were used for this study. The archaeological assemblages from the two sites were analyzed at the National Museums of Kenya. Data gained from this analysis was compared across the two sites and used to draw inferences on the behavior of site occupants. Lithic materials were categorized into three major classes of Shaped tools Debitage and “Other pieces”. The length, width, thickness and weight of all the pieces were taken and entered on excel sheets. Means of these metric measurements was calculated and used for comparison. All this information was presented on tables and charts. The results indicate that these two sites were manufacturing and occupational sites located close to river channels for water and perhaps easy hunting access. They utilized raw material such as chert and basalt, fine grained materials, although they were not as locally available as other raw materials such as quartz and obsidian. Some of these raw materials must have been traded over long distances. GxJi 4 site occupants curated their cores and used them for a long period till they were small and difficult to handle. Bead working was also practiced in the two sites with those from GxJi 4 making ostrich eggshell beads while those at FxJj 12 utilizing small polished bones. Hunting and fishing was highly practiced at FxJj 12 while only hunting is evident at GxJi 4. In the two sites, there was a higher interest in the use of the less amorphous chert and obsidian in relation to basalt. Overall study makes a comparison of the technology of two human groups of the late Pleistocene and early Holocene living in these localities during the period. Since this study looks at two study sites in each of the two regions, it recommends that future work should be directed into a larger site sample to get a more representative data for comparison. More precise methods of reconstructing past climate and ecology should also be used. More efforts should however be directed to comparative studies of LSA in Africa and beyond.
CHAPTER ONE

INTRODUCTION

1.1 Background of the study

This study is focused on a period archaeologists refer to as the Later Stone Age (LSA). In East Africa, this period started around 42,000 years ago and is synonymous with the Upper Paleolithic in North Africa and Europe (Ambrose, 1998). This period in East Africa is marked by a widespread use of microlithic tools, personal adornment together with an economic specialization revolving around fish and plant exploitation for food (Kusimba, 1999). Evidence has indicated that during this period, the climate in Africa was cooler and drier than it is today resulting to decrease in forest cover and spread of grasslands. This aridity posed a great challenge to hominids in this region prompting technological and cultural evolution to adapt (Avery, 1995). It is in light of these adaptations that this study is based.

It is very evident that the distribution of humanity together with other species of living things is highly influenced by physical environmental factors. Some of the ways these human groups respond is through technological change together with change of their subsistence mechanisms and resource exploitation. The effectiveness of resource utilization assures survival of the population (Avery, 1995).

Archaeological research on the Later Stone Age in Africa and its contemporaries in the rest of the world has been going on for many years. These studies have been conducted through surveys and excavations that have yielded lots of archaeological materials that have been studied to understand the culture of the hominids living at the time. In East Africa for
example, many LSA sites have been studied and reports published. Information on the cultures ranging from social organization, subsistence systems, and technology have been recorded. It is however necessary to note that these cultures are depicted by availability of resource and the need to exploit them. Technological change is a factor symptomatic of environmental changes and resource availability.

Archaeological work in both Lake Turkana and Lake Magadi has resulted in mapping and excavation of many archaeological sites of different ages. LSA sites in the lake basins have yielded lots of floral and faunal materials together with stone tools and other materials. FxJj 12, LSA site in Lake Turkana and GxJi 4 LSA site in Lake Magadi Basin form the basis of this study. The aim of this study was to examine the cultural remains in two contrasting ecological settings to understand how the ecology of the two sites influenced the economic activities and subsistent trends of the occupants as they were struggling to adapt to the changes in climatic conditions.

Most past archaeological studies in the LSA of Africa have taken a “culture historic” approach which is documenting and describing the archaeological assemblages in particular in relation to the raw materials used, stone tools and see how they differ from previous older and younger archaeological occurrences and then commenting on how similar or different the technology represented by the study of artifacts at hand was. My thesis study attempts to go further by looking at the ecological context and character of the archaeological materials from sites 500 kilometers in distance apart but from very much the same time interval.
Part of the goal of this study was to examine two ecologically contrasting archaeological assemblages and try and extract important information on the differences and similarities in the material culture as an indicator of the differences or similarities in their economic activities. The study will at the same time, hopefully, yield information that will answer questions on whether human population living in these different regions separated by diverse ecological settings and hundreds of kilometers (650 km) exploited the environment in similar or different ways. Information on the differences and similarities on the type of materials they exploited for tool production and the variability of these tools forms an integral part of the study.

1.2 Statement of the problem

Many researchers have carried out studies on the Later Stone Age in Africa. The culture of man during this period is well understood although there are still questions unanswered. Most of these studies have been done on individual sites or where studies have involved two or more sites, they are always separated from each other by a few hundreds of meters or a few kilometers at most. Very few studies if any have been directed in trying to compare the LSA of East Africa assemblages over areas separated from each other by hundreds of kilometers to try to find out if and how the ecology determined the culture of the hominids in terms of the tools they made for exploitation of the environment together with their contrasting subsistence strategies.

Both Lake Magadi and Lake Turkana basins supported a wide range of fauna and flora. Hominids were attracted to these areas as they provided a wide variety of food both terrestrial and aquatic. This study compares the archaeological assemblages from Gxji 4 in
Lake Magadi basin and FxJj 12 in Lake Turkana basin in an attempt to understand the differences and similarities of paleography and paleoecology between these two localities in the L.S.A. It has demonstrated how the different environmental conditions may have influenced subsistence strategies and tool procurement.

1.3 Objective of the study

The objectives of this study were to:

1. Reconstruct the cultural sequence of LSA in Kenya using Lake Turkana and Lake Magadi findings.

2. Investigate the similarities and differences of the lithic tool and raw material use in the two lake basins.

3. Look at differences in fauna record to establish what wildlife were exploited for food by the site occupants.

4. Examine the difference and similarities in the ecology of the two sites.

1.4 Research questions

a. Were the early occupants of these two sites during the Later Stone Age making the same tool types and were these tools used to exploit the environment in a similar or different way in the lake basins?

b. What kind of raw materials did these occupants utilize in the manufacture of stone tools? What is this reflecting in their behavior?

c. What is the difference in flora available in these two localities? What is the implication to showing different economic activities?
d. Was the ecology of these two different geographical locations different? What is the implication of these ecologies on diet, settlement patterns like movements, contact and trade?

1.5 Research Hypothesis

i. The LSA occupants of Lake Magadi and Turkana basins made similar tools and utilized them similarly as their ecology was similar.

ii. The LSA occupants of Lake Magadi and Turkana basins used a variety of materials to manufacture tools.

iii. LSA occupants of Lake Magadi and Turkana basins relied animals as food sources.

iv. The ecology of the two sites was similar in ways and in other ways different. This had an impact on subsistence systems as the site occupants exploited different animal and plant sources for food.

1.6 Justification and significance

The regions that are considered in this study are located in two lake basins which are over 650 km apart. Lake Magadi Basin is smaller and more known for its terrestrial animals as the waters are saline. Today it is a “corridor” connecting Amboseli National Park to areas of rangeland to the west located in Narok County. In contrast, the Holocene Lake Turkana was a much larger body of fresh water and had higher incidences of fish as a food resource associated with archaeological occurrences (Barthelme, 1975). At the same time, the two sites were occupied during the same period, around 10,000 years ago. With the change in climate experienced during the period under study, it is important to explore the contribution
of climate and ecology to the culture of the site occupants based on their technology and subsistence systems.

This study adds to what is already known on the culture of the LSA and the contribution of climatic factors on the culture of hominids especially on Magadi basin as there isn’t much published archaeological research on the area. Information on the differences and similarities in terms of ecology, tool typology and raw material sourcing are also examined.

1.7 Site Localities

Olkena (1°50’S, 36°13’E) is a site located at the Lake Magadi basin in the Rift Valley of Kenya (see figure 3.1). The site lies south of the Tiasilai Primary School. It is approximately 450 meters from the main road. FxJj12 is found in Koobi Fora region of Marsabit County. The sites lies at the base of these Galana Boi deposits. Geographically, it is located in Area 116 and lies on a ridge top that overlooks Laga Aberegeya (See Figure 2.7).

1.8 Scope

Geographically, the study has limited itself to FxJj 12 and GxJi 4 that were occupied around 10,000 B.P. and lie within the rift valley in Kenya. FxJj12 is an LSA site in Koobi Fora region of Marsabit County an area in which continued archaeological research has unearthed a lot of evidence of hominid occupation from millions of years ago. Today, this area is inhabited by the Dasannech who are pastoralists with groups close to the lake specializing in fishing. GxJi 4 also known as Olkena is a site in Lake Magadi Basin of Kajiado County. The area is currently inhabited by the Maasai people of Kenya whose main economic activity is pastoralism.
Having been surveyed and excavated by John Barthelme and others, these sites are good for the comparative study as the excavation techniques are similar. Barthelme’s entire field note books prepared during the survey and excavation process of both sites are also available in the National Museums of Kenya. Materials excavated from the two sites are also well catalogued and stored in the National Museums of Kenya archaeology laboratory. There are other sites of relatively the same age in these two regions that would be useful in adding data on the study, this study has not re-analyzed the assemblage from them but has utilized publications made on the sites to draw conclusions.

1.9. Limitation

In the course of carrying out this study, I met a number of limitations.

a. There are no pollen and phytolith samples that were collected during excavations on the two sites. This was addressed by relying on fauna remains from the excavations.

b. Challenges in putting faunal materials into their taxon as the researcher has limited knowledge on taxonomy. This was addressed by involving the expertise of the National Museums of Kenya staff.

1.10 LITERATURE REVIEW AND THEORETICAL FRAMEWORK

1.10.1 Review of related literature

This section intends to place the two archaeological sites under study on the geological and cultural timescale. The time period of the sites under study (around 10,000 years ago) fall within the Paleolithic or Stone Age. Scholars interested in the Stone Age period in Africa have divided prehistory into three periods. These are Early, Middle and Later Stone Ages. In Europe the terms used for these periods are the Lower, Middle and Upper Paleolithic.
The Early Stone Age (E.S.A.) dates back around 2.5 million years ago to about 200,000 years ago. The Early Stone Age is subdivided into the Oldowan industry and the Acheulian industry.

The earliest Oldowan site is Hadar in Ethiopia which dates 2.5 million years ago (Harris, 1983). A study conducted at Gona in Ethiopia between 1992 and 1994 has yielded artifacts that are presumably the oldest. Based on radioisotopic dating (40 Ar/39 Ar) and magnetostratigraphy, these artifacts date between 2.6 to 2.5 million years (Semaw, 2000) (Toth, 1985) In Kenya, Oldowan sites go back to 2.3 m.y.a. at Lokalalei (Roche, et al. 1999).

The term Middle Stone Age (MSA) was introduced in 1929 by Goodwin and Van Reit Lowe (Lowe, 1927, Clark, 1998). The term is used in Africa south of the Sahara in describing the combination of the typology and technology that comes after the Early Stone age but preceding the Later Stone Age. The term has not been adequately defined but, it is still a useful tool as it includes a wide variety of lithic industries that are also related chronologically. This term carries chronostratigraphic connotation to most researchers. The boundaries of Middle Stone Age are now better defined. The term is used synonymously with Middle Paleolithic a term that found use in the Old World in defining the lithic traditions found in places such as North Africa as well as Europe (Clark 1998).

Available evidence indicates that the Middle Stone Age/Middle Paleolithic begun sometimes between 200,000 and 100,000 years ago in Africa and ends between 40,000 and 30,000 years ago (Willoughby, 1993). In terms of technology, MSA is dominated by disc cores and Levallois method while blade core technology (bipolar technology) characterizes LSA (Mehlman, 1989, Philipson, 1993, Mabulla 1996, McCall & Thomas, 2009, Tryon, et al,
Scraper points and a general lack of formal bone, ivory, shell, tools, art objects as well as large number of variability in time and space characterize the MSA that cannot be attributed to differences or change in lithic raw material availability (Klein, 1989).

The Later Stone Age was defined by Godwin and Van Reit Lowe (Lowe, 1929, Wurz, 2014). From then the term has found use among very many authorities in describing the end of the Stone Age. In sub-Saharan Africa, Stone Age remains poorly defined carrying out both temporal and typological implications (Philipson, 1977a).

According to Ambrose (1998), the change from tool industries of MSA to the LSA is the marker of modernity in human behavior. This period is synonymous to the period called Upper Paleolithic period in Western Eurasia and Northern Africa. During this transition period, blade based industries replaced the flake-based industries that were normally made on Levallois and radial cores that had prepared platforms that were characteristic of the MSA industries. In East Africa, radio carbon dates on sites are done on bone apatite carbonate which is not as reliable as collagen.

According to Ambrose (1990), collagen, a material that is quite more reliable in giving close estimates of dates is rarely preserved in tropical Africa for a period preceding 3000 years in open sites and 7000 years in rock shelters. This makes dates attained through tooth enamel and ostrich eggshell more reliable in dating the transition period as they are more diagenesis resistant. Evidence from MSA/LSA transitional sites such as Border Cave, Matupi, Mumba, Nasera, Olduvai Gorge and Prospect Farm indicate that this transition took place 40,000 years ago. This evidence however can be questioned based on accuracy and validity of the dates. Enkapune ya Muto serve to reinforce the East African transition of 40,000 B.P.
The difference between Later Stone Age and its antecedent Middle Stone Age (MSA) is based on technology and typology. In terms of tool typology, LSA materials are much smaller in size as compared to those of MSA (Tryon & Faith, 2013). One very special feature is the introduction of backed pieces (microliths) which have a geometric shape that include crescents, trapezoids and triangles (Seitsonen, 2004). There is also evidence of increased reliance on tools in campsites (Philipson, 1993).

There is a further introduction of cultural practices that are much more diverse such as rock art, use of bone tools and arrows, symbolism interred persona, intensified use of plant and aquatic life for food, evidence of religion and aesthetic (Klein, 1989; Mabulla, 1996). In LSA, there is a notable presence of fish bones in the archaeological occurrence which is not noticeable in MSA. Evidence of more perishable material which include woven fibres and slings made intonets and bags together with clothes has also been found. These innovations are a significant feature in associating this period with modernity in human behavior that includes art, ornamentation, symbolism sophisticated architecture, burial rituals, land use planning, social alliances and resource exploitation (Ambrose, 2001b). Another notable occurrence of the LSA is the ground bone tools together with the ornaments made of perforated materials. The human populations also started adopting social-territorial organization structures that has resemblance to the ones practiced by recent hunter gatherer populations (Kusimba, 1999).

LSA industry assemblages are distributed more widely and are located in more diverse ecological niches. Their typology is also diversified. Re-known archaeologists like Philipson (1977b) have suggested that this diversity can best be explained as a result of climatic
changes. The diversification of the tool typology of LSA means that these people probably engaged in very diverse activities compared to their predecessors. The actual reason for this great change has not however been fully explained (Kessy, 1992).

A community that portrays full modernity during the MSA is the Howiesons Poort who lived in South Africa. Some of the characteristics of modernity shown by this group include ‘exchanging formal backed tools based on flake that were made from exotic materials together with an explicit spatial organization patterns around the earth. According to Ambrose and Lorenz (1990), this group doesn’t indicate full transition to modernity as they portray less resource exploitation pattern as compared LSA communities living in an environment with the same resource. This group also has no recorded evidence of use of ground bone artifacts and art (Ambrose, 1998).

East Africa is believed to have the earliest evidence of modernity something that is attributed to the migration of people out of Africa through Sinai Peninsula to occupy western and northern Eurasia. This happened between 47 to 40,000 B.P. (Kessy, 1992). The earliest Upper Pleistocene occurrence in North Africa has been found at Haua Fteah and Hagfeted Daabb caves which are found in coast of Libya. The sites are dated 40,000 BP. It should also be noted that there are rival hypothesis to suggest modernity occurred only 200,000 years ago, but that is associated with MSA industries which is not the topic of my thesis (McBrearty & Brooks 2000).

The archaeology of Sub-Saharan Africa from 50,000 to 12,000 B.P. is not very well known (Shaw, 1990). This is probably because of its widespread aridity and as well as low population densities (Kusimba, 1997). There are only a few sites in East Africa which have
produced Pleistocene sites that contain LSA lithic assemblages. The best of these are Olduvai Gorge, Nasera in Tanzania and Kisese Rock Shelter in Central Tanzania (Mehlman, 1989) other sites include Lukenya Hills and Enkapune ya Muto in South Central Kenya (Ambrose, 1998, Kusimba, 1997). The period between 40,000 and 20,000 B.P. has very little lithic assemblages that have both the MSA and LSA elements. These are called second intermediate industries (Nelson, 1980). Some of these sites include Mumba, and Nasera. These sites date 22,000 to 8,000 B.P. (Mehlman, 1977). On the central part of the Kenyan rift valley, LSA sites were found below the industry referred to as Eburan. They were underlying MSA materials. Here LSA was characterized with scrapers and convex outils écaillés, backed pieces together with ostrich egg shells. Beads were also present. This LSA industry is dated 39,000 to 29,000 BP. Kisese is an industry that is believed to mark the transition between LSA and MSA and it is dated 18,190 BP (Kessy, 1992, McCall & Thomas, 2009).

In general, it is suggested that the East Africa Later Stone Age is dated 40,000 BP. (Ambrose, 1992). Evidence from some areas has suggested that the Later Stone Age tool continued as late as 20,000 BP and more recent times (Philipson, 1977b). In several parts of East Africa, LSA and MSA have been reported to coexist (Mehlmans, 1989). Some of the sites that have demonstrated this include Mumba Rock Shelter, Lake Eyasi, Kondoa among others. The few archaeological traces in the region has been attributed to widespread aridity that made the region uninhabitable (Ambrose 2001).

African climatic conditions as that of the rest of the world has been changing over time. Research on marine oxygen isotope analysis indicates that global temperatures in the last half of the Upper Pleistocene were lower than the present up to 18,000- 20,000 B.P. (Last
Glacier Maximum) (Hamilton, 1982). Low latitude areas at the time were cold and dry. Lake level studies, sedimentology, palynology, glacial features on mountains in East Africa and data gathered from faunal remains give evidence that supports cold and greater aridity than that of present day (Hamilton, 1982).

Pollen sequence indicates that from 50,000-20,000 B.P. there was a general fluctuation of climate becoming cooler than today. It however becomes warmer around 25,000 B.P., a period in which most East African lakes become higher (Hamilton, 1982). Between 18,000-20,000 glaciers in east Africa reached the highest extent. This resulted to the shifting of Afroalpine grassland, ericaceous bushland and thicket together with dry montane forest 700-1000 meters downwards in altitude. This led to the expansion of grasslands at the expense of most forest types. Around this period, most of the Rift valley lakes dried up or reached extremely low levels. There was also a fall in temperatures from 5.1 to 8.8 degrees at the LGM and precipitation decrease to 10-15 % below the present precipitation level. The rainfall patterns on the Late Pleistocene can be equated to those of present day Kalahari. Although there was extreme aridity as indicated, evidence from fauna has indicates that there were some areas that were well watered (Hamilton, 1982).

In Sub-Saharan Africa’s climate was cooler and drier than it is today with a general decline in forest cover. Grasslands spread more that they are presently. The dry spreading grassland posed a big threat to the hominids living in Africa throughout the entire Pleistocene period. This also had a big impetus on the technology and evolution of the living populations (Avery, 1995).
In Kenya, there are two sites that are of much important as far as LSA is concerned. These sites are Lukenya Hill and Enkapune Ya Muto. Lukenya site is located on the plains of Athi of South Central Kenya (Kusimba 2001). This site is approximately 40 kilometers South East of Nairobi. Lukenya is an inselberg of granetoidgneisis that is approximately 8 kilometers long and 2 kilometers wide. A study and excavation carried out between 1970-1971 by Gramly in a rock shelter (Lukenya) yielded Pleistocene LSA material (Gramly, 1976). Both Bower et al. (1977) and Merrick (1975) also excavated the site and retrieved both MSA and LSA materials. Analysis of the materials found from this site showed that there were cultural remains that range from Acheulian to LSA. The Lukenya LSA is dominated by quartz, and a small percentage of obsidian made tools. The obsidian that was used in this site has been traced to Sonau, Kinangop, Mangu, Eburru, Kibokoni and Naivasha (Kisimba, 1997). LSA in Lukenya Hill has been dated 21,000-4,000 BP. Analysis of the remains of fauna have suggested that there was a hunter concentration on the fauna that migrate rather the species that are locally available (Ambrose, 1998)

The site of Enkapune Ya Muto lies in Central Rift Valley in Kenya. The site has two LSA industries that underlie Holocene Eburran industry. The level on the top is characterized by convex and scrappers, outils écaillés, backed pieces as well as beads made of ostrich egg shells (Marean, 1982). The industry lying on the lowermost part is characterized by backed blades which lack convex end scrappers that are common with DBL horizon. This horizon was radiocarbon dated between 29,000 and 33,000 BP (Marean, 1982). There were very few bones in these two horizons and they were very fragile when they were found. Pottery that was available at the rock shelter was dating about 4,900 BP. Domesticated animal remains dated 4,000 BP.
The site called Nderit Drift has been thought to be a campsite alongside an old course of the old Nderit River (Merrick, 1975) (see figure 1.1). This assemblage is predominantly microlithic, resembling the late Holocene Eburran but it is unique in the fact that it has few microlithic types that are clearly defined. Instead, the assemblage has poorly standardized miscellaneous pieces. Merrick suggests that with the low frequency of cores and a high frequency of backed pieces, either the materials were brought to the site as flakes or cores or tools were removed from the assemblage. Carbon 14 of the Nderit Drift has dated the site to be between 12,000 and 10,000 BP. (Ambrose et al, 1980).

The technological diversity experienced during this period led to population density that was indirectly reflected by the genetic structure of population of humans living during this period together with intensification of hunting of small prey. This was also coupled with the expansion to higher altitudes, colder latitudes and longitudes that resulted to dispersal of modern human from Africa to parts of Eurasia and Australia. There was also a rapid extinction of both mega fauna and archaic humans (Ambrose, 2001a).

