MALAWI EARLIER-MIDDLE STONE AGE PROJECT

2010 Project Report

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I. INTRODUCTION

The Malawi Earlier-Middle Stone Age Project

The Malawi Earlier-Middle Stone Age Project (MEMSAP) is an ongoing research agenda aimed at understanding changes in human technology, subsistence, and demography from the late Middle Pleistocene to the early Upper Pleistocene (ca. 310 – 128 thousand years ago [ka]). These investigations require well-documented and well-dated Earlier to Middle Stone Age archaeological and palaeoenvironmental records. The development of these two practical outcomes is therefore one of the long-term objectives of the MEMSAP.

Several smaller sub-projects have been identified that will be informative on their own as well as designed to contribute seamlessly to the larger research agenda. In this stepwise manner, we intend to begin with what is known and work towards the unknown. This ensures a useful result at the end of each field season regardless of the scale of the investigations. In August 2009 we conducted a pilot survey of the rich Middle Stone Age (MSA) archaeology of Malawi, with a focus on deposits in the Karonga District. Through this work we developed a series of specific research questions and identified several sites where further investigation would allow us to address these questions. This report contains a description of our work at these sites during July and August 2010 and embeds them within a description of the ongoing goals and results of the MEMSAP.

Summary of Reported Activities

This report updates the information provided in the 2009 field report (Thompson et al. 2009). MEMSAP activities in 2010 fall into five major categories:

1) Survey for new sites in the Karonga District between 1 July – 7 August 2010.
2) An excavation season conducted in Karonga between 1 July – 7 August 2010.
3) A visit to study collections housed at the Stone Age Institute, affiliated with the University of Indiana at Bloomington. Many of the original lithic and some of the original faunal materials excavated by J. Desmond Clark in the 1960’s are currently curated there (Clark et al. 1970; Clark and Haynes 1970).

4) Analyses of materials and samples either loaned from the Stone Age Institute or recovered in the field during the 2009 pilot field season or the 2010 excavation season in Karonga.

5) Survey in the Nkhata Bay District between 8 – 11 August 2010.

The report also includes discussion of the implications of this research, as well as recommendations for future work in Malawi.

**Personnel**

**Personnel involved in the August 2010 fieldwork were:**

- Dr. Jessica Thompson (University of Queensland [UQ])
- Dr. Alex Mackay, Australian National University (ANU)
- Menno Welling, Catholic University of Malawi (CUNIMA)
- Claire Turner, CUNIMA at the time of the fieldwork, now University of Pretoria
- Harrison Simfukwe, Senior Antiquities Officer based at the Karonga Museum
- Oris Malijani, Senior Antiquities Officer based in Lilongwe
- Edward Turner, an Honours student at UQ
- The following undergraduate students in Anthropology and Archaeology at CUNIMA: Rachel Warren, Davie Simengwa, Gervasio Nkhumbira, Kingsley Pamanda, Linda Kolomba, Levison Tsogolani, Sangwani Tembo, Lloyd Mdala, Margeret Wowa, Speracy Chigwale, Kings Mmemo, Martin Mbewe, Dalison Kasale

**Personnel not listed above involved in analysis of samples taken to date are:**

- Dr. Andrew Herries, a paleomagnetics specialist at the University of New South Wales (under analysis)
- Dr. Ann-Maria Hart, a sediment micromorphologist at UQ (under analysis)
- A/Prof. Jian-xin Zhao and Dr. Gilbert Price, U-series dating specialists at UQ (analysis complete)
- Prof. Jon Olley and Dr. Timothy Pietsch, OSL dating specialists at Griffith University (under analysis)
- Prof. Steven Forman, an OSL dating specialist at the University of Illinois at Chicago (under analysis)
- Dr. David Braun, a lithic specialist at the University of Cape Town (under analysis)
- Dr. Gail Robertson, a lithics residue and use-wear specialist at UQ (analysis complete)
- Dr. David Wright, a geoarchaeologist at Seoul National University and UQ Honours student Amanda Greaves (under analysis)
- Dr. Arun Banerjee, a specialist in elephant ivory at the University of Mainz (analysis complete)
- Dr. Jürgen Tuckermann, a specialist in micro-CT scanning at the University of Mainz (analysis complete)
- Dr. Patrick Moss, a pollen specialist at UQ (analysis complete, more underway)
- Dr. Lynley Wallis, a phytoliths specialist at UQ (analysis complete, more underway)
- Dr. Kathy Stewart, a specialist in fish archaeofaunas at the Canadian Museum of Nature (analysis complete)
II. CONTEXT OF RESEARCH

Aims and Background

Understanding the origins and dispersal of anatomically and behaviourally modern humans is one of the most prominent debates in current science and anthropology (Balter 2001; Klein 2008; Marean and Thompson 2003). Genetic work demonstrates that the apparent vast diversity of modern populations can all be traced to a single origin in Africa as recently as 200 ka (ka = thousand years ago) (Relethford 2008). Biological anthropologists confirm that modern skeletal anatomy was also established by this time (Pearson 2004; Pearson 2008; White et al. 2003). Along with these biological questions, there has been much debate amongst archaeologists regarding the specifics of when, where, and how the transition to *behavioural* modernity occurred (Henshilwood and Marean 2003).

Building upon successful pilot studies in 2009, MEMSAP is a cross-disciplinary project that will test six hypotheses about the emergence and dispersal of behaviourally-modern humans. It will do this by building a long, well-dated archaeological sequence of technological change in Malawi, mapping large-scale palaeodemographic parameters, and contextualising these data in a model of landscape evolution and palaeoclimatic variability. The 2010 project activities reported here comprise the first steps in achieving these goals.

What are the Issues?

Several research questions exist within the literature concerning the origins of modern humans. Our project will be the first to provide the quality of data required to address several specific aspects of these larger questions.

1) How is ‘modern behaviour’ defined, and what processes drove its emergence?
The phenomenal success of *Homo sapiens* in colonising the globe at the expense of other species (including other species and subspecies of *Homo* such as Neanderthals) marks us as a “spectacular evolutionary anomaly” in the natural world (Boyd and Richerson 2005). Archaeologists seeking to understand the origins of this success have attributed it to the appearance of a suite of abilities thought to be unique or highly developed in our species (Klein 2003; Klein 2008; Mellars 2007). However, early models of the emergence of these abilities (e.g. symbolic capacity, language, hunting ability) could not be tested with the archaeological record because they were developed directly from that record (Henshilwood and Marean 2003).

Recent multidisciplinary work has instead developed independent testable models that focus on the uniqueness of our social behaviour relative to other animals and to extinct members of the *Homo* lineage (Hill *et al.* 2009; Hutchins 2008; Mellars 2007). Such attributes include hypercooperative within-group sociality, external symbolic storage in the form of material culture, and fidelity in cultural and knowledge transmission facilitated by active ‘teaching’ (Hill *et al.* 2009; Tomasello *et al.* 2005). Much of this complexity in within-group cooperation is explained by the corresponding coevolution of between-group antagonism. Put simply, we cooperate within groups because we fight between groups (Bowles 2009; Choi and Bowles 2007; Powell *et al.* 2009). This process is exacerbated when crucial resources become limited, either because of external factors (e.g. a palaeoclimatic shift) or internal factors (e.g. population size increase). Humans may also respond to such stressors through technological innovation (e.g. development of a new food processing technique) or increased social signaling (e.g. personal ornamentation). Under these new models, interrelated changes in human demographic parameters, resource availability, and technological adaptation are all key elements in the emergence and dispersal of behaviourally modern humans. Our project will be the first that is explicitly designed to test these new models with the empirical record.

2) How and when can ‘modern behaviour’ be recognised in the archaeological record?
Recent discoveries of incised pigments, shell beads, and finely-crafted stone and bone tools from Blombos Cave in South Africa date to at least 75 ka (Henshilwood et al. 2001; Henshilwood et al. 2004). Shell beads from north Africa date to between 85 – 135 ka (Bouzouggar et al. 2007; Vanhaeren et al. 2006), and similar ages have been reported for elaborate bone harpoons from central Africa (Brooks et al. 1995; Yellen et al. 1995). These finds clearly demonstrate that cultural/technological complexity, high-fidelity social transmission, and the external storage of symbolic behaviour through media such as personal ornamentation were widespread in Africa by ca. 85 ka. These finds also suggest that more subtle evidence for modern behaviour might be expected to occur earlier, as precursors to these more obvious indicators. The technological capacity to cooperatively hunt and process large ungulates was in place in South Africa by ~ 160 ka (Thompson 2008; Thompson 2010). The use of pigments, potentially for ceremonial or decorative purposes, extends back to at least 250 ka (Watts 2009). All these finds date to within the time period known as the Middle Stone Age (MSA - from ca. 280 – 30 ka).

