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Preliminary Investigation into the Context and Integrity of an Earlier Stone Age Site in the Shashe-Limpopo Basin

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Declaration

I declare that this project report is my own, unaided work, except where otherwise acknowledged. It is being submitted for the degree of Bachelor of Science with Honours in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

Signed this ___ day of __________ 20___

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Abstract

High resolution excavation at the Earlier Stone Age site of Hackthorne in the Shashe-Limpopo Basin (near the border between South Africa and Botswana) has revealed a site with potentially good context and integrity. This initial study is concerned with the identification of the various natural processes which may have contributed to the formation of the site. The use of multiple models, contextual data and high resolution recovery techniques has provided a basis for the interpretation of the site's history of formation and alteration. It has been proposed that the horizontal distribution of artefacts within the site may not have suffered great disturbance, with interpretation regarding spatial patterning potentially possible. Any stratigraphic associations have been destroyed, and this limits the behavioural inferences that one can make. A further limitation is the possible time-scale of the site. The assemblage may have been deposited over a short period of geological time or over thousands of years. It has been proposed that the site may have been a desirable location for hominids, and as such the accumulation at the site could represent repeated visits over a long period of time, thus providing a time-averaged perspective on the hominid behaviour represented. Future analysis may, however, reveal that the site's time-scale is shorter than presently believed, resulting in a finer resolution at which behavioural inferences can be made. The conclusions drawn from this initial study must be considered preliminary as excavation and analysis is not complete. Future research at the site will hopefully add to our limited knowledge of the Acheulean in South Africa.

Chapter 1

Introduction

The Earlier Stone Age record in southern Africa consists first of artefacts dating to a late phase of the Oldowan Tradition, between 2 and 1.7-1.6 million years ago (Kuman 1998). This is then followed by an Acheulean Tradition, dating from 1.7-1.5 million years ago, with the majority of sites younger than 1 million years (Klein 2000). This Acheulean Tradition then ends around 250-200 thousand years ago (Klein 2000). Previous research has revealed that Earlier Stone Age sites occur virtually throughout southern Africa, but the majority of the sites lack stratigraphic context (Mason 1962, Sampson 1974, Klein 2000). Most assemblages have been recovered from surface sites, with fewer then 20 sealed sites reported so far (Sampson 1974, Klein 2000). This pattern occurs because southern African landscapes, for million of years, have been dominated by erosion and planation, with only rare sediment traps occurring in which early artefacts could become buried (Klein 2000). Many sites that have become buried suffer from the further problem that they lack suitable material for dating, and thus the cultural stratigraphy and dating for the region often relies on extrapolation from eastern Africa (Klein 2000). It can thus be seen that finding an Earlier Stone Age site of good integrity and context will be invaluable to Earlier Stone Age studies in the region.

Focus will now be given to the Acheulean. Acheulean people occupied the northern and eastern areas of southern Africa before 1 million years ago, and they then colonised the cooler southern and drier western areas (Klein 2000). The Acheulean has been distinguished from the Oldowan by the addition of handaxes, cleavers, picks and other large bifacial tools to assemblages. The Acheulean, which is characterised by a slow change in artefact types, is then separated into the early and later Acheulean. The early Acheulean, dating from 1.7-1.5 to 1 million years ago, and the later Acheulean, dating from 1 million to 250-200 thousand years ago, differ in that later Acheulean bifaces are often much more extensively trimmed, thinner, and more bilaterally symmetrical (Klein 2000). The late Acheulean is also characterised by a wide range of flake tools that are the forerunners to Middle Stone Age types (Klein 2000).

In addition to the stone artefacts, limited evidence exists for the use of standardised bone artefacts, as well as the controlled use of fire, however, no compelling evidence of structures has been found (Klein 2000). Site location does, however, indicate that Acheulean hominids may have been closely tied to standing water (Klein 2000). At this time it is also unclear as to whether hominids primarily hunted or scavenged, with few large animals represented. Klein (2000, 116) argues that this limited exploitation of large animals was probably the result of limited technology, with the consequence being a very low population density. In considering the actual tool-makers, many researchers believe that early representatives of the genus *Homo* produced most of the Oldowan and early Acheulean stone artefacts, with *Homo ergaster/erectus* making Acheulean artefacts until roughly 600 thousand years ago, and archaic *Homo sapiens* making the later ones (Klein 2000). A final point of note about the Acheulean is that it reveals the remarkable behavioural conservatism of non-modern humans, even as they were diverging anatomically on different continents (Klein 2000). It can be seen from this brief summary of the Acheulean that much is still to be discovered, with new sites potentially adding significantly to our limited knowledge.

Wits University research into the Earlier Stone Age of the Shashe-Limpopo Basin, in the Northern Province of South Africa, began with surveys of the farms of Reidel, Nekel, Hamilton, Schroda, Greefswald, Samaria, Hackthorne, Machete and Den Staat (Figure 1.1) (Kuman 2001*b*). The two brief surveys of the area, carried out in September 2000 and February 2001, obtained initial evidence for the Earlier Stone Age. This consisted of surface finds of Acheulean stone tools, including occasional handaxes, cleavers, numerous choppers, a variety of cores and flakes of various sizes. This material represents a period that typologically fits in with Acheulean material that dates in southern Africa to between 1 million and 250 thousand years ago (Kuman 2001*b*, 2002). The finds from the survey are significant in that South Africa has very few sites of this antiquity preserved in good contexts (Sampson 1974, Kuman 2002), and as such the Shashe-Limpopo Basin sites, if they prove to be of a good integrity, could provide new information on the regional Acheulean. The sites could thus be of great importance in expanding our knowledge of Acheulean lifeways in the Stone Age (Kuman 2001*b*).

From the survey it was established that the best location for the earliest artefact preservation on the above farms lies on higher ground, at elevations between 600 and 629 metres above sea-level (Kuman 2001*b*, 2002). The artefact bearing sediments are well preserved along a 4 kilometre long escarpment (625 m above sea-level), which runs across the farms of Samaria, Hackthorne and Machete (Figure 1.1). This escarpment is believed to be part of an ancient terrace of the Limpopo River, which has since cut down to lower levels in the valley (Kuman 2001*b*). Surface artefacts are visible along the edge of the escarpment where they are eroding out of thin sands that overlie a calcrete horizon. Moving back from the escarpment edge, the sediments thicken and artefacts are only occasionally exposed on the surface.

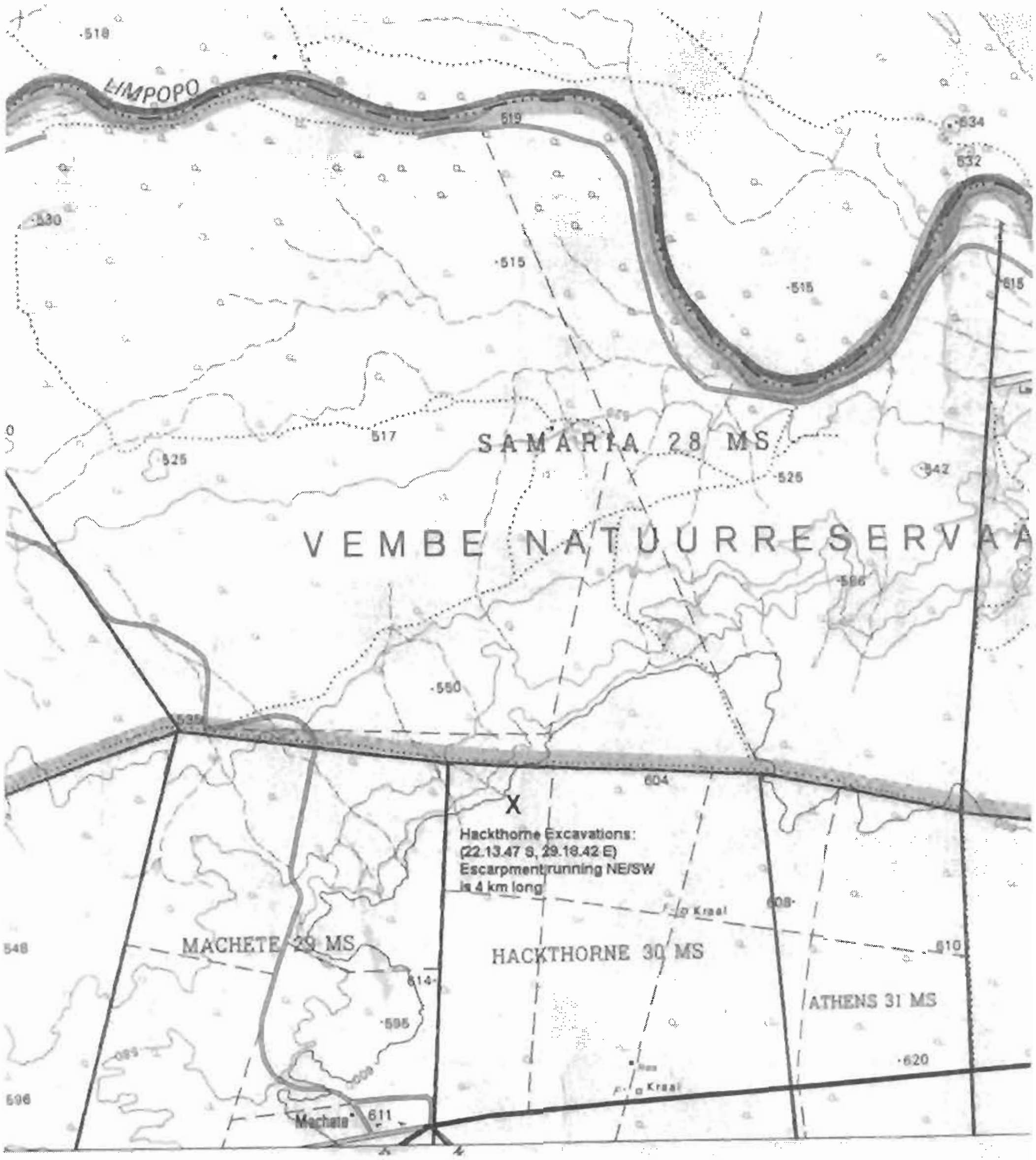

Figure 1.1: Location of Excavations

An initial analysis of the surface artefacts has suggested that they appear to belong to a single industry. Due to the abundance of choppers and the minimal flaking of many of the cores, the assemblage appears primitive, with only a few more elegant bifaces suggesting that the material is unlikely to be early Acheulean (Kuman 2001*b*, 2002). Thus no certain time period other than between 1 million and 250 thousands years can be attributed at this stage. Well-made bifaces occur in the Acheulean after 1 million years ago, with significant improvements in the technology occurring between 600 000 and 200 000 years ago. Thus the bifaces suggest that the artefacts probably belong to the later Acheulean. It must be remembered, however, that they could be significantly older (Kuman 2002).

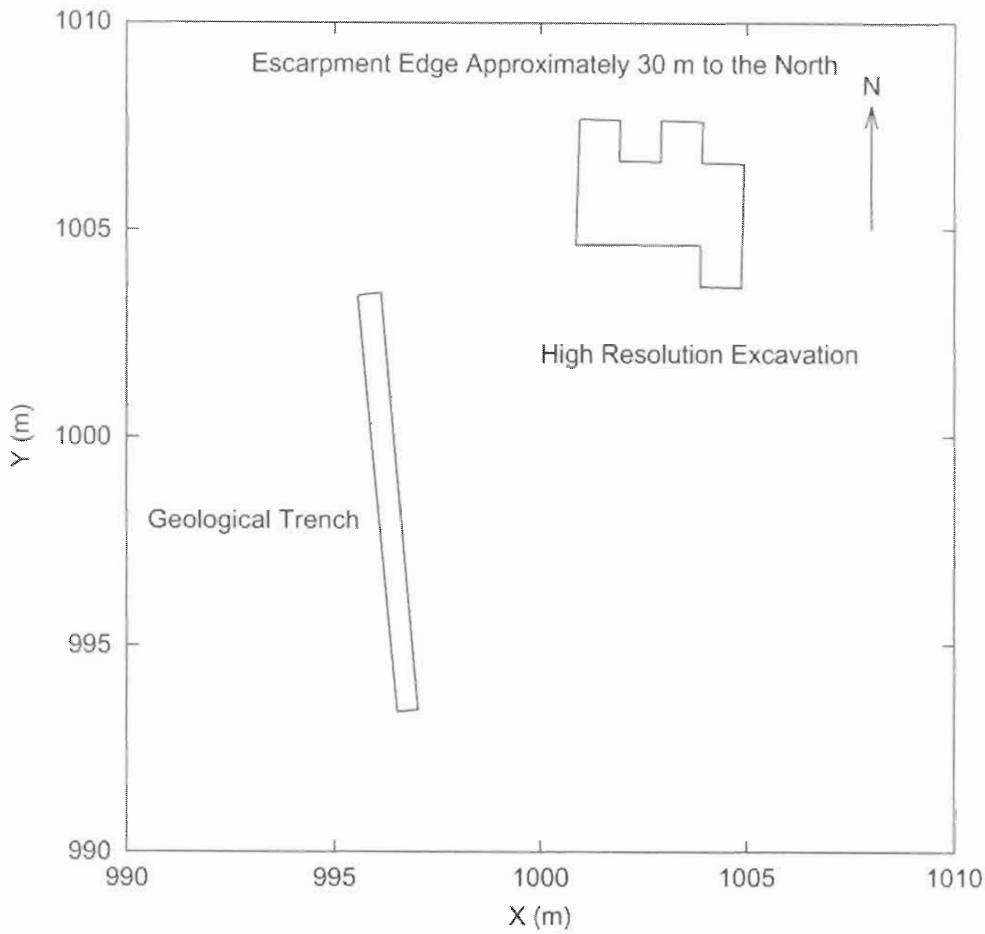

Figure 1.2: Site Plan

The site of Hackthorne (22.13.47S, 29.18.37 to 29.18.56E; Altitude 629 m above sea-level) has the richest artefact concentrations along the escarpment yet evident from the survey (Figure 1.1). The freshness of the artefacts and the presence of smaller flaking debris suggested that test excavations might reveal artefact horizons in good archaeological context (Kuman 2001*b*). Initial excavations at the site of Hackthorne were carried out in April of 2001. At this time an area was chosen about 30 m back from the escarpment edge which was to be excavated. A geological trench (10 m by 0.5 m) running perpendicular to the escarpment was excavated so as to gain an initial understanding of the sediments and the associated artefacts. An excavation grid (5 m by 5 m) was then set out to the east of the geological trench, with this area to be excavated using high resolution recovery techniques so as to maximise understanding and interpretation of the site (Figure 1.2). This would allow the integrity of the site and degree of disturbance to be more thoroughly assessed, and thus help provide a full understanding of the context of the site. This approach is important to use before any behavioural inferences can be made and thus can be seen as a key primary concern for research into Earlier Stone Age sites

(Gowlett 1997*a*, Isaac 1997). Further excavation at the site was conducted in September of 2001.

This Honours report deals with the high resolution excavation and recovery techniques that were conducted on Hackthorne. Theoretical considerations concerning archaeological research, excavation and excavation methodology will be discussed first. The excavation data is then analysed so as to achieve a greater understanding and interpretation of the site. This will include an evaluation of the disturbance and integrity of the site, based on comparisons with known natural formation processes and their resulting effects and patterns. The analysis will hopefully contribute to the full understanding of the archaeological context of the site. With a complete understanding of the context, one may make better informed behavioural inferences about the tool makers, about which little is known but much is hoped. What hopefully will be achieved in the long term from such an analysis is expressed by Morton (1996, 14):

"An understanding of the formation agencies is essential, but the absolute requirement is to draw inferences from the archaeological record that have behavioural significance."

Chapter 2

Theory and Excavation

2.0.1 Archaeological Theory

"It is essential that studies of formation processes come to be conducted routinely; for unless the genesis of deposits is understood, one cannot infer the behaviors of interest from artifact patterns in those deposits." (Schiffer 1983, 675).

This critical point made by Schiffer, which is relevant to all archaeological research, is of crucial importance when dealing with sites dating back thousands or millions of years. Early archaeological sites present the prospect for investigating the beginnings of human cultural behaviours. Such sites may reveal aspects of the transmission of rules for tool-manufacture and tool-use, as well as various activity patterns, both particular and general, of our early hominid ancestors (Schick 1991, 79). In order to achieve the above goals, archaeologists must be able to: delineate patterns produced by specific hominid activities; define how archaeological patterns are affected by non-cultural forces; and discriminate between site patterns produced by hominid and non-hominid agencies (Schick 1991, 79-80). The resulting task presented to the archaeologist is thus a complex one, with any investigation concerned with the many different kinds of processes that contribute to the characteristics of a site as perceived by the archaeologist (Isaac 1997, 237). It has been recognised that there are two broad types of transformation processes. C-transform processes are those directly induced by culturally engendered actions of humans or hominids, while N-transform processes are those natural/non-humanly induced processes (Isaac 1997, 237). With the archaeological record being part of a dynamic natural system that is constantly being changed and reworked, it is essential to understand how natural processes have affected the archaeological record, as these could affect the inferences that archaeologists make (Morton 1996, 1).