In the Turkana basin, Paleo-anthropological research started in the late 1960s after the area was discovered (Leakey 1970). This region has proved its worth as a very useful cradle for humankind. Research that has been done over the years has recovered many archaeological materials together with early ancestors of man. Evidence of controlled use of fire going back thousands of years has also been recovered here. Materials recovered in this region range from the Early Stone Age, Middle Stone Age together with Later Stone Age. Many LSA sites have been discovered by archaeologists after years of field work. Research here has recovered the oldest pottery in East Africa together with bone harpoons that are similar to
those that found along the Nile Valley and other places in the African continent (Robbins, 2006). Some of the most important LSA sites in the basin include Lothagam site which was the first major LSA fishing settlement to be discovered in Kenya. This is the site that focused a lot of research work to the basin with its two hundred barbed bone harpoons, microlith tools, pottery, and fish bones together with twenty one human skeletons. During the Holocene period, the lake was 80 meters higher than its level in 1968 which was 376 meters (Butzer 1980). Continued work done by archaeologist such as John Barthelme and David Philipson recovered more archaeological materials including bone harpoons from other sites in the Lake Turkana basin.

Archaeological research in Lake Magadi basin has been going on for a number of decades. John Barthelme started surveying the area in 1987. Evidence from the basin has indicated that during the Middle to Late Pleistocene together with the Holocene periods, Lake Magadi basin was occupied by hunters and gatherers. It was during the subsequent surveys that Lenderut was discovered (Barthelme et al, 2009).

The site is situated approximately 15 kilometers South West of Lake Magadi. Here, stone artifacts were found scattered and distributed over an area of approximately 3,000 square meters. After excavation and study, this site was found to contain fauna and flora remains together with stone tools that dated between 0.70-0.56 million years ago. This was an Upper Acheulian site. Stone artifacts were abundant but the recovered samples were very small. There were small triangular handaxes, light duty tools, and there were no cleavers suggesting that it was an Upper Acheulian site (Bathelme, 2003). This discovery marked Lake Magadi Basin as an important location in archaeological studies. This contributed in the
archaeological studies that followed. There are a few recorded LSA sites in the basin which include Olkena (the site of study), Oloololo and human burial site (GxJi 2) (Barthelme et al, 2009). This study helps to expand the knowledge on the LSA at Magadi and elucidate the importance of this site.

Studies on LSA that have been conducted in Kenya have basically specialized in identifying sites, excavating them and publishing the findings. These studies have focused on sites on the same geographical location. An example of this is research on Lukenya Hill. This hill has a number of LSA sites that have been extensively studied and published. No researcher had attempted to compare archaeological assemblages of sites separated from each other by a wide range of ecological settings with an aim of understanding the differences and similarities of man’s culture during the LSA and the contribution of ecology and climate to technological advancement.

1.10.2 Theoretical Frame Work.

1.10.2.1 Cultural Ecology Theory

A number of theories have been put forward by different researchers to try to explain past human interaction with the environment and the forces driving such interactions. One such theory is cultural ecology that was introduced by Stewart in 1938. According to this theory, physical factors such as rainfall, soils, topography together with climate are the ones that determine the nature, abundance as well as the distribution of subsistence resources (Rull, 2010). The theory argues that technology available plays a role in limiting their procurement. These arguments were based on the idea that habits of subsistence that were required anywhere was to a large extent determined by the nature, size and the level of the
population. All these factors on the other hand predetermined most of the features of the political control together with the social structure if the population (Rull, 2010). This theory has been rejected largely because it describes the relationship that exists between human behavior and particular environment context but not in explaining the reasons why these relations take the form they do (Rull, 2010, Codding, 2010).

Although the theory has been criticized by researchers as indicated, it was partially be used in this study. I have utilized it to understand the physical factors influencing the nature of abundance together with the distribution of patterns of subsistence. Its weaknesses were supplemented by the use of behavioral ecology theory.

1.10.2.2 Behavioral Ecology Theory

According to Bird and Connell (2006), Behavioral Ecology Theory is the study of behavior in relation to social and environmental circumstances. It is the subset of evolutionary ecology that is concerned with behavior trade-offs that are related to fitness. According to Bird & O’Connell (2006) analysts who utilize this perspective in conducting their studies believe that the strategies all living things including humans in the past used in reproduction and capacities of making decisions are all shaped by natural selection. The use of this perspective has resulted in very useful information on human past: subsistence, social organization together with other aspects of related to fossil and archaeological consequences.

The theory of Behavioral Ecology began in 1960’s and 1970’s. It was established by ecologists making studies in social, reproductive and foraging patterns in animals. The usefulness of the perspective in studying similar issues in the human past was realized by
ethnographers. These ecologists include Alexander, (1974); Hamilton, (1964); Hutchinson, (1965) among others.

Later on, the perspective was adopted by archaeologists trying to answer questions on subsistence. They used the perspective in looking at more complex issues like transportation of resources, changes in technology relating to subsistence, questions on the origin and spread of agriculture, early human social organization, and social hierarchy development together with the history of human evolution (Morgan, 2009).

Williams (1966) observes that human behavior is very complex, patterned and purposeful carrying all the characteristics depicting adaptive design. This behavior on the other hand leaves traces of materials that archaeologists can monitor. He further asserts that it is possible for archaeologists to come up with expectations about the past form of the behavior in a specific ecological setting and make assessment of the expectations archaeologically. The theory of behavioral ecology seeks to answer questions like why some specific behavior has emerged together with trying to establish answers using their socio-ecological contexts (Williams, 1996).

In archaeology, Behavioral Ecology looks at the issues dealing with the past subsistence systems of man. It mostly focuses on the subsistence patterns that are posed by patterned variations in the fauna and flora assemblages found in archaeological sites together with the technology related to them. A set of formal models popularly known as optimal “foraging theory” are used. The end point of all this is maximizing the nutrient intake or getting to a
threshold intake more quickly reserving time for some other activities related to fitness (Kennet & Winterhalder, 2006).

Application of Behavioral Ecology in archaeology are based on an assumption that the diversity of human behavior is in a big way the result of variability in some specified social ecological settings each of which has a set of unique circumstances which defines the fitness-related landscape where individuals carry out their operations. Formal models of behavioral ecology provide frame works through which propositions in behavior are tested (Kennet & Winterhalder, 2006).

In attaining the objectives of my study in both Lake Turkana and Magadi basins, I applied both Cultural Ecology and Behavioral Ecology to understand how the behavior of the site occupants is influenced by their ecology. This focused on their resource availability and utilization together with the kind of tools they manufacture to exploit the environment. Some of the key aspects of the theory that I put into use is transportation of resources (trade) and changes in technology and their implication on subsistence patterns.

1.11 Chapter summary

Chapter one has detailed the motivation behind embarking on this research work. This study yielded important information that has increased the understanding of LSA sites in Africa highlighting the archaeological potential of Lake Magadi basin in the LSA as it hasn’t received as much attention as compared to Lake Turkana basin. The chapter also provided background information in form of literature review and theoretical frameworks that was used to identify gaps in existing knowledge in LSA archaeology in Africa in general and the
two study regions in particular. The methodology that was followed in the achievement of the objectives have also been detailed.
Figure 1.1 Distribution of selected East African late Pleistocene-Holocene archaeological site. Adopted from Barthelme, J. 1977.
CHAPTER TWO

METHODOLOGY

2.1 Introduction

This chapter gives a very clear description of the two sites detailing their geology, paleographical descriptions of the sampling and excavation procedures together with the number of artifacts and faunal remains recovered from each of the sites. It also details the manner in which dates of the sites were reached. Maps of the sites together with the geological sections of the excavations are also included.

2.2. RESEARCH DESIGN

This study will entail analysis of archaeological materials that have been excavated from the two sites. These materials are preserved in the national Museums of Kenya. A reconnaissance visit was made to the two study sites prior the analysis. Both qualitative and quantitative methods of gathering information are used.

2.2.1 Sampling technique and sample size

All the materials recovered from FxJj 12 were analyzed as the collection is not very large and could be easily managed. The Olkena lithic collection totaled to 14,447. Out of this, only 1,907 materials were analyzed for the purpose of this study (see table 4.1). This number represents 12.7% of the total collection. Part of the materials unanalyzed is thousands of debitage. Most of the formal tools were analyzed apart from four bags labeled square A, B and C from surface collections whose specific year of collection and collection areas could not be determined as they had no labels on them. An effort to trace the collection from the
field notes and the catalogue for the site did not bear any fruits. Due to constraint of time and resources they were left unanalyzed. All the fauna from the two sites will be analyzed.

2.2.2 Research instruments

Research instruments used in this work include a caliper that was used to take the attribute data for each of the lithics analyzed. The weights of the pieces were also determined using a weighing scale. A LSA lithic typology designed by (Merrick, 1975), faunal reference collection at the Museum was also used.

2.2.3 Data collection and analysis

The collection from the two lake basins is large with thousands of lithic materials, animal remains together with other remains of man’s culture.

2.2.3.1 Archaeological Surveys and Excavations

Every archaeological work heavily rely on surveys and excavations. A survey is carried out to identify archaeological sites after which excavations are carried out. Archaeological excavations at Olkena were started in May- June 1999 by faculty and students of St Lawrence University in the United States, Catholic University and Kenyatta University in Kenya (Barthelme, 1999). Surface collection on the site was done on four 5x5 meters squares. Later on, four excavation units each measuring 2x2 meters were set up and excavation carried out using both arbitrary and natural levels. A 4 mm mesh wire was used to sieve all the sediments from the excavation units. From this, over 5,500 lithics were recovered. In 2002, north of the 1999 excavation, six surface collecting squares each measuring 2x2 meters were laid out. Sampling of Olkena continued during the 2006 and
2007 field seasons with twelve sampling units each of 5x5 meters gridded on Watene’s outcrop (Barthelme, 2003).

Archaeological work on FxJj 12 started in the year 1971 when a team of graduate students including Professor Jack Harris then of University of California Berkeley participated. This research group dug a number of geological trenches and small excavations (see figure 2.6).

Materials from one of the geological trenches were analyzed by Barthelme for his dissertation in 1985. The site was also sampled in 1976 during the field section in the area. This was work conducted with an aim of reconstructing the nature of disposition of different horizons of the sand. In 1979, the site was revisited by Professor Glynn Isaac. The site was re-excavated and stone artifacts, faunal remains, pot sherds and bone artifacts were recovered. Samples of mollusc shells from the site have been dated to 9660 ± 235 and 954 ±260 using C\textsuperscript{14} while samples of bone recovered from the site dated 8355± 235 and 8395± by bone apatite fraction (Barthelme, 1975)

2.2.3.2 Attribute analysis of lithics

Data on lithics was collected first observing them carefully by the presence of cultural modification features that can be identified. This facilitated placing them in their right typologies. The same standardized typology that was derived from Merrick (1975) established to help study LSA sites in Central Kenya was used in classifying all the lithics from the two sites. Changes were however made to enhance the effectiveness of the typology as it was deemed necessary by the task. The raw material used in the manufacture of each of the pieces was then determined and each of the lithic pieces analyses was measured with a digital calipers to determine its length, width and thickness. The weight was
also taken by a weighing scale. All these attributes were recorded and were used in the
determination of percentage frequencies on different tool types and their raw material. This
data was put on tables and compared side by side. Histograms comparing different sets of
data were made to enhance the comparison. ANOVAs tables were generated using the “R”
statistical program utilizing different data sets presented on tables were used to determine if
different categories of analysis are statistically similar or different across the two
archaeological sites in question. All this information was used to draw inferences.

2.2.4 Taxonomic analysis of fauna

All faunal material from the two sites was analyzed in the National Museums of Kenya. The
material was previously analyzed by John Barthelme hence they were clean and did not
require any more cleaning. This study was only limited to identifying the kind of fauna
represented as an indicator of possibly the preference of certain species. Where possible, the
species of each of the remains was determined and recorded. This was possible through
comparing the remains with the reference collection in both the archaeology and
paleontology labs at the museum. Where bones were very fragmentary and delicate, to
warrant such grouping, they were categorized as non-identifiable. Bones from GxJi 4 were
very fragmentary and poorly preserved and would disintegrate with the slightest handling.
This was a setback in their analysis. All this data was presented in tables and used for
drawing inferences.
CHAPTER THREE
GEOLOGY AND ENVIRONMENTAL SETTING OF THE STUDY SITES

3.1 Introduction

This chapter describes the geology of the two study sites looking at the formation of the landscape. Geological forces the resulted to the current landscape are explained. The environmental setting of the sites is also explained.

3.2 The Kenya rift valley system

Earth movements such as volcanic eruptions, tsunamis and earthquakes can best be described plate tectonics. The surface of the earth is made up of several large, thick plates that float of magma that is found below that surface of the earth. The movement and interaction of these plates results to the geological formations that can be witnessed in the world today. The theory of plate tectonics combines two theories namely: the continental drift and the sea-floor spreading (Dickinson, 2012).

The theory of continental drift states that the different continents are found on plates that are always on the move and that have changed their positions over years. Tectonic plates that make up the earth’s lithosphere. Their density is lower than that of molten magma enabling them to float. The conventional currents in the liquid magma allow for continuous movement below the surface that result in pushing stretching and pulling of the tectonic plates. Sea-floor spreading theory on the other hand explains that the ocean’s middle spreads apart with a slow movement to the opposing sides that pills plates away from each other (Nelson, 2015).
The two sites under study are found within the Kenyan Rift valley. A rift valley is formed when the Earth’s crust, or outermost layer, is spreading or splitting apart resulting in a kind of a valley with a flat floor and steep sides. The valley is usually narrow. The Kenyan rift valley runs south to north of Kenya (Saemundsson, 2008). Plate tectonics are responsible for the creation of the rift valley. These are huge slabs of Earth’s crust and upper mantle. The plates are usually under constant motion against one another. The fall beneath one another, crash into each other or shift against each other they can also tear against each other. In instances where these plates move from each other, they, they cause separation of the earth’s crust leading to rifts. Entirely new continents can be formed from these rifts. Valleys existing in continents can also be deepened (Chorowicz, J. 2005).

The Kenya rift system has been very well documented in terms of structure of the lithosphere. Beneath the graben valley, the crystal is 30km thick at latitude 0.5°, and 40 km in the western flank. In the eastern flank it is 35km. The sediment and layers of volcanic material in the graben are 3km thick. The rift shoulders are partially covered by volcanic rocks and are approximately 2000 m high in the east and approximately 2600m high in the west (Achauer et al. 1992).

### 3.3.2 Lake Magadi Basin

Lake Magadi is located in Southern Kenya and measures 20 km wide and 100 km long (see figure 3.1). It has an altitude of 600m and lies within the most southern and deepest depressions of the Gregory rift valley. The lake is just to the North of the Tanzanian boarder. West of the lake is the Ngurumau escarpment where outcrops are characterized by distinctive layers of basalt lava. Precambrian Basement schists and gneisses are
characteristic of the lakes to the west. A series of volcanoes traced to the Miocene and Pleistocene lie south of the lake (Baker, 1958).

Lake Magadi is an intermittently dry lake composed of sodium carbonate-bicarbonate. It is fed by hydrothermal springs and surface runoff water during the rainy seasons of the year. It is extensively covered by trona crust that can be up 30 meters thick (Renault, R. & Ashley, G. M, 2002) The current lake has an annual average rainfall of 409 mm that is concentrated between the month of October and May. The maximum air temperatures of the basin is as high as 35 degrees Celsius making the climate a semi-desert (Barthelme, et al. 2003).

Recent studies conducted in the region indicate that Lake Magadi and Lake Natron in current day Tanzania were previously joined to form a single body of water. The Oloronga beds composed of lacustrine silts and reworked tuffs together with clay have been dated at least to 780,000 years ago by K-Ar measurements (Baker, 1958). The archaeological site reported in this thesis was found in the younger deposits at the top of the sequence, the High Magadi Beds (Barthelme, 1999).

The High Magadi beds represent the more recent lacustrine deposits dated 14C dated to the late Pleistocene and the early Holocene (Butzer et al. 1972; Barthelme 1999 and 2003). The study indicated that between 12,450 and 9,650 Lake Natron and Lake Magadi formed a single lake that was 50-60 meters deep. According to Roberts et al (1994) in Barthelme, (2003), there is a broad synchronicity with the late Pleistocene regression-regression sequence at Lake Magadi, other East African lakes and the last European glaciations.
During survey by Barthelme on the sedimentary exposures adjacent to the northwestern lagoons of the lake, he identified a dense widespread scatter of lithics associated with the Later Stone Age. The scatter was eroding from three low laying outcrops consisting of sands, silts and gravels. He also identified microlithic debitage such as crescents, backed microlith, micro-drills and a number of thumbnail scrappers. Broken pieces of ostrich egg shells, eggshell beads and fragments of land snails together with grinding stones were also observed.
Figure 3.1 Map of Olkena showing GxJi 4. (Adopted from Baker, 1958).
3.3.2.1 Gxji 4 (Olkena)

The area around the site may have been an important migratory route for wildlife between Amboseli National Park and to areas to the West. The area holds large populations of elephants and other plains game as well as carnivores (see photos in plate 3.1). Based on recent comparative diatom, geochemistry and magnetic studies of Lake Magadi sediments, the archaeological site was occupied during cooler and drier periods and lowered lake levels prior to renewed warming and rainfall increases at ~10,000BP. The site is situated adjacent to or within a low energy distributary system of inter fingering streams that drained into Paleo-Lake Magadi (Barthelme, et al. 2003). This may be an important feature as there was probable water (fresh) available in the local area (see chapter 4).

The archaeological rich early Holocene age deposits outcrop over bad land topography situated on the west side of Lake Magadi. The exposures of the Holocene age deposits have been cut through by more recent river deposits draining east towards modern day Lake Magadi. The rivers are mostly dry for long periods of the year because of the semi-arid landscapes. At the base of the sequence is a major sand channel and adjacent are isolated outcrops of diatomaceous deposits formed as result of shallow lake conditions during intermittent wet periods. The presence of possible fresh water even seasonally available was clearly an attraction to people exploiting the local environment.

Deposits bearing the artifacts stratigraphically lie in the upper part of the sequence in the late Pleistocene/ Holocene, High Magadi Beds (Kodikara, 2009). Reconstruction of the geology of the site together with its stratigraphy and depositional contexts were made clear in 2002 following an extensive geological trenching and the correlation of the sediments. It was
realized that the layer that was bearing the LSA materials was made of lenses of coarse sub-angular to rounded gravel, finely sorted sands and silty sands (see figure 2.2). The archaeological horizon varied from 2-3 cm to 20-30 cm. A total of three subunits were observed as shown on figure 2.3. Unit A was is 67 cm in thickness and is composed of silty sands that are very well cemented with distinct lenses of sub-rounded gravel. Artifacts were abundant in the unit. Unit B was composed of well cemented silty sand with very distinct lenses of sub-rounded gravel together with CaCO₃ concretions. It was 6-7 cm thick with very abundant concentration of artifacts. Unit C was made of extremely cemented light brown sandy silt with scattered, very small sub-rounded gravel. The unit was 14-16 cm in thickness with artifact abundance in its upper 3 meters (Barthelme, 2003).

This site seems to have been situated within a river distributary system that was mostly low energy inter fingering streams. The occupation site was then buried by the repeated episodes of low energy movement of water based on the presence of large numbers of small obsidian and chert artifacts measuring around 5mm with sharp flake release margins. These small dimensional artifacts are present because of low energy nature of water causing minimal redeposition (see chapter 4). Above unit 1 is a layer of CaCO₃ concretion 1-2mm thick that suggests sub-aerial exposures whose time is not determined. Transgressive, un laminated silts, part of the Magadi Bed overlie the layer of concretion (Barthelme, 2003) (Kodikara, 2009). The dates of the site were reached by C.14 dating of the ostrich egg shell fragments which yielded a 10,300+100 BP (beta uncalibrated) date in 2002 (Barthelme, 2003).
Plate 3.1 (a), (b), (c), (d) and (e), photos of the area around GxJi 4 showing the general vegetation and wild life that freely roam the landscape photo (f) trona on Lake Magadi. (Photos by James, K.)
Figure 2.2 Geological section of Olkena. (Adopted from Nyame Akuma 60, 2003.)
3.3.3 Lake Turkana basin

Lake Turkana basin is a sedimentary and hydrographic system that encompasses approximately 131,000 km square of the northern part of Kenya together with the southern part of Ethiopia (See figure 2.3). This basin is dominated by alkaine Lake Turkana whose primary water source is Omo River which flows from Ethiopia (Feibel, 2011). Lake Turkana is the largest lake in the east African rift system and occupies a topographic low within the eastern rift that is called the “Turkana depression” (Yuretich, 1986, Beyin 2011).

During the early and middle Holocene, Lake Turkana rouse up to 90 meters above its current level was connected to the adjacent rift basin that provided it an outlet to the Nile River (Yuretich, 1986). The current state of the lake isolation is attributed to the current balance of water based on the tectonic dynamics controlling the accumulation and exposure of sediments an issue that has made the lake famous worldwide. These sediments come from the runoff and detrial sediments coming from proto-Omo river and from Kerio and Turkwel Rivers together with some other smaller drainage systems (Yuretich, 1986) (Mc Dougalli & Brown, 2012). Conglomerates make up the predominant sediment. Sand silt and clay are also deposited. At the present time, this lake is the main depocentre with stratigraphic record showing that there were few and short intervals with widespread deposition in lacustrine environment which is interpreted as an indicator that the lake has existed over 4 million years. Available data show that there is more than 4 km of sediments deposited under the current lake. Throughout the sequence is rhyolitltuffaceous horizons caused by volcanic eruptions also found in the Omo river basin (Mc. Dougall, & Brown, 2012). These provide the means for very accurate dating of the whole sequence.
Plate 3.2 General landscapes in Lake Turkana basin region. (Photos by James, K.)
Figure 2.3 Map showing Lake Turkana basin (Adopted from Koobi Fora Field School on Paleoanthropology 2011 Course pack)

Figure 2.4. Koobi Fora collection area from Koobi Fora Field School on Paleoanthropology, 2011 Course pack
In short, the geological mappings of sediments in the Koobi Fora region begun in the late 1960s. Here sediments were close to horizontal with the topographic relief being rather subdued with lack of conformity and disconformity in some parts making mapping a challenge (Harris et al. 1988). The stratigraphy was later documented as the Koobi Fora formation by Brown and Feibel (1986).