The discoveries have challenged the longest-standing model for the origins of behavioural complexity, which posits a very rapid change in technology, population size, and cognitive ability quite recently in human prehistory, between 50 – 40 ka (Klein 2000; Klein 2008). An alternative model sees these critical changes as accumulating gradually throughout the MSA (Henshilwood and Marean 2003; Klein 2008; McBrearty and Brooks 2000; Mellars 2007). This long-standing debate makes one of the most important current questions in modern human origins research whether the emergence of behavioural complexity took place over a short or a long period of time. *We will develop one of the first datasets suitable for addressing this issue.*

3) **How can important behavioural changes be identified in the ‘everyday’ archaeological record?**

A major technological shift has been documented across the Earlier to Middle Stone Age boundary ~ 280 ka, but at the few sites where this transition is recorded the change was not abrupt. Instead, change was slow and new innovations were rooted in previous technologies (McBrearty and Tryon 2005; Morgan and Renne 2008; Tryon and McBrearty 2002; Tryon and McBrearty 2006; Van Peer et al. 2003). Multi-step lithic
preparation techniques such as the use of fire to heat treat raw materials was regularly used in South Africa by ~ 70 ka (Brown et al. 2009). Complex technologies such as these that persist for several generations were likely developed and maintained through active social transmission of knowledge. Such transmission is also apparent much earlier, in Earlier Stone Age biface technology (Archer and Braun 2010). Discoveries such as shell beads and bone tools are rare at MSA sites, likely in part because special circumstances are required to preserve these materials (Henshilwood and Marean 2003). In contrast, ochre pigments and lithic artefacts provide a durable and ubiquitous record across Africa. Ochre use has been proposed to have played both technological and social roles during the MSA (Wadley 2005; Watts 2002). Lithics represent technological solutions to problems of resource extraction, and many aspects of their manufacture are socially transmitted (Ferguson 2008). The durability, ubiquity, and behavioural implications of the lithic and ochre records make them ideal for building a long, detailed sequence of human behaviour with few problems of sample size or taphonomic bias. We will employ both standard and innovative methods to recognise subtle changes in these records, and develop the first continuous sequence of behavioural change over this crucial time period.

4) What were the relationships between climate change, human demography, and the emergence and dispersal of modern humans?

Palaeoclimatic research has revealed that the Middle Stone Age was a period of extreme global climatic instability (Augustin et al. 2004). A detailed terrestrial record based on cores from Lake Malawi has recently shown that several periods of ‘megadrought’ occurred in central Africa between ca. 135 – 75 ka, during which time water volumes in Lake Malawi were reduced by as much as 95% (Brown et al. 2007; Cohen et al. 2007; Scholz et al. 2007). These periods have been proposed as a mechanism that drove human populations into ephemeral refugia or out of central Africa entirely (Cohen et al. 2007), with subsequent transition into wetter conditions ca. 70 ka then positioning early modern human populations for expansion and subsequent dispersal out of Africa (Scholz et al. 2007). These fluctuations would have fragmented and rearranged surviving populations (Basell 2008), resulting in demographic changes that exacerbated
existing propensities for between-group antagonism because of increased competition for diminishing resources.

Responses to these pressures are expected to appear in the archaeological record in the form of technological innovation such as improved hunting technology and external social signaling – perhaps in the form of personal ornamentation and art. Such indications should be present in regions where human populations remained (potential refugia) and hiatuses should be recorded in the archaeological record in areas that were no longer habitable. Thus, new models of the emergence of modern humans link changes in human behaviour to demographic pressures underlain by climate change. We will test these models using carefully-selected archaeological samples paired with an existing high-quality palaeoclimatic dataset.

**What will this Project do?**

The recent theoretical advances described above make now the ideal time to turn to the archaeological record to test hypotheses about the emergence and dispersal of modern humans. These hypotheses are only testable with long archaeological and palaeoclimatic sequences embedded within a well-understood chronometric framework. Unfortunately, individual well-dated MSA sites only record small subsets of this time period or are not accompanied by high-resolution palaeoclimatic datasets (Marean and Assefa 2005). Our project will build the first long MSA sequence in Africa through investigations of the exceptional archaeological record of northern Malawi. This sequence will then be used to achieve four project goals:

**Goal 1:** Characterise significant attributes of technological behaviour throughout the entire MSA;

**Goal 2:** Identify important changes in landscape and resource use (specifically lithic raw materials and water sources);

**Goal 3:** Link human demographics to climatic variability by identifying where populations were during periods of harsh climate; and
Goal 4: Test the following six hypotheses about the timing and mechanisms of behavioural/demographic change:

- **H1**: There are detectable differences in stone tool manufacturing techniques over time in a single locality.
- **H2**: Discernable behavioural change took place across the entire Middle Stone Age (rather than only at the end).
- **H3**: Technological change occurred in concert with changed conditions for the availability of lithic raw material resources (owing to tectonic and geomorphic forcing of landscape change).
- **H4**: Behavioural change was most rapid and punctuated during periods of harsh climate conditions.
- **H5**: Northernmost Malawi became depopulated during Late Pleistocene megadroughts as lake levels shrank.
- **H6**: Permanent lakeshores in Malawi acted as population refugia during these megadroughts.

The Importance of the Malawian Record

The Chitimwe Beds of northern Malawi preserve a rich MSA record that is uniquely positioned to integrate the archaeological, paleoenvironmental, and landscape data necessary to achieve the project goals (Figure 1). Near the Chaminade Secondary School in the Karonga District, at least 6 km² of sediments contain *in situ* earlier and later MSA deposits (Clark 1966; Clark *et al.* 1970; Clark and Haynes 1970; Clark *et al.* 1966). Throughout the locality MSA artefacts erode from the Chitimwe Beds in such profusion that they are often spread as gravels to improve local dirt roads (Thompson *et al.* 2009). The Chaminade exposures represent a subset of MSA deposits that stretch for at least 40 km along the shores of Lake Malawi (Clark 1966; Clark 1968; Clark 1972; Clark *et al.* 1967; Clark and Haynes 1970; Clark *et al.* 1966), extending to a region where bathymetric data show that lake levels were less reduced during megadrought periods (Scholz *et al.* 2007). This phenomenal abundance of artefacts means that large, meaningful samples can be excavated and human adaptations compared between areas.
closer to permanent water sources and those subject to changes in availability of this resource.

Figure 1 Location of study area showing where the majority of work was conducted in 2010. Parts of Lake Malawi with diagonal lines indicate maximum extent of lake reduction during periods of ‘megadrought’ and dots represent drill core sites. Redrawn from Scholz et al. (2007).

Initial investigations in the 1960’s (Clark et al. 1970; Clark and Haynes 1970; Clark et al. 1966) revealed in situ sediments with stratified unweathered MSA lithic and ochre materials in low-energy depositional facies with occasional fossil preservation. Test excavations produced nearly 25,000 lithic artefacts from ca. 200 m$^3$ of stratified deposit, but these could not be dated or placed within their paleoenvironmental contexts using the methods available at the time (Clark et al. 1970). Clark later (1968) reported that sealed MSA activity areas have been excavated, where reconstruction of the entire spectrum of lithic reduction sequences was possible (Clark 1995; Clark 2001). Pigments
have also been recovered (Clark 1966), which is an artefact class that has been argued to have implications for modern human cognition because it was likely used in an artistic or symbolic manner (Henshilwood et al. 2009).

Key localities preserve both earlier and later MSA deposits. For example, the modern landscape at Chaminade comprises dozens of tall hills incised by ephemeral streams, with the slopes of the hills covered in stratified Chitimwe Bed gravels. The deposits include large quantities of unweathered MSA artefacts manufactured predominately on very fine-grained quartzites. These are embedded in gravelly and sandy facies of alluvial terraces (Clark 1966; Clark et al. 1966; Cole-King 1973). Many of the strata are buried under colluvium originating from tectonically uplifted terraces (Betzler and Ring 1995), and continue to the base of the Chitimwe Beds where they lie unconformably on top of Pliocene fossiliferous lacustrine sediments known as the Chiwondo Beds (Figure 2). The Chitimwe-Chiwondo contact has an estimated age of ca. 300 ka (Clark 1995; Kaufulu 1990), and upper Chitimwe sands continue in some places into the Later Stone Age. Excavating these sites will allow a long sequence of human behaviour to be built.

The Malawian landscape also imposes important constraints on human population movement. Lake Malawi forms a physical barrier along the eastern margin of the study area (Cohen et al. 2007). Less than 100 km to the west the Nyika Plateau and Misuku Hills rise to nearly 2500 m, leaving a narrow north-south strip of land between these
two major features. Today northern Malawi falls within the Zambezi ecozone vegetational community (White 1983), and is a large mammal barrier between endemic faunas of eastern and southern Africa (Klein 1984). The strip of land between lake and plateau was a natural funnel for animal and ancestral hominin populations (Bromage et al. 1995), and likely also guided major human population dispersals that ultimately led out of Africa. Understanding the mechanisms behind these dispersals is one of the biggest questions in modern human origins research.

The Chitimwe Beds are also located less than 20 km from one the longest and most detailed terrestrial palaeoclimatic lake core record available in Africa (Cohen et al. 2007; Scholz et al. 2007). Much of the palaeoenvironmental background is therefore already available, and a well-dated archaeological sequence developed here will be readily contextualized to test existing climate-driven models of early modern human demography (Figure 1). Many of the Chaminade deposits are stratified, and clear differences exist in lithic reduction strategies and raw material selection that represent behavioural change across the MSA (Clark et al. 1970; Clark and Haynes 1970). In addition, the MSA materials are entrained within well-developed palaeosols and fluvial facies which provided sources for lithic raw materials. This makes it possible to examine human responses to changing lithic raw material availability in relation to an evolving landscape driven by both tectonic and geomorphological changes.

**Significance of the Project to Science**

Researchers from dozens of disciplines have been brought together by the central problem of our origins. It has spurred the innovation of new scientific techniques (Jacobs et al. 2003), provided impetus for numerous conferences, symposia, and workshops, and papers on the topic regularly appear in high-impact journals (Cohen et al. 2007; Fagundes et al. 2007; Klein 2003; Marean et al. 2007). Following successful pilot studies, our project will uniquely contribute to high-priority issues in modern human origins research by: 1) excavating important sites in the Middle to Late Pleistocene Chitimwe Beds of northern Malawi; 2) analysing the recovered materials; 3) contextualising them within their depositional environments; 4) constructing a regional
chronology; and 5) linking these data to an existing high resolution palaeoclimatic dataset. This will overcome three specific obstacles that have plagued the discipline:

1) **No well-dated MSA sequence is available that spans both the early and later parts of the MSA record. We will build the first such sequence.**

Global sea levels lowered during periods of extreme cold and aridity (Ramsay and Cooper 2002), and human settlement was pushed onto the coastal plain or other refugia – potentially including the permanent part of the Lake Malawi shoreline. Rising sea levels during the Last Interglacial at 128 ka then drew an arbitrary line across the MSA in many key localities by erasing evidence of previous Middle Pliocene occupation (Marean *et al.* 2007). The few areas that preserve early MSA deposits derive mainly from northeastern Africa (McBrearty and Tryon 2005; Morgan and Renne 2008; Tryon and McBrearty 2002; Tryon and McBrearty 2006; Van Peer *et al.* 2003), and almost all sites dating to any part of the MSA are located in northeastern or southern Africa (Gowlett 2009).