Three important ideas about site formation processes have been put forward by Schiffer (1983, 678). First, formation processes introduce variability into the archaeological record. An archaeologist, in using particular characteristics of the archaeological record as evidence of specific behavioural phenomena, must make sure that variability contributed by formation processes is understood and taken into account. Secondly, in order to take formation processes into account, one must identify the formation processes. To identify a formation process is to infer that it occurred. Thirdly, the archaeologist identifies formation processes at the level of the deposit, and thus as a prerequisite for making virtually all archaeological inferences, the archaeologist must identify the processes that gave rise to the specific deposits that are to supply relevant evidence. It is with this understanding of formation processes that the archaeologist must proceed in their investigation.

While it can be said that cultural factors are the primary agency producing the remains with which archaeologists are concerned, it must always be remembered that non-cultural factors can substantially alter cultural materials as they become part of the archaeological record (Gifford 1978). The effect of non-cultural processes upon Earlier Stone Age archaeological occurrences is of particular importance. First, special circumstances are required for site preservation, as sites of this antiquity are rare. Secondly, the longer time frame allows for a greater chance that alteration of the site has occurred. Since non-cultural factors affecting the archaeological record are processes, they can be observed in the contemporary world, and their effects clarified by actualistic research (Gifford 1978, 77-78). Such studies aid in the understanding of ancient geomorphic environments and processes, which is vital for research into the Earlier Stone Age (Gifford 1978). This understanding is essential if archaeologists want to derive detailed inferences regarding hominid cultural behaviour from patterns in the archaeological record, as they cannot afford to ignore the patterning effects of non-cultural processes upon the record (Gifford 1978).

This point is also considered by Morton (1996, 7) when he asks the question: *"Why is it important to understand the context and the extent of modification of assemblages?"* He states that the basic reason can be subdivided into three units. Such understanding will allow the archaeologist to: first increase the confidence levels of interpretations; secondly avoid falsely ascribing an interpretation based on a derived context; and thirdly avoid rejecting a hypothesis from a supposed derived context (Morton 1996, 7). Research which aims to achieve such an understanding will help the archaeologist to understand assemblage contexts and raise the confidence level of interpretations.

At this stage further discussion is required regarding the term *context*. A good definition of contextual data is given by Carr (1991, 223).

"...contextual data are defined as those that are relevant to identifying some archaeological observation or pattern, or to interpreting some facts, excluding the data that are used by the one model to make the identification/interpretation. Thus contextual data are not definable in absolute terms...they are defined relative to the phenomenon of interest and the current model being applied to understand it. Data used by a current model can serve as contextual data

relative to another model. Contextual data can also be case-specific circumstances that are unlikely to have identifying or interpreting power in general and that consequently are unlikely to be included in models for identifying observations/patterns or interpreting facts."

There has been a trend in archaeology to narrow the range of exploited data to that which is specified by middle-range theory (model-specific data), to the exclusion of a great deal of diverse, relevant information that is stored in a researcher's mind (Carr 1991). This has resulted in much information, which is often case-specific, being excluded from interpretation of the archaeological record, thus producing poorer interpretations (Carr 1991). An archaeologist must not solely focus on model-specified data, as this may have several negative consequences. These include: first that contextual evidence that may be strongly supporting or refuting in a specific case may be ignored for much weaker evidence that is stipulated by a model; secondly overlooking diverse contextual data and focusing only on model specified information may result in the archaeologist not accurately identifying observations and patterns that may be crucial for understanding and interpretation; thirdly by not considering contextual data and only focusing on model-specified data, one reduces the diversity of data that is used in making interpretations, which may reduce the plausibility of the argument (Carr 1991, 224-225).

This understanding of context, can be seen to be relevant in the suggestion that it is the interaction between the cultural and non-cultural environment that produces the artefact and its context, and thus to study artefacts without regard to all site formation processes is to study only a fraction of the archaeological record (Stein & Farrand 1988). Contextual data is thus critical to the interpretation of the archaeological record. The plausibility of an interpretation in part thus depends on the diversity of data that is evoked (Carr 1991, Wylie 1993). A context sensitive approach to identification draws on more kinds of observations than a model-focused one (Carr 1991). This approach would thus use alternative model analogues when trying to understand the formation processes which may have contributed to the characteristics of a site (Carr 1991, Morton 1996).

The use of modern analogues in archaeological research is an important tool in investigating basic site formation processes (Morton 1996). However, the contexts of modern studies do not necessarily replicate ancient contexts, and thus they may not reveal all of the probable variability in the interaction of different processes (Morton 1996, 27). This highlights the point that narrowly defined modern analogues are more appropriately used in combination with other analogues to reconstruct behaviour from complex archaeological evidence (Morton 1996, 27). Thus, reconstruction that uses many lines of evidence is preferable to single-cause explanation (Wylie 1993, Morton 1996). Morton (1996, 171) emphasises this critical concept in the statement:

"If a single model analogue is used exclusively rather than in combination with

alternative analogues and models, there is a risk of providing a simplistic, narrow solution to a complex problem."

In understanding and recognising the natural formation processes that may have influenced an archaeological site, alternative model analogues allow the identification of different processes that may have biased an archaeological assemblage in their own distinct way (Morton 1996, 204). The use of many models allows the archaeologist to evaluate the indicators of the different site formation processes in terms of similarity, dissimilarity and how much one can transform another (Morton 1996, 204). This allows for the understanding of the manner and extent to which one alternative model analogue may affect another, as well as the type of archaeological indicators that are likely to survive in the record (Morton 1996, 204). The use of many model analogues is thus crucial for an Earlier Stone Age archaeologist when trying to interpret a site, both in terms of natural and cultural processes, and thus will influence the resulting interpretation. The analysis that leads to an interpretation of site formation requires using diverse contextual data as well as explicit models and model-specified data. It also requires data exploration as well as model confirmation (Carr 1991, 253).

2.0.2 Earlier Stone Age Research

At this stage a discussion is needed concerning research into the Earlier Stone Age, with many of the ideas and concepts brought up previously critical to this type of research. Isaac (1997, 237) has acknowledged that in former times archaeologists more or less proceeded directly from an exposition of the empirical evidence to inferences about past hominid behaviour. It is, however, now recognised that one must first enquire into the processes involved in the formation of the early archaeological record (Isaac 1997, 237). If a site has been disturbed, rearranged, jumbled with other sites, or transported, then the anthropological inferences that can be made will be slight to zero. Because of this, an archaeologist may want to only investigate sites where almost all items of stone, bone etc. lie where they were dropped or placed (Isaac 1997). Such a luxury is not ever available, as all sites have probably suffered disturbance after having been abandoned by hominids (Isaac 1997). The archaeologist is then faced with trying to identify the extent to which materials have been modified, rearranged, and transported by the action of non-hominid agencies, as well as trying to factor out and distinguish the actions of hominids from the outcome of the other kinds of processes (Isaac 1997, 237).

Isaac (1997, 238) has identified four types of processes that contribute to Earlier Stone Age site formation. These include:

1. *"The actions of hominids that modified their environment in potentially detectable ways.*

2. *The action of non-hominid animals that further modified the materials that hominids had already modified or that performed modifications resembling the modificatory acts of hominids.*

3. *The effects of geological and soil-forming processes, such as weathering, movement by hydraulic or gravitational forces, burial by sediment, diagenetic alteration, and re-exposure by erosion.*

4. *The recovery and recording procedures of archaeologists. These, of course, are not part of the 'real world' formation of the site, but they are inextricably involved in archaeological perception of the character of the site. Since perception precedes interpretation, this category of 'process' needs to be considered every bit as much as (1),(2), or (3)."*

The above four processes are especially crucial for an interpretation of early sites. A major problem of previous research is that archaeologists used to place sites into two groups, classified as either 'primary' or 'secondary' (Gowlett 1997*a*). Primary context sites were seen not to have been greatly influenced by processes, other than those in point 1 above, which are a direct result of hominid behaviour. The remaining sites were classified as secondary and were not seen as useful to make behavioural inferences (Gowlett 1997*a*). As stated earlier, however, probably all sites have suffered disturbance after being abandoned by hominids, and thus the resulting picture is not so black and white as it was once perceived, with this having implications for studies which have drawn conclusions about hominid behaviour. Even when it appears that an archaeological site has not been at all or only minimally altered from its original behavioural context, such a judgement must be demonstrated rather than assumed (Audouze & Enloe 1997, 196). It is better to conceive of Earlier Stone Age sites as representing various stages of preservation along a continuum, where there is a great deal of variability in natural and cultural formation processes, with the archaeologist trying to evaluate the degree of integrity or disturbance of the site (Paddayya & Petraglia 1993, Audouze & Enloe 1997). It can thus be seen that the archaeologist must understand all of the formation processes which may have influenced a site before drawing any interpretation from the site.

2.0.3 Time Resolution

Stern (1993) discusses the difficulty of time resolution in the Earlier Stone Age in her assessment of the archaeological record of the lower Okote Member of the Koobi Fora Formation. Stern recommends that Earlier Stone Age archaeologists abandon hope of fine chronological inquiry and instead content themselves with a time resolution of 70 000 years. She argues that archaeologist's theory and methods are poorly developed for studying such long time periods and she questions archaeologists who interpret patterned associations in the archaeological record as if they are proxy for the actual observations of the movements and interactions of hominids. She believes that such direct and specific interpretations are erroneous due to the large time-scales that lead to infinite variability (Stern 1993, Morton 1996). She also questions the uniformitarian assumptions upon which these interpretations are based, suggesting that one can not be sure that processes in the past (natural or cultural) are the same as today. The consequence of this is that archaeologists need to identify the patterns and trends in the long time spans and to develop a theory of hominid action over the middle to long term (Stern 1993, Morton 1996).

An approach such as Stern's tends to eliminate the individual from the past and only provides the archaeologist with interpretation about the most macroscopic trends in hominid history (Conard 1994, 281). However, it is believed that while there is no need for archaeologists to restrict themselves to either long or short periods, Earlier Stone Age sites must exist where one can productively consider relatively short spans of time (Conard 1994, 281). It is thus recognised that one needs to consider the context of the archaeological material, as this will determine what can be said about a site. The point must be made that there may be some highly resolved lenses within ancient landscapes, and we should thus treat each site at the appropriate level of resolution (Gowlett 1997*a*). It becomes evident that much effort must be made by the archaeologist in the calculation of a site's time-scale, as well as in the identification of inter-site relationships and contextual integrity (Morton 1996, 23-24). If an understanding of the formation of a site can be established, then the archaeologist can begin to draw inferences from the archaeological record that have behavioural significance.

2.0.4 Excavation and Analytical Techniques

The understanding of the formation of a site involves many steps in an archaeological inquiry, one of which, the excavation, can be seen to be of extreme importance. Discussion will follow on appropriate excavation methodology and analytical techniques that should be used when conducting studies of the Earlier Stone Age. These are aimed at extracting the most out of the archaeological record, which will help in the understanding of the formation of the site, and thus the interpretation of its context. This will hopefully provide archaeologists with information that will prevent them from falsely attributing behavioural inferences based on palimpsests, or from dismissing interpretations because of the uncertainty over derived context (Morton 1996).

There are a number of techniques that Earlier Stone Age archaeologists can employ in excavation and site analysis, which will enhance their ability to make behavioural inferences from archaeological patterning. These techniques allow the archaeologist to pay careful attention to whether the artefact assemblages found at early sites, as well as their spatial patterns and associations, result directly from the actions of hominids, or whether they have been influenced by post-occupation, natural processes (Schick 1991, 80). The excavation techniques thus provide a more potent data set for making inferences about hominid behaviour and particular conditions of site context (Schick 1991, 94). Schick (1991) has put forward a number of analytical techniques that can be used when excavating and analysing early sites. These techniques are said to provide a higher level of resolution on the diverse formation processes contributing to sites, and may allow the researcher to see more clearly the behavioural implications of Earlier Stone Age archaeological occurrences (Schick 1991, 106). These techniques, which relate directly to how excavation and analysis should be conducted are summarised briefly (Schick 1991, 106):

1. *"Thorough recovery techniques which include fine-mesh screening (5 mm or smaller) and at least periodic wet-sieving with even finer mesh.*

2. *Size distribution analysis of debitage.*

3. *Consideration of the spatial distribution of different size groups, and inspection for other conspicuous spatial patterns, such as gaps in distribution, separation of site components reflecting fluvial disturbance, or site ≫ stretching ≪ in the downcurrent direction.*

4. *Thorough conjoining studies, technological analysis of reconstructed cores, and spatial analysis of conjoining sets.*

5. *Analysis of fine details of the disposition of artifacts, such as orientation, inclination or dip, clustering, and microsedimentology".*

Although Schick determined these techniques based on studies of how fluvial processes influence the archaeological record, they are suitable in the analysis of most other formation processes which may have contributed to the archaeological record (Schick 1986, Morton 1996). This type of precision recording and analysis, including the use of an electronic theodolite, allows the archaeologist to pose new questions about the formation processes of the site and to make macroscopic and micromorphological studies of a sites potential stratigraphy (Tuffreau, Lamotte & Marcy 1997, 228).

Another important point concerning excavation methods has been brought forward by Kroll (1994, 1997). Kroll (1994, 115) believes that excavations need to be large enough to study the variability in vertical and horizontal distributions. Excavations need to be wider and deeper to investigate the variability in the probable widespread distribution of archaeological materials, which will allow systematic comparisons of the different kinds of distribution data (Kroll 1994, 115). The need for such large scale exposures can be seen from the large scale of archaeological distributions themselves, as well as from findings from actualistic studies (Kroll 1994, 115). Kroll (1994, 134) thus makes two important points:

1. Archaeologists must think big. Single-trench small excavations are not informative of probable large scale distributions, and

2. competing interpretations based on incompletely excavated distributions are premature and misleading.

Kroll (1994) believes that large-scale excavations of contiguous trenches and of discontinuous trenches at and away from presumed behavioural sites is imperative to document and understand landscape distributions. It can thus be seen that part of the proposed excavation methodology is that excavations should be of sufficient size. This will hopefully prevent the archaeologist from drawing any dubious conclusions, based on too few lines of evidence from the archaeological record.

Final discussion is needed on the justification of the use of high resolution excavation procedures. These procedures are part of Schick's (1991) proposed excavation and analytical techniques. The question has arisen as to whether archaeologists need new data (Gowlett 1997*a*, 152). Gowlett (1997*a*) believes that new excavation techniques that produce more data, are only a problem when evidence is brought out of the ground mindlessly, as a matter of form, and not part of a research question. The archaeologist should thus, in conjunction with their research question, use high resolution techniques that promote the discovery of relationships. In order to achieve an understanding of behaviour and the past dynamics of assemblages, it is relationships between artefacts and artefacts, and between artefacts and contexts, that provide an archaeologist with understanding and interpretation (Gowlett 1997*a*, 152). Studies that used high resolution techniques have shown that these techniques are able to trace relationships and decision paths that an archaeologist could not have seen had they used simpler recording and analytical techniques (Gowlett 1997*b*). The use of high resolution techniques at the start of an excavation is essential so as to prevent the loss of valuable data. If the technique proves to be too detailed or incorrect for a particular site's context, then it can be changed and another procedure followed. The reverse situation is, however, not possible and valuable data would have already been lost. It is the added information that these techniques provide that makes the discernment of site transformations possible, which as established is essential for research into the Earlier Stone Age (Morton 1996, 303).

The excavation methodology, recording methods and analysis discussed in this report is aimed at achieving the goals and objectives outlined in this chapter. The excavation and analysis discussed here deal with the preliminary results of the research which will assist with decisions regarding future research goals and excavation methodology to be used in subsequent years of work at Hackthorne and other related sites in the area. This preliminary analysis will also provide a model for the formation of the site, awaiting further research to either confirm or reject this interpretation. The next chapter thus focuses on the analysis of the site of Hackthorne, which includes a brief discussion of the exact excavation procedures followed. Preliminary interpretations concerning the context of the site is then investigated in relation to various natural formation processes. The following chapter will thus apply the ideas raised so far.