This work was started by Teleki and Von Hohnel in the 1890s. Most systematic research work begun at the 1960s and 1975 and has contributed greatly to the gaining knowledge on the basins geology. In the mid-1960s, great efforts by Paleo-Athropological investigators revolved around the geology of the area. This research was carried out in areas around lower Omo valley, Koobi Fora and West Turkana (Feibel, 2011).

On the east side of Lake Turkana, have been divided into the Pliopleistocene Koobi Fora formation and overlay disconformably by deposits of late Pleistocene/Holocene the Galana Boi formation (Brown & Rebel 2012) (see figure 2.3). The Galana Boi deposits consist of a narrow thickness of sediments extending laterally over long distances in the Koobi Fora basin (see figure 2.5). The sediments disconformably lies on top of the Koobi Fora formation deposits.
Figure 2.5 Geological section of FxJj 12.  
from (Adopted from Barthelme, J. 1985)

Figure 2.6 FxJj 12 site plan (Adopted Barthelme, J. 1985)
3.3.3.1 FxJj 12

The Holocene sediment in this section is approximately 2.25 meters in thickness (see figure 2.6). These sediments overlay Plio-pleistocene indurated sandstones together with silty clays. The composition of these Holocene beds has muddy course sands, diatomaceous silty sands, and several horizons of coarse gravelly sands together with shell coquina melandioides and corbiecila. The site is near the shores of Paleo-lake Turkana (Barthelme, 1975).

Figure 2.4 indicates the depositional nature of FxJj 12 site setting. The site lies in the Galana Boi deposits that consist primarily of lacustine silty sands and coarse sands but include gravels of sub-lithorial and lithorial origin. Horizons A, B, C, and D indicate a beach with a fluctuating shore line (see figure 2.8). The presence of fish and barbed bone harpoons points indicate the presence of Holocene fishing peoples carrying out activities at the shores of the paleolake Turkana. The lower part of horizon D and horizon E indicates shallow lake water depositional conditions with the presence of conquina of shell fish melanoides and corbicula. The presence of lake conditions is confirmed by the presence of diatomaceous sands. This is a very contrasting paleoenvironmental setting to site GxJi 4 at Lake Magadi (see chapter four for behavioral implication).

3.3 Chapter summary

Chapter three gives a conclusive description of the two study site localities detailing their geology and environmental setting. Maps of the two sites are also included together with site plans and geological trenches. All this is to aid the interpretation of the recovered assemblage by relating it to the geological context of the sites.
Figure 2.7 Distribution of sites on Galana Boi deposit (Adopted for Ndiema, 201).
Figure 2.8 Koobi Fora formation (Adopted from Koobi Fora Paleo-Anthropological Field School Course pack 2007)
CHAPTER FOUR

DESCRIPTION OF ASSEMBLAGES FROM THE TWO RESEARCH SITES

4.1 Introduction

This chapter gives a description of each type of artifact recovered from the two sites together with their measurements or attribute data. The chapter covers three major artifact classes.

The following section gives the basic definitions of basic terms and methods that were used in obtaining metric data. All lithic materials were initially divided into three broad classes. These classes are shaped pieces, debitage and “other pieces” (see table 4.1). As stated earlier, a standardized typology designed by Merrick, 1975 was used to place each of the analyzed lithics into its right category.

Shaped pieces are basically all artifact types that appear to have been deliberately shaped and are commonly referred to as tools or secondarily modified pieces. They include all the pieces showing evidence of secondary modification of the original blank but exclude cores, flakes and flake fragments. This category includes tools such as scrapers, backed pieces, outils écaille’s whose characteristics results from intensive utilization. Tool types classified under shaped tools included backed microliths, truncations, scrapers, outils écaillés, burins, becs, and tool fragments.

The class debitage includes all flaked stone artifacts that are not included in shaped pieces and cores. This category includes whole flakes, broken flakes, angular fragments etc. The last class is “other pieces” a class which consisted of all other lithic materials that do not fit in the categories above. It includes cores, grindstones and hammerstones.
4.2 OLEKNA LITHICS
4.2.1 SHAPED TOOLS

Shaped tools formed a considerable important category in the Olkena collection. These shaped tools represented 33.1% (see table 4.2) of all the analyzed materials from the site. The shaped tools represented in the collection included microliths, outils écaillés, scrapers, burins, pecoirs, awls/drills, truncations and becs. The most predominant category of the shaped tools was microliths representing 23.1% of the entire analyzed collection. Scrapers and Awls or drills were also highly represented in the site and constituted 5% and 3.4% respectively of the whole collection. Outils écaillés were represented by 1.1% of the whole collection.

4.2.1.1.0 Microliths

Microliths included all crescentic forms, straight backed pieces, curved backed pieces, trapezoids, double backed microliths truncated blades and curved backed microliths. The term backed microliths was chosen in preference to backed blades to emphasize the small size of the backed pieces. There is no typological distinction that was made between microliths and macrolithic sized piece on an individual basis. Crescentic forms are pieces exhibiting a continuous convex backed edge which intersects the opposite lateral edge at a point at each end of the arc (see figure 3.1). Although there are many forms of crescentic forms such as crescents, pseudo-crescents and eared crescents, they were not recognized as distinct classes as they were very rare in the collection and were simply described as crescents.
Table 4.1 Frequency of major tool types from Olkena with their percentages on the collection

<table>
<thead>
<tr>
<th>Tool type</th>
<th>Shaped tools</th>
<th>Debitage</th>
<th>Other pieces</th>
</tr>
</thead>
<tbody>
<tr>
<td>(N)</td>
<td>(%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shaped tools</td>
<td>632</td>
<td>857</td>
<td>418</td>
</tr>
<tr>
<td>Shaped tools</td>
<td>33.1</td>
<td>45</td>
<td>21.9</td>
</tr>
</tbody>
</table>

Table 4.2 Inventory of lithics from Olkena

<table>
<thead>
<tr>
<th>Tool type</th>
<th>Length (mm)</th>
<th>Width (mm)</th>
<th>Thickness (mm)</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular frags</td>
<td>17.64</td>
<td>10.74</td>
<td>5.09</td>
<td>1.59</td>
</tr>
<tr>
<td>Broken flakes</td>
<td>17.8</td>
<td>11.2</td>
<td>3.39</td>
<td>0.96</td>
</tr>
<tr>
<td>Other</td>
<td>19.13</td>
<td>10.11</td>
<td>3.21</td>
<td>0.91</td>
</tr>
<tr>
<td>Others</td>
<td>22.88</td>
<td>16.63</td>
<td>13.6</td>
<td>5.9</td>
</tr>
<tr>
<td>Grindstones</td>
<td>54.19</td>
<td>38.21</td>
<td>22.95</td>
<td>86.5</td>
</tr>
<tr>
<td>Hammer stones</td>
<td>48.29</td>
<td>40.47</td>
<td>21.99</td>
<td>70.84</td>
</tr>
</tbody>
</table>

Table 4.3 Mean metric measurement of lithic materials from Olkena
Plate 4.1 Lithics from Olkena (a) Awls/drills (b) pecoirs, (c) single platform cores, (d) backed microlith, (e) miscellaneous and end scraper, (f) grindstone, (g) burins, (h) thumbnail and end scraper, (i) grindstone handheld, (j) crescents, (k) flake cores (l) scrapers (may not be associated with LSA) (Photos by James, K.).
<table>
<thead>
<tr>
<th>Microliths</th>
<th>(N)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crescents</td>
<td>160</td>
<td>36.2</td>
</tr>
<tr>
<td>Backed microlith</td>
<td>282</td>
<td>63.8</td>
</tr>
<tr>
<td>Trapezoid</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>442</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Table 4.4 Frequency of microliths from Olkena site*

Double backed microliths were classified as pieces exhibiting backing on opposite lateral edges parallel to the long axis of the piece. Miscellaneous double backed microliths are all other pieces exhibiting backing on both lateral edges including double backed crescents. Truncated blades are pieces exhibiting primary line of backing perpendicular or oblique to the two parallel edges that are usually parallel. Retouch is either perpendicular or oblique to the long axis of the piece and truncates either the distal or proximal end of the piece. Curved backed microliths include eared crescents and markedly asymmetrical crescents.

**4.2.1.1 Backed microliths**

A total of 282 backed microliths were analyzed from the collection as indicated on table 4.4. Out of these, 184 were broken. These blades come in different typologies. Two of them had double side and end backing while twelve were double backed. Seven of them were straight backed. A total of fifteen blades exhibited backings and were curved. The largest number of them (45) were only backed on one side. Single backed miscellaneous blades were 14 in number. A majority of the blades had a bulb that was still very visible although its presence or absence is not a very critical attribute especially for the category of curved blades. The most predominantly used raw material for the manufacture of these backed microlith was chert with
63.8% of all analyzed backed microlith. Obsidian represented 29.1% while Quartz was represented by 7.1%.

4.2.1.1.2 Crescents

This is the second sub category of the microliths. A crescent is a piece that exhibits a line of backing continuous throughout the arc and forms a complete truncation of the piece at the end. Most of the crescents from this site exhibited steep backing with sharp opposite edges. They looked like they were made from large cores. Many of them exhibited very clear edge damage on the dorsal side resulting from use. Their dorsal ridge was also quite clear (see table 4.1).

A total of 160 crescents were recovered both from sampling and excavation which was 36.3% of all microliths as stated above. 75 of these were broken. In terms of raw material, chert and obsidian were the most preferred choice. 17.9% of all the crescents were made on chert while, 77% were made on obsidian. A few on the other hand were made on quartz. The proportion of broken to unbroken pieces across the raw material was almost the same. The average length, width thickness and weight of the analyzed crescents were 28.1mm, 9mm, 4mm and 1 gms respectively.

Trapezoid, truncated blades, bulbular trimming and casual trimming were absent in the collection.

4.2.2.2 Awls/drill

Awls or drills are small artifacts with pointed edges that are a basically used for drilling holes on surface especially for making beads (see plate 3.1). They are found in Later Stone Age
collections where they are used to drill ostrich egg shells for manufacture of ostrich egg shell beads (Gurova, 2014). In this collection, a total of 64 awls were recovered representing 3.4% of all analyzed materials in the site as stated above. Eleven of the 64 were broken. They had a mean length of 19 mm, width of 6.8 mm and thickness of 3.6 mm (see table 4.3). All of them were made on white chert and were double sided. They showed considerable crushing and edge damage suggesting that they were used to drill the numerous ostrich egg shells that were found in association.

4.2.2.3 Burins

Burins are piece that has been retouched with one or more “burin facets” these scars denote the removal of the edge by a longitudinal blow parallel with the edge (see plate 3.1). There exists sub classes of this but they were not considered in this study. In this collection, a total of 6 burins were recovered (see table 4.2). They were all made on chert except one piece that was made on obsidian. These burins exhibited a very clear “burin facet”. They had an average length of 30.8mm, width of 14.9mm and a thickness of 6.7mm. The average weight of the pieces was 3.5 gms (see table 4.3).

4.2.2.4 Outils écaillés

Outils écaillés were classified as pieces with one or more edges exhibiting a characteristic modification consisting of numerous short scalar step flake scars and localized crushing and fracturing. It may exhibit either unifacial or bifacial end modification. Its edge site view is slightly concave. No more distinctions were made on this class in this study.

A total of 22 pieces were recovered from the site. Most of the pieces had more than one edges with characterized modification with a flake removal on the dorsal side. The most predominant
raw material for the manufacture of these pieces was obsidian which represented 86% of all
the outils e’ccaille’s, quartz is represented by 9 %, while chert comes in as the least preferred
raw material with 4.5% (see table 4.2). In metric measurements, these pieces had a mean of
23.9 mm, 16.7 mm, 6.7 mm and 3.6 gms in average length, width, thickness and weight
respectively as captured on table 4.3.

4.2.2.5 Pecoir/ pointed
Percoirs were classified as any piece which is usually a flake or a flake fragment that has two
lines of retouch that are convergent that form and elongated relatively thick sectioned, refined
awl like point. In this collection, pecoirs exhibited crushing at the pointed edge presumably
due to use. There were only two pecoirs in GxJi 4 collection with one of them made from a
flake that was mostly cortex on the dorsal side (see plate 3.1). The only raw material here was
chert.

4.2.2.6 Scrapers
Scrapers were divided into formal and causal based on the degree of modification of the edges.
Retouch on scrapers is either invasive or sub invasive and it markedly alters the original shape
of the blank (see table 4.1). Casual scrapers exhibit sporadic retouch along the edges and is
invasive hence does not affect the original shape of the blank. Formal scrapers are those that
have been intensively retouched along the line of modification. Scraper types are largely
defined on the basis of position of the modified edge in relation to the blank (blade, flake,
flake fragment or angular fragment) on which retouch has been carried out.

A number of subcategories were identified including circular scrapers which were nine in
number and all made on chert. Endscrapers were also represented. They were 40 pieces of
which 28 were made on obsidian and the rest is chert. There was one end and double side
scraper and one notched scraper with two notches. A racloir transverse was also found. Seven miscellaneously retouched scrapers were also recovered together with one side scraper. Thumbnail scrapers were also highly represented with 23 of them made on obsidian while 10 were made on chert. Six end and side scrapers were made on obsidian while a single end and side scraper present was made on chert.

Side scrapers were categorized as those whose modified edge runs parallel to the long axis of the piece regardless of the piece’s orientation of the modified edge to the axis of the flake or platform. The plan shape of the pieces is usually straight and although concave scrapers can be found, they are usually rare and are classified as notched and concave. A number of single side scraper categories were identified. These include single side scrapers, double side scrapers, racoir transverse scrapers, end and side scraper, end scraper and circular scraper.

There were 9 large scrapers with several made from basalt, a raw material that has not found use in any of other pieces in the collection. They appear large and more crude as compared to the rest from the collection and were probably not related to the LSA. They had an average length of 38.5 mm, width of 26.4 mm and thickness of 10.9 mm. The other scrapers in the collection had a mean length of 22.3 mm, width of 16.9 mm and thickness of 5.6 mm. The mean weight of these scrapers differs greatly as the large ones weighed 122.4 gms while the others weigh 3.3 gms.

Some of the most striking subcategories of scrapers are described below.

4.2.2.6.1 Thumbnail scrapers

Thumbnail scrapers from Olkena were usually small and rounded on one end. Most of them have blade flake scars on the dorsal surface. They are relatively thin with a very steep
scrapping edge that matches the thickest part of the artifact. Majority of them show end damages presumably as a result of continued use (see plate 3.1). Their average dimensions in terms of length, width, thickness and weight are 22 mm, 16.6 mm, 5.4 mm and 2.3 gms respectively. Out of the 23 analyzed from the collection, obsidian was represented by 12 while chert had 11.

**4.2.2.6.2 Retouched miscellaneous scrapers**

This subclass of the scrapers is basically larger than end scrapers. They are retouched on one of the sides and end and indicate purposeful work and not breakages (see plate 3.1). In the collection, there were six of them with only one piece made on basalt while the rest was chert. Their mean length, width thickness and weight are 31.6mm, 25.2mm, 9.21mm and 7.9 gms respectively.

**4.2.3 DEBITAGE**

Debitage is basically the waste or in other words the byproducts-chips or debris that results from the process of flaking or shaping stone tools. For the purpose of this study, debitage was grouped in three classes. These classes are whole flakes, broken flakes and angular fragments. The total number of debitage analyzed from Olkena is 857 pieces which presented 45% of the entire analyzed collection (see table 4.1). The sub categories of debitage in the site include angular fragments, whole flakes and broken flakes. Chert is the most predominant material in the debitage. Chert is represented by 51.1% of all the debitage (n=857) while obsidian is the second predominant with 36.3% (see table 4.2). Basalt has only 40 pieces which is 4.7% while quartz is represented by 7.8%. There is only one piece of angular fragment made from unidentified stone type relatively hard and brownish in color that I have called clay stone for the purpose of this study.
4.2.3.1 Angular fragments

Angular fragments include distal flake fragments but which lack traces of bulb of percussion or the platform and fragments with plane fractures that are most probably artifactual in origin. There were a total of 234 pieces of angular fragments in the analyzed collection (see table 4.2). This represented 12.5% of the entire analyzed collection and at the same time represents 26.7% of all the debitage. Angular fragments in the collection have different raw material proportions with chert being the highest represented at 5.5% of the whole collection, quartz 3%, basalt 2% and sandstone 0.5% (see table 4.2). In metric measurements, on average, the pieces have length, width, thickness and weight of 17.6 mm, 10.7 mm, 5.1 mm and 1.6 gms respectively (see table 4.3).

4.2.3.2 Whole flakes

Whole flakes are entire pieces as they were struck from a core including the striking platform. The most common were whole flakes that by definition have been struck from a core and show platform and bulb at the proximal end and a “release surface” at the opposite or distal end of the flake. They also included core trimming flake and tool trimming flakes. Core trimming flakes are flakes bearing on its dorsal surface portions of a core platform and the scars of flake struck from this platform. Tool trimming flakes exhibited dorsal surface traces of the retouched working edge of a trimmed piece. Flake scars on the working edge were normally smaller than those of core trimming flakes.

This is the largest subclass of all the debitage in the analyzed collection. There was a total of 391 pieces as indicated on table 4.1 representing 20.2% of all the analyzed material in the entire collection while at the same time representing 45.6% of all analyzed debitage. 15 core trimming flakes in this collection were also classified in this class. Three raw materials
represented here are obsidian, quartz and chert. The most predominant raw material here was obsidian with 10.1% of the whole collection followed by chert with 10.1% and lastly quartz with 0.1%. The average length of the pieces is 19.1 mm, width 10.1 mm, thickness, 3.1 and lastly weight is 0.9 gms (see table 4.3).

4.2.3.3 Broken flakes

Broken flakes are any pieces that represent part of a flake that broke during the process of manufacture. Many are the split and snapped flakes. There is a total of 232 pieces in the whole analyzed collection. This represents 12.2% of all the analyzed lithic. This number also represents 27.1% of all the debitage (see table 4.2).

4.2.4 “OTHER PIECES”

This class includes all other lithic materials that do not fit in the two broad categories already described. In this category there are cores, hammer stones, anvils, manuports and grind stones. In the GxJi 4 collection, three distinct classes of lithics were found to fit this class. These are cores, grindstones and hammerstones. This class represents the lowest of the broad categories with 21.9 % of the entire analyzed collection (see table 4.1).

4.2.4.1 Cores

Cores can be described as pieces of stone used as blanks from which flakes and blades are removed during the process of detachment. Also, they are actually by-products of tool manufacture. Classification of cores for this study was done on the basis of the orientation of flake removals and the resulting piece.

As indicated on table 4.2, GxJi 4 had a total of 405 cores which represented 21 % of all the analyzed lithics in the site. Five distinct types of cores were identified. These are single
platform, double platform, multi-platform, discoidal core, flake core. In addition, there were a number of core fragments.

4.2.4.2 Single platform cores.
Single platform cores are characterized by only one surface or ridge from which flakes have been removed. In this collection there were 80 such pieces that represented 19.8% of all the cores in the entire collection. Chert is the most preferred raw material for the single platform cores. Obsidian is the second highest preferred raw material with 28.8% and the least is quartz, with 12% (see table 4.2). No single platform cores were made on basalt or sandstone. Out of the 80 single platform cores, 5 of them were pyramidal in shape and the average length, width, thickness and weight of these pieces is 23.9 mm, 16.6 mm, 11.6 mm, 5.8 gms respectively (see table 4.3).

4.2.4.3 Double platform cores
These types of cores have two platforms from where flakes have been removed. They could be removed from the same plane or different planes (see table 4.1). This is the most predominant class of cores in the analyzed collection. There are a total of 174 double platform cores in this collection making it the largest class. This is 36.3% of all the cores. The most predominant raw material for manufacture of these double platform cores is chert at 50% followed by obsidian at 47.2% while quartz has 2.7% (see table 4.2). In terms of their metric dimensions, the average length, width, thickness and weight of these cores is 28 mm, 15.8 mm, 10 mm and 5.3 gms respectively.

4.2.4.4 Multi-platform cores
These cores have more than two surfaces or ridges from which flakes were removed. From the analyzed lithics, these cores were 138 in total representing 34.1% of all the cores in the
analyzed collection. Just like in the double platform cores, the most predominantly used raw material is obsidian representing 47.5% of all multiplatform cores. Chert represented 44.6% while quartz represented 7.9% (see table 4.2). In terms of their metric measurements, the average length, width thickness and weight of these pieces is 22.5 mm, 17.2 mm, 19.3 mm and 6.4 gms, respectively.

4.2.4.5 Discoidal cores

A discoidal core is another class of cores in GxJi 4 its frequency is very low as compared to the other classes. These are disc shaped core. There is only one piece of discoidal core in the whole collection representing 0.2% of all the cores analyzed in the collection. The piece is made up on obsidian. It is a small piece with length of 13.8 mm, width of 12.3 mm, thickness of 6.3 mm and weigh 1 gm.

4.2.4.6 Core fragments.

Core fragments in the collection represent 8.1% of all the cores. They are 33 in number with most of them made on quartz. They show evidence of breaking in the process of being reduced to produce flakes and blades. Most of these cores were made on chert 46.6% and obsidian 15.5% (see table 4.2). In terms of their metric measurements, these cores had an average length, width, thickness and weight of 24.3 mm, 17 mm, 11.5mm, and 5.9 gms, respectively.

4.2.4.7 Flake cores

This is the last class of cores present in Olkena collection. These are flakes that exhibit numerous flake removals. In other words, these are large flakes that were used to produce smaller flakes (see table 4.1). They were five in the entire collection representing 1.2% of all the cores. Most of these flake cores were made on obsidian which has a representation of
0.7%. On average, they measured 37 mm, 25.6 mm, 10.2 mm and 13 gms in length, width, thickness and weight, respectively.

### 4.2.5 Grind stones and handhelds

There are 11 grindstones in the collection two of them are pieces I will call handhelds for the sake of this study as captured on table 4.2. A grindstone handheld on this case will refer to a piece which is held by hand as one grinds grains on a grindstone. The grindstones are made of sandstone and have smooth hollowed parts that indicate wear out as a result of use in grinding grains and other foodstuffs (see table 4.1).