2) **The reported empirical record is biased toward eastern and southern Africa, and toward isolated sites rather than landscapes. We will develop the first landscape dataset for the MSA of central Africa.**

Very few MSA sites are reported from central Africa (Marean and Assefa 2005). The few that are, including those in Malawi, were investigated before the technological and methodological advances were available to date them or situate them within their palaeoclimatic contexts (Clark 1942; Clark 1954; Clark and Brown 2001; Clark *et al.* 1947). This is problematic because the region was the crossroads for demographic movement of MSA populations between the better-understood regions of southern and eastern Africa. The richness of the central African record has been more recently confirmed by work in Zambia and Mozambique, but these datapoints represent single sites rather than Middle Stone Age landscapes such as the one that is uniquely preserved in the Chitimwe Beds of Malawi (Barham 2000; Barham 2002; Barham and Robson-Brown 2001; Clark 2001; Mercader *et al.* 2009; Mercader *et al.* 2008). Although much work was been conducted in the 1960’s (Clark 1966; Clark 1968; Clark 1972; Clark *et al.* 1967; Clark and Haynes 1970; Clark *et al.* 1966; Kafulu 1990), little has
been done since on the Middle Stone Age of Malawi, and this leaves this important region unable to contribute internationally to current problems in the modern human origins debate.

3) **High resolution palaeoclimate records are unavailable for most MSA localities.**

We will link the human behavioural record to a high-quality palaeoenvironmental dataset that already exists in our study area. Various palaeoclimate and palaeoenvironmental indicators have been used to contextualise archaeological data, but these have rarely been from continuous high-resolution sequences that record fine incremental change. There are two main sources of terrestrial records available at this level of detail. Speleothems (e.g. flowstones and stalagmites/stalactites) record changing geochemical signals that correlate with variability in rainfall, vegetation, and temperature, and they can be precisely dated using uranium-thorium (U-Th) ratios. However, existing speleothem datasets relevant to modern human origins research are restricted to southern Africa (Bar-Matthews et al. 2010; Marean et al. 2007) and the Levant adjacent to north Africa (Vaks et al. 2007). Lake cores present long stratified records of many of these same parameters through their lithology, chemistry, and microfossil representation (e.g. pollen, ostracods, diatoms, fish). The Lake Malawi cores are by far the longest and most detailed of these records in Africa, and expectations about ancient human demography in equatorial Africa are best tested against the MSA record immediately adjacent to these cores (Brown et al. 2007; Cohen et al. 2007; Scholz et al. 2007) - namely the one from the Chitimwe Beds targeted by this project.

4) **Subtle changes in human behaviour have been difficult to identify in the MSA lithic record.** We will augment traditional lithic analyses with innovative new methods designed to reveal small differences in lithic reduction strategies. Because there are few obvious differences in stone tool morphology during the MSA (such as point hafting styles), little technological change has been assumed to have taken place over the huge amounts of time and space in which MSA assemblages occur. Recent work has begun to tease out more subtle differences in stone tool manufacture (Minichillo 2006; Soriano et al. 2007; Wurz et al. 2003), but these studies lack an
experimental referential framework. Project collaborator Braun has developed this framework for earlier assemblages using morphometric methods and multivariate techniques that can identify small differences in lithic reduction sequences (Archer and Braun 2010). Project collaborator Clarkson has also developed innovative three-dimensional scanning methods for analysing the core component of lithic assemblages (Clarkson 2007). Collaborator Mackay has developed new ways to collect and analyse lithic data and to discern minute differences in technological attributes of MSA assemblages over time (Mackay 2008; Mackay 2009). All three approaches will be uniquely joined here by efforts from the three collaborators.

Significance of the Project to Malawi

The most immediate benefit of the project to the Malawian people is through direct training. The MEMSAP offers the opportunity for Malawians to obtain exposure to an international group of researchers with a variety of specialisations in archaeology, geochronology, and other related disciplines that are not well-represented in the country. This is particularly important for people in Malawi who are considering or engaged in careers that emphasise archaeology and heritage management, such as people working for Malawi Antiquities. Such interactions are a two-way street: the MEMSAP benefits enormously from the local and historical knowledge of Malawian people and none of the project goals could be met without their support.

Malawi contains a record of human history and prehistory that extends back to the very origins of modern people. It is unique, extremely rich, and offers the opportunity to answer many questions that cannot be addressed in other parts of Africa. However, many sites of cultural significance are destroyed without record over the course of new developments such as mines, pipelines, and transport infrastructure. These economic activities are essential for the growth of Malawi in the modern world, but this need should be balanced by the need to also record irreplaceable cultural resources. The two objectives are not necessarily opposed: many jobs for Malawians with archaeological training can be generated by stricter enforcement of existing heritage laws. However, this requires intensive training opportunities for Malawian people at all different levels.
The MEMSAP plays a key role in the development and training of new archaeologists in Malawi through its collaboration with the Catholic University of Malawi.

There are excellent tourism opportunities in Malawi that can provide reliable, sustainable forms of income. However, many more tourists choose to visit places in eastern and southern Africa. This is likely because these other places are better known to the world, and have a longer-established history of international tourism. Most people visiting Africa are drawn to its wildlife reserves and national parks, but there is also a strong archaeotourism component to their interests. Currently, Karonga receives international visitors who are either working with foreign companies (especially mines) in the area or simply passing through. Karonga could easily be changed into a destination for visitors by offering people the opportunity to become involved in tours that exhibit the cultural richness of the area. With fossil deposits that even pre-date the dinosaurs, discoveries of hominin fossils, and abundant archaeological materials at the top of the sequence, there is something for any visitor interested in the past. The critical step is in making this past accessible to the public through engagement with the local community.

The ideal outlet for the development of a tourist programme in Karonga is the Cultural and Museum Centre at Karonga. Part of the long-term vision of the MEMSAP is to develop a Middle-Late Pleistocene archaeological exhibit that features the findings of the project. The MEMSAP can also provide international advertising for the region so that the exhibit is complemented by scheduled visits by tourists to the sites from which the artefacts are derived. Over the long term this could result in many jobs in the area, because tourists need places to stay, eat, and knowledgeable trained guides to take them on tours. Continued collaboration with the Malawi Ministry of Tourism, Wildlife, and Culture is essential for the success of this vision.

Finally, the MEMSAP will disseminate the results of its research to international scientific and public audiences. This stimulates good publicity for the country and shows the world what can be accomplished by building solid collaborative relationships. The Stone Age record of Malawi is not well known outside of the
boundaries of the country, and this can lead to misconceptions about how sites are distributed in Africa and how they fit into the larger picture of human evolution. Publications of our results in international journals will help to correct this, and our annual reports to the Ministry will ensure that a continuous record of all the data we recover is available as an archived resource in Malawi.
III. 2010 SURVEY IN KARONGA

Overview

Survey in Karonga in 2010 had two major objectives. First, it was important to systematically map known areas of good Chitimwe Bed exposures within 5 km of the town of Karonga, and to set in a network of permanent control points that could form the basis for future mapping. Second, we sought to locate new sites, particularly with the aim of contrasting archaeological data between river catchment systems where lithic raw material availability may have been different in the past.

Objective 1 – Mapping near the Karonga Airstrip

Rationale

Two sites (Mwanganda’s Village and the Airport Site) were subjected to intensive investigation in 2010, including excavation and sub-surface sampling of sediments for dating and geochemical correlation. Initial maps had been made in 2009 using a total station (Thompson et al. 2009), so that the data within each site were accurate relative to one another within ca. 1 – 2 cm. The 2009 maps were created based upon the UTM coordinate system, but the slight inaccuracies of a hand-held GPS meant that different sites were only accurate relative to one another within an error range of a few metres. Also owing to the limitations of hand-held GPS, neither site was mapped in 2009 in true elevation above mean sea level (AMSL). Therefore, their elevations relative to one another were unknown. This makes it difficult to move beyond the scale of the individual site and consider how different sites relate to one another across an entire landscape. The major objective of the mapping was therefore to create a single master grid system based upon UTM coordinates and real elevations within which any object or feature within the study area could be mapped within 1 – 5 cm accuracy of any another object or feature and in any dimension. This also establishes a basis for extending the grid system for mapping of sites that are located and/or investigated by any researcher in the future who works in the area.
Methods

We obtained a hand-held GPS reading whilst standing at the standard elevation survey beacon in front of the CCAP church near the airstrip. Using this reading, and the elevation reading from the beacon, we established a control point here by setting a nail into concrete that was poured into a shallow basin dug into the earth. Because we already had named control points at the excavation sites, we used the next available number, which was Control Point (CP) 8. We then set up the total station over CP8 and sighted to a new location that could be observed from that position. We set a new control point into the new location and gave it the next available number in the sequence, which was at that time CP12. We used the total station to map the three-dimensional coordinates of the new control point, moved the position of the instrument to directly over the new control point, and then sighted to a new location. Each time a new control point was established it was incised with the name (e.g. CP18), its location was described, and it was photographed both close-up and from a distance so that it could be easily re-located (Figure 3).