Chapter 3

Application: Analysis of Hackthorne

The application of the theoretical considerations to the analysis and preliminary interpretation of the Hackthorne site are presented in this chapter. First, a summary on the exact methodology that was followed during the excavation of the site is discussed. This is followed by an analysis of the site in order to better understand and interpret its context. This analysis is aimed at identifying the natural formation processes which may have contributed to the formation of the site. A number of models and contextual data are used in this analysis, considering many lines of evidence, so as to prevent simplistic, narrow interpretations of complex problems. It must be stressed that excavation and analysis is not complete, and as a result any interpretations made must be considered preliminary and tentative. Further research, which has more lines of 'evidence' to draw from, will invariably challenge or dismiss some of the conclusions drawn in this study.

3.1 Excavation Procedure

A summary of the excavation procedure will follow. This is only a brief description of the methodology, which highlights the most important excavation and recording procedures used. Further discussion regarding specific aspects of the excavation procedure are included in the discussion on the analysis of the site.

After determining where excavation was to be conducted (established from the survey), a geological trench (10 m by 0.5 m) running perpendicular to the escarpment was excavated (see Figure 1.2). The aim of this trench, which started approximately 30 m from the escarpment edge, was to gain an initial understanding of the sediments and the associated artefacts. It would allow for the observation of potential stratigraphic units without excessive disturbance to valuable deposits, as well as provide insight into problems that may be encountered during the high resolution excavation. This trench was excavated with shovels and trowels. Resolution of the recording of artefacts varied throughout the trench, with the majority of artefacts given spit (5 cm spits - vertical) and square (1 m by 0.5 m - horizontal) coordinates. This report does not deal with the geological trench, and as such this part of the excavation does not warrant further discussion. However, some data from this tench will be referred to in conjunction with data from the high resolution excavation.

The high resolution excavation was conducted approximately 5 metres to the east of the geological trench (see Figure 1.2). To date, 12 square metres have been excavated. This study deals only with 11 square metres, as the twelfth square suffered collapse in the top 30 cm and is thus not consistent with the rest of the excavation procedure. The procedures followed during this excavation are outlined below.

1. The top 20 cm of the sediment was excavated in 5 cm spits, with artefacts given square provenance. This was done due to the fact that the top 20 cm contained few artefacts, as established from the geological trench.

2. From a depth of 20 cm, excavation proceeded with each square metre excavated in sixteenths in vertical spits of 5 cm.

3. Lithics measuring less than 20 mm were bagged by sixteenth quadrant for each square metre, so that spatial information could be obtained for the small debitage.

4. Lithics of 20 mm and greater were recorded in fine detail. This included: the recording of the position of the artefact using an electronic theodolite (EDM); the recording of the exposed surface of each artefact ie. ventral, dorsal, edge or tip; the recording of the platform orientation, dip orientation, exact degree of dip angle and long axis orientation of the artefact.

5. An excavation form for each square metre spit was also used in the recording. This contained a sketch in plan view and included information on the location of the lithics and calcrete, as well as any other observations (eg. roots, burrows etc.).

6. EDM mapping of the calcrete as it was exposed was conducted after each completed spit.

7. During the excavation all sediment was screened using 2 mm coarse sieves.

This is the basic high resolution recording procedure that was followed during excavation. With an understanding of the excavation procedure, I now turn to the analysis and interpretation of the site.

3.2 Analysis and Interpretation of Hackthorne

Schick (1991) established a number of analytical techniques that should be used when excavating and analysing Earlier Stone Age sites. She advocates these techniques to provide a higher level of resolution on the diverse processes contributing to sites, and to allow the researcher to see more clearly the behavioural implications of Earlier Stone Age archaeological occurrences (Schick 1991, 106). Although Schick's work deals mainly with the effects of fluvial processes on archaeological assemblages, her techniques are suitable in the analysis of most other formation processes which may have contributed to the archaeological record. From her studies, Schick (1986, 1991) also established some other important ideas and models that are useful in the analysis of the integrity and context of a site. As such, a good place to begin in trying to interpret site context is to consider her findings and how they may relate to Hackthorne. After this initial analysis of the site, other processes which may have contributed to the formation of the site are discussed.

3.2.1 Fluvial Processes and Site Integrity

It has long been recognised that flooding and related stream flow phenomena have had an extensive impact on the archaeological record (Shackley 1978, Turnbaugh 1978, Schick 1986, Gladfelter 1988). Archaeologists are likely to misunderstand or misinterpret the evidence available if they do not understand the effects of stream flow dynamics (Turnbaugh 1978). Some early studies into the effects of water on archaeological materials, which recognised that many artefact concentrations were the result of fluviatile processes, brought some crucial ideas to the fore (Shackley 1978). However, many of these ideas were assumptions that needed to be tested. The strength of these early studies was to bring to the attention of archaeologists the behaviour of artefacts as sedimentary particles. Such studies applied to stone artefacts were subsequently conducted by Schick (1986), drawing on many of the ideas raised by previous researchers (eg. Shackley 1978).

In Schick's (1986) work she first considered a very basic aspect of site formation processes, ie., the relationship between the stone-tool manufacture and the types of tools that should be expected in the archaeological record at sites where stone-flaking was actually done. In other words, she characterised the salient features of complete sets of stone flaking products (Schick 1997, 244). She conducted these experiments in order to see if regular, predictable patterns would emerge that could be usefully applied in site analysis and interpretation. Deviation from patterns characteristic of knapping at a lithic accumulation would necessitate explanation (Schick 1997, 244). Such alternative explanations that then could be considered included (Schick 1997, 244-245):

- *"Importation of pre-manufactured artefacts to the site.*

- *Large-scale exportation of manufactured products away from the site.*
- *Post-occupation disturbance of the site, producing selective removal and dislocation of some of the full set of components (e.g. through the action of flowing water, trampling, bioturbation, etc.)."*

These initial studies are extremely useful in the interpretation of the context of a site, and as a result similar studies have subsequently been conducted by other researchers (Morton 1996). Discussion follows on how these findings can be applied to Hackthorne and thus provide some interpretation relating to the integrity of the site.

3.2.1.1 Debitage Size Distribution

Schick (1986) determined that a good way of detecting site modification processes was to look at the size frequency of the fractured stones that were recovered from a site and to compare that with the size frequency of original knapping locations. This was done because stone-flaking experiments produced flake and chip populations with predictable size frequency distribution patterns that were determined by the physics and engineering of stone fracture (Schick 1986). The experiments indicated that stone tool manufacture produces debitage with a very regular size distribution, with only minor variations according to the core type produced and raw material used (Schick 1991, 80). It was determined that extensive flaking of a few cores at a site produces large proportions of small flakes and flake fragments (Schick 1991, 80). Proportions of small debitage (greater than 5 mm but less than 20 mm) ranged from about 60 to 75% among most experiments (Schick 1997, 246). If a debitage size distribution is dominated by small fragments, it can suggest on-site tool manufacture, but as discussed below it is never this simple. Schick (1991, 89) believes that if size distributions differ from those produced by tool manufacture (eg. an assemblage dominated by larger material), then other possible interpretations must be explored. These include: the site represents a place where already manufactured lithics were brought in by hominids; the site has suffered fluvial winnowing which has removed much of its material, particulary small debitage; the site is made up of materials redeposited through fluvial forces from one or more locations upstream. With this initial understanding of how debitage size distribution can be used to aid in the interpretation of the context of the site, further discussion is needed on the strengths and weaknesses of this analysis.

First, a great deal of attention must be given to high resolution excavation procedures before researchers can rely upon size frequency distributions (Morton 1996, 131-134). Archaeologists must use procedures which ensure the recovery of most of the small debitage (ie., all debitage in the range from 5 mm to 20 mm). If such an excavation procedure has not been followed the archaeologist cannot rely on frequency distributions. In conjunction with the above, apart from rigorous screening of the site sediments, archaeologists should include wet-screen sieving in their excavation procedure. It is useful to subject selected square or spits to wet screening with a very fine mesh (0.5-1 mm) (Schick 1991, 89). Large quantities of debitage in this size range are said to give a good indication of a very low degree of site disturbance during burial (Schick 1991, 89). The absence of this debitage is ambiguous as it may have been winnowed from the site or even chemically dissolved. However, its presence can potentially provide evidence of areas where on-site knapping took place (Schick 1991, 89). Excavation procedures must be at a suitable level before drawing conclusions from size distributions.

Secondly, if size distribution analysis suggests on-site knapping, conjoining studies must be used to corroborate this (Schick 1991, Morton 1996, Isaac, Harris, Kaufulu & Schick 1997). This is essential because if size distribution analysis suggests tool manufacture but very little material conjoins together, then two major hypotheses should be considered (Schick 1991, 93). These include: large scale hominid export of manufacturing products; or a deposit of materials fluvially transported from somewhere upstream (Schick 1991, 93). The presence of small debitage does not necessarily imply an undisturbed site; this supposition needs to be corroborated by conjoining studies and spatial analysis.

A third point which should be made about size distribution analysis is that a number of analytical techniques should be used to gain a full understanding of the distribution. In Schick's (1986) work, her measure of size is the maximum dimension (length) of the artefact. However, other analyses can also be conducted and are also extremely useful in trying to interpret to context of a site. These include 'mean weight' and 'weight distribution' analysis (Petraglia & Potts 1994, 241-242). This is similar to the analysis of the maximum length of the artefact, with an assemblage that contained on-site knapping expected to have a relatively low 'mean weight', and a high percentage of artefacts weighing less than 50 grams. A further analysis is to determine the core to debitage ratio (Petraglia & Potts 1994, Morton 1996). Such an analysis checks whether the number of cores and waste flakes correspond technologically (Morton 1996, 210). Core production requires the manufacture of many flakes and a predicted ratio for an archaeological site where knapping has occurred would be low numbers of cores and high numbers of flakes (Morton 1996, 211). For a better understanding of size distribution, and thus the context of the site, the above analytical techniques are extremely useful.

I now turn to the analysis of the size distribution from the site of Hackthorne and to what this may indicate about the integrity of the site. The frequency distribution of debitage from Hackthorne and from biface replication experiments has been plotted in Figure 3.1. The assemblage from Hackthorne contains less artefacts in the 0 to 1 cm range, an elevated number in the 1 to 4 cm range, and less large artefacts than those from the replication experiments. Artefact size frequencies give an indication of winnowing at an archaeological occurrence, since the smallest artefacts are the most transportable and are thus the first

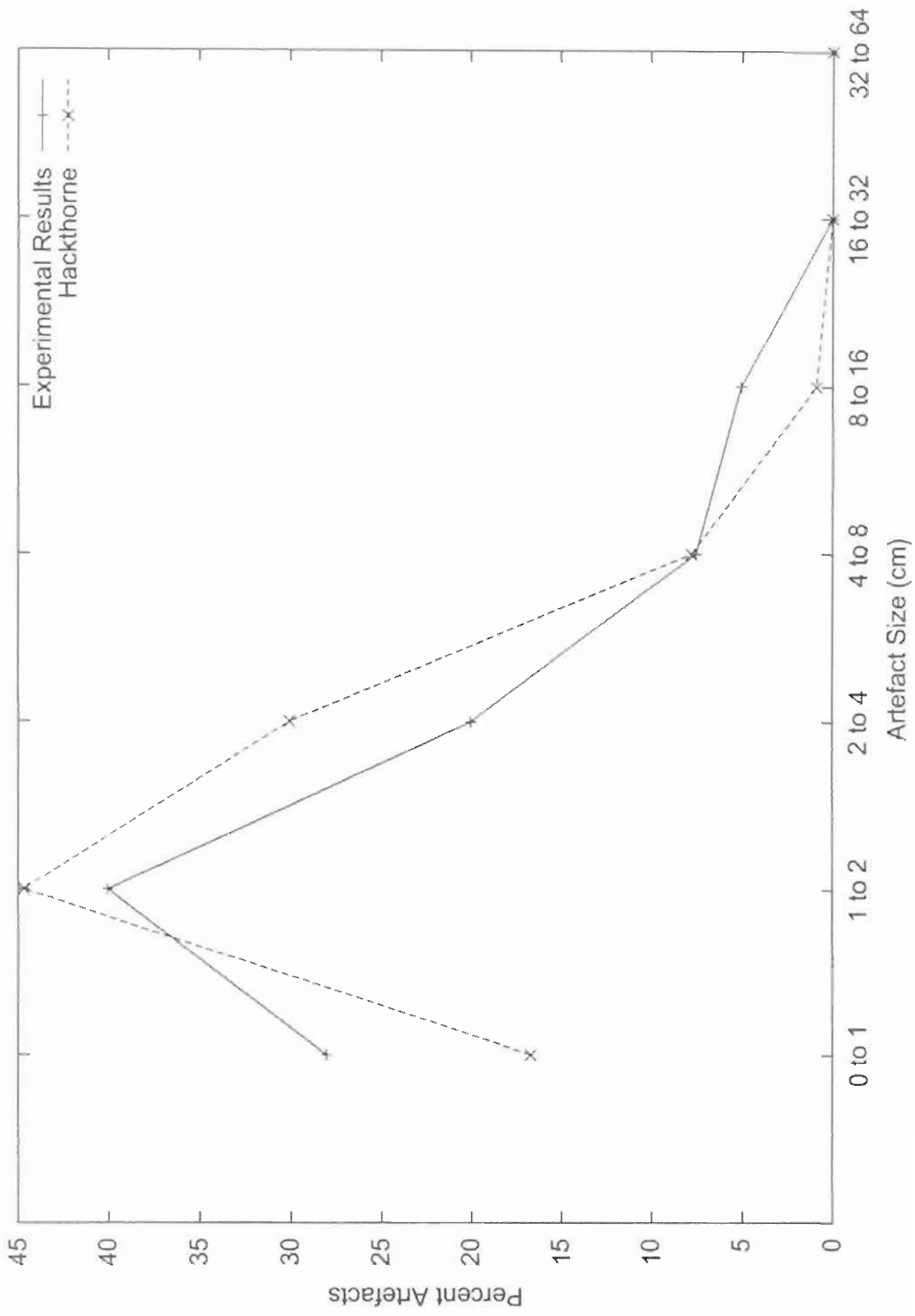

Figure 3.1: Frequency distribution of debitage from Hackthorne (N=799) and from biface replication experiments (N=5931) from Schick (1992).

to be removed from a site by fluviatile processes (Schick 1986, Morton 1996). However, despite the removal of half of the flakes from experimental plots conducted during actualistic research, flake percentages and heavy cobble and core percentages were raised only slightly (Petraglia & Potts 1994, 231). Core and biface categories may only increase by 5 to 10 % (Petraglia & Potts 1994, 231). In interpreting the size distribution at Hackthorne in relation to the effect of fluvial processes, Figure 3.1 indicates that the site may have lost a percentage of the smallest debitage, which would result in the increase noted in the 1 to 4 cm category. The fact that only the smallest material has been removed, indicates that the site may have suffered minimal winnowing. An interesting point to be noted is that there are fewer larger artefacts than expected at Hackthorne, with this finding still unexplained.

In drawing any conclusive interpretation for Hackthorne based on size distribution a number of limitations need to be noted:

1. The site has not been dug to calcrete throughout the excavation area, and thus a great deal more material is still to be uncovered, which may have a bearing on the size distribution.
2. Only artefact size, in terms of maximum length, has been analysed, with further analyses needed.
3. Conjoining studies have yet to be conducted.
4. Wet screening has not been conducted.
5. The affect of fluviatile processes on the site at its time of formation is yet to be determined by sediment studies.

It is thus evident that one must be careful in drawing any firm conclusions about the integrity of the site based on size distribution. Further analysis relating to the above points could, however, prove to be fruitful. The most that one can say at this stage is that the site 'appears' to resemble a location where knapping may have occurred; however, some of the small debitage appears to be lost from the assemblage. This is not a firm statement with further analysis needed. As a matter of interest, Hackthorne can be compared to an Acheulean factory site near Taung. The factory site contains 69% small flaking debris under 20 mm, while Hackthorne contains 61% small flaking debris under 20 mm (Kuman 2001*a*). This factory site has been said to meet the criteria of a site with good integrity and context (Kuman 2001*a*). Many more lines of evidence, however, need to be considered for the complex Hackthorne before any such statements could be drawn. It has been established that the integrity of Hackthorne cannot be determined alone from an analysis of the size distribution.