One of the grindstones has hollows on its two sides meaning that both sides were used in grinding. These grindstones are made from tabular blocks. The handhelds have one of their surfaces very smooth. These handhelds are made from rounded pebbles that fit perfectly to one’s hand. One of the handhelds was worn out from the grinding till approximately a third of it had been lost as a result of continued use. The other does not seem much used. One of the handhelds perfectly fit in the hollow on one of the grindstones. The two seem to have been used together. The largest of these grindstones is 86.2 mm long, 47.7 mm wide, 36.2 mm thick and 258.6 gms in weight (see table 4.3 for metric data).

### 4.2.6 Hammer stones fragments

There are two hammer stones in the collection. They have edges that show characterized pitting and crushing on the most projected edges. These hammer stones are made on quartz (see table 4.2). They have an average length, width and thickness of 48.3mm, 40.5 mm, 22 mm, and 70.84 gms.
4.2.6 OTHER FINDS

4.2.6.1 Hematite

There is a single piece of hematite that was recovered from surface collection. Hematite is used by in traditional industries to smelt iron. There is no evidence of use of this hematite in the site and the surroundings. The piece is light brown has some matrix embedded (see table 4.1). There is however no evidence of any attempt to process the hematite into iron.

4.2.6.2 Stromatolite

These are buildups of microbial mats forming in limestone and look like rocks which form by trapping, baffling and precipitation of microorganisms such as algae and bacteria. A total of 23 stromatolite pieces were recorded from the archaeological collection (see plate 3.3). They are grayish in color.

4.3 LAKE TURKANA LITHICS

4.3.1 Introduction

The only materials analyzed for site FxJj 12 was from surface collection and excavations supervised by Jack Harris during the 1971 field season. Dr. John Barthelme indicated in his thesis that all the other materials collected from the site from all the other excavations supervised by John Onyango Abunje and Jonathan Karoma could not be traced in the National Museum and consequently could not be used for his thesis in 1985. Effort by the researcher to find them proved futile so that they could be included in analysis also did also not bear fruits. As a result, just like Barthelme, I only analyzed the materials form Jack Harris’s’s surface collection and excavation which totaled to 793 lithics (see table 4.5). Similar to Olkena
assemblage, the FxJj12 assemblage, this collection was classified into three main artifact classes namely shaped tools, debitage and “other pieces”.

4.3.2 SHAPED TOOLS

Shaped tools represented the smallest class of lithics in FxJj12 with a proportion of 8.6% of the whole collection (see table 4.5). Some of the categories of shaped tools recorded from the site include microliths, outils écaillés, scraper, burins, and pecoirs, truncations among others. The total number of the shaped tools in the collection is 68. In terms of raw material, chert was the most predominant material with 75.4% of all the shaped tools made from it. The second most predominant raw material was quartz with 16.4%. The least preferred raw material was basalt with a representation of only 9.6%. There were no shaped tools manufactured from claystone.

4.3.2.1 Microliths

This is the largest class of the shaped tools in the collection with a total of 34 pieces representing 50% of all the shaped tools (see table 4.6). These are in three classes namely crescents, blades and a trapezoid. In terms of their average abundance, crescents were more common as were represented by 52.9% of all the microliths while backed blades and trapezoids were 44.1% and 2.9% respectively (see figure 3.7). In terms of raw material, all the microliths were made on chert. The average length, width, thickness and weight of the microliths are 26.8 mm, 12.2 mm, 4.6 mm, and 1.6gms, respectively (see table 4.4). The following sections 1.1.1, 1.1.2 and 1.1.3 are subcategories of microliths.

4.3.2.1.1 Crescents

As stated above, crescents represent 47.4% of all the microliths in the collection. These crescents were all made on chert as indicated earlier (see table 4.2). Their average length,
width, thickness and weight are 26.8 mm, 12.2 mm, 4.6 mm and 1.6 gms, respectively. The crescents here had relatively deep backing with their opposite edges being sharp. The sharp edges exhibited edge damage as a result of use. A number of the pieces were broken.

4.3.2.1.2 Backed microliths

These formed the second largest portion of all the microliths in the collection after crescents (see table 4.7). These were both single backed and curved backed microliths. Curved backed microliths were higher in frequency as compared to the single backed pieces. Their average length, width, thickness and weight are 25.7 mm, 12.2 mm, 4.6 mm, and 1.6 gms, respectively. As stated in a different part of this section, all the pieces were made from chert.

4.3.2.2 Trapezoid

There is only one piece of trapezoid in the entire collection. It’s a relatively small piece made from chert (see plate 3.2). Its length, width, thickness and weight are 23.8 mm, 13.9 mm, 3.2 mm and 1.6 gms respectively.
Plate 4.2 Sample Lithics From Fxjj12. (a) convergent scraper, (b) trihedral pointed tool, (c) bulbular timmings, (d) trapezoid, (e) truncation, (f) burins, (g) becs, (h) cores, (i) side scrapers (broken), (j) whole flakes, (k) truncations, (l) crescents.
<table>
<thead>
<tr>
<th>Major class</th>
<th>FxJj 12</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(N)</td>
<td>%</td>
</tr>
<tr>
<td>Shaped tools</td>
<td>68</td>
<td>8.6</td>
</tr>
<tr>
<td>Debitage</td>
<td>641</td>
<td>80.8</td>
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<tr>
<td>“Other pieces”</td>
<td>84</td>
<td>10.6</td>
</tr>
<tr>
<td>Total</td>
<td><strong>793</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Table 4.5 Frequency of major tool types from FxJj 12*

<table>
<thead>
<tr>
<th>Microliths</th>
<th>N</th>
<th>% frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backed blade</td>
<td>15</td>
<td>44.1</td>
</tr>
<tr>
<td>Crescents</td>
<td>18</td>
<td>52.9</td>
</tr>
<tr>
<td>Trapezoid</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Total</td>
<td><strong>34</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Table 4.7 Frequency of microliths from FxJj 12*

<table>
<thead>
<tr>
<th>Tool type</th>
<th>FxJj 12</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td><strong>Tool type</strong></td>
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<td></td>
</tr>
<tr>
<td>Shaped tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microliths</td>
<td>34</td>
<td>50</td>
</tr>
<tr>
<td>Outils écaillés</td>
<td>9</td>
<td>13.2</td>
</tr>
<tr>
<td>Scrapers</td>
<td>8</td>
<td>11.8</td>
</tr>
<tr>
<td>Burins</td>
<td>2</td>
<td>3.2</td>
</tr>
<tr>
<td>Percors</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Awls</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Truncations</td>
<td>8</td>
<td>11.8</td>
</tr>
<tr>
<td>Becs</td>
<td>3</td>
<td>4.4</td>
</tr>
<tr>
<td>Tool frags</td>
<td>3</td>
<td>4.4</td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Total</td>
<td><strong>68</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td>Debitage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angular fragments</td>
<td>211</td>
<td>32.9</td>
</tr>
<tr>
<td>Broken flakes</td>
<td>281</td>
<td>43.8</td>
</tr>
<tr>
<td>Whole flakes</td>
<td>149</td>
<td>23.3</td>
</tr>
<tr>
<td>Total</td>
<td><strong>641</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cores</td>
<td>83</td>
<td>98.8</td>
</tr>
<tr>
<td>Grindstones</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hammer stones</td>
<td>1</td>
<td>2.2</td>
</tr>
<tr>
<td>Total</td>
<td><strong>84</strong></td>
<td><strong>100</strong></td>
</tr>
<tr>
<td><strong>Grand total</strong></td>
<td><strong>793</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Table 4.8 Frequency of cores from FxJj 12*

<table>
<thead>
<tr>
<th>Core type</th>
<th>FxJj 12</th>
<th>FxJj 12</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Casual</td>
<td>7</td>
<td></td>
<td>8.4</td>
</tr>
<tr>
<td>Single platform</td>
<td>4</td>
<td></td>
<td>4.8</td>
</tr>
<tr>
<td>Double Platform</td>
<td>39</td>
<td></td>
<td>47</td>
</tr>
<tr>
<td>Multiplatform</td>
<td>30</td>
<td></td>
<td>36.1</td>
</tr>
<tr>
<td>Discoidal</td>
<td>1</td>
<td></td>
<td>1.2</td>
</tr>
<tr>
<td>Core frags</td>
<td>2</td>
<td></td>
<td>2.4</td>
</tr>
<tr>
<td>Flake core</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td><strong>83</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

*Table 4.6 Inventory of lithics from FxJj 12*
4.3.2.3 Outils écaillés

Outils écaillés is another important class of shaped tools in the collection. They make up 13.2% of the shaped tools as indicated in table 4.6. 5 of them are made on quartz while the rest are made on chert. The average length, width, thickness and weight of the pieces is 21.5mm, 14.7 mm, 6.2 mm and 3 gms.

4.3.2.4 Scrapers

This is the third category of the shaped tools from this site. The total number of these scrapers is eight representing 11.8% of all the shaped tools (see table 4.6). These scrapers existed as end scrapers, side scrapers, a notched scraper and a convergent scraper. End scrapers were two, while side scrapers are nine. There is only one convergent scraper and one notched scraper. The most predominant raw material for the scrapers was basalt with six out of the eight scrapers made from this raw material. One piece was made on chert while the other was made on quartz. In terms of metric measurements, they measures 48 mm, 32.1mm, 11.8 mm and 29.4 gms in length, width, thickness and weight respectively.

4.3.2.5 Bec

Becs are pieces which is usually a flake or a flake fragment that has a thick sectioned point that is retouched minimally. They are usually formed by slight modification on the intersection of two snaps or fractures, or by modification to some other naturally sharp point or apex. The modification edge is usually minimal and in many cases the end exhibit utilization or edge damage. Becs represent 4.4% of all the shaped tools in the collection (see table 4.6). All the three pieces are made on chert. In metric measurements, these becs had average length, width, thickness and weight of 44 mm, 19.1 mm, 10.7 mm and 28.8 gms respectively.
4.3.2.6 Burins

Burins were also represented in the collection. There were only two pieces making up 0.2% of all the shaped tools. Their “burin facets” were very distinct and clear with a number of flake removals. The raw material used in the manufacture of these burins was chert. Their average length, width, thickness and weight is 23.2 mm, 11.1 mm, 6 mm and 2.5 gms respectively.

4.3.2.7 Truncations

Truncations are flake or flake fragment (and much less commonly large blades) that exhibit a straight line of steep or nearly perpendicular truncates the long axis of the piece and greatly alters its shape. The morphology of these pieces grades retouch which is usually oriented perpendicular or slightly oblique to the long axis of the piece. There are eight truncations in the entire collection representing 11.8% of the shaped tools. All the truncations are made up of quartz except two that are made on chert. In metric measurements, they have an average length, width, thickness and weight of 28.5 mm, 13.3mm 5.3 mm and 2.3 gms.

4.3.2.8 Others

4.3.2.8.1 Trihedral pointed tool

Under this category is one piece of a trihedral pointed tool. It is a large piece made on basalt. It is 107 mm in length, 28.9 mm in width, 23.8 mm in thickness and weighs 88 gms. It is pointed to one side and the butt fits perfectly into ones hand (see plate 3.2).

4.3.3 DEBITAGE

Debitage represented in this collection are angular fragments, whole flakes and broken flakes. This debitage represent the highest lithic type in the entire analyzed collection. As shown on table 4.5, debitage represents 80.8% (n= 641) of the entire lithic collection from the site.
4.3.3.1 Angular fragments

The total number of angular fragments in the collection is 211 representing 32.9% (see table 4.6) of all the debitage analyzed (n= 641). Different types of raw materials represented here include chert, basalt claystone, sand stone and quartz. The material with the highest frequency is basalt at 50% followed by chert at 45.7 % of all the analyzed angular fragments. Quartz and sandstone has the least representation at 1.1% and 2.4% respectively. In terms of metric measurements, these angular fragments have an average length, width, thickness and weight of 33.6 mm, 14.4 mm, 11.6 mm, and 13.9 gms.

4.3.3.2 Whole flakes

This category included the entire pieces struck from cores exhibiting the striking platform and core trimming flakes which are flakes that bear dorsal surface portions of a core and scars of flakes struck from the core. There are a total of 149 whole flakes in the entire analyzed collection. This represents 23.2 % of all the debitage analyzed (n=641). Different raw materials are present here. This includes sandstone that is least used raw material. Sand stone is represented 0.7% of the whole flakes analyzed (n=149), quartz 4.7%, and basalt 36.1% (see table 4.2). Chert was the most predominant raw material with a representation of 58.5%. In metric measurements, the average length, width, thickness and weight of the pieces are 25.2 mm, 18.3 mm, 6.3 mm and 6.3 gms, respectively.

4.3.3.3 Broken flakes

This category includes snapped flakes, split flakes and broken blades. A total of 281 broken flakes were analyzed in this collection (see table 4.6). This number represents 43.8% of all the debitage (n=641) pieces. Different types of raw materials are represented here including chert,
quarts, basalt and sand stone. In terms of their relative proportions, chert represented 50.5% and as the most abundantly used raw material, basalt was 42.7% while quartz is 6.8% of all the broken flakes (n=281).

4.3.4 “OTHER PIECES”
This class just like stated earlier in this work is made up of lithic materials that do not fit in any of the two classes described above, shaped tools and debitage. In this collection, this class is made up of cores and hammerstones.

4.3.4.1 Cores
FxJj 12 recorded a total of 83 cores (see table 4.8). Different types of cores were represented including single platform, double platform and multiplatform cores. The most predominant raw material in this category is the chert as indicated on table 4.2 with 67.5% followed by basalt 15.7% (n=83). This is the class that had an obsidian piece in the entire tool kit. The average length, width, thickness and weight of all the analyzed cores are 30.4 mm, 20.7 mm, 13.9 mm and 28.9 gms respectively (see table 4.4). Different classes of cores are represented in the collection. These are casual cores, single platform, double platform cores, discoidal core, core fragments, and multi-platform cores.

4.3.4.1.1 Casual cores
Seven casual cores were recorded both from excavation and surface collection of FxJj 12. These cores represent 8.4% of all the cores retrieved from the site (n=83). Four out of the seven cores were made on chert while two were made on quartz (see table 4.8). The remaining one was made from obsidian. These cores had an average length, width, thickness and weight of 26.1 mm, 19.6 mm, 14.0 mm and 7.3 gms.
4.3.4.1.2 Single platform cores

Only four single platform cores were represented in the site (see table 4.8). This amounts to only
4.8% of all cores (n=83). These cores have an average length, width, thickness and weight of
21.5mm, 12.5 mm, 9.3 mm and 2.7 gms, respectively. All of the cores are made on chert.

4.3.4.1.3 Double platform cores

There are 39 double platform cores in the analyzed collection representing 47% of all the cores
from the site (see table 4.8). This is the most predominant class of cores in the entire
collection. 87.1% of all these cores are made on chert while 10.3 % are made on quartz while
only 2.6% is made on basalt. There were none made from obsidian.

4.3.4.1.4 Multi-platform cores

There are only 30 pieces of multiplatform cores a figure that represents 36.1% of all the cores
in the collection. Half of these cores were on chert while those made on basalt were 36.7%.
Quartz was representing by 13.3% (see table 4.2). These had an average length, width,
thickness and weight of 36.9 mm, 28.4 mm, 20.6 mm and 61 gms, respectively.

4.3.4.1.5 Core fragments

The collection also has two core fragments both of which are made on chert. It’s clear that the
pieces were broken from a core probably in the process of reducing it.

4.3.4.1.6 Discoidal core

There is only one piece of discoidal core in the collection. The piece is made on basalt with a
length, width, thickness and weight is 61.9 mm, 53.3 mm, 30.3 mm and 108.7 gms,
respectively.
4.4 BONE TOOLS

4.4.1 Bone harpoons from FxJj 12

A total of seven bone harpoons were collected from the site. One of the six bone harpoons was complete while the rest were broken. It was evident that the broken pieces were from different harpoons and none of the pieces were from the same harpoon. They were all however barbed on one side (unilateral bone harpoons) (see plate 3.3). A few of them have their barbs broken probably from the length of time of use on large sized fish.

4.5. FAUNAL ANALYSIS

4.5.1 Introduction

This section includes data from faunal analysis of the material recovered from the two sites under study. A description of each set of data has recovered has been made with tables reflecting the percentages of each of the different categories.

4.5.2 OLKENA FAUNA

4.5.2.1 Mammalian bone

There were only four fragments of mammalian bones. Sections of both long and short bones were identified. These bones were however highly fragmented and were not analyzed further. This class represents 0.2% of all the faunal pieces recovered.

4.5.2.2 Polished bead

There was one piece of polished bead. It is made on a small hollow bone that is less than 2mm long. It is well rounded on the surface and has a small hole in the middle large enough to fit a thin thread if it was to be used as bead.
4.5.2.3 Achartina snail shells

There are 561 achartina snail shell fragments two of these fragments are ¾ complete but there is one complete piece. They represent 26.6% of all the analyzed fauna. They are whitish grey and highly fragmental. Achartina snails are characterized for fresh water and might have been brought to the site from the small in fingering streams that were running close to the site draining into the lake.

4.5.2.4 Ostrich egg shells fragments

There are 751 ostrich egg shell fragments both from the surface collections and from excavations. Some of these fragments are burnt while others are not. These represent 35.6% of all the fauna at the site.

<table>
<thead>
<tr>
<th>Faunal type</th>
<th>Number of pieces</th>
<th>% in collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mammals</td>
<td>4</td>
<td>0.2</td>
</tr>
<tr>
<td>Polished bead</td>
<td>1</td>
<td>0.05</td>
</tr>
<tr>
<td>Achatina frags</td>
<td>561</td>
<td>26.6</td>
</tr>
<tr>
<td>Achartina whole</td>
<td>1</td>
<td>0.05</td>
</tr>
<tr>
<td>Pila ovata snail</td>
<td>136</td>
<td>6.4</td>
</tr>
<tr>
<td>Non identifiable bones</td>
<td>436</td>
<td>20.7</td>
</tr>
<tr>
<td>Ostrich egg shell frags</td>
<td>751</td>
<td>35.6</td>
</tr>
<tr>
<td>Ostrich egg shell beads</td>
<td>78</td>
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<tr>
<td>Ostrich egg shell performs</td>
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<tr>
<td>Bird element</td>
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<td>0.05</td>
</tr>
<tr>
<td>Total</td>
<td>2109</td>
<td>100</td>
</tr>
</tbody>
</table>

*Table 4.9 Inventory of GxJi 4 Fauna*
4.5.2.5 Ostrich eggshell beads

There are 78 well-made ostrich egg shell beads exhibiting well rounded edges and a hole drilled in the middle. Some looks like they were slightly burnt and have a grayish coloration. A total of 117 preforms were also recorded from the collection (see table 4.9). These performs were in different stages of manufacture. Some of the preforms had holes drilled on them but their edges are incompletely worked. Others appear in halves probably indicating that they broke before they could completely be fashioned into finished beads. The existence of drills as reported earlier in this paper is justified by these beads and preforms. The numbers of the drills is also supported by the high number of the eggshell fragments, performs and the beads.

4.5.2.6 Pila ovata snail shells

There were a total of 134 pila ovata snail shell fragments representing 6.4% of all the fauna remains from the site. There were two other complete shells. The complete shells were relatively smaller than those of the achartina. Pila ovata snails are characteristic of saline water conditions.
4.5.2.7 Bird element
A single piece of bird element was also recorded. It was short piece recognizable by its hollow space and lightness.

4.5.2.8 Non identifiable bones
There are 436 small fragile non identifiable bones. They represented 20.7% of all the analyzed fauna.

4.5.3 LAKE TURKANA FAUNA
4.5.3.1 Fish Bones
Fish bones are the main fauna found in this collection. Different parts of fish skeleton are represented. A total of 2,827 were found and this represents 74.4% of all the fauna recovered (see table 4.10). No attempt was done to identify the various species of fish represented. Some of the bones were quite large meaning that the fish represented here were large probably Nile Perch and the smaller bones probably represented a tilapia size fish. Some of the bones were however highly fragmented.

4.5.3.2 Tortoise/turtle shells
A total of 164 shells from either tortoise or turtle were recovered from both excavation and surface collection (see plate 3.4). These shells represent 4.3% of all the fauna realized. It is not clear if the tortoise and turtle were utilized by the site occupants as food. A number of African pastoralist communities utilize tortoise for food (Avery et al, 2014).

4.5.3.3 Crocodile bones
There are three fragments of crocodile bones in the collection representing 0.1% of all the analyzed fauna (see plate 3.4). These bones are however fragmentary and highly fragile.
4.5.3.4 Ostrich egg shell fragments

There were two fragments of ostrich egg shells from the excavation trenches. The pieces are however unworked and small.

4.5.3.5 Lizard/Snake

A skull and some few vertebrae columns of a small vertebrate thought to be either a lizard or a snake were recovered.

4.5.3.6 Hippopotamus

Five long bones of hippopotamus were recorded from the site. They were easily identifiable because they were long and had articulating facets that made it easy to identify them to the hippopotamus.

4.5.3.7 Non identifiable fragments

Just like in GxJi 4 above, there were a number of non-identifiable pieces of bones. They totaled 68 making up 1.8% of the entire faunal collection (see table 4.10).

4.5.3.8 Mammals

721 pieces of mammalian bones were also identified from the assemblage. Most of them were very fragmentary and delicate to handle. They were also small for any conclusive classification. The best preserved bones were quite large indicating that they were from large mammal (see plate 3.4).
Plate 4. Sample of faunal remains from FxJj 12, (a) polished beads, (b) fish vertebrae, (c) crocodile incisor, (d) turtle/tortoise shell fragments, (e) crocodile or turtle bone fragments, (f) ostrich eggshell fragment, (g) mammal bone fragments, (h) bone harpoons.
<table>
<thead>
<tr>
<th>Faunal type</th>
<th>Number of pieces</th>
<th>% in collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish bones</td>
<td>2827</td>
<td>74.4</td>
</tr>
<tr>
<td>Turtle/Tortoise</td>
<td>164</td>
<td>4.3</td>
</tr>
<tr>
<td>Crocodile</td>
<td>3</td>
<td>0.1</td>
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<tr>
<td>Hippo</td>
<td>5</td>
<td>0.1</td>
</tr>
<tr>
<td>Mammal</td>
<td>721</td>
<td>19</td>
</tr>
<tr>
<td>Ostrich egg shell</td>
<td>2</td>
<td>0.05</td>
</tr>
<tr>
<td>Lizard/Snake</td>
<td>2</td>
<td>0.05</td>
</tr>
<tr>
<td>Non identifiable fragments</td>
<td>68</td>
<td>1.8</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>3799</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Table 4.10 Inventory of FxJj 12 fauna*

### 4.6 Chapter summary

This chapter describes the archaeological assemblages from the two study sites classifying them to their different classes, their percentage frequencies and raw material proportions together with their metric measurements. It also describes the faunal materials from the two sites indicating their frequencies and grouping them into their respective classes. Data derived from these descriptions were used to draw inferences on the behavior of the site occupants.
CHAPTER FIVE
ANALYSIS AND DISCUSSION

5.1 Introduction
This chapter gives a detailed analysis of the two archaeological collections whose artifact, and fauna remains described in chapter three above. All the ANOVA tables generated for different sets of data will not be displayed here but will form part of the appendices because of their large numbers however, a summary of each of the categories of comparison will be included in each of the written category sections. The aim of this chapter is to bring out similarities and differences of the tool kit of the study sites together with those of the fauna remains. This information is presented in tables and charts and inferences drawn on the influence of climatic factors as depicted by the faunal remains to the kind of tool kit in the sites. Conclusions on the cultures of the site occupants and their varying or similar subsistence practices are provided.