Figure 3 Example of a control point (CP18) that was established in the survey area.

Following this survey protocol, control points were established in a line that visually links the beacon to Mwanganda’s Village and continues along the Karonga Airstrip to the Airport Site (Figure 4). Three new control points were also established in the
Chaminade area, where we mapped some topography and took palaeomagnetic samples. However, these control points still need to be linked via survey into the master grid (Table 1). There were also three points (CP2, CP3, and CP11) that were established but became damaged and/or lost. Their coordinates are therefore not listed, and these numbers will be reassigned to new points in 2011.

**Figure 4** Satellite image of the Karonga Airstrip showing locations of control points (green dots). Blue stars represent localities from which samples were taken. Satellite image from Google Earth.
### Table 1: Locations and descriptions of all permanent control points established by the MEMSAP.

<table>
<thead>
<tr>
<th>PointName</th>
<th>UTM Easting</th>
<th>UTM Northing</th>
<th>Elevation</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>CP1</td>
<td>598473.374</td>
<td>8899315.701</td>
<td>522.428</td>
<td>On top of mound at APS</td>
</tr>
<tr>
<td>CP4</td>
<td>598459.738</td>
<td>8899290.079</td>
<td>521.311</td>
<td>To W of CP1 across gully at APS</td>
</tr>
<tr>
<td>CP5</td>
<td>598490.412</td>
<td>8899330.872</td>
<td>519.424</td>
<td>In basin near long section excavations at APS</td>
</tr>
<tr>
<td>CP6</td>
<td>598490.300</td>
<td>8899334.467</td>
<td>519.686</td>
<td>ca. 4m N of CP5</td>
</tr>
<tr>
<td>CP7</td>
<td>598481.565</td>
<td>8899330.598</td>
<td>520.630</td>
<td>ca. 8m W of CP5</td>
</tr>
<tr>
<td>CP8</td>
<td>596765.000</td>
<td>8900656.000</td>
<td>536.143</td>
<td>At beacon on the road side in front of CCAP church</td>
</tr>
<tr>
<td>CP9</td>
<td>598469.408</td>
<td>8899330.200</td>
<td>521.125</td>
<td>In basin below iron pan excavations at APS</td>
</tr>
<tr>
<td>CP10</td>
<td>598460.821</td>
<td>8899348.918</td>
<td>524.446</td>
<td>On small rise near second iron pans at APS</td>
</tr>
<tr>
<td>CP12</td>
<td>596765.000</td>
<td>8899923.068</td>
<td>535.453</td>
<td>On the side of a track that runs from the CCAP church W</td>
</tr>
<tr>
<td>CP13</td>
<td>596610.350</td>
<td>8900352.318</td>
<td>536.744</td>
<td>On the North Side of a track that runs from the CCAP church W</td>
</tr>
<tr>
<td>CP14</td>
<td>596693.541</td>
<td>8899352.188</td>
<td>535.583</td>
<td>At the edge of a mango tree</td>
</tr>
<tr>
<td>CP15</td>
<td>596775.878</td>
<td>8900260.012</td>
<td>533.478</td>
<td>Under a tree at a carpenters home</td>
</tr>
<tr>
<td>CP16</td>
<td>596926.195</td>
<td>8900141.498</td>
<td>529.691</td>
<td>On the S side of the road that immediately branches from the Chaminade school turn off</td>
</tr>
<tr>
<td>CP17</td>
<td>597089.955</td>
<td>8900279.042</td>
<td>523.251</td>
<td>Some 20m from the first right on Chaminade school road, S side</td>
</tr>
<tr>
<td>CP18</td>
<td>597127.805</td>
<td>8900350.648</td>
<td>521.820</td>
<td>E road edge of the Chaminade school road some 40m from junction with airport road.</td>
</tr>
<tr>
<td>CP19</td>
<td>597193.577</td>
<td>8900444.868</td>
<td>520.219</td>
<td>In front of a small grocery on the airport road</td>
</tr>
<tr>
<td>CP20</td>
<td>597312.355</td>
<td>8900460.000</td>
<td>524.172</td>
<td>On the high road side at the NW tip of the airport</td>
</tr>
<tr>
<td>CP21</td>
<td>597393.574</td>
<td>8900379.541</td>
<td>530.067</td>
<td>Some 30m along airport fence</td>
</tr>
<tr>
<td>CP22</td>
<td>597613.276</td>
<td>8900141.636</td>
<td>531.428</td>
<td>Along the airport fence</td>
</tr>
<tr>
<td>CP23</td>
<td>597743.028</td>
<td>8900000.854</td>
<td>532.048</td>
<td>Along the airport fence</td>
</tr>
<tr>
<td>CP24</td>
<td>597846.810</td>
<td>8899887.458</td>
<td>532.322</td>
<td>Along the airport fence</td>
</tr>
<tr>
<td>CP25</td>
<td>597878.367</td>
<td>8899385.396</td>
<td>531.792</td>
<td>Some 14m away from fence at edge of gulley</td>
</tr>
<tr>
<td>CP26</td>
<td>598102.415</td>
<td>8899611.261</td>
<td>531.670</td>
<td>Along the airport fence</td>
</tr>
<tr>
<td>CP27</td>
<td>598168.640</td>
<td>8899538.234</td>
<td>531.549</td>
<td>Along the airport fence</td>
</tr>
<tr>
<td>CP28</td>
<td>598296.215</td>
<td>8899404.142</td>
<td>531.146</td>
<td>SW corner of airport fence</td>
</tr>
<tr>
<td>CP29</td>
<td>597266.348</td>
<td>8900551.089</td>
<td>520.449</td>
<td>Edge field and gully on a path</td>
</tr>
<tr>
<td>CP30</td>
<td>597264.629</td>
<td>8900642.511</td>
<td>515.220</td>
<td>In field ; 20m from stream</td>
</tr>
<tr>
<td>CP31</td>
<td>597285.945</td>
<td>8900801.225</td>
<td>511.422</td>
<td>Along path</td>
</tr>
<tr>
<td>CP32</td>
<td>597406.695</td>
<td>8900848.082</td>
<td>511.832</td>
<td>On path in Mwanganda village</td>
</tr>
<tr>
<td>CP33</td>
<td>597416.920</td>
<td>8900832.467</td>
<td>512.754</td>
<td>A few metres up from CP32</td>
</tr>
<tr>
<td>MGDP5</td>
<td>597376.530</td>
<td>8900842.500</td>
<td>511.704</td>
<td>At the SW corner of the house closest to where the ivory flake was found</td>
</tr>
<tr>
<td>MGDP4</td>
<td>597356.985</td>
<td>8900808.753</td>
<td>513.087</td>
<td>Along the E side of a path through a cassava field S of the area where the flake was found. Easily covered with sand</td>
</tr>
<tr>
<td>MGDP3</td>
<td>597464.125</td>
<td>8900856.914</td>
<td>513.276</td>
<td>In front of NW corner of the house at p1</td>
</tr>
<tr>
<td>MGDP1</td>
<td>597497.076</td>
<td>8900862.579</td>
<td>514.326</td>
<td>On top of small spoil heap S of Clark’s excavation</td>
</tr>
</tbody>
</table>

**Chaminade Control Points - Require Integration into Master Grid**

| CP34 | 597644.000 | 8899279.000 | 536.000 | Chaminade at AAI hill |
| CP35 | 597513.173 | 8899283.859 | 531.888 | Chaminade on top of hill |
| CP36 | 597538.423 | 8899149.200 | 535.060 | Chaminade on top of tall hill |
Results and Future Work

A sound basis for future mapping in the area around the Karonga Airstrip has been established. All coordinate data collected during 2009 and 2010 from the region have been converted into a single master grid system based on the UTM grid established at the elevation beacon. This means that all coordinates from Mwanganda’s Village to the Airport Site can now be examined relative to one another within an accuracy of ca. 1 – 5 cm in any dimension, and in true elevation AMSL. All transformations of coordinate data were accomplished using a 2D conformal transform function in the Wolfpack freeware product, but in the future coordinates can be shot directly into the master grid using the control points listed in Table 1.

The three control points established in the Chaminade area must still be tied into the master grid system. Future work will focus on pushing the grid to the southwest to cover the Chaminade area, and to set in control points at the tops of hills. These hills will be mapped and sampled in detail, as their extensive erosion provides an opportunity to understand the complex inter-relationships between different lithologies and archaeological occurrences. The grid will also be pushed to the north in less detail, with control points established on high points in the landscape that have expansive viewsheds. This will allow for longer-range mapping of up to 1-2 km in a single shot, so that the northern sites located over the course of the 2010 field season can also be tied into this grid. Individual sites will receive greater detail in mapping and the establishment of control points.

Objective 2 – Location of New Sites

Rationale

It is a priority of the MEMSAP to spend part of each field season locating promising new sites that should be subjected to more intensive investigation in following seasons. Such sites can be artefact localities or localities of primarily geological significance that promise to contribute to the project goals. Clark (1968; 1970) demonstrated the richness of the Chaminade area and the potential for this locality to yield stratified and intact Middle Stone Age deposits. This, along with its proximity to the 2010 excavations,
made the eroded slopes southwest of the Chaminade Secondary School a logical place to survey for new sites.

New sites are also needed across the wider landscape in order to understand the movements of lithics (and by proxy Middle Stone Age people), potentially in concert with changing resource availability or palaeoenvironmental factors. Sourcing of lithic raw materials, either through physical characteristics of the stone or via more specific geochemical methods, is a common way to trace the movements of people and our hominin ancestors in the past (Braun et al. 2009; Braun et al. 2008). However, this is challenging on a landscape in which lithic raw materials were abundantly available in the form of secondary sources (ie: river cobbles or river terraces). Therefore, more subtle means of sourcing materials had to be envisaged for northern Malawi.