3.2.1.2 Artefact Scatter Patterns

The study of flake scatter patterns was a second analysis that Schick (1986) conducted in order to recognise residues that are characteristic of places where stone-flaking was done. The potential of these studies has subsequently been recognised by other researchers (Morton 1996, 106-117). Schick (1997, 247) discovered that one could discriminate between various postures used by a knapper, concluding that the area occupied by the most items from a single stationary flaking bout was between 50 and 120 cm. Core on the ground knapping produced distinctively tight clusters. An analysis of Hackthorne to discern if any knapping episodes took place at the site is as yet not possible. Conjoining studies must be attempted to see if any cores can be reconstructed at the site, as well as a study of the spatial analysis of the components of the conjoined core (Schick 1991). Such studies may provide positive proof of on-site tool manufacturing activities, show the locations of knapping activities, suggest transport of material within the site, or indicate whether the site has suffered post occupational disturbance (Schick 1991, 80-81). Excavation also needs to be expanded before any firm interpretations can be drawn. Future analysis will hopefully clarify issues relating to on-site knapping.

Conjoining of flaked material can also give invaluable evidence of hominid transport behaviours within site boundaries, as well as indicate transport behaviours above and beyond those evident within a site area (Schick 1991). A thorough attempt at conjoining can reveal 'invisible' or 'phantom' artefacts (artefacts not present within the defined site boundaries but nevertheless indicated by the lithic materials found at the site) (Schick 1991, 82). These missing artefacts can indicate hominid transport of stone material either to or from the site (Schick 1991, 82). Crucial further analysis of the site must therefore be concerned with conjoining studies. With an understanding of the relationship between the process of stone-tool manufacture and the physical properties that are liable to remain in the archaeological record, one can then investigate how fluvial processes may have altered site patterns before and during burial of archaeological debris.

3.2.1.3 Changes in Spatial Configuration

In most instances artefacts at a site that are subsequently affected by fluvial processes will result in material being transported in the direction of hydraulic flow (Schick 1986, 1991). In sites which have suffered only low to moderate fluvial disturbance, some materials generally stay in the original site vicinity while some proportion of the site, generally the smaller flakes, are moved some distance downstream (Schick 1986, 1991). If the transported materials are re-deposited close to the original site, the site may suffer severe changes in its original spatial distribution, with or without any real 'loss' of material (Schick 1991, 83). As such, conjoining studies are useful in that any linear trends among conjoining pieces could be helpful as an indication of fluvial dispersal of materials which had originally been more tightly concentrated.

A series of patterns can be observed in fluvially disturbed sites due to the different transport potential among artefacts (Schick 1986, 1991). Patterns observed due to moderate to high velocity flows include (Schick 1991, 85):

1. A loss of a large amount of artefacts in an assemblage, with larger proportional losses of smaller material, particularly small debitage under 20 mm in size.

2. If much site material has been deposited downstream from the original site, smaller debitage tends to travel further downstream while cores and larger flakes tend to end up closer to the original site.

3. Despite the tendency for smaller artefacts to travel further than larger artefacts, some small debitage may still remain in the upstream position of the site (Paddayya & Petraglia 1993).

Patterns observed due to low to moderate flows include (Schick 1991, 85-87):

1. The retention of some lithic materials within the original site area, particularly large flakes and cores but also some proportion of minute debitage if large quantities were originally present.

2. In many instances a 'gap' or area just down stream from the original site containing very little lithic debris may form.

3. In an area downstream from a site where artefacts are beginning to be deposited, the larger artefacts will tend to be deposited first and the smaller ones later.

In general, smaller debitage tends to be transported in large proportions and greater distances than larger flakes, cores and hammerstones (Schick 1986, 1991). It must be noted, however, that even quite large cores (up to 500 gm) are more readily transported than large flakes of equivalent or even lesser weight. Their bulk presents more resistance to turbulent flow and their more spherical shape tends to make them more mobile (Schick 1986, 1991). Occasionally, redeposited artefact assemblages may have size frequency distribution characteristics that are not too different from those of an undisturbed set (Schick 1986).

Schick (1986) also established that in certain circumstances artefacts can be expected to reconcentrate in significant quantities some distance downstream from their point of origin. These artefact reconcentrations occurred in places where flow velocity dropped suddenly locally, such as around an obstruction, like a tree or other large object. Mixing of materials from upstream sites can thus occur. Relating to the pattern observed above, one can also identify localised clusters of artefacts, which form with pieces in contact or close proximity to one another (Schick 1986, 1997). These clusters may be accompanied by depressions or scour pockets. These clusters form when smaller flakes get caught up in the vicinity of such clusters or around or underneath larger artefacts. The presence of such clusters indicates that the small flakes have escaped fluvial transport by high velocity currents due to their proximity to larger artefacts

(Schick 1986, 1991).

Changes in specific spatial configurations created by fluvial processes can also be associated with the redistribution of site materials, resulting in (Schick 1991, 84):

1. a reduction in artefact density,
2. changes in spatial relationships among artefacts,
3. enlargement of the overall areal extent of the site, and
4. changes in the overall site shape, usually in an elongation in the downstream direction.

The effect of winnowing is important first because it is one of the most sensitive ways of detecting hydraulic disturbance, and secondly, it distorts assemblage composition (Schick 1997, 255). This is crucial because assemblage composition is one of the main lines of evidence used by archaeologists in reconstructing prehistory, and thus it is important to be able to recognise bias and distortion (Schick 1997, 255). Archaeologists must also be aware when conducting an excavation, because many of the patterns mentioned above are of such a scale that excavation trenches may be too limited to detect them. This may result in the archaeologist only recovering a selective portion of the original site components, without realising that an important part of the site, valuable for evaluating site context, may be located a short distance away (Schick 1991, 1997).

I now turn to an analysis of Hackthorne to determine if any of the patterns relating to changes in spatial configuration from fluvial processes can be identified. At this time no statements can be made concerning evidence for the identification of site stretching. In conjunction with the excavation being too limited, uncertainty over the direction of water flow prevents any conclusions from being drawn. Future work aimed at decerning if any fluvial patterns are present, would include excavating a series of trenches along the escarpment or greatly expanding excavation.

A comparison will now be made between patterns observed due to different transport potentials among artefacts in fluvially disturbed sites. As established from the size distribution analysis, the site has not lost large proportions of the small material, but it does appear to be missing some of the smallest pieces. However, one must note the limitations of this analysis before drawing inferences from it (Figure 3.1). We cannot yet recognise the diagnostic pattern found by Schick (1986), in which a 'gap' or area just down stream from the original site containing very little lithic debris may form, due to the fact that excavation is too limited and needs to be widened. Similarly, an analysis cannot as yet to be done to determine whether there is a pattern where small debitage has travelled further downstream than cores or large flakes, or if the pattern

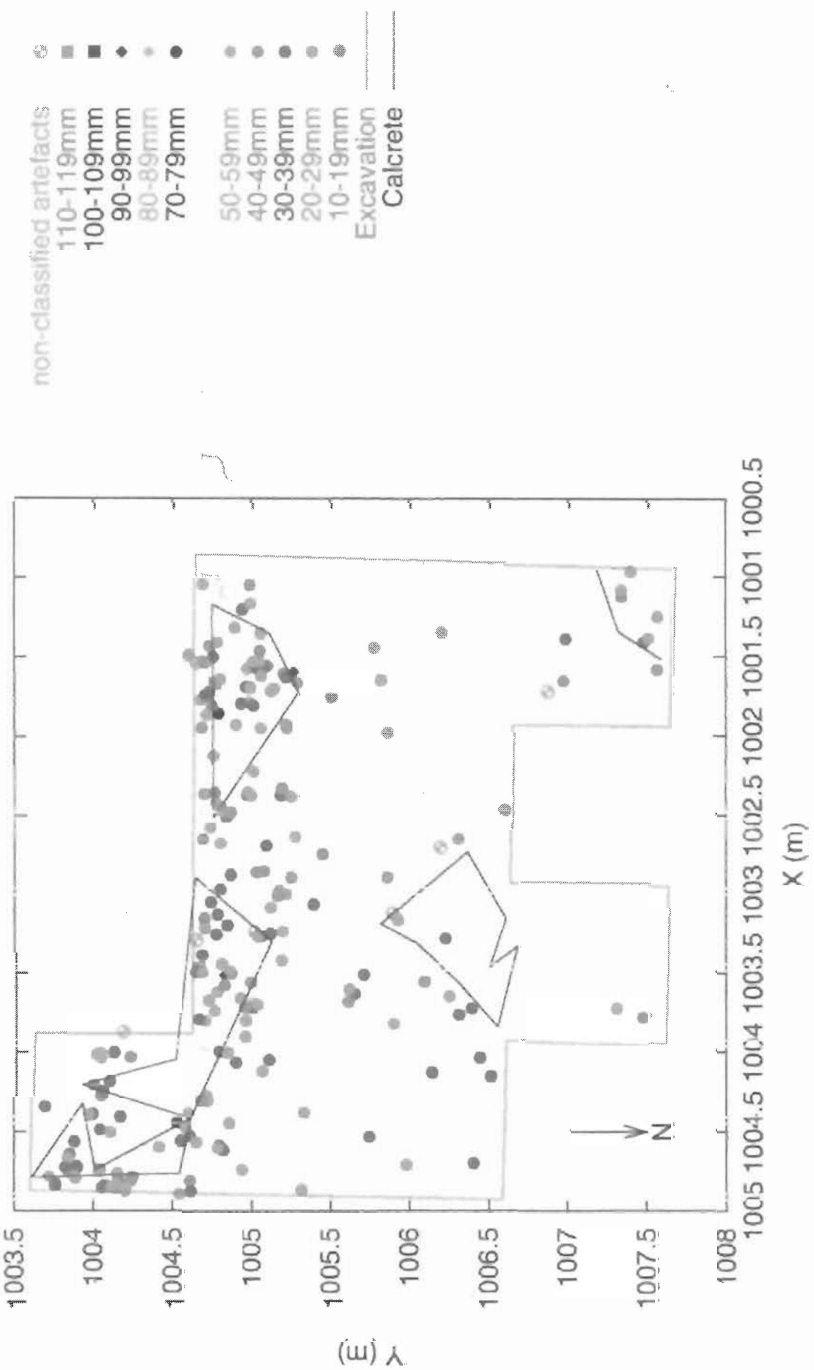

Figure 3.2: Plan view of point plotted artefacts $\geq$ 20mm (N=236) and calcrete features. Artefact size is indicated by colour. Non-classified artefacts are those that are missing from the collection and thus no data concerning size could be obtained.

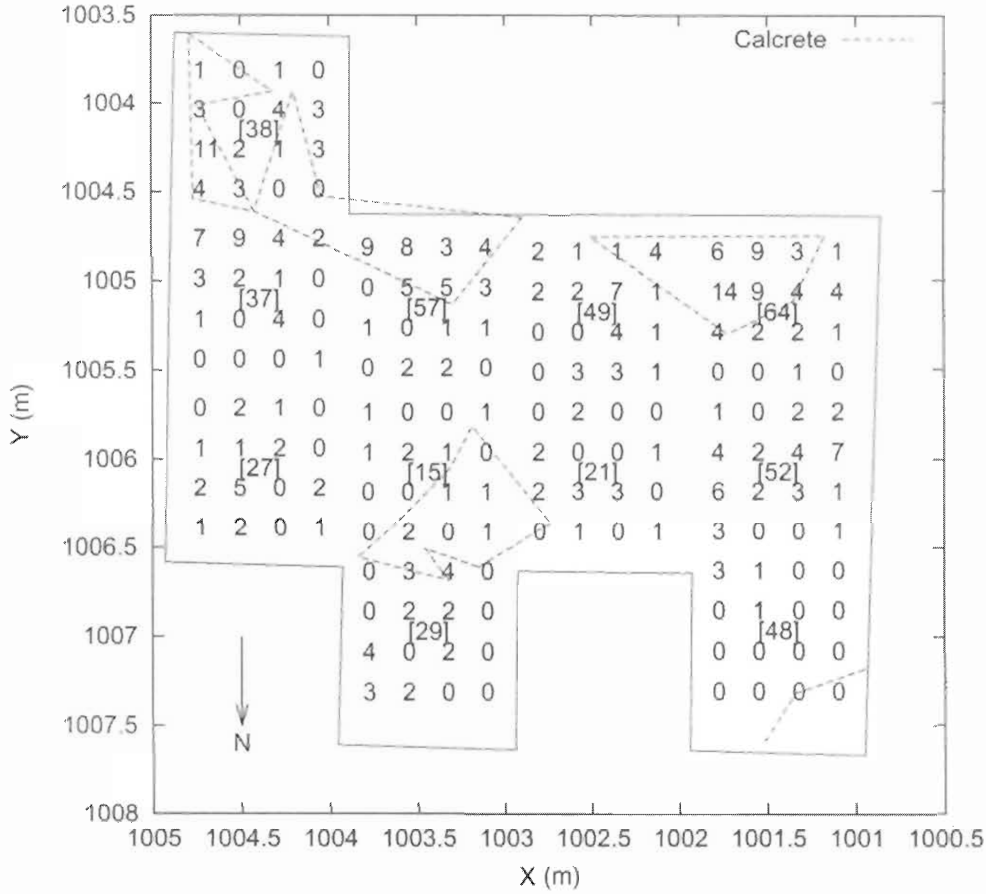

Figure 3.3: Distribution of non-point plotted artefacts (< 20mm) from 20 to 40 cm below the surface, in squares divided into sixteenths, with the number of artefacts indicated for each sixteenth. Figures in brackets indicate the number of non-point plotted artefacts for each square metre, recorded from the surface to a depth of 40 cm.

that large cores are more readily transported than large flakes of equivalent or even lesser weight can be seen. It must be noted that such analyses at the moment suffer from the same problems outlined above and thus wider excavation and analysis is needed.

Figures 3.2 to 3.4 do show patterns of artefact reconcentration or clustering that may possibly have been induced by fluvial processes. However, the clusters are associated more with the calcrete, than the clustering of smaller flakes around large artefacts or objects, with no significant clusters occurring away from the calcrete. The possibility must be considered that the artefacts became clustered or reconcentrated around the calcrete exposures, as a result of fluvial processes, at a time when the calcrete may have been exposed at the surface. However, artefacts may also have become clustered by the action of tree roots dissolving the calcrete (Kuman 2002). It is thus seen that much is still to be determined. Further discussion regarding whether the site has been influenced

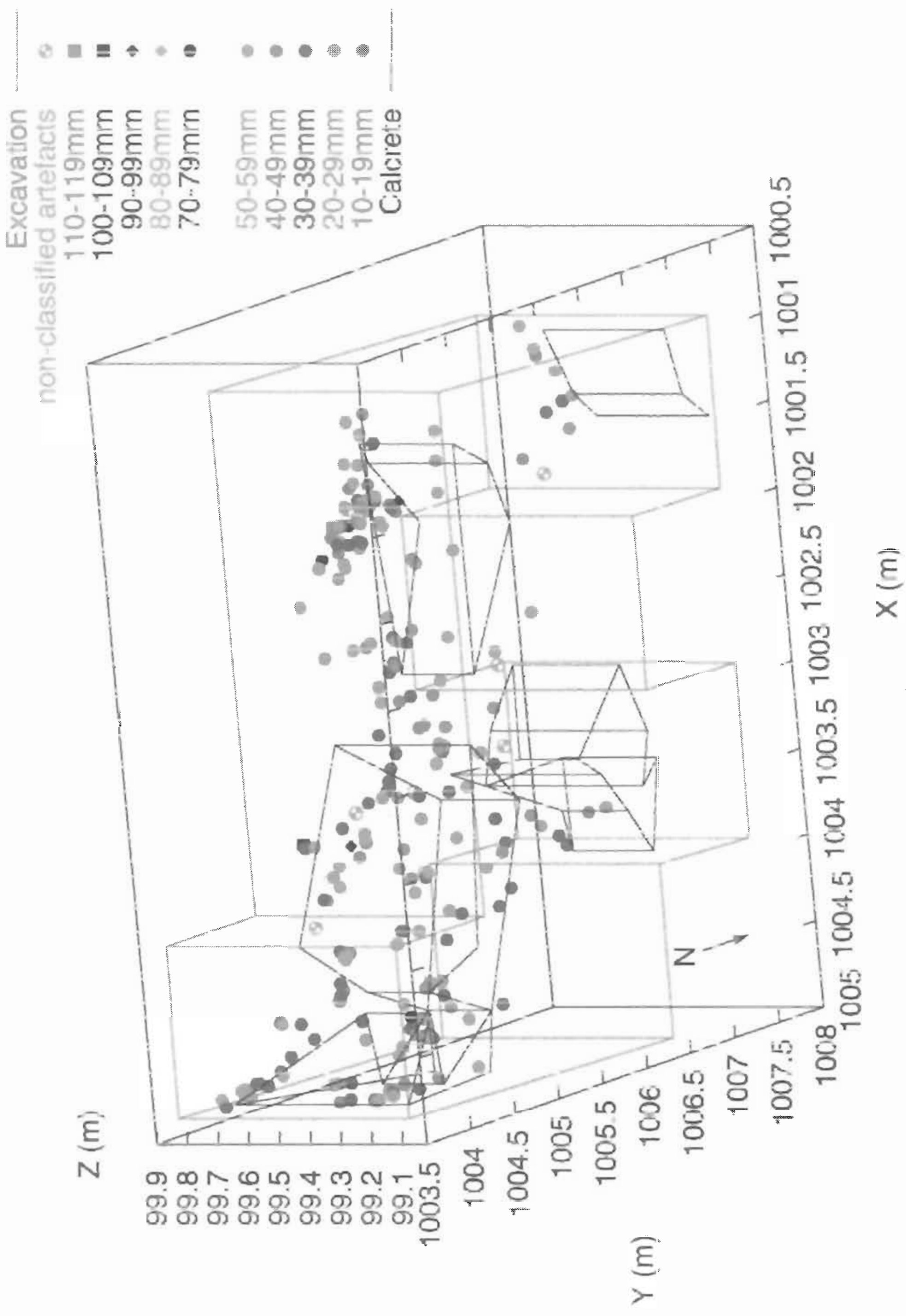

Figure 3.4: Position of point plotted artefacts ≥ 20mm (N=236) and calcrete features. Artefact size is indicated by colour.

by water follows after discussions on the dip and orientation of the artefacts.