5.2 COMPARISON OF LITHICS

5.2.1 Major tool types
The major tool types represented in the two sites are similar technologically although they differ in frequency of numbers, nature and size. Both sites are LSA based upon their dates and the similar overall character of assemblages, ways of producing flakes, tool types present etc. The major lithic types existing include shaped tool, debitage and the class referred to “other pieces” as indicated in chapter three. Table 5.1 shows the frequency of each of the three major lithic classes in the collections. The percentage frequency of shaped tools and “other pieces” is higher at GxJi 4 as compared to FxJj 12. 33.1 % of all analyzed lithics at GxJi 4 is shaped tools while at from FxJj 12 shaped tools are represented by only 8.6 % of all the analyzed lithics (see figure 5.1). On the other hand, the percentage frequency of the class “other pieces”
from GxJi 4 and FxJj 12 are 21.9% and 10.6%. Percentagedebitage from FxJj 12 was 80.8% compared to 45% from GxJi 4.

5.2.1.1 Shaped tools

The percentage frequency of microliths in GxJi 4 is higher than that of FxJj 12 with 69.9% and 55.9% respectively as shown on table 5.1. Outils écaillés are more represented in FxJj 12 with a percentage representation of 13.2% as compared to 3.5% in GxJi 4. Pecoirs and awls are only represented in GxJi 4 and are completely absent in FxJj 12. Truncations, becs, tool fragments and other shaped tools that do not fit in any of the mentioned categories are present at different percentage frequencies in FxJj 12 but are not in existence in GxJi 4.

ANOVA's analysis done on the same can be concluded as follows: taking the H0 (Null hypothesis): the percentage frequency of shaped tools in the two sites is significantly similar and H1 (Alternative hypothesis): the percentage frequency of shaped tools in the two sites is significantly different. With an alpha of 0.05, the p-value 3.769>0.05, hence reject the H0: and conclude that the percentage frequency of shaped tools in the two sites are significantly different (see appendix 1).

5.2.1.2 Debitage

Debitage is similarly represented in the collection with varying frequencies as indicated on the table 5.1. The highest frequency in this class is broken flakes from FxJj12 with 43.8% as compared to those from GxJi 4 at 27.1%. The frequency of whole flakes from GxJi 4 is equally higher with a frequency of 45.6 % which is higher than that of FxJj 12 which stands at 23.3%. Angular fragments are more represented in FxJj12 with a percentage frequency of 32.9 as compared to that of GxJi 4 which stands at 27.1% (see table 5.1).
ANOVA analysis of the data from the debitage can be concluded as: taking the H0: the percentage frequency of debitage in the two sites is significantly similar and the H1: the percentage frequency of debitage in the two sites significantly different. At alpha at 0.05, the p-value is 0.3506>0.05, hence reject the H0: and conclude that the percentage frequency of debitage in the two sites is significantly different (see appendix 2).

Figure 5.1 % frequency of major tool types

Figure 5.2 % frequency of shaped tools per site

Figure 5.3 % frequency of others in the two sites

Figure 4.4% frequency of debitage in the two sites
<table>
<thead>
<tr>
<th>Tool type</th>
<th>N</th>
<th>% in collection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>GxJi 4</td>
<td>Fx.Jj 12</td>
</tr>
<tr>
<td>Shaped tools</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Microliths</td>
<td>442</td>
<td>38</td>
</tr>
<tr>
<td>Outils écaillés</td>
<td>22</td>
<td>9</td>
</tr>
<tr>
<td>Scrapers</td>
<td>96</td>
<td>8</td>
</tr>
<tr>
<td>Burins</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Percors</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>Awls</td>
<td>64</td>
<td>-</td>
</tr>
<tr>
<td>Truncations</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>Becs</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Tool frags</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Others</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>632</td>
<td>68</td>
</tr>
<tr>
<td>Debitage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Angular fragments</td>
<td>234</td>
<td>211</td>
</tr>
<tr>
<td>Broken flakes</td>
<td>232</td>
<td>281</td>
</tr>
<tr>
<td>Whole flakes</td>
<td>391</td>
<td>149</td>
</tr>
<tr>
<td>Total</td>
<td>857</td>
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<tr>
<td>“Other pieces”</td>
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<td></td>
</tr>
<tr>
<td>Cores</td>
<td>405</td>
<td>83</td>
</tr>
<tr>
<td>Grindstones</td>
<td>11</td>
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<tr>
<td>Hammer stones</td>
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<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>418</td>
<td>84</td>
</tr>
<tr>
<td>Grand total</td>
<td>1,907</td>
<td>793</td>
</tr>
</tbody>
</table>

Table 5.1 Frequency of all tool classes from the two sites
5.2.1.3 “Other pieces”

Almost all the lithic materials categorized under the class “other pieces” are cores with a percentage frequency 96.9% in GxJi 4 and 98.8% in FxJj 12 (see figure 5.1). Other lithic types include grindstones only represented in GxJi 4 and are totally absent in FxJj12. Hammerstones are very rare in the two collections with one piece recovered from FxJj 12 and two pieces from GxJi 4.

ANOVAs table generated from data on “other pieces” can be concludes as follows. Taking the H0: percentage frequency of class “other pieces” in the two sites is significantly similar and H1: the percentage frequency of class “other pieces” in the two sites is significantly different. With an alpha of 0.05, the p-value 0.02455<0.05, hence do not reject the H0: and conclude that the percentage frequency of class “other pieces” in the two sites is significantly similar (see appendix 4).

5.3 Raw material use

Different raw materials are utilized for the manufacture of stone tools in the two sites under study. The raw materials utilized here include basalt, chert, obsidian and quartz. Other raw materials showing little use are sandstone and claystone. For the purpose of this study, the two raw materials are clustered together as others. The utilization of different raw materials for tool making is a factor of advancement of tool making technology together with the availability of these raw materials. Where these raw materials were not plentiful, they were traded from areas where they are found.

There are differences in how the two site occupants used raw materials based on typology and material proportions together with the strategies for use. These differences also indicate that there are differences in strategies of the assemblages makers. Two strategies of raw material
use have been defined. A raw material may be expediently used, meaning that it is used immediately and then discarded or it may be curated, meaning that it may be procured and used in the future. Transportation, caching/conservation, and recycling can be termed as curated strategies. Expedient strategies are often associated with shorter periods of occupation, the plan to reuse the raw material and curating strategies associated with longer occupation a period which is related to high mobility (Andrefsky 1994; Kelly 1992) the two strategies can however be found in the same site.

Figure 5.5 % frequency of microliths in the two sites
<table>
<thead>
<tr>
<th>Tool type</th>
<th>N</th>
<th>% Obsidian</th>
<th>% Chert</th>
<th>% Quartz</th>
<th>% Basalt</th>
<th>% “Other pieces”</th>
<th>% Total</th>
</tr>
</thead>
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<td>Sites</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
<td>Backed blade</td>
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<td>29.1</td>
<td>-</td>
<td>63.8</td>
<td>100</td>
<td>100</td>
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<td>Crescents</td>
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<td>18</td>
<td>48.1</td>
<td>-</td>
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<td>100</td>
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<td>-</td>
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<td>75</td>
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<td>100</td>
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<td></td>
</tr>
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</tr>
<tr>
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<td></td>
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<tr>
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<td>Grindstones</td>
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</tr>
<tr>
<td>Hammer stones</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.2 Comparison of lithic tool types per raw material
5.3.1 General raw material use

Different raw materials have been used in the manufacture of the stone tools in the two sites under study (see figure 5.3). The raw materials used are chert, obsidian, basalt, quartz, sandstone, and claystone. Claystone and sandstone are rarely used. A comparison of the use of the above raw material was important to determine if this use is significantly similar or different across the two sites under study.

![Figure 5.6](image1.png) % frequency of raw material in the made two sites.

![Figure 5.7](image2.png) % frequency of shaped tools of chert in the two sites.

![Figure 5.8](image3.png) % frequency of quartz shaped tools in the two sites.
The most predominantly used raw material in the two sites is chert as shown in table 5.3. The percentage frequency of chert utilization in FxJj 12 is 55.5% which is slightly higher than that of GxJi 4 which stands at 52.7% (see figure 5.6). Obsidian is more predominantly used in GxJi 4 as compared to FxJj 12 as only one obsidian piece was recovered from the site which represents 0.1% of all the pieces. Obsidian is highly used and is actually the second most preferred raw material in GxJi 4 after chert with a frequency of 37.7% which is very comparable with the use of basalt in FxJj 12 at 37.6% also being the second most preferred raw material after chert. Basalt is barely used in GxJi 4 as it is represented by 2.3% of all the analyzed materials. It was used to manufacture some scrapers that appeared large and may not be associated with the LSA. Quartz is also utilized in the two sites at relatively small proportions with FxJj 12 at 6.3% and GxJi 4 at 7.2%. Sand stone and claystone are also utilized but are extremely rare with sandstone appearing in FxJj 12 and claystone at GxJi 4.

ANOVAs table generated to enable the comparison of the raw material in the two sites can be concluded as: Taking H0: percentage usage of raw materials in the two sites is significantly similar and H1: percentage usage of raw materials in the two sites is significantly different. With an alpha of 0.05, the p-value 0.4543>0.05, hence reject H0: and conclude that the percentage usage of raw materials in the two sites is significantly different (see appendix 4).

5.3.2 Raw material use for shaped tools

Information on the percentage frequency of different raw materials per tool type is contained in table 5.2. Obsidian was more predominantly used in the manufacture of outil
escailles in GxJi 4 with 86.3% as compared to other tool types such as scrapers, microliths and burins with 51%, 36% and 16.7% respectively. ANOVAs table generated for comparing the frequencies of obsidian on the two sites can be concluded as: the level of significance cannot be identified since sum of square due to error is zero (see appendix 5).

As stated before in this work, chert is the most predominantly used raw material in the two sites of study. Among the shaped tools, chert is most predominant in the manufacture of becs, microliths and tool fragments where they are represented by 100% in all three. Becs and tool fragments and truncations are however only found in FxJj 12 and are totally not in existence in GxJi 4 (see figure 5.7). Burins, pecoirs and awls are on the other hand only found in GxJi 4 and are mainly manufactured from chert and are represented by 83.3%, 100% and 100% respectively.

ANOVA table for chert can be concluded as: Taking H0: percentage usage of chert as a raw material for shaped tools in the two sites is significantly similar and H1: percentage usage of chert as a raw material on shaped tools in the two sites is significantly different. With an alpha of 0.05, the p-value 0.1712>0.05, hence reject the H0: and conclude that the usage of chert on shaped tools in the two sites is significantly different (see appendix 6).

Quartz is not highly utilized in the manufacture of shaped tools as compared to both obsidian and chert with only small proportions in microliths, outils écaillés and scrapers in the two sites this is the same case with basalt which is barely used in these shaped tools (see figure 5.8). It’s only represented in the manufacture of end scrapers in FxJj 12 at 75% and GxJi 4 at 5.2%. All the other types of shaped tools that could not fit the categories utilized for this particular study are all manufactured from basalt. It’s however only one such piece
that was recovered from FxJj 12. Sandstone and clay stone are not utilized in the two sites for the manufacture of shaped tools (see table 5.2)

ANOVA's table for quartz on shaped tools can be concluded as follows: Taking H0: Percentage usage of quartz on shaped tools in the two sites is significantly similar and H1: percentage usage of quartz on shaped tools in the two sites is significantly different. With an alpha of 0.05, the p-value 0.783>0.05, hence reject the H0: and conclude that percentage usage of quartz in the two sites is significantly different (see appendix 7).

<table>
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<th></th>
<th>(N)</th>
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<th>% Obsidian</th>
<th>% Quartz</th>
<th>% Basalt</th>
<th>% Clay stone</th>
<th>% Sandstone</th>
<th>Total %</th>
</tr>
</thead>
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<td>55.5</td>
<td>0.1</td>
<td>6.3</td>
<td>37.6</td>
<td>-</td>
<td>0.5</td>
<td>100</td>
</tr>
<tr>
<td>GxJi 4</td>
<td>1,907</td>
<td>52.7</td>
<td>37.7</td>
<td>7.2</td>
<td>2.3</td>
<td>0.1</td>
<td>-</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 5.3 Raw material percentages for lithic from archaeological research sites

Microliths and scrapers are two important classes of shaped tools. Chert is the most preferred raw material for the manufacture of the microliths. All microliths from the FxJj 12 and majority of those from GxJi 4 are made from chert (see table 5.2). Various types of scrapers made on different raw material are represented in the two sites. Most of these are made from chert and obsidian were available (see table 5.2).

5.3.3 Raw material use for debitage

All the raw materials listed in the two sites are represented in shaped tools are in existence in the class debitage (see table 5.3). This is largely because debitage is produced in the process of the manufacture of the shaped tool. For every piece of shaped tools, there must have been debitage involved. It is also worth noting that not all processes of flaking and subsequent debitage results into a shaped tool. Obsidian is not present in debitage in FxJj12
but is quite abundant in GxJi 4 (see figure 5.11). The largest proportion of obsidian pieces in the debitage in GxJi 4 comprised of whole flakes at 50% compared to 34.5% of broken flakes and 14.4% of angular fragments as indicated on table 5.2.

ANOVAs table for the frequency of obsidian debitage gave a residual standard error: 17.85 on 2 degrees of freedom hence we cannot determine if the frequency is significantly similar or different (see appendix 8).

Chert is another raw material represented in debitage. The use of chert is in relatively high frequency as compared to obsidian (see figure 5.9). Chert is utilized in the two sites. FxJj 12 recorded a slightly higher percentage in angular fragments as compared to GxJi 4 at 51.6% and 51.1% respectively. GxJi 4 has a higher frequency of broken flakes made on chert at 60.8% as compared to 50.5% of those from FxJj 12. There were however more chert whole flakes from FxJj 12 as compared to those from GxJi 4 at 58.5% and 49.1% respectively.

A ANOVAs generated to compare the frequencies of chert debitage can be concluded as: taking H0: percentage usage of chert on debitage in the two sites is significantly similar and H1: Percentage usage of chert on debitage in the two is significantly different. With an alpha of 0.05, the p-value is 0.9272>0.05, reject the H0: and conclude that usage of chert on debitage in the two sites is significantly different (see appendix 9).
Quartz is another important raw material in the debitage assemblage. The proportions are relatively small in GxJi 4 as compared to FxJj 12 (see table 5.10). Only 3.4% of all the angular fragments from GxJi 4 are made on quartz as compared to 50% from FxJj 12. Broken flakes from FxJj 12 are also higher with 42.7% compared to those of GxJi 4 at 0.9%. There is however no whole flakes made from quartz recorded from GxJj 12 while FxJj 12 has recorded 36.1%.
ANOVAs table generated for quartz debitage can be summarized as Taking H0: percentage usage of quartz on debitage in the two sites is significantly similar and H1: percentage usage of quartz on debitage in the two sites is significantly different. With an alpha of 0.05, the p-value 0.3099>0.05, reject the H0: and conclude that percentage usage of quartz on debitage in the two sites is significantly different (see appendix 10).

![Figure 5.13 % frequency of quartz cores in the two sites](image)

**Figure 5.13 % frequency of quartz cores in the two sites**

5.3.4 Raw material use for “other pieces”

Just as stated earlier, the tool types categorized as “other pieces” here includes cores, grindstones and hammerstones. Just like other tool types discusses above, this class is made up of a number of raw materials. Cores are the major sub class of this class. Different types of cores are identified in both the two sites. Some of these core classes include casual cores, single platform cores, double platform cores, multiplatform cores among others.

Obsidian cores are more predominant in GxJj 12 than in FxJj 12. There is only one pieces of casual core (the only obsidian piece) in the entire FxJj 12 collection which account for 14.3% of all the cores analyzed from the site as shown on figure 5.14. There is however no casual core of obsidian from GxJi 4.
Single platform cores, double platform cores, multiplatform, core fragments and flake cores of obsidian in GxJi 4 are at a frequency of 27.7%, 50%, 47.5%, 20% and 15.5% respectively. A ANOVAs table for the frequency of obsidian cores in the two sites can be summed up as follows: taking H0: percentage usage of obsidian on cores in the two sites is significantly similar and H1: percentage usage of obsidian on cores in the two sites is significantly different. With an alpha of 0.05, the p-value 0.2549>0.05, hence reject the H0: and conclude that percentage usage of obsidian on cores in the two sites is significantly different (see appendix 11).

Chert is also largely a raw material in the cores. Quite a huge number of cores have been made from chert in both sites. All the single platform cores from FxJj 12 are made from chert while only 58.6 % of those from GxJi 4 were made from chert as indicated on figure 5.15. The percentage frequency of the multiplatform cores from FxJj 12 is higher than that of GxJi 4 with 50% and 44.6% respectively. There is only one core fragment from FxJj 12 and it of chert while GxJi 4 has none. More information on this can be seen figure 5.15 above.
ANOVAs table generated for the frequency of chert in cores can be summed as: Taking H0: percentage frequency of chert on cores is significantly similar and H1: percentage frequency of chert on cores is significantly different. With an alpha of 0.05, the p-value 0.3415>0.05, hence reject the H0: and conclude that percentage frequency of chert cores in two sites is significantly different (see appendix 13).

Quartz cores are also numerous from the two sites there are no casual cores made on quartz from GxJi 4 while from FxJj 12 they make up to 28.6% of all casual core (see figure 5.13).

No single platform cores made on quartz were recovered from FxJj 12 while 13.3% of those at GxJi 4 were quartz. Core fragments and flake cores made from quartz were only recovered from GxJi 4 as indicated on the table 5.2. Double platform cores and multiplatform cores have a higher percentage frequency in FxJj 12 at 10.3% and 13.3% respectively as compared to those at GxJi 4 at 3.4% and 7.9% respectively. There are however no discoidal cores made on quartz from the two sites.

ANOVAs for percentage frequency of quartz cores can be summarized as: Taking H0: Percentage usage of quartz on cores is significantly similar and H1: percentage frequency of quartz on cores is significantly different. With an alpha of 0.05, the p-value 0.2925>0.05, hence reject the H0: and conclude that the percentage frequency of quartz on cores in the two sites is significantly different (see appendix 14).

Basalt is another important raw material although not as widely used in cores in GxJi 4 as in FxJj 12. There is only 39.4% of core flakes from GxJi 4 made from basalt and none from FxJj 12 as indicated on table 5.2. Both sites have no recorded casual cores from this
raw material but, 2.6% of double platform cores, 36.7% of single platform cores and 100% discoidal cores exist from FxJj 12.

ANOVAs of the use of basalt cores can be summarized as: taking H0: percentage usage of basalt on cores is significantly similar and H1: percentage usage of basalt on cores is significantly different. With an alpha of 0.05, the p-value 0.6166>0.05, hence reject the H0: and conclude that percentage usage of basalt on cores in the sites is significantly different. There is no recorded sandstone and clay stone core from the two sites. All grindstones and hammerstones from both sites were all made on quartz.

5.4 Metric measurements

Different tool are of different metric measurements. A comparison on the length, width, thickness and mass will help know how these measurements compare between the two sites under study.

5.4.1 Shaped tools

Truncations, becs, tool fragments and other shaped tools are not present in the shaped tool categories utilized in this analysis are only found in FxJj 12 but are totally absent in GxJi 4. Pecoirs and awls on the other hand are found at GxJi 4 and are totally absent in FxJi 4. Outils écaillés and scrapers from GxJi 4 have a mean length smaller than those from FxJj12 at 17.7mm and 22.3mm in GxJi 4 and 21.5 mm and 48mm in FxJj 12. Microliths in the two sites have almost similar lengths with a mean of 27.4 mm in GxJi 4 and a mean of 26.4 mm in FxJj 12. More details on how these lengths compare are carried on the table 5.4.

ANOVAs table generated to compare these lengths can be summarized as follows: Taking H0: average length of shaped tools is significantly similar and H1: average length of shaped
tools is significantly different. With an alpha of 0.05, the p-value 0.05599>0.05, hence reject the H0: and conclude that the average length of shaped tools is significantly different (see appendix 14).

The width of these shaped tools is also worth comparing. Figure 5.17 above illustrates the comparison on the widths. Generally speaking, microliths, outils écaillés and scrapers from FxJj 12 lithics are much larger than those from GxJi 4. Burins from FxJj 12 have a smaller width than burins. Those from FxJj 12 have a mean width of 11.1 mm compared to those of GxJi 4 at 14.9 mm. Peccoirs and awls are however not found in FxJj 12.

ANOVA table for average width of shaped tools can be concluded as follows: Taking H0: average width of shaped tools is significantly similar and H1: average width of shaped tools is significantly different. With an alpha of 0.05, the p-value 0.1825>0.05, hence reject the H0: and conclude that the average width of shaped is significantly different (see appendix 15).