Because the entire landscape was potentially a source of lithic raw materials in the past (in the form of river or river terrace cobbles), large-scale differences between river catchment systems seemed most likely to yield detectable differences in material availability. Lithic assemblages within each catchment might be expected to show differences that could be traced back to their original catchment area – allowing the movements of people between these areas to be identified. This is a different approach from traditional ways of tracing movements of materials (and people) in the past, because it does not identify specific raw material sources and then map the movements of materials away from this source – usually displayed as dots on a map that represent sites relative to dots on a map that represent sources. Rather, this approach views the landscape as a continuous surface of variable potential, with the largest breaks in assemblage composition expected between catchments. These breaks may be characterised by a few rare rock types (perhaps from geological sources that have contributed cobbles to only one river catchment in an area), or in the form of slightly different proportions of what are otherwise the same suite of available raw material types (e.g. one might find that proportions of quartz versus quartzite vary in availability between catchments). Survey for new sites in different catchment systems is an essential part of developing and testing this model, as is sampling of non-artefactual cobble deposits to identify what the ‘background potential’ of each catchment was for supplying different raw material packages.
Methods

Time was limited for extensive and systematic survey. However, a survey team spent several days in the Chaminade area identifying new exposures where the Chitimwe-Chiwondo contact points were clearly visible. Paired sediment samples of the two lithological units were taken at these points, and will be used in geochemical correlation of the basal Chitimwe Beds. In some places the Chitimwe-Chiwondo contact is characterised by in situ Chitimwe pebbles and gravels, and in other places the contact has been reworked and/or extensively mixed together. Furthermore, it is possible that the Chitimwe Beds are variably incised into the underlying Chiwondo, with some areas containing relatively recent Chitimwe material and others containing Chitimwe deposits that date to a different phase of landscape evolution. If such phases were characterised by different source materials, then they should have different elemental compositions that can be identified using X-ray fluorescence (XRF). This is one of the methods we will use to identify changes in the landscape in the past, and to tease apart areas that may have been subject to multiple periods of deposition, erosion, and re-deposition over the course of the Middle – Late Pleistocene. It was during survey for these Chitimwe-Chiwondo exposures that new sites in the Chaminade area were recorded opportunistically.

Time constraints also limited our ability to conduct systematic survey of different river catchments. However, two exploratory excursions were undertaken in the northern part of Karonga to identify new archaeological and/or geological localities that should receive more intensive focus in coming field seasons. The North Rukuru and Lufira Rivers were designated as the foci of these excursions (Figure 5). One objective was to investigate a doleritic outcrop that was shown on Malawi Geological Survey Map 42E as being unique to the Lufira catchment. A second objective was to explore other exposures of Chitimwe Beds between the Lufira and Songwe Rivers. These excursions were undertaken on 18 and 25 July 2010 by Thompson, Welling, and Mackay.

At some localities unmodified cobbles were tested and collected to determine the availability of different raw material types in both active river and ancient river terrace
contexts. At artefactual localities cores were collected if they exhibited more than three flake scars. This was the start of a collection programme of surface cores that could inform about variability in approaches to lithic reduction within each of the investigated catchments. Even out-of-context surface cores can offer some information at this broad scale, and then localities can be revisited for more systematic collection based on the results of these analyses. Only cores were collected (rather than, for example, interesting flakes) so as to limit these analyses to broad comparisons within a single technological class rather than selecting only pieces that the investigators deem to be ‘important’ because of aesthetic or historical biases.

Figure 5 Composite satellite image showing the North Rukuru and Lufira river catchments. Investigated areas are marked with green dots, which designate control points. Image modified from Google Earth.
Only more heavily-reduced cores (those with more than three flake scars) were collected for two reasons. First, the landscape is covered with cobbles and many of these are tested or simply split open. It is simply unfeasible to collect them all, even within a limited area. Second, minimally flaked pieces are unlikely to provide much information about reduction strategies and because they are also out of context they cannot be dated to address alternative questions of change over time. Focusing on more heavily-reduced cores limited the collection to only a few pieces that can be highly informative rather than expending energy (and curation space) on pieces with little research value. The collected cores will provide general guidelines for what localities are likely to be most promising for future work, and they will form the basis of a general description of the lithic technology of northern Malawi across the broader landscape.

Results

A large outcrop of bedrock was explored where the Lufira River emerges from the western foothills and out onto the floodplain. No rock shelters or other archaeological localities were identified on it, but the cultivated field below it contained abundant stone tools. Many of these were Middle Stone Age in character and included a very fine grey-green quartzite raw material that has not yet been observed in the North Rukuru catchment (Figure 6). Other raw materials also seemed more abundant, such as crystal and milky quartz. This initially suggests that there are differences in the relative abundances of raw materials between the two catchments. However, these observations are anecdotal and systematic collections and analyses are required to test this hypothesis. All new recorded localities are illustrated in Figure 7.
An initial foray further up the Lufira River toward the dolerite dyke revealed active cobble localities but no archaeological occurrences (Figure 8). A random sample of cobbles was split open to determine if the quartzites that dominate the MSA lithic assemblages were abundant in the present-day Lufira. However, most cobbles were rough (ie: non tool-quality) quartz and micaceous stone not suitable for flaking into sharp edges. The few quartzites were intractable poor-quality yellowish stone not yet observed in the archaeological deposits. However, cobbles in the same river ca. 500 m downstream contained relatively more quartzites and included some additional colours and a wider variety of textures. Most had a ‘sugary’ appearance when split open.
Figure 7 Locations of new artefact (ART), cobble (COB), and geological (GEO) localities of interest recorded over the course of the two days of northern survey. Bottom illustration is enlargement of the cluster of sites around Kafula Ridge. Image modified from Google Earth.
Because the rough terrain would have meant a full day of exploration in pursuit of the dyke, that goal was left for future work and it was considered a more economical use of time to explore for new artefact-bearing localities further to the north. These included an outcrop of Chitimwe Beds apparently resting on top of a variable Chiwondo/bedrock surface. The top of the outcrop was covered in broken lithics, predominately made on fine-grained quartzite. Most of the edges of the lithics were unweathered, and suggested recent exposure. Unmodified cobbles were abundant, as were several ‘tested’ and split cobbles, as well as large flakes (Figure 9).

A series of localities were discovered further to the north, in the area of the Kasantha and Kafula Rivers. Both are tributaries of the Lufira. These localities are briefly described here, with more detail on Kafula Ridge West provided in the Excavations section of this report.
Kafula Ridge 1 (KR1) – 36L 0589090 mE 0589090 mN
This locality was a smattering of large, heavily eroded quartzite cores and flakes exposed on a path on the crest of the ridge immediately west of the Kafula River. We also noted one bipolar quartz core and a small retouched quartz flake. The slope along the path was moderate and the artefacts were distributed within a reasonably limited area. It was not clear whether they had been rolled or eroded *in situ*. No quartzite cobbles were noted in this area and the background rocks were almost invariably small to moderate fragments of quartz. This initially appears to have been an area of high ground in which cobbles were not available in the immediate vicinity, but at present the geomorphological history of the ridge is unknown.

Kafula Ridge Foothills 1 (KRF2) – 36L 0589033 mE 8920589 mN
This locality occurred on the crest of a spur in an area where the slope was somewhat reduced. A few quartzite flakes were noted. All were heavily eroded. No quartzite cobbles were observed in this area and the background rocks were almost invariably small fragments of quartz.
Kafula Ridge Red Beds 1 (KRRB1) – 36L 0589454 mE 8920530 mN
This locality relates to a small area of apparent red beds occurring on the side of a ridge. Upon arrival it was determined that the alleged red beds were in fact reddish-coloured grass. However, flakes were noted and again all were heavily eroded. Small quartzite pebbles and some cobbles up to 70 mm were noted in the area but the surrounding surface geology was generally quartz and no unmodified cobbles were observed.

Kafula Ridge 2 (KR2) – 36L 0589653 mE 8920601 mN
This locality occurred on the side of a ridge above the floodplain and relates to an extensive scatter of heavily eroded flakes and cores extending down the slope among quartzite cobbles. A single silcrete flake with no cortex and a faceted platform was noted. All observed cores were collected from an area ca. 10 x 10 m of the GPS point.
Figure 10  Eroded gully showing location and context of in situ artefacts. This became the site of a 1 x 1 m test pit designated KRW1 TP1. These excavations are treated in more detail later.

**Kafula Ridge West 1 (KRW1) - 36L 0589758 mE 8920658 mN**

This locality occurred at the base of the slope below KR2 in a steep-sided gully. The artefacts in this area were less heavily eroded than those upslope and several were noted in situ in an eroded section. Quartzite cobbles were abundant on the surface of the area. Only surface cores were collected during initial survey. However, the site was revisited on four occasions over the course of the 2010 field season. A 1 x 1 m test pit was excavated in the section with the in situ artefacts, and the downslope pathway in the erosion gully was screened to recover more associated artefacts (Figure 10).
Figure 11 Opposing sections of the gully at KRW2. Both scales are 25 cm. Yellow box denotes area from which an OSL sample was taken immediately below recovered cores. The colour difference is attributable to two different cameras and times of day for the shots.

Kafula Ridge West 2 (KRW2) – 36L 0589752 mE 8920684 mN
This locality refers to a few heavily eroded flakes and cores found in a field of quartzite cobbles. The area appears to have undergone recent surface modification, possibly relating to quarrying. Only cores were collected. A deep gully was incised into this field, ca. 30 m to the north of the KRW1 locality. This was named Kafula Ridge West 2 Section (KRW2 Sec). When viewed from a nearby hill, it became apparent that the section runs downslope roughly through the centre of a colluvial fan. Only cores were collected, and these were taken from the section (Figure 11).
The cobble bed to which KRW2 relates was clearly the uppermost layer in the section. Artefacts in this context were generally heavily eroded, but several were also recovered from the base of this unit (which progressively comprised finer sediment) and are much less heavily eroded. An OSL sample was taken from the eastern section of the gully below the recovered cores. Below this a grey-white lithology was observed that may be an exposure of the Chiwondo Beds.