3.2.1.4 Artefact Dip

An analysis of the dip of the base of an artefact can indicate the degree of fluvial disturbance at a site (Schiffer 1983, Schick 1986). If dips are pronounced, this analysis can suggest that artefactual material may have been lost from a site, or spatial relationships might have been disrupted, as well as suggest the general vector of fluvial disturbance (Schick 1986). Schick's (1986) studies have demonstrated that large particles which have laid in moving water for some time without substantial downstream movement tend to develop a pronounced upstream dip, with this occurring at subcritical erosion velocities. A stone artefact will dip when the flow has sufficient velocity and duration to erode or scour out the substrate underneath the upstream end of the artefact. It must be noted, however, that this can occur after the artefact has been transported some distance by water and has come to rest at a downstream location. Such upstream dip is produced more readily on a sandy substrate than on fine silts and clays, which are more cohesive and relatively more resistent to erosion. Schick (1986) also found that in general, steeper dip is produced by higher flow velocities and among larger, thicker particles.

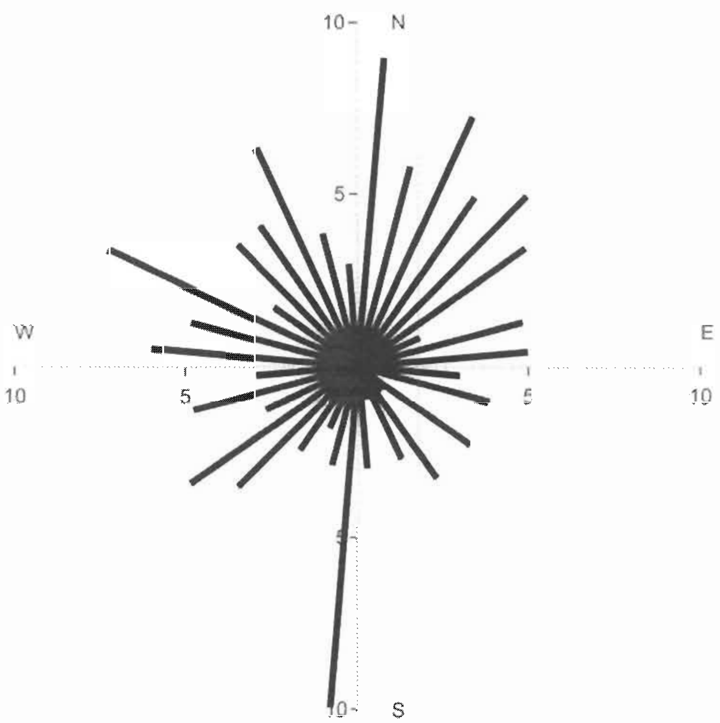

Figure 3.5: Dip Orientation - length of the line corresponds to the number of artefacts (N=163).

An analysis of artefact dip across an excavated area can thus reveal evidence of site reworking by flowing water. If it is found that artefacts tend to be inclined in a consistent direction locally within a site, the direction of flow can be inferred to have been generally opposite to the direction of dip (Schick 1986). This allows predictions to be made concerning the vector of site disturbance and the direction in which site components may have been transported (Schick 1986). The degree of dip can also be informative in that steeper angles can indicate higher velocity flow across a site, while shallow angles suggest lower velocity currents (Schick 1986).

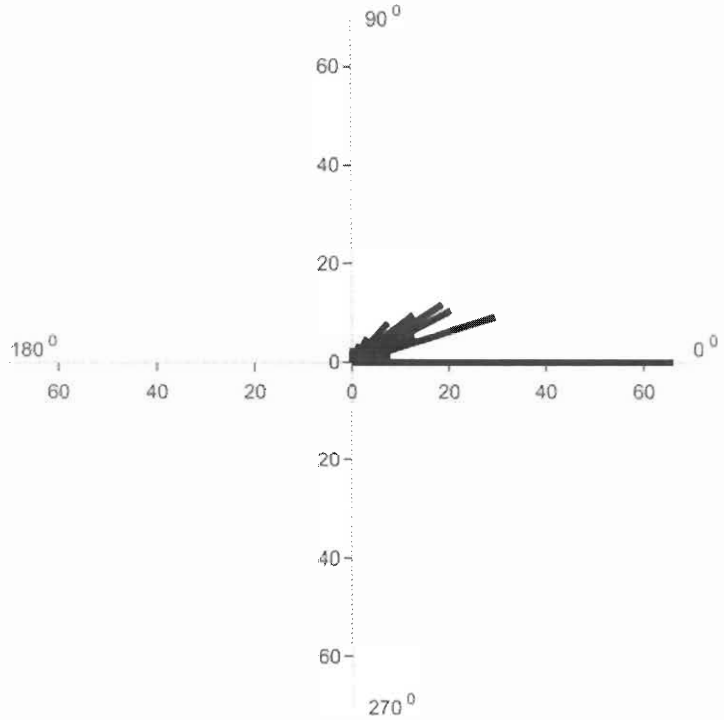

Figure 3.6: Dip Angle - length of the line corresponds to the number of artefacts (N=162).

An analysis of the dip of artefacts from Hackthorne is shown in Figures 3.5 and 3.6. Figure 3.5 demonstrates that there is no dominant direction in which artefacts dip. It was observed during excavation that a large proportion of artefacts recovered were associated with the calcrete and tended to dip with the slope of the calcrete feature with which they were associated. The calcrete exposed is a highly eroded surface which occurs at varying heights and has no characteristic shape or form (such as a large flat surface dipping in a certain direction), and thus artefacts resting upon, or near it, dip in all orientations. The dip angle (Figure 3.6) is thus also probably the result of the complex nature of the calcrete. It must be noted that a large proportion of artefacts do also lie flat. During excavation it was not noted which specific artefacts lay on the calcrete and which were engulfed in sediments. Future excavation should take note of this, so that an analysis can be conducted of pieces engulfed by sediments. This will allow for stronger conclusions to be drawn regarding whether or not water has had an affect on the site, as seen from the dip of artefacts. It can be concluded, however, that the dip of a large proportion of the artefacts is a direct result of the artefacts resting on the complex forms of calcrete. However, other factors such as bioturbation and wetting and drying (discussed later) could also have influenced artefact dip.

3.2.1.5 Artefact Orientation

Fluvial processes, particularly flow with a strong linear pattern, result in characteristic long axis orientation patterns for elongated artefacts (Schiffer 1983, Schick 1986). Artefacts tend to orientate either generally parallel or perpendicular to the flow vector, and thus analysis of the long axis orientation of artefacts can indicate whether water has affected a site or not (Schick 1986). It has also been established that in addition to documenting fluvial action, orientation analysis can give a rough indication of the velocity of the fluvial currents involved in site formation (Schick 1986).

It has been found that particles tend to develop different orientation patterns as a function of the size or mass relative to the flow velocities which have acted upon them (Schick 1986). At a given flow velocity, smaller particles tend to orientate more parallel to the flow, while larger ones tend to orientate perpendicular to flow in greater proportion. This differentiation can thus be used as an indication of the direction of flow which has affected the site. In addition, inspection of orientation patterns according to artefact size can be used as a rough estimate of the magnitude of the fluvial forces which have operated on the site, because with increasing velocities, increasingly large artefacts can be brought into the parallel-to-flow direction (Schick 1986). If large artefacts have orientated parallel to the flow, then relatively high velocity currents have swept over the site, while if a good proportion of small artefacts orientate perpendicular to the flow, this can suggest that relatively low velocity currents have affected the site. Often the trajectory of water flow can change across a site, particulary in a site with a very large area, and it can thus be useful to break the site down into smaller units when conducting such an analysis (Schick 1986).

An analysis was conducted on the long axis orientation of the artefacts (Figures 3.7 to 3.12). This included an analysis which took into account the size of the artefacts. The sample was of sufficient size (greater than 72 pieces) to display any orientation patterns, with an analysis containing less that this number believed by Lyman (1994) to be unrepresentative of the action of water. No discernable patterns could, however, be identified which would relate to fluvial processes (Figures 3.7 and 3.8). Artefacts seem to be orientated randomly with no significant dominant orientation. An analysis which considered the size of the artefacts (Figures 3.9 to 3.12) proved to be no more fruitful in respect to identifying discernable patterns. Both the orientation of artefacts less than,

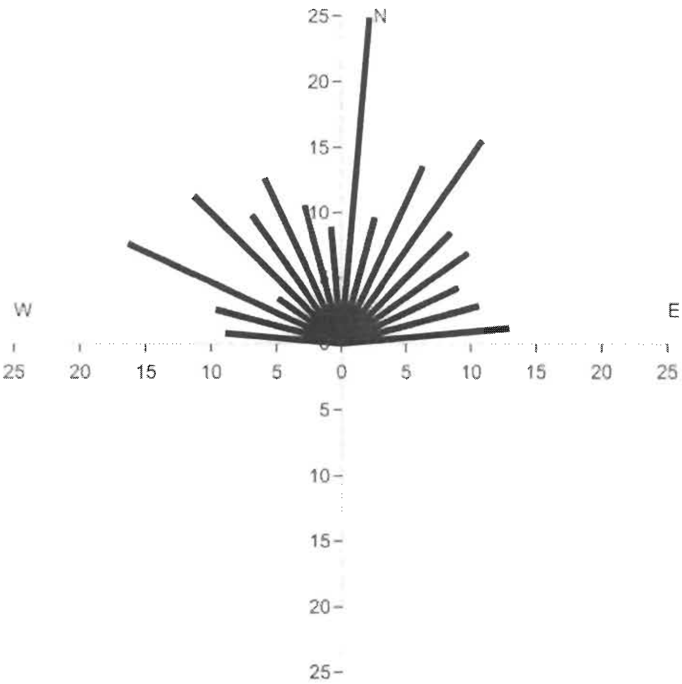

Figure 3.7: Long Axis Orientation of all the Artefacts - length of the line corresponds to the number of artefacts (N=232).

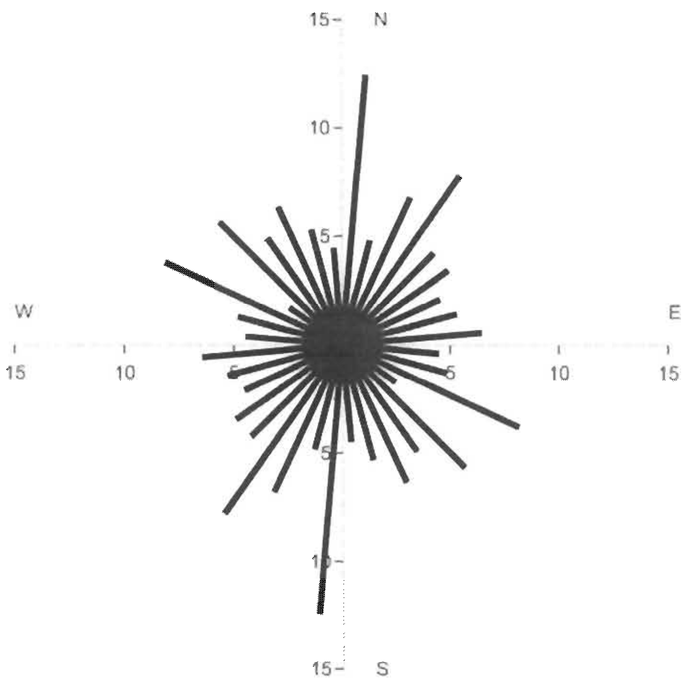

Figure 3.8: Long Axis Orientation of all the Artefacts - mirror-image diagram - length of the line corresponds to the number of artefacts (N=232).

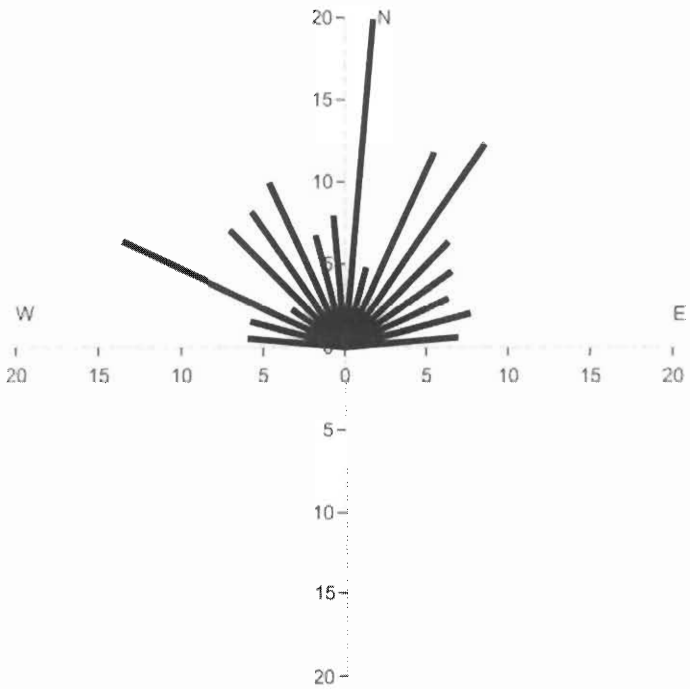

Figure 3.9: Long Axis Orientation of Artefacts < 40mm - length of the line corresponds to the number of artefacts (N=169).

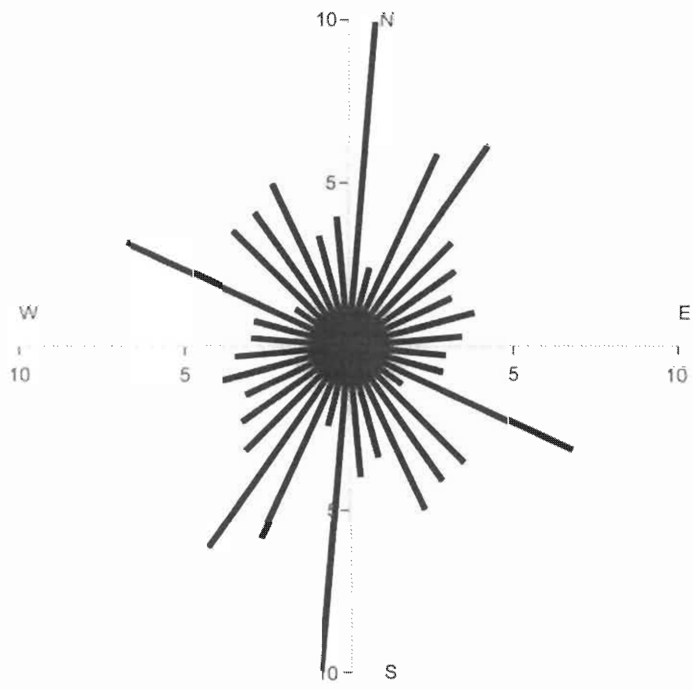

Figure 3.10: Long Axis Orientation of Artefacts < 40mm - mirror-image diagram - length of the line corresponds to the number of artefacts (N=169).