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<td>48.3</td>
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</table>

**Table 5.4** Comparison of metric measurements of lithic artifacts in the two sites
Lithics form the two sites differ greatly in thickness. Generally speaking, shaped tools from FxJj 12 are relatively thicker than those from GxJi 4. As indicated by figure 5.18, microliths and scrapers form FxJj 12 have a mean thickness higher than their counterparts form GxJi 4 while outils écaillés and burins from GxJi 4 are thinner than those from FxJj 12. It should also be borne in mind the difference in the frequencies of outils écaillés and burins which stand at 22 outils écaillés for GxJj 12 against nine for FxJj 12 and six burins for GxJi 4 against two pieces for FxJj12.
The weight of the shaped tools is again relatively higher in at FxJj 12 comparison to that of GxJj 4 apart from burins where we have those from GxJi 4 having an average weight of 3.5 g against 2.5 g from FxJj 12. A ANOVAs table generated to compare these masses can be concluded as Taking H0: average weight of shaped is significantly similar and H1: average weight of shaped is significantly different. With an alpha of 0.05, the p-value 0.08434>0.05, hence reject the H0: and conclude that the average weight of shaped is significantly different (see appendix 16).

5.4.2 Debitage

As indicated earlier on this thesis, debitage includes all angular fragments, whole flakes and broken flakes. The length, width, thickness and weight of this debitage vary across the two sites and thus is worth noting and discussing in chapter five.

![Figure 5.20 Mean length of debitage in the two sites in the two sites.](image1)

![Figure 5.21 Mean width of debitage in the two sites](image2)

From figure 5.20, 5.21, 5.22 and 5.23 above, it is very clear that the length and width of debitage from FxJj 12 are higher than those from GxJj 12. The length of broken flakes was not taken during measurement. Angular fragments from FxJj 12 had a mean length of 33.6 compared to 17.6 from GxJi 4 (see figure 5.20).
An ANOVA table created for them can be concluded as: Taking H0: mean length of debitage is significantly similar and H1: mean length of debitage is significantly different. With an alpha of 0.05, the p-value 0.5122>0.05, hence reject the H0: and conclude that the mean length of debitage from the two sites is significantly different (see appendix 17).

The mean width of debitage from GxJi 4 is relatively small as compared to the mean length of debitage from FxJj 12 (see figure 5.21). ANOVAs table for the width can be concluded as: Taking H0: mean width of debitage is significantly similar and H1: mean width of debitage is significantly different. With an alpha of 0.05, the p-value 0.7964>0.05, hence reject the H0: and conclude that the mean width of debitage from the two sites is significantly different (see appendix 18).

Thickness is also following the same pattern in length and width with more mean thickness in FxJj 12 than in GxJi4 (see figure 5.22). ANOVAs table for that can be concluded as: taking the H0: mean thickness of debitage from the two sites is significantly similar and H1: mean thickness of debitage from the two sites is significantly different. With an alpha
of 0.05, the p-value $0.3932 > 0.05$, hence reject the $H_0$: and conclude that the thickness of debitage from the two sites is significantly different (see appendix 18).

The comparison of mean weight of the analyzed debitage is showed on the graph above. Angular fragments, whole flakes and broken flakes of FxJj 12 are much heavier than those from GxJi4. A ANOVA table generated to compare the weight can be concluded as Taking $H_0$: mean weight of debitage in the two sites is significantly similar and $H_1$: mean weight of debitage in the two sites is significantly different. With an alpha of 0.05, the p-value $0.299 > 0.05$, hence reject the $H_0$: and conclude that the mean weight of debitage in the two sites is significantly different (see appendix 21).

Figure 5.24 Mean width of cores from the two sites

Figure 5.25 Mean length of cores from the two sites

5.4.3 “Other pieces”

In this class, we compare the metric measurement of cores, grindstones and hammerstones. All core types present in FxJj 12 have longer than similar type cores found at GxJi 4 apart from core fragments and single platform cores as indicated on figure 5.24. Single platform cores from GxJj 4 have a mean length of 24.1 mm while those from FxJj 12 have 21.4 mm.
core fragments from GxJi 4 and FxJj 12 on the other hand have a mean length of 24.3 mm and 21 mm, respectively. Discoidal cores show the biggest difference with those from GxJi 4 being 13.8 mm compared to 61.9 mm from FxJj 12. Double platform cores from GxJi 4 and those from FxJj 12 have a mean length of 21.9 mm and 26.7 mm respectively while multiplatform cores are 22.5 mm and 36.9 mm following the same order.

A ANOVAs table prepared for this comparison can be concluded as follows; taking H0: mean length of cores in the two sites is significantly similar and H1: mean length of cores is in the two sites is significantly different. With an alpha of 0.05, the p-value 0.8412>0.05, hence reject the H0: and conclude that the mean length of cores from the two sites is significantly different (see appendix 22).

The width of cores types present in the two sites compares very closely with all core types from FxJj 12 being far wider than those from GxJi 4 apart from core fragments and single platform cores. Single platform cores from GxJi 4 have a mean width of 16.8 mm compared to 12.8mm from FxJj 12. Core fragments from GxJi 4 on the other hand have a mean length of 24.3 mm while those from FxJj 12 have 21mm.

ANOVAs table generated for this comparison can be concluded as follows: Taking H0: mean width of cores is significantly similar in the two sites and H1: width of cores is significantly different. With an alpha of 0.05, the p-value 0.9675>0.05, hence reject the H0: and conclude that the mean width of cores is significantly different (see appendix 22).
The thickness of different types of cores varies. Most of the cores types from GxJi 4 are heavier than their counterparts from FxJj 12 (see figure 5.27). These include single platform cores, double platform cores and core fragments. Multiplatform and discoidal cores from FxJj 12 are thicker than those from GxJi 4. Single platform cores from GxJi 4 FxJj 12 and have a mean thickness of 11.7 mm and 9.3 mm respectively while double platform cores are 10 mm and 9.3 mm following the same order. Multiplatform cores from GxJi 4 and FxJj 12...
have a mean thickness of 19.3 mm and 20.6 mm respectively while discoidal cores are 6.3 mm and 30.3 mm following the same order.

ANOVAs table generated for this can be concluded as: taking H0: mean thickness of cores from the two sites is significantly similar and H1: mean thickness of cores is significantly different. With an alpha of 0.05, the p-value 0.5888>0.05, hence reject the H0: and conclude that the thickness of cores from the two sites is significantly different (appendix 23).

Apart from single platform cores and core fragments, all other core types from FxJj 12 are heavier than those from GxJi 4. Single platform cores from GxJi 4 and FxJj 12 have a mean weight of 6 g and 2.7g respectively while core fragments are 5.7g and 1.7g following the same order as indicated on the chart above. Double platform cores from GxJi 4 and FxJj 12 are 5.2 g and 10.1g while multiplatform cores are 6.4g and 61g following the same order. ANOVAs table generated for this comparison can be summarized as: taking H0: mean weight of cores from the two sites is significantly similar and H1: mean weight of cores is significantly different. With an alpha of 0.05, the p-value 0.5957>0.05, hence reject the H0: and conclude that the weight of cores is significantly different (appendix 24).

The weight of cores of different raw materials varies significantly in the two collections (see figure 5.28). Chert cores from FxJj 12 are heavier than those from GxJi 4 with 36.9 gms against 8.24 gms. Quartz cores from FxJj 12 are lighter than those from GxJi 4 at 2.3 gms against 36.9 gms. There is little use of obsidian core in FxJj 12 as compared to GxJi 4. Basalt is not used at all in GxJi 4 (see behavioral implications on chapter 5).
5.4.3.1 Hammerstones

Hammerstones from GxJi 4 are longer with a mean length of 48.3 mm compared to that from FxJj 12 at 10.3 mm while in width FxJj 12 has higher at 55.9 mm against 40.5 mm from GxJj 12. GxJi 4 has thicker cores than FxJj 12 at 22 mm and 21.1 mm respectively. In weight, those from FxJj 12 were heavier than their counterparts from GxJi 4 at 97.1 g against 70.8 g.

5.5.3.2 Metric measurements of major tool classes

The mean length, width thickness and mass of major tool types in the two sites are taking the same trend with those from FxJj 12 being larger than those from GxJi 4. Details on this are captured on figure 5.29, 5.30, 5.31 and 5.32.

![Figure 5.29 Mean thicknesses of major classes in the two sites.](image)

![Figure 5.30 Mean widths of major lithic classes in the two sites.](image)
5.5 Chapter summary

This chapter compares and contrasts the collection in the two sites. It details the similarities and differences arising from analysis of each of the collections. It is evident from the chapter that there are significant differences in the typology, frequencies and raw material used in the two sites. This could mean differences in resource availability and exploitation in the two sites and differences in the behavior of the site occupants. Details on the implications of these differences to behavior are detailed in chapter five of this work.
CHAPTER SIX
SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Introduction

After analyzing of lithic material, faunal remains, an archeologist is able to draw inferences on the behavior of the site occupants. Analyzing lithics into different types and subtypes can help give inferences to preference of technology used in a site together with the activities that might have been conducted in the site. The analysis of fauna helps in drawing conclusions on peoples past subsistence patterns together with reconstruction of past environments.

This chapter draws inferences from the comparisons made in chapter four above. It details what the researcher has been able to find out in the process of his research and what new research interests can be pursued through this research. To reiterate on the objectives of embarking on this work, the study intended in part to reconstruct the cultural sequence of LSA in Kenya using Lake Turkana and Lake Magadi findings together with investigating the differences and similarities on the lithic tool and raw material use in the two lake basins. Also it intended to identify the differences in the fauna record between the sites to establish what animals were exploited for food by the site inhabitants and examines the differences and similarities in the ecology of the two sites and what they imply about the behavior of the site occupants.

6.2 Conclusion

The first objective of this study was to reconstruct the cultural sequence of LSA in Kenya using Lake Turkana and Lake Magadi. Both FxJj 12 and GxJi 4 belong to a period archaeologists refer to as the Later Stone Age. This is a period ranging from around 40,000
year ago to a few thousand years ago. It was a period characterized by use of small sized stone tool referred to as microliths. Although the two sites under study are open sites, a good number of sites of this period have been found in caves and rock shelters. GxJi 4 is a single occupational site while FxJj 12 is a multiple occupational site. GxJi 4, the archaeological horizon was divided into sections A, B and C section A and C had a small concentration (see figure 2.13). FxJj 12 on the other hand had artifacts in two distinct layers. The top most (A) stratigraphic unit had a small concentration of artifacts while the fourth unit (D) had abundant artifacts (see figure 2.17). This is a clear indicator that the site was occupied in two different occupational periods. Although a number of large crude scrapers and a trihedral pointed tool were recovered from FxJj 12, it does not mean that the site was occupied by earlier human groups. These artifacts were found by surface collection method and might have been deposited by water current. As indicated earlier on this work, dates obtained through C.14 dating of the ostrich egg shell fragments recovered during excavations at GxJi 4 in 2002 yielded a 10,300+100 BP (beta Uncaliblated) (Barthelme, 2003). Mollusc shell and mammal bones form FxJj 12 were submitted to a radio carbon analysis in two different laboratories and yielded a series of dates i.e. 9660 +235 BP, Geochron Labs and 9510 +260 BP, Radiocarbon Ltd (Barthelme, 1985)

The second objective of the study was to investigate the similarities and differences and similarities of lithic tool and raw materials use in the two lake basins. Human groups manufacture different tool types depending on their intended use and available raw materials (Williams, 1996). From lithic evidence from the site, it can be concluded that the two sites were manufacturing sites due to the lithic remains such as cores, shaped tools and hundreds of animal and fish bones. Evidence of use of fire at GxJi 4 together with existence
of grinding stones indicates that it’s also a habitation site. The setting of both sites is very ideal for a hunting community as they are close to river channels that is important for getting water for domestic use together with attracting animals which they could easily hunt as they come down to quench their thirst. The setting is also ideal as could be used as blinds to ensure that the wild animals do not see them as they prepare to strike. The short shrubs around the water channels would have also been very ideal for site occupants to hide and attack from. Areas around water channels also offer a wider variety of vegetation hence attract herbivores making it an ideal setting for hunting practices.

GxJi 4 was inhabited by a considerable larger group of people as compared to FxJj 12 this is evident by the high frequency of lithic both analyzed and unanalyzed together with the scatter currently spread over a wide area at the site locality. FxJj 12 on the other hand was inhabited by a smaller group of people over a long period of time evident by the accumulation of high numbers of animal and fish bones in relation to the low density of lithics compared to those form GxJi 4.

From the frequency of lithic artifacts analyzed, it is in order to conclude than the site occupants in both sites embraced microlithic technology which is characteristic of LSA sites. Microliths exist in very high proportions in the two sites compared to other shaped tool categories. The two sites are blade industry sites owing to their preference in the manufacture of small blades compared to other microlith subclasses. These microliths were hafted on wood and used for doing various activities from killing game to processing plants for food. Blades become predominant in the LSA and are used as markers of modernity, a shift from the more crude tools used during the ESA and MSA periods. Hafting is also
indicated by the small sized awls recovered. Their size is small and it would have been difficult for the site occupants to drill ostrich eggshell beads without hafting them wood. The high frequency of scrapers in both sides indicates that both site occupants may have been processing hide for clothing purposes although they could have been just as useful in shaping wood to make arrows.

It is evident from the shaped tool densities and sizes of collection from GxJi 4 that the site occupants were more proficient tool makers as compared to their counterparts at FxJj 12. There was a wider variability of shaped tools that were had less length, width, thickness and mass. LSA technology is characterized by small artifacts as compared to the MSA and ESA. This change resulted in better and sharper tools that would be more efficient in exploiting resources. In terms of resource utilization, GxJi 4 site occupants were more versed with techniques of ensuring that they get the maximum of resources available. The small size in measurements of debitage from GxJi 4 as compared to those at FxJj 12 together with the varying sizes of cores from the two sites indicates that GxJi 4 utilized the obsidian, a rare lithic resource, maximally than their FxJj 12 counterparts. The sizes of the cores form GxJj 12 were also smaller and weighed relatively less than those from FxJj 12 which indicated that they were curated and used over time and discarded when they were small and difficult to knap. The high frequency of debitage of smaller size at GxJi 4 is a good indicator of reworking of tools and high level of reduction of cores.

On raw material use, there is a high preference of the fine grained chert and obsidian in the two sites as compared to other more amorphous course grained basalt. This technique was more perfected at GxJi 4 compared to FxJj 12. The occupants of GxJi 4 opted to use chert and obsidian, raw materials that were not readily available, in favor of basalt that was found
around the site in high proportions. FxJj 12 site occupants utilized basalt that was readily available in the site locality. The choice of raw material is, however, not only depicted by the advancement of tool technology but also availability of the resource. Chert and obsidian are the most largely used raw material for manufacture of shaped tools at GxJi 4. Obsidian is however not locally available around the site. It must have been traded over distances ranging from short to very long. Long distance exchange of commodities can be viewed as an indicator of a community with a stable resource base and long distance social networks. Past communities might have taken trade as an adaptive mechanism instrumental in building social networks with other surrounding groups. These networks were important in accessing resources that were not locally available.

Obsidian sourcing in Lake Turkana basin was mostly from local sources during Nderit (Illeret ware) period (Nash et al. 2011; Ndiema et al, 2011). Obsidian could also be sourced from the Northern Island, a rocky island in Lake Turkana, but it required sophisticated ways of transport across the lake and knowledge of difficult lake conditions.

In FxJj 12 in this case, obsidian was not locally available around the site as the other raw materials such as chert and quartz and basalt that can be found in river gravels near the site. It is interesting that these past communities used trade as a way of possibly maintaining social ties for some other reasons not necessarily tied to acquisition of the raw material, these reasons could even be kin networks as it is done with the present communities. The today’s local community from the area utilizes the local resources but at the same time, they exchange with their neighboring communities in the north across river Omo.
In GxJi 4, chert is found in areas a few hundred meters from the site while obsidian is not locally found. Obsidian source studies conducted in Central Rift Valley indicate that the resource was rare and was traded over long distances from such as Mount Eburu and other regions in Laikipia. Although it is not clear where the source of the obsidian used in the site is, it is clear that it was transported over long distances. This unavailability is also indicated by highly reduced cores at the site as indicated earlier in this work. Basalt cobbles were plenty in the site but rarely utilized apart from in the manufacture of a few scrapers which might not be associated with L.S.A. as they were very crude and larger in size compared to the rest.

If the two site occupants traded obsidian over long distances, then they must have enjoyed the social cultural network that ran North-South along the Rift Valley for exchange of raw materials (Seitsonen, O. et al. 2012).

At FxJj 12, chert and basalt are the most predominant raw materials. Here, the site occupants may have discarded basalt and chert cores after the first flaking phase and collected more if need arose. Chert and basalt cobbles are available in high numbers at the site hence did not need to be traded far distances as the case of chert and obsidian at GxJi 4. This is implied by the large sizes of cores and angular fragments in the collection.

In Turkana, sources of obsidian are extremely rare and existing usable geologic sources for stone tools production have nodules that range from 5-10 cm in diameter. An analysis of geochemical samples done around the region indicates that the sources but are not restricted to Shin and Suregei sources. It is also probable that some of the obsidian was also brought from outside the Lake Turkana basin sources such as Ethiopian volcanoes (Ndiema et al, 2011).
The third objective was to look at the differences in the fauna record to determine the wildlife exploited for food by the site occupants. As Kennet & Witherhalder, (2006) indicate on behavioral ecology theory, the end results of any activities by man result in maximizing the nutrient intake or getting to a threshold intake more quickly reserving time for some other fitness related activities. This theory is evident in the subsistence systems of the occupants of the two sites.

During the LSA both basins supported a wide range of flora and fauna. This is evidenced by the various and diversified animal remains recovered from the excavations. The two basins also attracted a considerable habitation by human groups owing to the diversified ecology of lake and land. Areas where two ecological niches meet have a potential for supporting high plant population that as a result draw animals habitation. This on the other hand attracts human habitation due to the diversity of subsistence resources.

Faunal remains from GxJi 4 were highly fragmented to warrant reasonable grouping into taxon as compared to those from FxJj 12. This might have been due to poor preservation characteristics of the prevailing climate at GxJi 4 compared to FxJj12. There might have been higher incidences of or a relatively wetter climate that is not good for faunal preservation compared to FxJj 12 which might have been drier resulting into better preservation of faunal remains. This might also explain the preference of fish by the FxJj 12 site occupants as compared to GxJj 12 where there is no fishing evidence. The high acidity levels of soils at GxJi 4 would also not have allowed any quality preservation of animal bones.

The site occupants of FxJj 12 utilized both terrestrial and aquatic life for their subsistence. They hunted wild animals using the tools they made and they prepared then for food. This is
evident from the large number of bones of large bovids and equids that have been recovered from the site. On the other hand, they exploited fish from the lake and used it as food using the bone harpoons they manufactured. This explains the huge amount of fish bones recovered from the excavations. It also explains the seven bone harpoon tools recovered both from surface collection together with excavations. The size of the bone harpoons indicates that they targeted relatively large fish which would supply the food resources required more abundantly. In many past African societies, tortoise was used as food (Stewart et al 2011). The high number of tortoise/ turtle shells fragments indicates that they may have also captured utilized them as food. Tortoises are currently many in the region and can be easily captured and turned into a delicacy.

At GxJi 4 on the other hand, exploited both plant and animal resources. Their decision to occupy the shores of the lake may have been guided by availability of water from streams draining into the lake that run close to the site. Grind stones recovered from the site also suggest that the site occupants utilized wild grains or grasses that were processed into flour to supplement the meat supply. This might have been wheat and barley that grew wild during this period in many places in Africa The adaptive advantage was that there was a diversity of food sources that would be exploited when others were depleted.

Lots of modified and unmodified ostrich egg shell and beads in different levels of manufacture were recovered from GxJi 4 and two pieces of polished bone with a small hollow from FxJj 12 (see figure 4.4) are indicative of bead work technology that also characterize LSA occupational sites in many areas. Although a single ostrich egg shell fragment was recovered from FxJj 12, there is no evidence of any shaping on it. This indicates that the site occupants may not have learnt the technology of working beads form
ostrich egg shell fragments. Although these could be said to represent some form of aesthetic appeal or social identification but, they are also believed to represent a cultural institutions embedded socially in the minimization of risk. These beadworks were probably given as gifts and served the purpose of increasing social solidarity which eventually led to strengthening social networks that made life easier in the hot and dry marginal lands these communities was living in, (Ndiema et al, 2011).

The last objective of the study was to check the similarities and differences of the ecological settings of the two sites and their implications to subsistence strategies of LSA site occupants. Although the two sites are set on lake basins a few hundred meters form present lake shores, they differ highly in some ways. FxJj 12 lies at an altitude of 360 meters while GxJi 4 lies at 600 meters. Both sites are in habited currently by numerous species of wild animals. The present occupants of the areas of the two sites are pastoralist with those in Turkana supplementing with fish while those in Magadi supplementing with gathering. The landscape is quite comparable with plains and river channels. The difference is that, as GxJi 4 could not support any aquatic life because of the high concentration of the soda in the lake while Lake Turkana supported a wide variety of aquatic life. Lake Turkana at the same time supplied the much needed water resource to the site occupants together with the wild animals. Both landscapes are dotted with shrubs and short deciduous trees and little grass which provided food for the large numbers of wild animals in the areas.

6.3 Further studies

This study use only two sites in each of the two lake basins, the sites are not well representative of LSA sites in the two regions bearing in mind that the two are approximately 10,000 years old with the LSA stretching back 42,000 years ago. More sites
should be sampled in the two regions to increase the sample sizes and make a better informed comparison. Some more precise methods of reconstructing the environment and ecology of the two sites should be used to get a better picture of the ecology. A lot of research should be directed towards Magadi as the area is rich in LSA archaeology although its full potential has not realized. Many of the sites reported by Barthelme in his years of research need to be revisited as most of them were not thoroughly studied.

6.4 Recommendations

This study recommends that archaeologists studying the life ways of the LSA people should not only study each individual site on its own but compare sites in the same and in different geographical areas. This will not only help them in reconstructing the behavior of the site occupants but also will help them understand the advancement of lithic technology across the landscape. This will yield more information that will answer questions on the relationship between the ecology and technological advancements. The National Museums of Kenya which is the custodian of all cultural heritage in Kenya needs to do something in preservation of archaeological sites. The Olkena site is highly eroded and will completely be destroyed if nothing is done soon.