**False Disappearing Hill 1 (FDH1) – 36L 0589873 mE 8920693 mN**

This was a large eroding hill covered in quartzite cobbles. Only a few artefacts were found at the base and at the top. Those at the top were heavily eroded; those at the base were both heavily eroded and somewhat fresher. The cores taken for the sample derive only from the base of the hill. Near this point there is a large crack (or possibly erosion gully) up to 5 m deep with at least 2.5 m of exposed Chitimwe cobbles (Figure 12). These lie at the confluence of FDH1 and the large colluvial fan of KRW2, and may be reworked deposit.

**Levallois Flats 1 (LF1) – 36L 0589643 mE 8920918 mN**

This locality relates to a small area where several artefacts (including some with Levallois technology) were eroding out of what appeared to be a remnant area of red beds on the modern alluvial flats. There were a few unworked quartzite cobbles in the area. Only cores were collected. The section containing the eroding artefacts appears to be intact, but only ca. 40 cm in depth.
Figure 12 Preliminary contour map of the area around Kafula Ridge West 1. Red dots denote control points. The two control points to the far east are emplaced on the top of False Disappearing Hill 1 and the large earth crack/erosion gully is visible in the satellite image immediately to the northeast. Satellite image from Google Earth.

Ighembe Ridge 1 (IR1) – 36L 0590638 mE 8928944 mN

A new locality was also discovered ca. 5 km south of the Malawi/Tanzania border, which is defined by the Songwe River. This introduces the possibility of another major river catchment that can be used to compare lithic reduction and the movements of raw materials across the palaeolandscape. This could be particularly fruitful if it is linked with more recent work in the Songwe basin on the Tanzanian side of the border (Willoughby 2001; Willoughby and Sipe 2002). Another very large area of red beds was observed, and a track affords access directly up the side of the exposure. However, it should be noted that the geological map shows Chiwondo but not Chitimwe Beds in this area. At a high point along the track we observed abundant cobbles of quartzite and numerous cores generally of quasi-Levallois (tortoise-shell) form. Most notably these cores had a well-defined perimeter and two hemispheres. In most cases the ‘upper’ hemisphere retained cortex and had only ~40% of its surface exploited while scars extended across the entire ‘lower’ surface (Figure 13).
Figure 13 Examples of the ‘lower’ exploited surface of ‘tortoise-shell’ cores from Ighembe Ridge 1. These cores were collected from the surface of an area ca. 20 x 20 m in extent.

**Ighembe Ridge 2 (IR2) – 36L 8928928 mE 8928944 mN**

A fascinating geological locality was discovered further along the track from IR1. The road had cut a section into red beds overlying grey beds, which was reminiscent of the Chitimwe-Chiwondo contact situation further to the south. The red beds are capped at the top by a deflated pavement of cobbles and potentially artefacts – although time did not allow for systematic survey. The red beds were underlain by a potential ash deposit ranging from 0.25 – 0.75 m in thickness (Figure 14).

The majority of the MEMSAP has so far focused on the Chitimwe Beds about 30 km to the south, where no Middle-Upper Pleistocene volcanic deposits of any kind have been reported. Volcanic deposits in association with MSA sites are present on the Tanzanian side of the Songwe (Willoughby and Sipe 2002), and about 45 km north of the Malawi-Tanzania border the Rungwe Volcanic Province marks the junction of the Malawi Rift, Rukwa/Tanganyika Rift and the Usangu Basin. The three large volcanic centres, Ngozi caldera, Rungwe, and Kyejo, are controlled by the local tectonic context and Kyejo in particular began extruding volcanic deposits during the Middle Pleistocene (Fontijn et al. 2010). The oldest flow likely began with Kyejo, and is dated at 0.42 ± 0.03 Ma (Ebinger et al. 1989). If some of these deposits became associated with the Middle Stone Age tools at Ighembe Ridge, this might open up new possibilities for dating the MSA of this part of northern Malawi.
Another interesting aspect of this section is found within and below the brown-grey silt. In one part of the section the brown silts continue to an unknown depth, but contain intersecting lines of pebbles that are likely *in situ*. At another part about 20 m to the west, waxy clays ranging from green to pink in colour are intercalated with very fine white deposits that break into distinct blocky structures. The closest analogues known in the experience of the authors are the lacustrine clays and diatomite deposits found at Olduvai Gorge, Tanzania. A second bed of white clay (diatomite?) at least 1.5 m thick was found exposed at 36L 0591040 mE, 8929244 mN. An unscaled sketch of the stratigraphic relationships is provided in Figure 15.
Future Work

The survey activities near the lakeshore in the northern part of Karonga have confirmed that rich exposures containing *in situ* Middle Stone Age artefacts are both present and likely abundant all the way to the Tanzanian border. One locality in particular (Kafula Ridge West 1) has been identified as a site that potentially preserves lithic artefacts with near-pristine spatial integrity relative to where they were originally manufactured and/or discarded.
A variety of new cobble localities have been identified and these will provide the starting point for more systematic collections and analyses of unmodified cobbles across the landscape. These collections will enable an understanding of the background availability of different lithic raw materials (in the form of river or river terrace cobbles), their quality, and the sizes in which they were available. These data can then be linked to archaeological data to understand how MSA people were exploiting and moving around upon what was effectively a continuous surface of potential lithic raw material resources.

At Ighembe Ridge potential volcanic deposits have been identified, and these will be subjected to more rigorous analysis and mapping to determine their relationship to the artefacts in the area and their potential to provide radiometric Ar-Ar ages. To begin this process, samples of the potential ash, waxy clay, and diatomite were taken and are currently in quarantine at the University of Queensland. These will be subjected to more intensive analyses to identify their composition and likely origin.
IV. 2010 EXCAVATIONS

Methods and Protocols

Two main sites within the Chitimwe Beds were investigated via excavation over the course of the six-week field season in Karonga in 2010. These were the Airport Site and Mwanganda’s Village (note southern and northern-most blue stars in Figure 4). Base maps of the modern topography had been produced in 2009 from points taken with a total station. The objectives for each excavation had also been laid out in 2009 and 2010 based on those pilot field observations. We elected to excavate a test pit at Kafula Ridge West 1 as well, after establishing that an very promising in situ series of buried lithics was rapidly eroding down the gully and would not likely be present the following year.

All site mapping, including piece-plotting, was conducted with a total station following the protocols developed by Marean et al. (2010). Stratigraphic profiles were drawn using points obtained with a total station, and digital section photographs were taken with and without paper targets inserted into the section. The three-dimensional coordinates of those targets were obtained with the total station so that the section photographs could be georectified to real-world coordinates. This resulted in maps and section drawings that more closely approximated the reality of what was excavated than using traditional means of section drawing and mapping by hand.

Where a lot of points had to be plotted and the coordinates tied into a specimen number (ie: for the hundreds of piece-plotted surface specimens at the Airport Site), a hand-held computer was used to operate the total station. This was in turn linked to a Bluetooth barcode scanner, and pre-printed specimen labels with barcodes were used to package each artefact as it was collected. This procedure ensured that specimen numbers were not accidentally duplicated and provided digital spreadsheets of coordinate data with attached attribute information that could be downloaded directly from the total station without the transcription error than can occur when large quantities of data are manually or verbally transferred.
Screen-washing of all excavated sediments was undertaken where it was practical to do so, and the residue was dried and sorted back at the ‘dig house’, which also doubled as a field lab. However, because water sources were not available on site this meant that excavated material had to be transported in large maize sacks to the field lab for washing. Therefore, samples were taken from larger excavations for screen-washing and the remainder was dry-screened on site through a 2 mm window mesh.

Excavation squares were named by the southwestern coordinates of their location within an individual site grid system. At APS the grid was an arbitrary site grid, with Control Point 5 located at point E100N100. Therefore, for example, square E58N98 at APS would occur at 58 m east and 98 m north of the grid origin. At Mwanganda’s Village the last digits of UTM coordinates were used. Four digits were used in the easting and three in the northing; for example E7491N866 would represent the southwestern corner of a 1 x 1 m square located at UTM 36L 597491 mE 8900866 mN. These names are retained as square names throughout the 2010 paperwork, but all coordinates have since been transformed into a single master grid based on the elevation beacon-based grid. Therefore, the square names are no longer identical to their coordinate locations within the grid. Subsequent excavations will all have excavation squares named according to the master grid.

The majority of work undertaken at the Airport Site was directed by Thompson, with particular assistance from Antiquities Officers Simfukwe and Malijani. Most of the work at Mwanganda’s Village was directed by Welling, who delegated many tasks in one excavation area to recent CUNIMA graduate Rachel Warren. Excavations at Kafula Ridge West 1 were begun by Mackay and Malijani and completed by Mackay and Thompson on a weekend when time became scarce.

At the end of the field season all excavated areas were back-filled with the residue that had passed through the screen. This was effective for most excavations except for one area at the Airport Site (the ‘long section’), where excavations had proceeded into a section that was already exposed prior to digging. Therefore, back-filled sediment tended to slump back down the exposed side of the section and could not be stabilised enough to reach the top of the excavated area. We noted that the sediments here were
extremely hard, and likely to remain in place until next year when we plan to return with sandbags to rebuild the section.