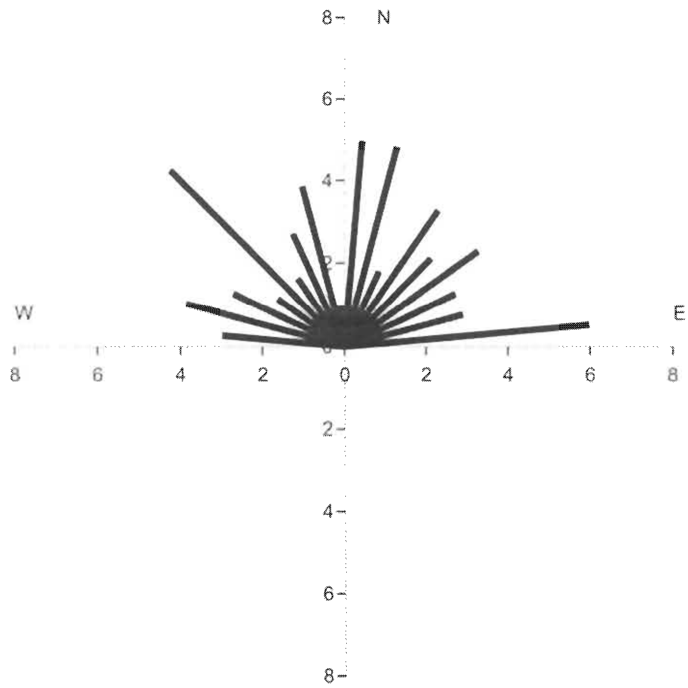

Figure 3.11: Long Axis Orientation of Artefacts > 40mm - length of the line corresponds to the number of artefacts (N=63).

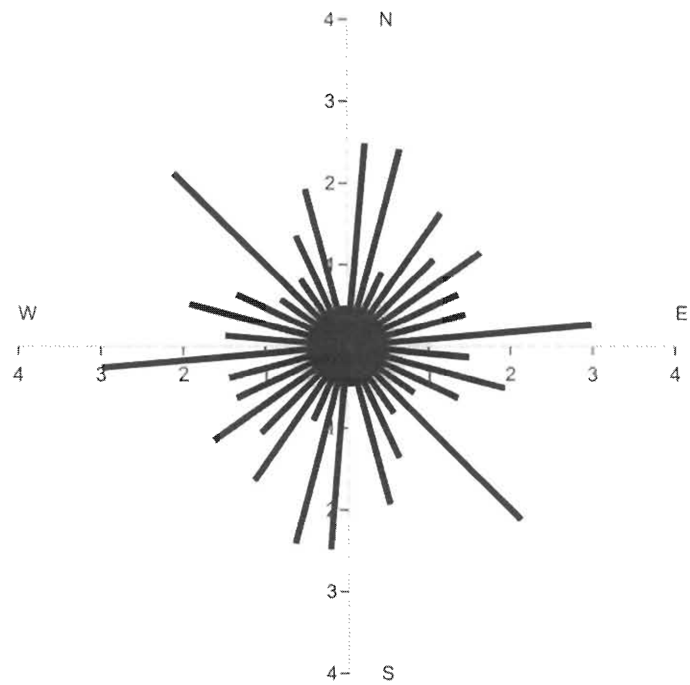

Figure 3.12: Long Axis Orientation of Artefacts > 40mm - mirror-image diagram - length of the line corresponds to the number of artefacts (N=63).

and greater than, 40 mm appear to be random. The influence of fluvial processes, as identified by artefact orientation, can thus not be established. The excavated area is as yet not large enough to determine if the results of the analysis could be due to a change in the trajectory of water flow across a site. Future excavation should take note of which artefacts are resting on the calcrete, or engulfed in sediments, as this may reveal patterns produced by fluvial processes. The calcrete could thus also have had an influence on the orientation of the artefacts, just as it appears to have influenced the dip of the artefacts. From the evidence currently available no conclusive statements can be made regarding the influence of fluvial processes based upon the orientation of the artefacts.

3.2.1.6 Depositional Environment

It is clear that the original spatial arrangements and composition of archaeological assemblages are more likely to be modified in high energy contexts or environments (Schick 1986, Petraglia & Potts 1994). Studies have shown that coarse grain sediments signal higher energy environments where site modification was likely, while silt and clay size deposits signal low energy environments, where preservation of original spatial patterns and retention of the material of assemblages are most favoured (Petraglia & Potts 1994). However, despite this relationship, findings have also shown that sites within any particular depositional environment exhibit variable degrees of modification, as a result of factors such as the time between site abandonment and burial, the characteristics of the terrain, and the energy of other post depositional processes (Petraglia & Potts 1994). Experimental observations indicate that the amount of artefact movement is better correlated with the length of time assemblages were exposed on the ground surface than with sediment type or geographic context. It has been noted that sedimentological analysis is necessary for an understanding of the formation processes, but is often insufficient criteria for inferring the nature of site disturbance during the process of sedimentation (Schick 1986, Morton 1996). Sedimentological analysis is currently being carried out by Mr. LeBaron (A Geo-archaeologist with the School of Geography, Archaeology and Environmental Studies, University of the Witwatersrand). This analysis will hopefully shed more light on the processes which may have contributed to the formation of the site, and as discussed later is critical for determining whether water has had an influence on the site.

3.2.1.7 Fluvial Processes Conclusion

In determining the effect that fluvial processes may have had on the archaeological record, it must be noted that Schick (1986) found that preferred orientation, dip, winnowing and position of rest of the artefacts to be the most sensitive indicators that an assemblage has been subject to the passage of water. From this initial analysis of Hackthorne nothing conclusive can be said about the size distribution, and the site may or may not have suffered a loss of small debitage as a result of fluvial processes. No conclusive statements can be made either about any spatial arrangements that are the result of fluvial processes, due to the small area excavated. Artefact dip and orientation are no more informative as to whether fluvial processes may have acted upon the site. One cannot exclude that fluvial processes may have contributed to the formation of the site, however, the effect of these processes is as yet not discernable in the archaeological record. Further excavation and analysis may, however, provide evidence that the site has been subject to the passage of water. Other formation processes thus need to be considered in order to achieve a greater understanding of the site in terms of its integrity and context.

3.2.2 Lacustrine Processes

Considering the geographical setting and known geomorphological history of the site, situated on an ancient terrace of the Limpopo River, one may wish to exclude the use of the lacustrine model from the analysis of the formation processes which may have contributed to the site. However, as research is still in its preliminary stages it is relevant to consider this model as such an analysis may reveal other contextual data, which may be crucial for a fuller understanding of the site. The most visible archaeological indicators concerning the effect of lacustrine processes are considered.

Morton (1996) conducted actualistic research into lacustrine processes and site formation. His findings are summarised below. Artefact orientation is a strong indication of this type of site formation. Elongate artefacts tend to orientate parallel with the lake margins, with smaller artefacts orientating with the flow more readily than larger artefacts. Flatter artefacts tend to be more transportable than angular ones, both downshore and downslope. This relative transportability is opposite to the pattern observed in fluvial settings. Morton also found that substantial accumulations of artefacts can form at lake margin obstructions, where most accumulations were made up of only the most transportable artefacts (weight categories of 0 to 10 grams). Larger, less transportable artefacts were incorporated into such an assemblage if they became exposed to the wave action by a shift in sediments, and were subsequently washed in the downshore direction. Particle interaction is also seen to have a role in artefact sedimentation, resulting in the formation of clusters similar to those found in fluvial settings. Site elongation occurs around lake margins as transportable smaller artefacts are dispersed downshore and become buried.

About half of all artefacts may be removed from a site by either being washed away completely, or becoming deeply buried in the continuously worked sediment (up to 20 cm in sediment) by lacustrine processes. It is thus seen that lake margin processes can result in a size skewed data set which will profoundly affect archaeological inferences. The vertical distribution of artefacts influenced by lacustrine processes results in the smaller sizes of artefacts tending to become more deeply buried than larger ones. The analysis of spatial configurations of simulated archaeological assemblages has revealed that lake margin processes produce linear arrangements of artefacts along the shoreline. A final point of note is that artefacts are more readily transported in an oscillating (lake margin) versus a linear flow (fluvial) environment. This indicates that profound site disturbance can occur in quiet water situations. The above indicators of lacustrine processes will be considered in relation to Hackthorne.

As established in the analysis of fluvial processes no distinct patterns could be identified concerning the orientation of artefacts (see Figures 3.7 to 3.12). Similarly, further analysis and excavation is needed before any conclusions can be drawn regarding the transportability of artefacts with regard to their shape. No conclusive interpretation regarding accumulations, clusters or site elongation can be drawn with respect to the effect of lacustrine processes, with larger excavation and further analysis required. However, none of these indicators appears to be present at this stage of the study.

Lacustrine processes are similar to fluvial processes in that many artefacts can be removed from an assemblage, starting with the smallest pieces. This will invariably lead to a size skewed assemblage. Smaller artefacts would thus be expected to be located further downshore from the original assemblage. Such a pattern cannot be observed at this stage of excavation. Figure 3.1 does indicate an assemblage which is similar in size composition to an original knapping location. However, the already established precautions of using this analysis must be considered.

A characteristic feature of lacustrine processes is that smaller artefacts tend to become buried deeper in the sediment than larger artefacts. An analysis of the vertical distribution of artefacts by artefact size (Figures 3.13 to 3.15) does not indicate this type of patterning. A second feature is the formation of linear arrangements of artefacts. No linear arrangements have been observed from Figures 3.2 and 3.3, with artefacts simply associated with the exposed calcrete and not the result of lake margin processes. From this analysis and the geographical setting of the site, it appears that lacustrine processes do not seem to have played a role in the formation of the site; however, further analysis is still required.

3.2.3 Downslope Dispersal

A further model of site formation that must be considered is the effect that downslope dispersal may have on an archaeological assemblage. The site today is relatively flat, with a slight slope down towards the escarpment edge. The

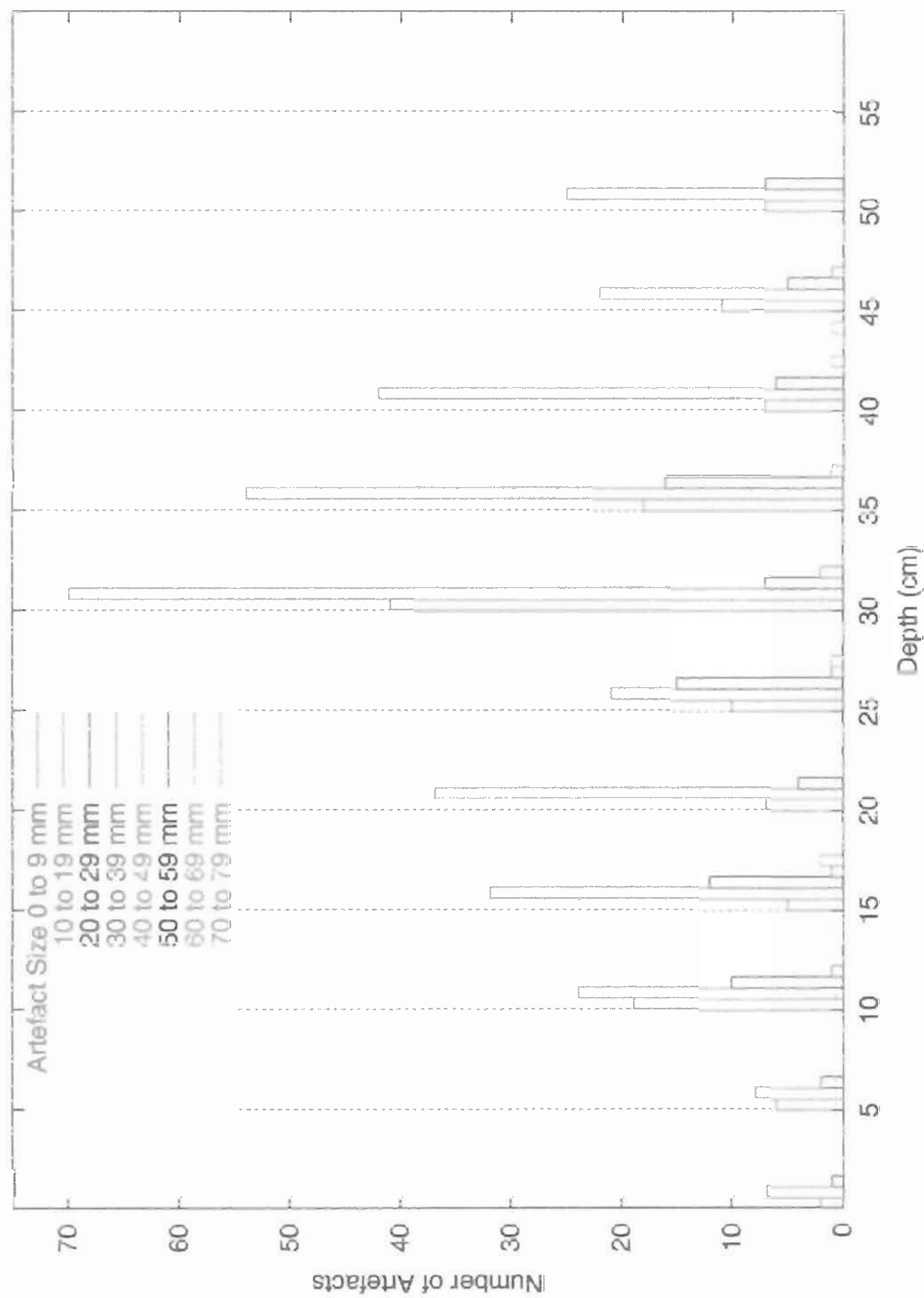

Figure 3.13: Artefact size distribution with depth of non-point plotted pieces < 20mm (all squares excavated to 40 cm, with six squares excavated to 55 cm below the surface). Larger pieces that were not point plotted have also been included.

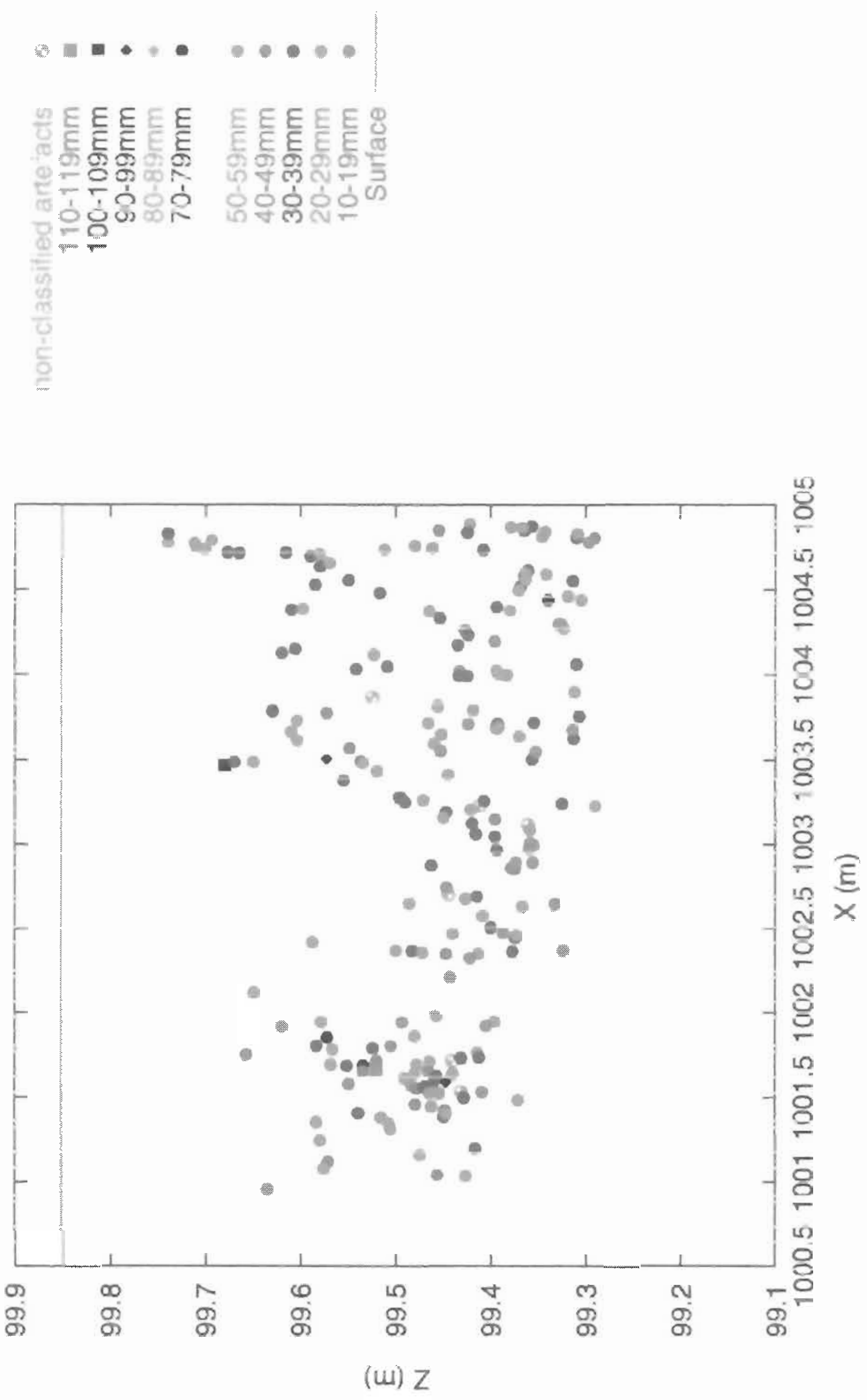

Figure 3.14: Vertical distribution of point plotted artefacts ≥ 20mm along the West to East axis (N=236). Artefact size is indicated by colour.