6.5 Chapter Summary

GxJi 4 and FxJj 12 are two LSA sites in localities that are similar and different in various aspects. Both sites are located along river channels that drain in two Paleo-lakes in the Rift Valley. They are both Later Stone Age open sites in which both manufacture of stone tools and use was carried out. The typology of stone tools manufactured is similar in some ways and different in other ways. All these tools were used differently to exploit the environment for food. Lake Turkana is currently a fresh water lake that supports a lot of aquatic life
while Lake Magadi is an intermittently dry lake that is toxic and cannot support life. The two sites are both industrial and occupational sites specializing in blade technology. Hunting of wild game and fishing were practiced at FxJj 12 while hunting and gathering is evident from GxJi 4. The two regions supported a large number of terrestrial animals that the two site occupants utilized for subsistence. Processing of grains for food was also practiced at GxJi 4. Different raw materials for manufacture of stone tools were exploited with a high interest in the less amorphous chert and obsidian in relation to basalt. Basalt is the least used raw material in the two sites.
REFERENCES


_________ (1977a). The Latter Prehistory of Eastern and Southern Africa. London:


APPENDICES

Appendix 1 ANOVAs table for frequency of shaped tools
>shapedtools

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Microliths</td>
<td>69.9</td>
<td>55.9</td>
</tr>
<tr>
<td>2 Outils écailles</td>
<td>3.5</td>
<td>13.2</td>
</tr>
<tr>
<td>3 Scrapers</td>
<td>15.2</td>
<td>11.8</td>
</tr>
<tr>
<td>4 Burins</td>
<td>0.9</td>
<td>2.9</td>
</tr>
<tr>
<td>5 Percoirs</td>
<td>0.3</td>
<td>0.0</td>
</tr>
<tr>
<td>6 Awls</td>
<td>10.1</td>
<td>0.0</td>
</tr>
<tr>
<td>7 Truncations</td>
<td>0.0</td>
<td>11.8</td>
</tr>
<tr>
<td>8 Becs</td>
<td>0.0</td>
<td>4.4</td>
</tr>
<tr>
<td>9 Tool frags</td>
<td>0.0</td>
<td>4.4</td>
</tr>
<tr>
<td>10 Others</td>
<td>0.0</td>
<td>1.5</td>
</tr>
</tbody>
</table>

> shapedtools1<-lm(GxJi4~FxJj12,data=shapedtools) > shapedtools1 Call:
  lm(formula = GxJi4 ~ FxJj12, data = shapedtools) Coefficients:
    (Intercept)       FxJj12
    -3.019        1.228
>summary(shapedtools1) Call:
  lm(formula = GxJi4 ~ FxJj12, data = shapedtools)
Residuals:
     Min      1Q  Median       3Q      Max
  -11.4763 -2.3863  0.7662  3.6224  13.1186
Coefficients:
              Estimate  Std. Error t value Pr(>|t|)
(Intercept)   -3.0186    2.8652  -1.054  0.323
FxJj12        1.2284     0.1504   8.165 3.77e-05 ***
---
Signif. codes:  0 ’***’ 0.001 ’**’ 0.01 ’*’ 0.05 . ’ 1

Residual standard error: 7.531 on 8 degrees of freedom
Multiple R-squared:  0.8929,  Adjusted R-squared:  0.8795
F-statistic: 66.67 on 1 and 8 DF, p-value: 3.769e-05

> #Taking the H0: the shaped tools in the two sites are significantly similar and H1: the shaped tools in the two sites are significantly different. With an alpha of 0.05, the p-value 3.769>0.05, hence reject the H0: and conclude that the shaped tools in the two sites are significantly different.
Appendix 2: ANOVAs table for debitage of shaped tools

> debitage

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>Fxjj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular fragments</td>
<td>27.3</td>
<td>32.9</td>
</tr>
<tr>
<td>Broken flakes</td>
<td>27.1</td>
<td>43.8</td>
</tr>
<tr>
<td>Whole flakes</td>
<td>45.6</td>
<td>23.3</td>
</tr>
</tbody>
</table>

> debitage1<-lm(GxJi4~Fxjj12,data=debitage)
> debitage1

Call:
lm(formula = GxJi4 ~ Fxjj12, data = debitage)

Coefficients:
(Intercept)    Fxjj12
62.7531        -0.8826

> summary(debitage1)

Call:
lm(formula = GxJi4 ~ Fxjj12, data = debitage)

Residuals:
1     2     3
-6.416  3.004  3.411

Coefficients:

|             | Estimate | Std. Error | t value | Pr(>|t|) |
|-------------|----------|------------|---------|----------|
| (Intercept) | 62.7531  | 18.6306    | 3.368   | 0.184    |
| Fxjj12      | -0.8826  | 0.5421     | -1.628  | 0.351    |

Residual standard error: 7.863 on 1 degrees of freedom
Multiple R-squared: 0.7261, Adjusted R-squared: 0.4522
F-statistic: 2.651 on 1 and 1 DF, p-value: 0.3506

> #Taking the H0: the debitage in the two sites are significantly similar and the H1: the debitage in the two sites are significantly different. At alpha at 0.05, the p-value is 0.3506>0.05, hence reject the H0: and conclude that the debitage in the two sites is significantly different.
Appendix 3: ANOVAs table for “other pieces” of shaped tools

> Other pieces

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cores</td>
<td>96.9</td>
<td>98.8</td>
</tr>
<tr>
<td>Grindstones</td>
<td>2.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Hammer stones</td>
<td>0.5</td>
<td>2.2</td>
</tr>
</tbody>
</table>

> others1 <- lm(GxJi4 ~ FxJj12, data = others)
> others1

Call:
lm(formula = GxJi4 ~ FxJj12, data = others)

Coefficients:
(Intercept) FxJj12
0.5012 0.9752

> summary(others1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = others)

Residuals:
1 2 3
0.0478 2.0988 -2.1466

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) 0.50117 2.14717 0.233 0.8540
FxJj12 0.97521 0.03763 25.914 0.0246 *
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.003 on 1 degrees of freedom
Multiple R-squared: 0.9985, Adjusted R-squared: 0.997
F-statistic: 671.5 on 1 and 1 DF, p-value: 0.02455

> # Taking the H0: the class others in the two sites is significantly similar and H1: the class others in the two sites is significantly different. With an alpha of 0.05, the p-value 0.02455 < 0.05, hence do not reject the H0: and conclude that the class others in the two sites is significantly similar.
Appendix 4: ANOVAs table for % usage of raw material

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>% Chert</td>
<td>52.7</td>
</tr>
<tr>
<td>2</td>
<td>% Obsidian</td>
<td>37.7</td>
</tr>
<tr>
<td>3</td>
<td>% Quartz</td>
<td>7.2</td>
</tr>
<tr>
<td>4</td>
<td>% Basalt</td>
<td>2.3</td>
</tr>
<tr>
<td>5</td>
<td>%Others</td>
<td>0.1</td>
</tr>
</tbody>
</table>

> rawmaterials1 <- lm(GxJi4 ~ FxJj12, data = raw materials)
> rawmaterials1

Call:
lm(formula = GxJi4 ~ FxJj12, data = raw materials)

Coefficients:
(Intercept) FxJj12
11.6296 0.4185

> summary(raw materials1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = raw materials)

Residuals:
1 2 3 4 5
17.843 26.029 -7.066 -25.066 -11.739

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) 11.6296 14.7014 0.791 0.487
FxJj12 0.4185 0.4882 0.857 0.454

Residual standard error: 24.58 on 3 degrees of freedom
Multiple R-squared: 0.1968, Adjusted R-squared: -0.07098
F-statistic: 0.7349 on 1 and 3 DF, p-value: 0.4543

> #Taking H0: usage of raw materials in the two sites is significantly similar and H1: usage of raw materials in the two sites is significantly different. With an alpha of 0.05, the p-value 0.4543>0.05, hence reject H0: and conclude that usage of raw materials in the two sites is significantly different.
Appendix 5: ANOVAs table for % usage of obsidian in the two sites

> lithic obsidian

<table>
<thead>
<tr>
<th>Sites</th>
<th>GxJj4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Shaped tools</td>
<td>36.1</td>
<td>0</td>
</tr>
<tr>
<td>2 Debitage</td>
<td>36.3</td>
<td>0</td>
</tr>
</tbody>
</table>

> lithicobsidian1 <- lm(GxJj4 ~ FxJj12, data=lithicobsidian)

Call:
lm(formula = GxJj4 ~ FxJj12, data = lithicobsidian)

Coefficients:
(Intercept)      FxJj12
36.2      NA

> summary(lithicobsidian1)

Call:
lm(formula = GxJj4 ~ FxJj12, data = lithicobsidian)

Residuals:
   1    2
-0.1  0.1

Coefficients: (1 not defined because of singularities)

    Estimate Std. Error   t value Pr(>|t|)
(Intercept)    36.2     0.1   362    0.00176 **
FxJj12          NA      NA      NA      NA
---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.1414 on 1 degrees of freedom

#the level of significance cannot be identified since the sum of squares due to error is zero. 6:
Appendix 6: ANOVAs table for % usage of chert on shaped tools

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microliths</td>
<td>58.6</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Outils écaillés</td>
<td>4.5</td>
<td>44.4</td>
<td></td>
</tr>
<tr>
<td>Scrapers</td>
<td>42.7</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Burins</td>
<td>83.3</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Percoirs</td>
<td>100.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Awls</td>
<td>100.0</td>
<td>0.0</td>
<td></td>
</tr>
<tr>
<td>Truncations</td>
<td>0.0</td>
<td>25.0</td>
<td></td>
</tr>
<tr>
<td>Becs</td>
<td>0.0</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Tool frags</td>
<td>0.0</td>
<td>100.0</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>0.0</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

> shapedchert <- lm(GxJi4 ~ FxJj12, data = shapedchert)
> shapedchert1

Call:
lm(formula = GxJi4 ~ FxJj12, data = shapedchert)
Coefficients:
(Intercept)   FxJj12
   56.286   -0.455

> summary(shapedchert1)
Call:
lm(formula = GxJi4 ~ FxJj12, data = shapedchert)
Residuals:
   Min     1Q    Median     3Q    Max
-56.286 -26.385  -9.343   39.539  47.813
Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)     56.2860   17.3223   3.249 0.0117 *
FxJj12        -0.4550     0.3027  -1.503 0.1712 ---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 40.8 on 8 degrees of freedom
Multiple R-squared:  0.2202,  Adjusted R-squared:  0.1228
F-statistic:  2.26 on 1 and 8 DF,  p-value: 0.1712

> # Taking H0: usage of chert as a raw material on shaped tools in the two sites is significantly similar and H1: usage of chert as a raw material on shaped tools in the two sites is significantly different. With an alpha of 0.05, the p-value 0.1712 > 0.05, hence reject the H0: and conclude that the usage of chert on shaped tools in the two sites is significantly different.
Appendix 7: ANOVAs table for % usage of quartz on shaped tools in the two sites

<table>
<thead>
<tr>
<th></th>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Microliths</td>
<td>5.4</td>
<td>0.0</td>
</tr>
<tr>
<td>2</td>
<td>Outils écaillés</td>
<td>0.9</td>
<td>55.6</td>
</tr>
<tr>
<td>3</td>
<td>Scrapers</td>
<td>1.0</td>
<td>12.5</td>
</tr>
<tr>
<td></td>
<td>Burins</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>5</td>
<td>Percors</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>6</td>
<td>Awls</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>7</td>
<td>Truncations</td>
<td>0.0</td>
<td>75.0</td>
</tr>
<tr>
<td>8</td>
<td>Becs</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>9</td>
<td>Tool frags</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>10</td>
<td>Others</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

> shapedquartz1 <- lm(GxJi4 ~ FxJj12, data = shapedquartz)
> summary(shapedquartz1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = shapedquartz)

Coefficients:
(Intercept)   FxJj12
  0.817902   -0.006143

Residuals:
  Min 1Q Median 3Q Max -0.8179 -0.8179 -0.8179 0.1049 4.5821

Coefficients:
(Intercept)   Estimate Std. Error t value Pr(>|t|)
  0.817902   0.642258   1.273    0.239
FxJj12       -0.006143   0.021562  -0.285    0.783

Residual standard error: 1.781 on 8 degrees of freedom
Multiple R-squared: 0.01004, Adjusted R-squared: -0.1137
F-statistic: 0.08116 on 1 and 8 DF, p-value: 0.783

> #Taking H0: usage of quartz on shaped tools in the two sites is significantly similar and H1: usage of quartz on shaped tools in the two sites is significantly different. With an alpha of 0.05, the p-value 0.783 > 0.05, hence reject the H0: and conclude that usage of quartz in the two sites is significantly different.
Appendix 8: ANOVAs table for % usage of obsidian on debitage in the two sites

```r
> debitage obsidian
     X     GxJi 4   FxJj12
1 Angular fragments 14.4     0
2 Broken flakes      34.5     0
3 Whole flakes       50.0     0
> debitageobsidian1 <- lm(GxJi4 ~ FxjJj12, data = debitageobsidian)
> debitageobsidian1

Call:
  lm(formula = GxJi4 ~ FxjJj12, data = debitageobsidian)

Coefficients:
            Estimate Std. Error t value Pr(>|t|)  
(Intercept)  32.972     10.314   3.199   0.0854 .
FxjJj12         NA         NA      NA       NA
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 17.85 on 2 degrees of freedom
```

---

**Residual standard error:** 17.85 on 2 degrees of freedom
Appendix 9: ANOVAs table for % usage of chert on debitage in the two sites

> debitagechert
   X  GxJi4  FxJj12
1 Angular fragments  44.9  45.7
2 Broken flakes  60.8  50.5
3 Whole flakes  49.1  58.5

> debitagechert1 <- lm(GxJi4 ~ FxJj12, data = debitagechert)
> debitagechert1

Call:
  lm(formula = GxJi4 ~ FxJj12, data = debitagechert)

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)   44.1018    65.6195   0.672    0.623
FxJj12        0.1454     1.2659   0.115    0.927

> summary(debitagechert1)

Call:
  lm(formula = GxJi4 ~ FxJj12, data = debitagechert)

Residuals:
           1           2           3
     -5.847      9.355     -3.508

Coefficients:
                Estimate   Std. Error   t value     Pr(>|t|)
(Intercept)     44.1018      65.6195     0.672     0.623
FxJj12           0.1454      1.2659     0.115     0.927

Residual standard error: 11.58 on 1 degrees of freedom
Multiple R-squared:  0.01302,   Adjusted R-squared: -0.974
F-statistic: 0.01319 on 1 and 1 DF,  p-value: 0.9272

> # Taking H0: usage of chert on debitage in the two sites is significantly similar and H1: usage of chert on debitage in the two is significantly different. With an alpha of 0.05, the p-value is 0.9272 > 0.05, reject the H0: and conclude that usage of chert on debitage in the two sites is significantly different.
**Appendix 10: ANOVAs table for % usage of quartz on debitage in the two sites**

```
> debitagequartz
     X      GxJi4 Fxjj12
1. Angular fragments 24.4     1.1
2. Broken flakes     3.9      6.8
3. Whole flakes      1.0      4.7

> debitagequartz1 <- lm(GxJi4 ~ Fxjj12, data = debitagequartz)
Error in model.frame.default(formula = GxJi4 ~ FxJj12, data = debitagequartz, : variable lengths differ (found for 'FxJj12')
> debitagequartz1 <- lm(GxJi4 ~ Fxjj12, data = debitagequartz)
> debitagequartz1

Call:
  lm(formula = GxJi4 ~ Fxjj12, data = debitagequartz)

Coefficients:
  (Intercept)    Fxjj12
       26.193      -3.911

> summary(debitagequartz1)

Call:
  lm(formula = GxJi4 ~ Fxjj12, data = debitagequartz)

Residuals:
   1       2       3
  2.509   4.302  -6.811

Coefficients:
                      Estimate Std. Error t value Pr(>|t|)
(Intercept)           26.193     9.965  2.629    0.231
Fxjj12                -3.911     2.070 -1.890    0.310

Residual standard error: 8.438 on 1 degrees of freedom
Multiple R-squared: 0.7812, Adjusted R-squared: 0.5624
F-statistic: 3.571 on 1 and 1 DF, p-value: 0.3099
```

> # Taking H0: usage of quartz on debitage in the two sites is significantly similar and H1: usage of quartz on debitage in the two sites is significantly different. With an alpha of 0.05, the p-value 0.3099 > 0.05, reject the H0: and conclude that usage of quartz on debitage in the two sites is significantly different.
Appendix 11: ANOVAs table for % usage of obsidian on cores in the two sites
>coresobsidian

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Casual</td>
<td>0.0</td>
<td>14.3</td>
</tr>
<tr>
<td>2 Single Platform</td>
<td>27.7</td>
<td>0.0</td>
</tr>
<tr>
<td>3 Double platform</td>
<td>50.0</td>
<td>0.0</td>
</tr>
<tr>
<td>4 Multiplatform</td>
<td>47.5</td>
<td>0.0</td>
</tr>
<tr>
<td>5 Discoidal</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>6 Core frag</td>
<td>15.5</td>
<td>0.0</td>
</tr>
<tr>
<td>7 Flake core</td>
<td>20.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

> coresobsidian1<-lm(GxJi4~FxJj12,data=coresobsidian)
> coresobsidian1

Call:
lm(formula = GxJi4 ~ FxJj12, data = coresobsidian)

Coefficients:
(Intercept) FxJj12
26.783 -1.873

> summary(coresobsidian1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = coresobsidian)

Residuals:
1          2          3          4          5          6          7
-1.343e-15 9.167e-01 2.322e+01 2.072e+01 -2.678e+01 -1.128e+01 -6.783e+00

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) 26.783 7.873 3.402 0.0192 *
FxJj12 -1.873 1.457 -1.286 0.2549 ---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 19.29 on 5 degrees of freedom
Multiple R-squared: 0.2485, Adjusted R-squared: 0.09817
F-statistic: 1.653 on 1 and 5 DF, p-value: 0.2549

> #Taking H0: usage of obsidian on cores in the two sites is significantly similar and H1: usage of obsidian on cores in the two sites is significantly different. With an alpha of 0.05, the p-value 0.2549>0.05, hence reject the H0: and conclude that usage of obsidian on cores in the two sites is significantly different.
Appendix 12: ANOVAs table for % usage of chert on cores in the two sites
> coreschert
> X                               GxJi4            FxJj12
1 Casual                                     0.0            57.1
2 Single Platform                     58.6            100.0
3 Double platform                   47.2             87.1
4 Multiplatform                       44.6             50.0
5 Discoidal                             100.0                0.0
6 Core frag                               46.6            100.0
7 Flake core                             60.0                0.0
> coreschert1 <- lm(GxJi4 ~ FxJj12, data = coreschert)
> coreschert1

Call:
lm(formula = GxJi4 ~ FxJj12, data = coreschert)

Coefficients:
(Intercept)       FxJj12
 67.3829       -0.2909

> summary(coreschert1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = coreschert)

Residuals:
     1       2       3       4       5       6       7

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept) 67.3829    19.1081   3.526   0.0168 *
FxJj12 -0.2909     0.2768  -1.051   0.3415 ---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 29.23 on 5 degrees of freedom
Multiple R-squared:  0.1809,    Adjusted R-squared:  0.01708
F-statistic: 1.104 on 1 and 5 DF,  p-value: 0.3415

> # Taking H0: usage of chert on cores is significantly similar and H1: usage of chert on cores is significantly different. With an alpha of 0.05, the p-value 0.3415 > 0.05, hence reject the H0: and conclude that usage of chert on cores in the two sites is significantly different.
Appendix 13: ANOVAs table for % usage of quartz on cores in the two sites

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Casual</td>
<td>0.0</td>
<td>28.6</td>
</tr>
<tr>
<td>2. Single Platform</td>
<td>13.8</td>
<td>0.0</td>
</tr>
<tr>
<td>3. Double platform</td>
<td>3.4</td>
<td>10.3</td>
</tr>
<tr>
<td>4. Multiplatform</td>
<td>7.9</td>
<td>13.3</td>
</tr>
<tr>
<td>5. Discoidal</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>6. Core frag</td>
<td>60.0</td>
<td>0.0</td>
</tr>
<tr>
<td>7. Flake core</td>
<td>20.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

> coresquartz1 <- lm(GxJi4 ~ FxJj12, data=coresquartz)
> coresquartz1

Call:
lm(formula = GxJi4 ~ FxJj12, data = coresquartz)

Coefficients:
(Intercept) FxJj12
21.7587 -0.9044

> summary(coresquartz1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = coresquartz)

Residuals:
1 2 3 4 5 6 7

Coefficients:
Estimate Std. Error t value Pr(>|t|)  (Intercept) 21.7587 9.6440 2.256 0.0737 .
FxJj12 -0.9044 0.7690 -1.176 0.2925 ---
Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 20.51 on 5 degrees of freedom
Multiple R-squared: 0.2167, Adjusted R-squared: 0.06004
F-statistic: 1.383 on 1 and 5 DF, p-value: 0.2925

> #Taking H0: usage of quartz on cores is significantly similar and H1: usage of quartz on cores is significantly different. With an alpha of 0.05, the p-value 0.2925>0.05, hence reject the H0: and conclude that usage of quartz on cores in the two sites is significantly different.
Appendix 14: ANOVAs table for mean length of shaped tools in the two sites