**Airport Site**

**Overview**

The Airport Site (APS) received the most excavation focus in 2010 (Figure 16). It is located at the southeastern side of the Chaminade area, and is named for its proximity to the Karonga Airstrip. Its existence has been known at least since the 1970’s, when Kaufulu (1983) noted that gravel pits had been dug in the area, and that these provided geological exposures representative of the Chitimwe Beds.

![Figure 16 Overview of the study area in Karonga, Malawi (SRTM data), showing the location of the Airport Site. Note the proximity to the Site 2 palaeoenvironmental drill core record (Scholz et al. 2007). The artifact-bearing Chitimwe Beds are restricted to the light, low-lying area adjacent to the western lakeshore.](image)
APS is characterised by a general sequence of Chiwondo Beds overlain by Chitimwe cobbles. These are in turn covered by coarse sand and capped at the top by finer sand. The entire sequence is oxidised, and lateritic alteration of the sediments is apparent in iron pan formation at the juncture between the coarse and fine sands in the northwestern part of the site. Where these iron pans are exposed at the surface, hundreds of artefacts have become deflated on top of them, but artefacts within and below them should have remained *in situ* (Figure 17).

![Figure 17 Close-up of iron pan nodules. Note artefacts embedded within and below the nodules.](image)

**Target Problems**

Pilot survey and sampling in 2009 guided the excavations in 2010. In 2009 much of the Chitimwe sequence could be observed in an area designated at the ‘long section’ because previous gravel extraction for road improvement had resulted in a long exposed section. The northwestern area is designated as the ‘iron pans’ because of the presence of iron nodules eroding from the section left by gravel extraction. The iron pans were located ca. 36 metres to the west and northwest of the long section (Figure 18). Excavation at the site had five main goals:

1. Obtain a large sample of Middle Stone Age lithics from an excavated context for analysis;
2. Determine the degree to which artefacts are *in situ*;
3. Understand the distribution of artefacts within different lithofacies at the site;
4. Correlate the stratigraphy between the long section and the iron pans; and

...
5) Open sufficient sections for sampling of sediments from the profile.

**Excavation**

Excavations focused on the long section and iron pans, with four additional test pits emplaced between the two areas to determine how the deposits correlated with one another. A total area of 6 m² (total volume 4.42 m³) was excavated in adjacent 1 x 1 m test pits from the long section, using the exposed stratigraphy as a guide. A control square was designated, and this was excavated in arbitrary 10 cm spits until a change in lithology was noted. All sediments from this square were screen-washed through a 2 mm screen, and sediments from all other long section excavations were dry-screened on site through a 2 mm mesh. Artefacts of any size that were discovered over the course of excavation were piece-plotted, resulting in a total of 112 specimens. Analysis of sieved material is currently underway.

![Contour map of the Airport Site at 0.5 m intervals, showing excavated areas (white squares). The long section is at the far east and the iron pans are at the far west.](image_url)
The iron pans were selected for excavation because: 1) sharp, unweathered lithic artefacts were abundantly distributed on the surface, suggesting that a large sample could be readily obtained; and 2) artefacts could be seen within and underneath the iron pans in section, indicating that a proportion of the assemblage had been in situ since the iron pan formed (Figure 17). Because of the abundance of artefacts, a total area of 2 m$^2$ (total volume 0.66 m$^3$) was excavated in adjacent 50 x 50 cm subsquares. Arbitrary 5 cm spits were used until a change in lithostratigraphy became apparent. Artefacts of any size that were discovered over the course of excavation were piece-plotted and all sediments were screen-washed through a 2 mm screen. As the iron pans were rapidly eroding in the excavated location, all loose surface artefacts within a 1-metre buffer of the excavation area were piece-plotted and collected to conserve them and provide a larger sample for analysis. A total of 1,665 specimens were piece-plotted from the excavated area and an additional 664 were piece-plotted from the surface in the buffer zone. Analysis of screen-washed material from the excavated squares is currently underway.

**Stratigraphy and Results**

There are some immediately observable differences between the two excavation areas. One has iron pans and a high concentration of artefacts (approximately 2.5 artefacts/liter of sediment). The long section lacks iron nodule formation and has a concentration of artefacts that is two orders of magnitude lower than observed at the iron pans (approximately 0.025 artefacts/liter of sediment). Several smaller geological test pits were excavated primarily along the northern part of the eroding section to correlate the lithostratigraphy between the two excavation areas, and a detailed topographic map was created for context. A summary of the stratigraphy and correlations is provided in Figure 19. Subtle differences in color, texture, and inclusions between the excavation areas suggest that different facies within the same generalized Chitimwe sequence are represented across the site. Artefacts were concentrated at the top of the iron pan deposits, although several were also found in situ below the nodules at both the iron pan and geological trench localities. The majority of artefacts from the long section were found on top of and incorporated into the first 5 – 10 cm of the cobble horizon. All illustrated basal units continue into unexcavated deposits below.
The vertical and horizontal scales for the three areas are true relative to one another, but the distances between sections have been compressed for illustration (distances indicated in metre). The iron pan deposits were capped by iron nodules that tapered and disappeared toward the west. Hence, the iron pan itself is not represented in the west section but its approximate location at the top of the sequence is indicated with an arrow.

The long section excavations revealed a sequence of up to 1 m of fine red sand that appeared to become progressively coarser toward the base. Confirmation of this is underway through particle size analysis of bulk sediment samples that were taken from each spit in the sequence. However, after the section was exposed it became apparent
that there was a more distinct separation between the fine upper sands and the coarse lower sands. Rather than a continuous fining-up sequence, the long section sands appear to represent two episodes of deposition. Below this a cobble horizon ca. 10 cm in depth overlies a series of alternating pebble and cobble layers. This becomes intermixed with sediment of a more grey than red colour, eventually giving way to clay-rich sediment at the base that contains abundant feldspar blocks in addition to cobbles. This was considered to be well within the Chiwondo horizon and excavations were stopped (Figure 20).

![Georectified and stitched photograph of the north wall of the long section excavations.](image)

**Figure 20** Georectified and stitched photograph of the north wall of the long section excavations. Yellow circles represent piece-plotted artefacts and blue stars represent samples. Note that the deposits slope slightly downward away from the viewer, and that yellow dots represent artefacts excavated within a 1-metre line from north to south.

Some artefacts were found distributed within the upper sands, but most were recovered in the screen and await analysis. The general impression is that there were very few, perhaps less than ten. The majority of artefacts were recovered from the upper 5 – 10 cm of the cobble horizon (Figure 20). These were not resting on top of the cobbles but were rather intermixed within them (Figure 21).
At the iron pans very little sediment remained on top of the pans. Only a ca. 50 cm x 1 m surface area of iron pans had been exposed by erosion, so excavations were planned in hope that it would disappear into section and allow observations on sediments and artefacts both above and below the iron nodules. However, excavation revealed that the pans were discontinuous, and did not penetrate far into the section. Instead, they capped and slightly intruded into a sequence of coarse sand that in turn overlay a cobble horizon. At the base of this horizon more cobbles appeared within a grey matrix that was taken to be the Chiwondo Beds.

**Figure 21** Plan view of the cobble horizon that underlies the sands at the long section. Asterisks denote artefacts that have just been uncovered.
Artefacts were abundant on top of the iron pans, but many were loose and had likely deflated down onto the nodules. However, several exhibited iron nodule formation on their surfaces or were clearly embedded within or below the iron nodules. A distinction was made while excavating between artefacts that were above and artefacts that were below the iron pans. This was not possible in some areas, where the nodules were not present. Artefacts remained abundant within the uppermost coarse sandy matrix, regardless of their position relative to the iron pan. However, ca. 2 cm below the pans the sand became even coarser and had a visible component of larger rounded quartz fragments. These gave the impression of sediment that was greyer in colour, but this might also be attributable to bioturbation of finer sediments upward from the underlying Chiwondo Beds. Within these coarser sands artefacts were present but not as abundant. There was a clear distinction between this sedimentary unit and the underlying cobble/pebble horizon. The underlying horizon also contained artefacts but they were very sparse and mainly found within the uppermost 5 cm. This situation was reminiscent of that at the long section, where almost all artefacts were found incorporated into the very top of the cobble horizon.
However, there were some key differences between the details of the stratigraphic sequence at the two main excavation areas. First, the long section did not contain any iron nodule formation. Second, artefacts were much more abundant at the iron pans and most of these likely derived from the overlying sands that had since been eroded away. Thus, correlation of the stratigraphy between the two excavation areas became very important. As part of this, attempts were made to identify the lateral extent of the iron pan formations and to excavate a sequence that included the iron pans in section. This procedure involved the establishment of several geological test pits. Though their primary purpose was geological, these were excavated archaeologically (including piece-plotting) to maximise the quality of data that were recovered.

**Figure 23** Oblique plan view of the cobble horizon underlying the coarse sands at the iron pans. Note the similarity to the cobbles at the long section, with artefacts sparsely intermixed amongst the cobbles (including the largest cobble in the bottom right). Trowel indicates north.

The long section and iron pans were separated from one another by a large basin up to 100 m in width that had been excavated for gravel extraction to build the airstrip. The Chiwondo Beds appeared at the iron pans ca. 2.5 m higher than they did at the long section, so it was hoped that a physical connection could be made between both excavation areas, starting with a 1 x 2 m geological trench in the centre of the basin.
This trench revealed a sequence of finely-laminated red sands directly overlying grey clay with cobbles (Chiwondo Beds). The grey sediments had small strings of red sediment penetrating into them, perhaps as the result of root or insect bioturbation. However, the contact is much more distinct than at either main excavation area, and what appears to be modern charcoal was found in the sands. The current interpretation is that gravel extraction extended well into the Chiwondo Beds in the area separating the long section from the iron pans, and the red sands at the top of the geological trench represent subsequent reworking of surrounding Chitimwe sands through aeolian deposition or slopewash into the basin.