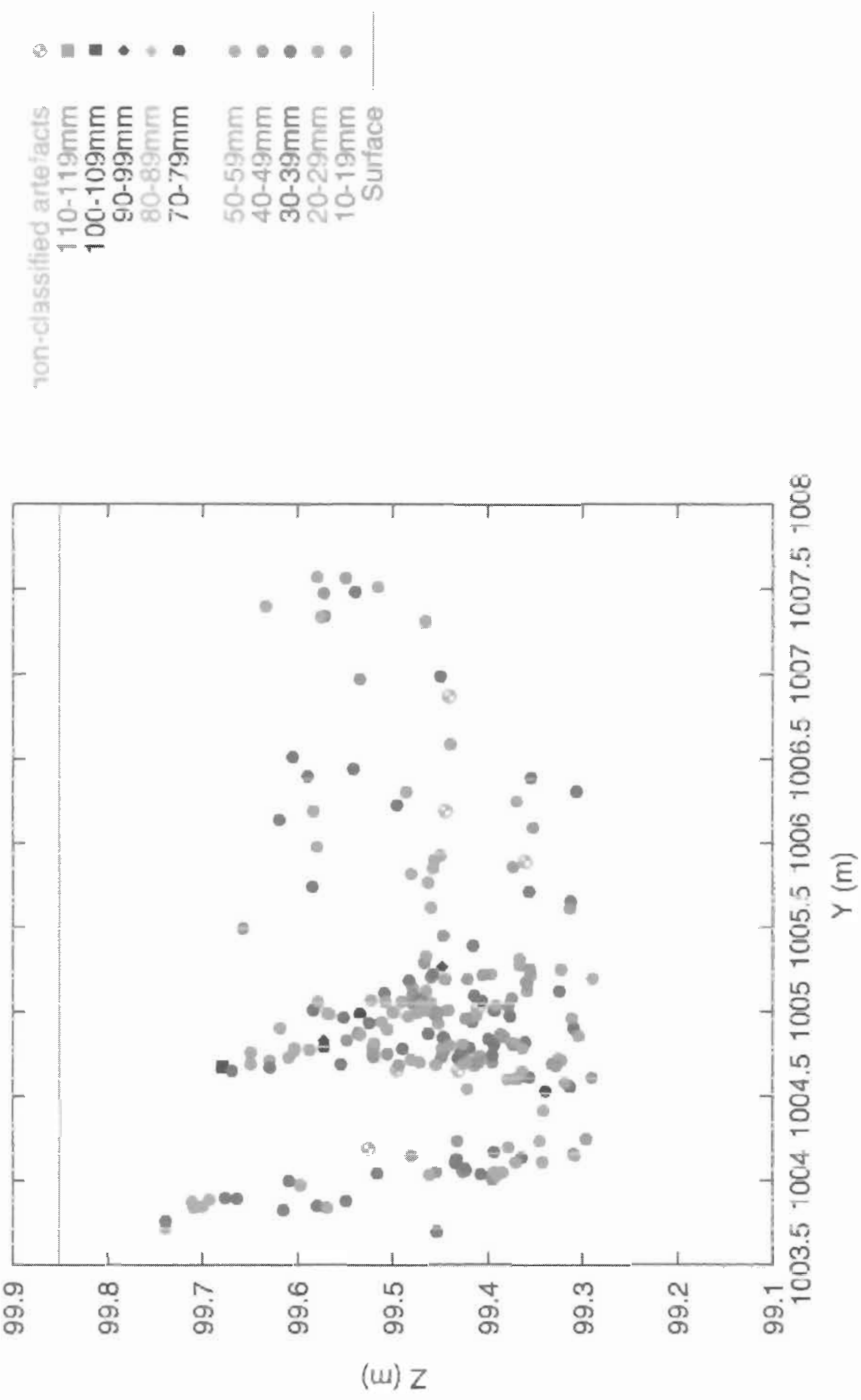

Figure 3.15: Vertical distribution of point plotted artefacts $\geq$ 20mm along the South to North axis (N=236). Artefact size is indicated by colour.

small degree of slope, in conjunction with the nature of the soft, sandy sediments, does not, however, allow for dispersal of material downslope under the influence of gravity. Objects were likely to remain where they were dropped. However, this model will be considered as it may provide information concerning past formation processes which may have had an influence on the site.

Actualistic studies have found that the extent of downslope dispersal is dependent on the gradient of the hill slope and the presence or absence of vegetation cover (Morton 1996, 33). Spherical and rod-shaped particles have been found to be transported downslope first, with blade and disc shaped particles having slower transport rates (Morton 1996, 33). On moderately steep slopes, larger particles have greater transport rates (Morton 1996, 33).

In attempting to identify any of the above patterns, one must conduct an analysis of the distribution of artefacts, taking into consideration artefact size and shape. Time restraints have not permitted me to classify artefact shapes and analysis can only be conducted on size. Based on the model one may expect to find a greater proportion of large artefacts in the downslope direction. An analysis of Figure 3.2 indicates that no such pattern can be seen, although the excavation is not complete and the sample may be too limited. However, the relatively flat nature of the site and sandy sediments suggest that downslope dispersal has not had an influence on the formation of the site. The resulting patterns from downslope dispersal are distinctive and only the effects of trampling on an assemblage may produce similar patterns (Morton 1996, 233). Thus if future analysis does not reveal these characteristic patterns, then the contribution of this formation process can be excluded.

3.2.4 Vertisols

Vertisols are clays subject to seasonal swelling and shrinking, and they have been described as 'self swallowing soils' (Morton 1996, 183). As the soil is churned by an active vertisol, both large and small flakes are transported vertically (Morton 1996, 183). The archaeological indicators that a site may have been transformed by vertisols are the presence of distinctive wedge-shaped structures in profile, the presence of mound microrelief at the surface called *gilgai*, and the vertical dispersal of artefacts (Morton 1996, 33).

Vertisols are only active in clay rich soils. The Hackthorne sediments are sandy in nature and it is thus believed that this process was not involved in the formation of the site. In confirmation of this no wedge-shaped structures or *gilgai* were identified. The movement of artefacts in predominantly sandy soils is discussed in section 3.2.7.

3.2.5 Trampling

Trampling is an important process that must be considered in the formation of a site. Archaeologically visible indicators relating to both horizontal and vertical dispersal will be identified. Studies have shown that very small artefacts (less than 2 cm) are readily trodden into loose sediments (Morton 1996, 34). This tends to restrict the horizontal movement of small particles, with these items found close to their original place of deposition. Small to medium sized artefacts (up to 50 cm) remain on the surface, where trampling displaces them randomly outside the zone of the most intense traffic, where they tend to remain stationary (Morton 1996, 34). Artefacts greater than 50 cm are kicked as opposed to trampled and tend to move faster and more regularly to a stable position outside the main traffic area (Morton 1996, 34).

These studies have also shown that vertical dispersal of up to 16 cm can occur and is heavily dependant on the substrate (Morton 1996, 34). Hard-packed sediments tend to allow for very little vertical movement, while a looser sediment allows for substantial vertical migration. Size sorting can occur, in that smaller artefacts tend to migrate vertically before larger ones (Morton 1996, 34). It must be noted that very large standard deviations occurred in sediments with the same grain size (Morton 1996, 34).

The effect of trampling must be considered at Hackthorne, as the site today is situated directly in the path of a game route from the plains, up the gully, and onto the escarpment. Thus trampling may also have played a part in the formation of the site after the material had originally been deposited. Figures 3.2 to 3.4 do not show any obvious horizontal patterns that could be the result of trampling. All sizes of artefacts are found associated with one another, with no patterns discernable such as clustering of small artefacts, or a cluster of larger artefacts which had been kicked out the way and come to rest in a stable position. The excavation does, however, need to be widened to confirm this impression. In terms of vertical dispersal, artefacts are distributed over a greater distance than that attributed to trampling, and there is also no evidence for size sorting of the artefacts with depth, at least within the 55 cm deep excavation (Figures 3.14 and 3.15). However, it must be noted that in the geological trench a number of large artefacts were found at the bottom of 1 to 1.5 m deep pits. This size sorting pattern will be studied in the future.

Refitting attempts may in the future be able to give a stronger indication as to whether the site has suffered from trampling. If the majority of refits consist of two or more refitted pieces of the split, snapped or split/snapped types, including lateral, medial or distal flake fragments, this could indicate trampling (Kroll 1997, 465). Studies have concluded that these type of refits, are the result of the flakes being broken artificially during core reduction or tool use, or naturally by trampling, floods or sediment compaction (Kroll 1997, 465). Thus if refits consist only of this type, it may indicate that trampling of the assemblage has occurred. A further analysis which must be conducted is to look for crushing of the artefact edges. Artefacts with crushed edges indicate trampling, although lighter trampling tends to break rather than crush thinner flake edges (Kuman 2001*a*). Further analysis is needed, and at this stage no conclusive evidence can be found that the assemblage has been subjected to trampling.

3.2.6 Bioturbation

Plant growth and burrowing animals, including the action of earthworms and termites, will be considered together, so as to achieve an understanding of how their combined processes may affect an assemblage. The differing effects that each process has on a site will thus also be considered.

1. Termites: A number of features can be used by the archaeologist that indicate that termites may have been active. These include: modern or fossil termitaria; fragments of compact or vesicular construction material; 'baked' clay lumps or clay lined depressions; excavated foraging passages; complete lack of microstratigraphy; a uniform, porous, clay-rich mantle soil; and vertically dispersed or vertically concentrated artefacts (McBrearty 1990, 132). The action of termites results in the mixing and homogenisation of the soil, leading to a featureless microstratigraphy, with termite activity sometimes discernable by artefact concentrations that have sharp upper and lower limits (McBrearty 1990). A sedimentary mantle continuously reworked by termites can lead to the dispersal of artefacts through considerable depth of the deposit (McBrearty 1990, 125).

   No termite activity (ancient or modern) was identified in the immediate vicinity of the excavations; however, termites are found in the region. Similarly, no structures relating to termites were uncovered ('baked' clay lumps, clay rich mantle soil, etc.). Artefact concentrations are also vertically diffused without sharp upper and lower boundaries (see Figures 3.4, 3.14 and 3.15), and thus do not reflect termite activity. The lack of microstratigraphy found at the site could be the result of other formation processes and is thus not conclusive in itself. At this stage there is no certain evidence that termites have had an affect of the formation of the site. However, their presence in the past cannot be excluded.

2. Earthworms: Studies have shown that the mixing of soil by the action of earthworms does not lead to changes in the spatial distribution of artefacts (Morton 1996, 183). Earthworms do, however, obliterate stratification within a site, and surface deposition of earthworm castings can bury objects (Morton 1996, 34). A further point is that a site's botanical assemblage can be transformed, as anything smaller than 2 mm in

diameter may become digested (Morton 1996, 34). The actions of earthworms can thus effectively be responsible for burying objects and obliterating structures within the soil.

Earthworms were found to be active within the site, and thus could be a critical agent responsible for obliterating stratification within the sediments. Objects originally deposited on the surface could also have become buried due to the action of the earthworms. The spatial distribution of the artefacts has, however, not been affected.

3. Plant Roots: The mechanical blending of the soil by plant action can lead to reworking and is therefore an important factor in the disturbance of archaeological sites. It is believed that plant roots could be responsible for limited vertical and horizontal movement of artefacts, however, no such actualistic studies have been conducted (Morton 1996, 183). Root growth, decay and soil development is, however, responsible for obliterating the internal structure of sedimentary units (bedding) (Kaufulu 1997, 244). The effect of roots on the soil is thus seen to be very similar to that of earthworms.

   Active root systems were a characteristic of the excavated sediments, with roots varying from the size of fine hairs to a few centimetres in diameter. The mechanical blending of the soil by plant action has thus probably been an active processes throughout the formation of the site. The result of this action has invariably contributed to the obliteration of any bedding structures that may have been present, and potential movement of artefacts within the sediments. A further point about the influence of root systems on the site is that tree roots are most likely responsible for the dissolution of the calcrete (Kuman 2002). This dissolution is probably responsible for the deep sandy pockets found within the calcrete.

4. Burrowing Animals: The burrowing of animals also results in the obliteration of the internal structure of the sedimentary units, as well as the disturbance of archaeological horizons (Kaufulu 1997, 244). Artefacts can be moved around both horizontally and vertically. A characteristic result of burrowing is a bimodal pattern of cultural materials in vertical distribution (Morton 1996, 294). This characteristic can then be used for the discernment of burrowing animals.

   Figures 3.14 and 3.15 do not show evidence of any bimodal distribution of artefacts. Figure 3.13 does, however, indicate a slight bimodal distribution of the smaller artefacts and may indicate that burrowing has occurred. Full excavation to the calcrete is needed before any strong statements can be made regarding this type of evidence. Burrowing animals were, however, observed during excavation, and included various types of insects and scorpions. Mole rats are prolific throughout the area, but no current evidence of their activity was seen at the site. This does not exclude them from having disturbed the sediments in the past. Based on the slight bimodal distribution of the smaller artefacts, and current observations of substantial burrowing in the area, it is believed that this process has certainly contributed to the formation of the site.

The affect of bioturbation on the site can be seen to have been substantial. At this stage no conclusive evidence is available that termites have contributed to the formation of the site. It is clear, however, that earthworms, plant roots and burrowing animals and insects have contributed to its formation. The combined effects of these three processes have certainly been responsible for obliterating the internal structure of any sedimentary units, as well as potentially disturbing and moving archaeological materials. The sites sediments have constantly been reworked by bioturbation.

3.2.7 The Behaviour of Stone Artefacts Buried in Consolidating Kalahari Sands

A series of experiments were conducted by Cahen and Moeyersons (1977) and Moeyersons (1978) to understand the movement of stone implements buried in consolidating Kalahari Sands. The findings of these experiments will be applied to Hackthorne, as it is believed that the sediments at the site are of a type similar to Kalahari Sands (LeBaron 2002, personal communication). Future analysis by Mr LeBaron will hopefully corroborate this initial impression.

A detailed summary of the findings from the experiments conducted by Cahen and Moeyersons (1977) and Moeyersons (1978) is given below. The experiments established that stones do not sink, by their own weight, through a mantle of reworked Kalahari Sands, alternatively wetted and dried (Moeyersons 1978, 125). An artefact can only penetrate into the top of the mantle over a distance of a few centimetres, with this distance depending on the weight of the artefact (Moeyersons 1978, 125). This is believed to happen due to slight compression of the sediment just beneath the artefact, with the amount of penetration showing a linear relationship with the logarithm of the number of wetting and drying cycles. The experiments also showed that the weight of the artefact becomes unimportant and negligible once it is covered by a few centimetres of sediment.

The experiments further established that artefacts buried in a non-consolidated mantle of reworked Kalahari Sands did not strictly accompany the vertical movement (compaction) of the surrounding sediment during the consolidation of the soil column (Moeyersons 1978, 125). Depending on the size, shape and orientation of the artefacts, and on the water content of the sediment, artefacts penetrated, during their absolute descent through the soil profile, into sediments either originally situated above or below them (Moeyersons 1978, 125). In brief, artefacts descend through the soil, however, this descent is highly variable for each artefact, resulting in the vertical dispersion of the artefacts.