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backed blade</td>
<td>26.7</td>
<td>26.1</td>
</tr>
<tr>
<td>Crescents</td>
<td>28.1</td>
<td>26.6</td>
</tr>
<tr>
<td>Trapezoid</td>
<td>0.0</td>
<td>23.6</td>
</tr>
<tr>
<td>Outils écaillés</td>
<td>17.7</td>
<td>21.5</td>
</tr>
<tr>
<td>End scraper</td>
<td>22.6</td>
<td>41.8</td>
</tr>
<tr>
<td>Notched</td>
<td>22.0</td>
<td>37.9</td>
</tr>
<tr>
<td>Side</td>
<td>44.7</td>
<td>4.7</td>
</tr>
<tr>
<td>Convergent</td>
<td>0.0</td>
<td>85.0</td>
</tr>
<tr>
<td>End and double side</td>
<td>22.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Notched</td>
<td>22.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Racoir transverse</td>
<td>4.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Retouched misc.</td>
<td>31.6</td>
<td>0.0</td>
</tr>
<tr>
<td>Thumbnail</td>
<td>19.8</td>
<td>0.0</td>
</tr>
<tr>
<td>End and side</td>
<td>28.8</td>
<td>0.0</td>
</tr>
<tr>
<td>Rounded end</td>
<td>16.3</td>
<td>0.0</td>
</tr>
<tr>
<td>Circular</td>
<td>20.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Others</td>
<td>38.5</td>
<td>0.0</td>
</tr>
<tr>
<td>Burins</td>
<td>30.8</td>
<td>23.3</td>
</tr>
<tr>
<td>Percoirs</td>
<td>23.9</td>
<td>0.0</td>
</tr>
<tr>
<td>Awls</td>
<td>19.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Truncations</td>
<td>0.0</td>
<td>28.5</td>
</tr>
<tr>
<td>Becs</td>
<td>0.0</td>
<td>44.0</td>
</tr>
<tr>
<td>Tool frags</td>
<td>0.0</td>
<td>23.4</td>
</tr>
<tr>
<td>Others</td>
<td>0.0</td>
<td>107.3</td>
</tr>
</tbody>
</table>

```r
> shapedlength1 <- lm(GxJi4~FxJj12, data=shapedlength)
> summary(shapedlength1)
```

Call:
```
lm(formula = GxJi4 ~ FxJj12, data = shapedlength)
```

Coefficients:
```
(Intercept)         FxJj12
  22.4575           -0.1849
```

```r
>summary(shapedlength1)
```

Call:
```
lm(formula = GxJi4 ~ FxJj12, data = shapedlength)
```

Residuals:
```
     Min      1Q  Median      3Q     Max
-18.1575 -6.3044  0.6204  8.1687  30.9305
```
Coefficients:

|            | Estimate | Std. Error | t value | Pr(>|t|) |
|------------|----------|------------|---------|----------|
| (Intercept)| 22.45749 | 3.25946    | 6.890   | 6.42e-07 |
| FxJj12     | -0.18485 | 0.09162    | -2.018  | 0.056    |

---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 12.43 on 22 degrees of freedom
Multiple R-squared: 0.1561,  Adjusted R-squared: 0.1178
F-statistic: 4.071 on 1 and 22 DF, p-value: 0.05599

> #Taking H0: length of shaped tools is significantly similar and H1: length of shaped tools is significantly different. With an alpha of 0.05, the p-value 0.05599>0.05, hence reject the H0: and conclude that the length of shaped tools is significantly different.
Appendix 15: ANOVAs table for mean width of shaped tools in the two sites

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Backed blade</td>
<td>9.7</td>
<td>14.0</td>
</tr>
<tr>
<td>2. Crescents</td>
<td>9.0</td>
<td>11.3</td>
</tr>
<tr>
<td>3. Trapezoid</td>
<td>0.0</td>
<td>13.9</td>
</tr>
<tr>
<td>4. Outils écaillés</td>
<td>13.8</td>
<td>14.9</td>
</tr>
<tr>
<td>5. End scraper</td>
<td>17.2</td>
<td>30.1</td>
</tr>
<tr>
<td>6. Notched</td>
<td>14.9</td>
<td>33.2</td>
</tr>
<tr>
<td>7. Side</td>
<td>36.5</td>
<td>26.0</td>
</tr>
<tr>
<td>8. Convergent</td>
<td>0.0</td>
<td>50.7</td>
</tr>
<tr>
<td>9. End and double side</td>
<td>17.2</td>
<td>0.0</td>
</tr>
<tr>
<td>10. Notched</td>
<td>14.9</td>
<td>0.0</td>
</tr>
<tr>
<td>11. Racoir transverse</td>
<td>32.1</td>
<td>0.0</td>
</tr>
<tr>
<td>12. Retouched misc.</td>
<td>9.4</td>
<td>0.0</td>
</tr>
<tr>
<td>13. 13 Thumbnail</td>
<td>14.8</td>
<td>0.0</td>
</tr>
<tr>
<td>14. End and side</td>
<td>10.9</td>
<td>0.0</td>
</tr>
<tr>
<td>15. Rounded end</td>
<td>13.6</td>
<td>0.0</td>
</tr>
<tr>
<td>16. Circular</td>
<td>16.5</td>
<td>0.0</td>
</tr>
<tr>
<td>17. Others</td>
<td>26.4</td>
<td>0.0</td>
</tr>
<tr>
<td>18. Burins</td>
<td>14.9</td>
<td>11.1</td>
</tr>
<tr>
<td>19. Percoirs</td>
<td>16.7</td>
<td>0.0</td>
</tr>
<tr>
<td>20. Awls</td>
<td>6.8</td>
<td>0.0</td>
</tr>
<tr>
<td>21. Truncations</td>
<td>0.0</td>
<td>13.3</td>
</tr>
<tr>
<td>22. Becs</td>
<td>0.0</td>
<td>19.1</td>
</tr>
<tr>
<td>23. Tool frags</td>
<td>0.0</td>
<td>14.7</td>
</tr>
<tr>
<td>24. Others</td>
<td>0.0</td>
<td>28.8</td>
</tr>
</tbody>
</table>

> shapedwidth1 <- lm(GxJi4 ~ FxJj12, data = shapedwidth)

Coeficients:

<table>
<thead>
<tr>
<th>(Intercept)</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>14.6638</td>
<td>-0.2015</td>
</tr>
</tbody>
</table>

>summary(shapedwidth1)

Residuals:

<table>
<thead>
<tr>
<th>Min</th>
<th>1Q</th>
<th>Median</th>
<th>3Q</th>
<th>Max</th>
</tr>
</thead>
</table>
-11.9843 -5.9138 -0.4638 2.4884 27.0742

Coefficients:

|                | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | 14.6638  | 2.6222     | 5.592   | 1.27e-05 *** |
| FxJj12         | -0.2015  | 0.1464     | -1.377  | 0.183    | --- |

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 9.721 on 22 degrees of freedom
Multiple R-squared: 0.0793, Adjusted R-squared: 0.03745
F-statistic: 1.895 on 1 and 22 DF, p-value: 0.1825

> #Taking H0: width of shaped is significantly similar and H1: width of shaped significantly different. With an alpha of 0.05, the p-value 0.1825 > 0.05, hence reject the H0: and conclude that the width of shaped is significantly different.
### Appendix 16: ANOVAs table for mean thickness of shaped tools in the two sites

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Microliths</td>
<td>3.8</td>
<td>4.6</td>
</tr>
<tr>
<td>2. Outils écailles</td>
<td>6.9</td>
<td>6.2</td>
</tr>
<tr>
<td>3. Scrapers</td>
<td>5.6</td>
<td>11.8</td>
</tr>
<tr>
<td>4. Burins</td>
<td>6.7</td>
<td>6.0</td>
</tr>
<tr>
<td>5. Percoirs</td>
<td>6.3</td>
<td>0.0</td>
</tr>
<tr>
<td>6. Awls</td>
<td>3.6</td>
<td>0.0</td>
</tr>
<tr>
<td>7. Truncations</td>
<td>0.0</td>
<td>5.3</td>
</tr>
<tr>
<td>8. Becs</td>
<td>0.0</td>
<td>10.7</td>
</tr>
<tr>
<td>9. Tool frags</td>
<td>0.0</td>
<td>5.9</td>
</tr>
<tr>
<td>10. Others</td>
<td>0.0</td>
<td>28.8</td>
</tr>
<tr>
<td>11. Angular fragments</td>
<td>5.1</td>
<td>11.6</td>
</tr>
<tr>
<td>12. Broken flakes</td>
<td>3.2</td>
<td>0.0</td>
</tr>
<tr>
<td>13. Whole flakes</td>
<td>3.1</td>
<td>6.3</td>
</tr>
<tr>
<td>14. Cores</td>
<td>13.6</td>
<td>13.9</td>
</tr>
<tr>
<td>15. Grindstones</td>
<td>23.0</td>
<td>0.0</td>
</tr>
<tr>
<td>16. Hammer stones</td>
<td>22.0</td>
<td>21.1</td>
</tr>
</tbody>
</table>

```
NA     NA
> wholethickness1 <- lm(GxJi4 ~ FxJj12, data=wholethickness)
> wholethickness1

Call:
lm(formula = GxJi4 ~ FxJj12, data = wholethickness)

Coefficients:
(Intercept)   FxJj12
  6.01678 0.05016

>summary(wholethickness1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = wholethickness)

Residuals:
    Min     1Q    Median     3Q    Max
-7.4615 -3.9953 -1.9577  0.4297 16.9832

Coefficients:
   Estimate Std. Error  t value Pr(>|t|)
(Intercept)   6.01678  2.71034   2.22 0.0434 *
   FxJj12    0.05016  0.23919   0.21 0.8369
---
```
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Residual standard error: 7.419 on 14 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared:  0.003132, Adjusted R-squared: -0.06807
F-statistic: 0.04398 on 1 and 14 DF, p-value: 0.8369

> #Taking H0: thickness of the whole collection is significantly similar and H1: thickness of
the whole collection is significantly different. With an alpha of 0.05, the p-value 0.8369>0.05
hence reject the H0: and conclude that the thickness of the whole collection is significantly
different.
Appendix 17: ANOVAs table for length of debitage in the two sites

> debitagelength
<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angular fragments</td>
<td>17.6</td>
<td>33.6</td>
</tr>
<tr>
<td>Broken flakes</td>
<td>19.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Whole flakes</td>
<td>19.1</td>
<td>25.2</td>
</tr>
</tbody>
</table>

> debitagelength1 <- lm(GxJi4 ~ FxJj12, data = debitagelength)
> debitagelength1

Call:
\[
\text{lm(formula = GxJi4 ~ FxJj12, data = debitagelength)}
\]

Coefficients:
(Intercept)   FxJj12
 19.27308     -0.03434

> summary(debitagelength1)

Call:
\[
\text{lm(formula = GxJi4 ~ FxJj12, data = debitagelength)}
\]

Residuals:

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.5192</td>
<td>-0.1731</td>
<td>0.6923</td>
</tr>
</tbody>
</table>

Coefficients:

|                | Estimate | Std. Error | t value | Pr(>|t|) |
|----------------|----------|------------|---------|----------|
| (Intercept)    | 19.27308 | 0.86538    | 22.271  | 0.0286 * |
| FxJj12         | -0.03434 | 0.03569    | -0.962  | 0.5122   |

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.8825 on 1 degrees of freedom
Multiple R-squared: 0.4808, Adjusted R-squared: -0.03846
F-statistic: 0.9259 on 1 and 1 DF, p-value: 0.5122

> # Taking H0: length of debitage is significantly similar and H1: length of debitage is significantly different. With an alpha of 0.05, the p-value 0.5122 > 0.05, hence reject the H0: and conclude that the length of debitage is significantly different.
Appendix 18: ANOVAs table for width of debitage in the two sites
> debitagewidth

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Angular fragments</td>
<td>10.7</td>
<td>14.4</td>
</tr>
<tr>
<td>2. Broken flakes</td>
<td>10.1</td>
<td>0.0</td>
</tr>
<tr>
<td>3. Whole flakes</td>
<td>10.1</td>
<td>18.3</td>
</tr>
</tbody>
</table>

> debitagewidth1 <- lm(GxJi4 ~ FxJj12, data=debitagewidth)
> debitagewidth1

Call:
lm(formula = GxJi4 ~ FxJj12, data = debitagewidth)

Coefficients:
(Intercept)       FxJj12
10.1768        0.01130

> summary(debitagewidth1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = debitagewidth)

Residuals:
1        2        3
0.36045 -0.07682 -0.28363

Coefficients:
Estimate  Std. Error   t value   Pr(>|t|)
(Intercept) 10.17682     0.45866    22.188    0.0287 *
FxJj12       0.01130      0.03412     0.331    0.7964

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.465 on 1 degrees of freedom
Multiple R-squared: 0.09889,  Adjusted R-squared: -0.8022
F-statistic: 0.1097 on 1 and 1 DF, p-value: 0.7964

> #Taking H0: width of debitage is significantly similar and H1: width of debitage is significantly different. With an alpha of 0.05, the p-value 0.7964>0.05, hence reject the H0: and conclude that the width of debitage is significantly different.
Appendix 19: ANOVAs table for thickness in the two sites

> debitagethickness
X                      GxJi4                        FxJj12
1. Angular fragments  5.1                        11.6
2. Broken flakes      3.2                        0.0
3. Whole flakes       3.1                        6.3

> debitagethickness1 <- lm(GxJi4 ~ FxJj12, data=debitagethickness)
> debitagethickness1

Call:
lm(formula = GxJi4 ~ FxJj12, data = debitagethickness)

Coefficients:
(Intercept)       FxJj12
2.8561       0.1582

> summary(debitagethickness1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = debitagethickness)

Residuals:
  1       2       3
0.4088  0.3439 -0.7527

Coefficients:
    Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.8561     0.8566   3.334    0.185
FxJj12       0.1582     0.1124   1.408    0.393

Residual standard error: 0.923 on 1 degrees of freedom
Multiple R-squared:  0.6646,    Adjusted R-squared:  0.3291
F-statistic: 1.981 on 1 and 1 DF,  p-value: 0.3932

> # Taking the H0: thickness of debitage is significantly similar and H1: thickness of debitage is significantly different. With an alpha of 0.05, the p-value 0.3932>0.05, hence reject the H0: and conclude that the thickness of debitage is significantly different.
Appendix 20: ANOVAs table for width of debitage in the two sites
> debitagemass

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Angular frags</td>
<td>1.6</td>
<td>13.9</td>
</tr>
<tr>
<td>2 Broken flakes</td>
<td>0.9</td>
<td>0.0</td>
</tr>
<tr>
<td>3 Whole flakes</td>
<td>0.9</td>
<td>6.3</td>
</tr>
</tbody>
</table>

> debitagemass1 <- lm(GxJi4 ~ FxJj12, data=debitagemass)
> debitagemass1

Call:
lm(formula = GxJi4 ~ FxJj12, data = debitagemass)

Coefficients:
(Intercept) FxJj12
 0.78469   0.05178

> summary(debitagemass1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = debitagemass)

Residuals:
   1     2     3
 0.09559 0.11531 -0.21090

Coefficients:
Estimate Std. Error t value Pr(>|t|)
(Intercept)   0.78469   0.23155   3.389    0.183
FxJj12        0.05178   0.02628   1.970    0.299

Residual standard error: 0.2587 on 1 degrees of freedom
Multiple R-squared:  0.7952,   Adjusted R-squared:  0.5903
F-statistic: 3.882 on 1 and 1 DF,  p-value: 0.299

> # Taking H0: mass of debitage is significantly similar and H1: mass of debitage is significantly different. With an alpha of 0.05, the p-value 0.299 > 0.05, hence reject the H0: and conclude that the mass of debitage is significantly different.
Appendix 21: ANOVAs table for length of cores in the two sites

> lengthcores

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casual</td>
<td>0.0</td>
<td>26.1</td>
</tr>
<tr>
<td>Single Platform</td>
<td>24.1</td>
<td>21.4</td>
</tr>
<tr>
<td>Double platform</td>
<td>21.9</td>
<td>26.7</td>
</tr>
<tr>
<td>Multiplatform</td>
<td>22.5</td>
<td>36.9</td>
</tr>
<tr>
<td>Discoidal</td>
<td>13.8</td>
<td>61.9</td>
</tr>
<tr>
<td>Core frag</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Flake core</td>
<td>37.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

> lengthcores1 <- lm(GxJi4~FxJj12, data=lengthcores)
> lengthcores1

Call:
lm(formula = GxJi4 ~ FxJj12, data = lengthcores)

Coefficients:
(Intercept)       FxJj12
18.50155         -0.05902

> summary(lengthcores1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = lengthcores)

Residuals:
1       2       3       4       5       6       7

Coefficients:

| Estimate | Std. Error | t value | Pr(>|t|) |
|----------|------------|---------|----------|
| (Intercept) | 18.50155 | 8.87283 | 2.085 | 0.0915 . |
| FxJj12 | -0.05902  | 0.27968 | -0.211 | 0.8412  --- |

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 14.72 on 5 degrees of freedom
Multiple R-squared: 0.008828, Adjusted R-squared: -0.1894
F-statistic: 0.04454 on 1 and 5 DF, p-value: 0.8412

> # Taking H0: length of cores is similar and H1: length of cores is significantly different. With an alpha of 0.05, the p-value 0.8412>0.05, hence reject the H0: and conclude that the length of cores is significantly different.
Appendix 22: ANOVAs table for length of cores in the two sites

<table>
<thead>
<tr>
<th>X</th>
<th>GxJi4</th>
<th>FxJj12</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casual</td>
<td>0.0</td>
<td>19.6</td>
</tr>
<tr>
<td>Single Platform</td>
<td>16.8</td>
<td>12.8</td>
</tr>
<tr>
<td>Double platform</td>
<td>15.8</td>
<td>15.4</td>
</tr>
<tr>
<td>Multiplatform</td>
<td>17.2</td>
<td>28.4</td>
</tr>
<tr>
<td>Discoidal</td>
<td>12.3</td>
<td>53.3</td>
</tr>
<tr>
<td>Core frag</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Flake core</td>
<td>25.6</td>
<td>0.0</td>
</tr>
<tr>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

> coreswidth1 <- lm(GxJi4~FxJj12, data=coreswidth) > coreswidth1 Call:
lm(formula = GxJi4 ~ FxJj12, data = coreswidth)

Coefficients:
(Intercept) 12.710405
FxJj12 -0.009829

> summary(coreswidth1)

Call:
lm(formula = GxJi4 ~ FxJj12, data = coreswidth)

Residuals:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-12.5178</td>
<td>4.2154</td>
<td>3.2410</td>
<td>4.7687</td>
<td>0.1135</td>
<td>-12.7104</td>
<td>12.8896</td>
</tr>
</tbody>
</table>

Coefficients:

| Estimate | Std. Error | t value | Pr(>|t|) |
|----------|------------|---------|---------|
| (Intercept) | 12.710405 | 5.769809 | 2.203  | 0.0788 |
| FxJj12    | -0.009829  | 0.229288 | -0.043 | 0.9675 |

---

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 10.35 on 5 degrees of freedom
(1 observation deleted due to missingness)
Multiple R-squared: 0.0003674, Adjusted R-squared: -0.1996
F-statistic: 0.001838 on 1 and 5 DF, p-value: 0.9675

> Taking H0: width of cores is similar and H1: width of cores is significantly different. With an alpha of 0.05, the p-value 0.9675>0.05, hence reject the H0: and conclude that the width of cores is significantly different.
Error: unexpected symbol in "Taking H0"
Appendix 23: ANOVAs table for thickness of cores in the two sites

<table>
<thead>
<tr>
<th></th>
<th>debitagethickness1 &lt;- lm(GxJi4 ~ FxJj12, data = debitagethickness)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>debitage thickness</td>
</tr>
<tr>
<td>1</td>
<td>Angular fragments</td>
</tr>
<tr>
<td>2</td>
<td>Broken flakes</td>
</tr>
<tr>
<td>3</td>
<td>Whole flakes</td>
</tr>
</tbody>
</table>

Call:
\[ \text{lm(formula = GxJi4 ~ FxJj12, data = debitagethickness)} \]

Coefficients:
\[
\begin{array}{ll}
(\text{Intercept}) & 2.8561 \\
FxJj12 & 0.1582 \\
\end{array}
\]

> summary(debitagethickness1)

Call:
\[ \text{lm(formula = GxJi4 ~ FxJj12, data = debitagethickness)} \]

Residuals:
\[
\begin{array}{ccc}
1 & 2 & 3 \\
0.4088 & 0.3439 & -0.7527 \\
\end{array}
\]

Coefficients:
\[
\begin{array}{cccc}
\text{Estimate} & \text{Std. Error} & t value & \text{Pr(>|t|)} \\
(\text{Intercept}) & 2.8561 & 0.8566 & 3.334 & 0.185 \\
FxJj12 & 0.1582 & 0.1124 & 1.408 & 0.393 \\
\end{array}
\]

Residual standard error: 0.923 on 1 degrees of freedom
Multiple R-squared: 0.6646, Adjusted R-squared: 0.3291
F-statistic: 1.981 on 1 and 1 DF, p-value: 0.3932

> # Taking the H0: thickness of debitage is significantly similar and H1: thickness of debitage is significantly different. With an alpha of 0.05, the p-value 0.3932 > 0.05, hence reject the H0: and conclude that the thickness of debitage is significantly different.
Appendix 24: ANOVAs table for weight of cores in the two sites
> coresweight
                      X       GxJi4      FxJj12
1. Casual            0.0       7.3
2. Single Platform   6.0       2.7
3. Double platform   5.2       10.1
4. Multiplatform     6.4       61.0
5. Discoidal         1.0       108.7
6. Core frag         0.0       0.0
7. Flake core        13.0      0.0
NA     NA
> coresmass1<-lm(GxJi4~FxJj12,data=coresmass)
> summary(coresmass1)

Call:
  lm(formula = GxJi4 ~ FxJj12, data = coresmass)

Residuals:
     1       2       3       4       5       6       7
-5.0569  0.8171  0.2198  2.8137 -1.2801  7.7432

Coefficients:          Estimate Std. Error  t value   Pr(>|t|)  
(Intercept)            5.25680    2.29053   2.295   0.0702 . 
FxJj12                -0.02738    0.04837  -0.566    0.5957

Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 4.969 on 5 degrees of freedom
  (1 observation deleted due to missingness)
Multiple R-squared:  0.06025, Adjusted R-squared: -0.1277
F-statistic: 0.3206 on 1 and 5 DF,  p-value: 0.5957

> #Taking H0: weight of cores is similar and H1: mass of cores is significantly different. With an alpha of 0.05, the p-value 0.5957>0.05, hence reject the H0: and conclude that the weight of cores is significantly different.
DECLARATION

This thesis is my original work and has not been presented for a degree in any other university or any other award.

Student

James Koome Munene

Signature: __________________ Date: 26/06/2016

This thesis has been submitted with our approval as university supervisors

Prof, J.W.K. Harris

Signature: __________________ Date: 26/06/2016

Emeritus Professor, Rutgers University U.S.A.

Research Associate, National Museums of Kenya

Dr. L.K Ngari

Signature: __________________ Date: 10/07/2016

Department of History, Archaeology and Political Science,

Kenyatta University