It can thus be seen that the downward vertical dispersion of artefacts can be expected in consolidating sediments. A high degree of vertical dispersion of artefacts can be explained if consolidation and destruction of structures within the soil (eg. earthworm tunnels) has occurred repeatedly. It has been strongly suggested by Moeyersons (1978) that the activity of termites and worms can lead to the recurrent or maybe continuous consolidation of the sediments. Galleries, holes and burrows are partly the result of the removal of particles from the sediment, with continued removal causing an ever-densifying pattern of this type of structure (Moeyersons 1978, 126). The consecutive collapse of these structures (eg. burrow) will transform the soil, which may have been consolidated before, into a loose mantle, ready to reconsolidate under the weight of the over burden (Moeyersons 1978, 126). Biogenic activity will also continue to occur during reconsolidation. It can thus be seen that continuous bioturbation of the soil will result in the Kalahari Sand continuously reconsolidating, which will thus have implications for the vertical movement of artefacts in the sediments.

An understanding of the differences in the vertical movement indices of the artefacts is important. The lowering of a certain level in the soil profile is not due to the removal of the particles themselves, but to the collapse of the biogenic structures and to reconsolidation afterwards (Moeyersons 1978, 126). Thus taking into account the high variability of artefact forms within an assemblage, the high changes in water content in the mantle in space and time, and the non-homogenous spread of biogenic activity (bioturbation), artefacts will be found at various levels throughout the sediment during their descent (Moeyersons 1978, 126).

An important consequence of Moeyersons' (1978) findings is that when continuously reconsolidating Kalahari Sand overlies solid bedrock or an undeformable layer, the artefacts will eventually concentrate upon this layer, at the base of the mantle. This finding is crucial because an archaeologist could be misled in their interpretations by the presence of this concentration, as it is difficult to know if it represents one or more original artefact horizons (Moeyersons 1978, 127). A number of artefact depositions (culturally or naturally induced) could have originally been dispersed in the overlying loose sediments but have now become concentrated. Only the presence of stratigraphic layers in the overlying mantle can entirely exclude the possibility that mixing of materials from different episodes of deposition may have occurred (Moeyersons 1978, 127). Any original succession of artefact concentration will have been obliterated, and thus the vertical position of artefacts cannot be considered *in situ*. In summary the experiments have demonstrated that a post sedimentary descent of artefacts in Consolidating Kalahari Sand occurs, with this process catalysed by biogenic activity.

If this model for the movement of artefacts in consolidating Kalahari Sands is to be applied to Hackthorne, it must first be established if indeed the sediments are consolidating. It has already been established that the affect of bioturbation on the site has probably been substantial. Earthworms, burrowing animals and plant roots have continuously reworked the sediments, obliterating any internal structure of the soil, creating structures that can continuously collapse. Thus their action can be seen to have resulted in the sediments reconsolidating. Reconsolidation has probably occurred throughout the sites history and thus this has implications for the movement of the artefacts.

Artefacts deposited on the surface of the sand would thus under their own weight be able to become embedded into the sediment, after a series of wetting and drying cycles, and thus may become protected from other post-depositional site formation processes (trampling, fluvial processes etc.). Once encased, the artefacts would move at different rates through the profile of the soil, leading to vertical dispersal of artefacts which may have been deposited at the same time. An undeformable layer beneath the Kalahari Sands would result in the concentration of the downward moving artefacts upon it. It must be noted that other factors such as burrowing will also contribute to the movement of the artefacts in the soil. Later episodes of sand deposition (eg. aeolian) could also have resulted in the deeper burial of the artefacts.

An examination of Figures 3.4, 3.14 and 3.15 show that there is great vertical dispersal of artefacts throughout the soil profile. Conjoining studies are needed to see if pieces that were deposited at the same time are in fact found at different depths within the sediment. Figures 3.2, 3.3, 3.4 and 3.15 show that concentrations of artefacts occur just above, upon and embedded in the calcrete, with the calcrete seen to form a non-penetrative barrier. The majority of excavated pieces lay in these positions. No artefacts have yet been found in the calcrete itself, with artefacts only embedded into its top laminar layer. The artefacts become embedded within the top of the calcrete as a result of the dissolution and redeposition of the calcrete around the artefacts (LeBaron 2002, personal communication). This invariably results in a few artefacts becoming embedded into the top of the calcrete. It can clearly be seen that concentration of artefacts above the calcrete has occurred (Figures 3.2, 3.3, 3.4 and 3.15), and does seem to follow the model's predictions. It must be noted, however, that the top portion of the calcrete horizon is in the process of chemical erosion. This erosion is believed to be the result of humic acids released by vegetation growing in the sediment, dissolving the calcrete (Kuman 2002). The calcrete is thus very irregular, with sediments varying with depth. Some sediments continue down into decalcified solution pockets, and thus the depth at which artefacts accumulate depends on the specific shape of the calcrete horizon. This explains the paucity of artefacts away from the exposed calcrete, evidenced at this stage of the excavation (Figure 3.2 and 3.3). A similar concentration of artefacts above bedrock has been found at the site of Gombe, in Central Africa, with up to 95% of the assemblage occurring in this position in the Kalahari Sands (Cahen & Moeyersons 1977).

These findings do have the implication that the original succession of artefact concentrations may have been obliterated, and thus behavioural interpretation may be limited. However, lateral movements should not have been greatly affected (Cahen & Moeyersons 1977). An important point that needs to be noted is that if artefacts become embedded quickly into the sediment, they may become protected from other site disturbance processes. Conjoining studies are still needed to clarify the degree of vertical dispersal of the artefacts.

3.2.8 Summary of the Analysis of Hackthorne

With this initial analysis of the site of Hackthorne complete, a few conclusions regarding the site's context and integrity can be drawn. As excavation and analysis are not complete, any conclusions can only be regarded as preliminary and tentative, with future research potentially dismissing some of them. However, this initial interpretation does provide suggestions and ideas concerning further research, and as such it can be used as a guide and basis for ongoing research problems that will provide greater understanding of the context of the site.

Regarding the integrity of the site, based on the size distribution analysis, no firmer statements can be made than that 'the site appears to resemble a location where knapping may have occurred, with some of the small debitage lost from the assemblage'. The limitations of this initial analysis and interpretation must be considered, and thus this statement awaits either confirmation of refutation. Interpretation regarding evidence for on-site knapping is not yet possible, with further excavation, spatial analysis and conjoining studies needed.

With regards to the most sensitive indicators of a site that has been subject to the passage of water, no conclusive evidence exists that fluvial processes have influenced the formation of the site. From the completed excavation and analysis no strong evidence of fluvial processes can be seen from the size distribution and spatial analysis, or from patterns found in the dip and orientation of the artefacts. One cannot at this time, however, exclude that fluvial processes may have contributed to the formation of the site, with further excavation and analysis potentially providing evidence for the passage of water.

From the geographical setting and analysis of the site, it does not appear that lacustrine processes have influenced its formation. Similarly it does not appear that downslope dispersal of the artefacts has occurred, or that vertisols have contributed to site formation. At this stage no conclusive evidence exists that the assemblage has been subjected to trampling; however, only future refitting studies and analysis of artefact edges may be able to confirm or dismiss this factor.

The effect of bioturbation on the site can be seen to have been substantial.

Earthworms, plant roots, burrowing animals and insects, and potentially termites at some stage in the past, have contributed to site alteration. The combined effects of these have obliterated the internal structure of any sedimentary units and have potentially disturbed and moved some archaeological materials. The site's sediments may have thus constantly been reworked by bioturbation.

In conjunction with the evidence for bioturbation of the site, potentially throughout its history, a model for the behaviour of stone artefacts in consolidating Kalahari Sands can be applied to understand the formation of Hackthorne. Bioturbation has resulted in the sediments, which are believed to be similar to Kalahari Sand, continuously reconsolidating, with this in turn having implications for the movements of artefacts within these sediments. Artefacts deposited on the surface of the sand, under their own weight, become embedded into the sediment. Once encased by the sediments, artefacts move at different rates through the profile of the soil, until they reach a non-penetrative barrier, where they concentrate forming dense accumulations. The predictions of this model are apparent at Hackthorne, with the majority of the artefacts concentrated upon the calcrete (Figure 3.4). It must be noted that conjoining studies are still needed to see if artefacts deposited at the same time do occur at different depths within the soil. If this is established it would give further strength in using this model to understand the formation of the site. The findings associated with this model do have the implication that the original succession of artefact concentrations has been obliterated; however, it is not believed that artefacts have suffered great lateral movement. Another important point is that if artefacts become embedded quite quickly into the sediment, then they may have become protected from other site disturbance processes.

At this stage of excavation and analysis, I propose that the artefacts were deposited on the surface of the sediments. The sediments may have been either shallower or deeper at this time. Once embedded in the sediments, either due to the artefacts own weight, or through the action of trampling (refitting and edge damage studies may be able to confirm if trampling was involved), the artefacts proceeded to move down through the sediment at differing rates. Those that have reached the calcrete horizon have formed concentrations at this level. The vertical position of artefacts has thus changed greatly and any stratigraphic interpretations will be impossible. It must be noted that the position of artefacts (vertical and horizontal) may also have been disrupted to some degree by bioturbation, with the effect of burrowing the most damaging process in relation to the horizontal movement of artefacts. This interpretation thus proposes that there may not have been great disruptions in the horizontal distribution of the artefacts.

The influence of fluvial processes on the formation of the site has been dismissed at this time, due in part to the freshness of the recovered artefacts. Archaeologists for many years have been using the sharp edges of artefacts as evidence that an artefact has not been transported, with rounded artefacts believed to have been moved some distance (Petraglia & Potts 1994). There are, however, many problems with this simple classification, as there are numerous factors which influence rounding rates. These include the hardness of the material, water velocity, artefact shape and sedimentary conditions (Petraglia & Potts 1994, 234). It has also been found that chemical weathering and aeolian processes can mimic water flow rounding (Petraglia & Potts 1994, 234). Studies have, however, shown that the lack of rounding is a strong suggestion that an archaeological occurrence has not been transported (Morton 1996). Differential abrasion rates evidenced by lake margin experiments strongly support this proposition (Morton 1996, 201-203). Future quantification of artefact rounding, as proposed by Petraglia and Potts (1994), may give further strength to this initial impression of the artefacts not being transported by fluvial processes. The lack of any other evidence of fluvial processes, at this time, also adds to the strength of this interpretation.

Further analysis, involving the employment of conjoining studies is crucial to the above interpretation, as this will be able to establish if, or what the strength of fluvial processes on the site may have been. Any linear trends found among conjoined pieces would be helpful in the identification of fluvial dispersal of material which had originally been more tightly concentrated. If such trends are found, this would have implications regarding the interpretation of any horizontal patterns. The above model of site formation would then have to be adjusted. Conjoining studies are further needed in conjunction with the size distribution analysis, as this will provide much greater certainty concerning the integrity of the site. If many conjoinable pieces are found in close proximity horizontally, this would indicate that the above interpretation of the site may be correct, and that behavioural inferences relating to spatial patterns may be possible. Conjoining studies that reveal that, artefacts that were deposited at the same time, are now found at differing depths, will also give strength to this interpretation.

This present interpretation would, however, be dismissed if future research reveals that the deposition of the artefacts took place during the fluvial formation of this part of the terrace, and not at a slightly later time. If this was true, then the artefacts could have become encased by sediment during back water deposition, and any patterning would have invariably been disturbed by the water. The freshness of the artefacts, size distribution and the fine nature of the sediments is said to indicate low energy deposition (Kuman 2002). The question thus arises as to whether hominids deposited the artefacts during the formation of the terrace, resulting in the artefacts being disturbed by fluvial processes, or whether the artefacts were deposited at a subsequent time when the influence of water would have been minimal. If the latter is true then the current interpretation will hold, along with it's implications for behavioural inferences. The depositional history of the sands can be seen to be key in determining which one of the two propositions is true. The analysis of grain size, grain composition, surface texture, shape and angularity will be used by

Mr LeBaron in interpreting the complex depositional history of the sediments. This requires understanding the various roles played by aeolian and fluvial processes, as well as the nature of the original calcretised sediment and parent rock from which the sediments formed. The fact that the sediment shows largely aeolian grain sizes (Kuman 2002, 4) suggests that deposition of the artefacts may have occurred slightly after the formation of the terrace by the Limpopo River. Analysis of the sediments will hopefully be able to solve this dilemma, establishing whether or not the current model of site formation will hold.

It must also be noted that this preliminary interpretation of the formation of the site may change as additional analyses (eg. core to debitage ratio) suggested in this report, apart from the conjoining studies, reveal more information. The current interpretation of the formation of the site must thus only be considered preliminary. However, if such an interpretation is able to hold up when confronted with further analysis, it does hold the promise of a site that can be used to draw behavioural inferences regarding hominid activities. No similarly complete Earlier Stone Age site has been found in South Africa, and a good context Acheulean site can be seen to be of great importance for providing a better understanding of Acheulean life-ways. The potential limitation of the site is the uncertainty as to how long deposition of the artefacts occurred on the sediments. If the accumulation of artefacts represents a period of thousands of years, then the behavioural inferences will become limited. An archaeologist may then only be able to draw inferences regarding long term characteristics of hominid behaviour. If, however, conjoining studies show tight accumulations of refitting pieces, then the time-scale may be greatly reduced, and an increase in inferences may result. Future work will hopefully reveal the type of behavioural inferences that may be possible from the site.

Chapter 4

Conclusion

It has been demonstrated in this report that one must have a full understanding of the formation of a site before beginning to draw interpretations about past hominid behaviour. The identification of the effects of various natural formation processes upon a site is crucial. This identification allows for an understanding as to how a site may have changed from the time that the artefacts were originally deposited by hominids, to the time of excavation. The identification and interpretation of the potential processes that may have contributed to a site's formation must employ the use of both multiple models and contextual data in the analysis. This allows for a greater understanding of the context of a site to be achieved. In conjunction with the above approach, it has been demonstrated that excavation must be conducted at a high resolution so as to maximise the amount of data available. The use of this methodology allows the archaeologist greater insight into processes that may have contributed to the formation of the site, as well as providing more lines of evidence to be used in the interpretation. The approach to Earlier Stone Age research outlined in this report allows for the context and integrity of a site to be established. This then determines the type of behavioural inferences that can be made, with the ultimate goal of an archaeologist seen as the drawing of inferences from the archaeological record that have behavioural significance.

It is proposed in this report that the formation of the site at Hackthorne involved the deposition of artefacts upon the surface of the sediment. Once embedded in the sediment, either due to the artefacts own weight, or through the action of trampling, the artefacts proceeded to move down through the profile at differing rates. Artefacts that have reached the calcrete horizon have formed concentrations at this level. The vertical position of artefacts has thus changed greatly and any stratigraphic interpretations will be impossible. It must be noted that the position of artefacts (vertical and horizontal) may also have been disrupted to some degree by bioturbation, with the effect of burrowing the most damaging process in relation to the horizontal movement of artefacts. This interpretation thus proposes that there may not have been great disruptions in the horizontal distribution of the artefacts. The influence of fluvial processes upon the site has been ruled out at this time, however, future work may reveal its involvement, which will then have implications for interpretation of any horizontal patterns.

In considering the interpretation of the context and integrity of the site of Hackthorne, a few important points must be noted. The current interpretation implies that the horizontal spatial distribution of artefacts may not have suffered greatly during the formation of the site. If future work, particulary conjoining studies, corroborate this interpretation, then the site could potentially be used to draw inferences about hominid behaviour. With greatly expanded excavation, invaluable evidence of hominid transport behaviours within site boundaries, as well as transport behaviours above and beyond those evident within the site, may become discernable. The potential limitation of such an interpretation relates to the time-scale of the site. Conjoining studies that reveal single knapping episodes would allow for interpretations to be made regarding the above behaviours. It has been noted, however, that the time-scale of the site could be much greater, with the deposition of the artefacts potentially occurring over thousands of years. If this is true then the inferences that archaeologists make will become limited.

However, sites may be positioned in particular locations because of specific topographic, geomorphological or vegetational features, that were an attraction to hominids (Kroll 1994, Tuffreau et al. 1997). These locations may have been attractive for perhaps decades, or as suggested by Kroll (1994), for the lifespan of a good shade tree. As such, the time-span represented at such a location may not lessen the behavioural significance of hominids repeatedly returning to that place (Kroll 1994). Such a desirable place might have been reused preferentially during a relatively short period of geological time and thus some behavioural inferences would be able to be made from such a site. The availability of raw materials eroding out of the older deposits in the escarpment may be such an attraction at the site of Hackthorne. The continual use of this location over a relatively short period of geological time, or even over thousands of years, will still allow behavioural interpretations to be drawn. As such, the site of Hackthorne, and future work looks promising for being able to make statements regarding the actions of hominids. Future analysis will reveal the resolution at which behavioural inferences can potentially be made, and will hopefully add to our limited knowledge of the Acheulean in southern Africa.

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