It is worth noting that ca. 5 cm into the Chiwondo Beds, a chunk of clay was lifted to reveal an artefact *in situ* (Figure 24). Reports of artefacts in the Chiwondo Beds are all based on finds near the Chitimwe – Chiwondo contact (Clark and Haynes 1970; Kafululu and Stern 1987), although some have been met with controversy (Juwayeyi and Betzler 1995). In this case it is impossible to tell how far above the artefact the Chitimwe-Chiwondo contact may originally have been, but it may be worthwhile to consider a larger excavation in this area to see if any other *in situ* artefacts can be located.

*Figure 24* North section of the geological trench. Image at top right shows core *in situ* under distinctly grey sediments and image at bottom right shows the artefact in more detail.
A second 1 x 2 m geological trench was sunk 11 m to the north on the margin of the basin, and it was hoped that it would clarify the relationship between the sediments at the iron pans and the sediments at the long section. In this case the uppermost (artefact-bearing) deposits had been eroded away, leaving only basal Chitimwe cobbles and uppermost Chiwondo Bed clays. The contact point is clearly visible in this area, as is the slope that explains why the Chiwondo Beds occur so much higher in elevation at the iron pans than they do at the long section (Figure 25). The Chitimwe cobbles here likely correlate with the lowermost Chitimwe cobbles at the long section, and consistent with this is the fact that neither contained artefacts.

![Figure 25 South section of the section geological trench showing Chitimwe cobbles overlying a clear slope (downhill is east) in the grey Chiwondo Beds.](image)

A small 50 x 50 cm test pit was excavated 6 m to the west, where the deposit was thicker and the uppermost artefact-bearing deposits were likely to be represented. They were, and artefacts were found in situ. However, in this case the entire sequence (including the iron pans themselves) was not strictly present. The iron pans were only represented as remnant occasional iron nodules, although these were found to occur at a junction between finer upper sands and coarser lower sands. Artefacts were concentrated just above this junction (Figure 26).
Figure 26 North section of a 50 x 50 cm test pit excavated in hopes of discovering the iron pans in section. A few iron nodules are present, but this area appears to represent the easternmost extent of the iron pans at the site. Lithics, iron nodules, and a contact between fine and coarse sand are all discernable in the image.

The discontinuous nature of the iron pans made it difficult to identify a location at the Airport Site where they could be captured in section. Wherever they outcropped, erosional processes appeared to have removed most of the sediments that used to overlie them. In some cases adjacent sediments would be intact, but the relationship of the iron nodule formation to those sediments could not be directly observed. A final geological pit was excavated that solved this problem, as the iron pans were distinctly present as a continuous feature across the excavated area (Figure 27). This locality demonstrated that the pans likely formed at a juncture between upper sands and coarser lower sands. Artefacts are concentrated in a band both above and below this same juncture that is about 20 cm in maximum thickness. More artefacts are scattered amongst sediments in the underlying horizon, which has abundant cobbles and pebbles but not at the same density as the deposits at either the iron pans or the long section. This demonstrates a degree of variability in the nature of the Chitimwe-Chiwondo contact even across very short distances.
Figure 27 Georectified photograph of the north section of a 50 cm x 1 m test pit in which the iron pans were located in situ (note that more distortion will be present near the bottom because a level photograph could not be achieved for the entire section). Yellow dots represent piece-plotted artefacts and blue stars represent sample locations.

Future Work – Research

Initial excavations at APS have ceased, but there are several aspects of the site that merit further investigation. Many of these are primarily geological, and obtaining dates from the site will be an important aspect of all future work. However, there are also specific archaeological goals that could be met through further excavation.

- Open an area large enough in lateral extent to determine the spatial distribution of artefacts upon the ancient cobble surface;
- Open an area large enough to clarify the vertical distribution of artefacts relative to the iron pans in the upper sands; ie: do most artefacts occur above, below, or
within the pans? Currently, the sample of artefacts from a locality containing the iron pans in section is too small to address this statistically;

- Obtain, through the above approaches to excavation, a large enough excavated sample of silcrete artefacts to investigate preliminary patterns of differential reduction by raw material type;

- Obtain, through the above approaches to excavation, a large enough excavated sample of artefacts associated with the cobble horizon to compare them (in terms of raw material, technology, taphonomy, etc.) to the excavated sample from the iron pans.

This future work could become increasingly urgent over the next several years. Karonga is expanding in population and infrastructure, particularly with the presence of the Paladin Uranium Mine, and commercial flights have commenced transit to the Karonga airport. This could result in immediate plans to extend the airstrip, which would destroy what is left of the site. The first phase of airport building resulted in gravel extraction from the site, and most of these ‘gravels’ were in fact artefact-bearing cobbles and iron pans. In any event, the extremely valuable in situ artefact accumulations with iron pans in section lie directly under the current dirt track that skirts the airstrip fence. Such instances of interstratification do not occur elsewhere at the Airport Site. If the access road was improved or the airstrip was extended out over it to the southeast, this particularly valuable part of the site would be destroyed. There are nearby areas where the deposits have experienced a great deal of post-depositional movement and the gravels do not have the same cultural significance. Such areas could provide the materials needed for building without impacting deposits of high scientific and cultural significance. This means that both goals of airport improvement and cultural site conservation could be achieved through close collaboration between Malawi Antiquities and the Karonga Airport stakeholders during future building plans. A cultural impact assessment is recommended if further large-scale construction in the area is set to commence, as this can guide both site management and development plans.
Future Work – Heritage Management and Community Liaison

The Airport Site is close enough to Karonga and rich enough archaeologically that it is in many ways the ideal place to construct a site museum. Latex peels of sections and original artefacts from the site could be displayed at the Karonga Museum, along with an introduction to the Middle Stone Age and the Pleistocene prehistory that is so abundant in the Karonga District. The site’s proximity to the Museum means that guided tours could easily bring visitors out to the site to see the original sections themselves, with artefacts in situ, thus providing a new income stream for the Museum and educating people about the region’s archaeology in a more interactive manner. The stratigraphy at the Airport Site is relatively simple and provides an excellent introduction to geoarchaeological principles, and the sediments are indurated and resistant to mechanical weathering. This means that a simple construction over an exposed section and/or exposed lateral extension would require very little consolidation and maintenance if it were left open under the construction as an exhibit.

Such a construction could also operate as a small shop or café (much like the Mbande Café at the Museum), to draw additional visitors. It would give people who live immediately around the site awareness of and pride in the incredible heritage they have right on their doorsteps. During the 2010 excavations many local people, especially those attending Chaminade Secondary School, stopped to ask what we were doing and became very interested in the work. Most had been unaware of the presence of an archaeological site there, and indeed until we began excavations some people used the gravel pits as a latrine. Raising awareness through local heritage engagement could provide real benefits to the people who live nearby: employment, international recognition, and conservation for this potentially very rare and important site.

Mwanganda’s Village

Overview

Mwanganda’s Village is a site in the Karonga District of northern Malawi, and one of the best-reported MSA sites from Malawi (Clark and Haynes 1970; Kafulu 1990; Kafulu 1983). It is heavily referenced as an early MSA occurrence with Sangoan stone tool
technology and as a proboscidean butchery locality (McBrearty 1988; Mussi and Villa 2008; Surovell and Waguespack 2008; Surovell et al. 2005). It is also only one of two published MSA sites from northern Malawi and one of a handful from central Africa. These factors make Mwanganda’s Village a critical reference point for workers seeking to understand larger patterns of behavioural change during the MSA.

The Mwanganda site has been investigated twice over the course of the last fifty years. J. Desmond Clark excavated a large area in 1966, uncovering the partial skeleton of a single elephant in association with stone tools he assigned to the Middle Pleistocene stone tool industry referred to as the Sangoan (Clark and Haynes 1970). The area with the elephant was designated as Area 1, and an area immediately upslope to the south was designated as Area 2. Zefe Kaufulu revisited Mwangana’s Village while collecting data for his (1983) dissertation. He dug 17 geological trenches in the area around the Mwanganda site, including 5 trenches along the sides of Clark’s excavations (Figure 28). It is not clear in which year these trenches were dug, although it seems likely that they were in the late 1970’s given the timing of Kaufulu’s dissertation and personal communication (August 2009) from Chimwemwe, the brother of the current Chief Mwanganda. Chimwemwe informed us he was involved in the excavation of several of these trenches, and was able to show three of them to us in August 2009. None have been back-filled.
Figure 28 Digital Elevation Model (DEM) of Mwanganda’s Village (lighter areas are higher), overlain with a basic geological map created by Kafulu (1983). Not all of Kafulu’s geological trenches are within the map boundaries. Stars represent various samples (e.g. sediment, micromorphology, dating) taken by the MEMSAP. Excavation areas are from Clark and Haynes (1970) and Kafulu (1990; 1983).

Kafulu (1990; 1983) reassessed the stratigraphy as outlined by Clark and Haynes (1970) and provided an overview of the lithological sequence of the region (Table 2). In essence, the reconstructed depositional sequence at the site is as follows: 1) Floodplain conditions during the Plio-Pleistocene, leading to deposition of the upper Chiwondo deposits; 2) Subaerial exposure leading to formation of an artefact- and fossil-bearing palaeosols formed on the very top of the Chiwondo Beds; 3) Slopewash and
accumulation of a carbonate layer; 4) Prolonged aggradation of the sand and pebble facies of the iron-rich Chitimwe Beds (Kaufulu 1990).

Table 2 Lithology of the Mwanganda site (modified from Kaufulu [1990:18]).

<table>
<thead>
<tr>
<th>Lithology (Kaufulu 1990)*</th>
<th>Designation</th>
<th>Lithology (Clark and Haynes 1970)</th>
<th>Designation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stony soil</td>
<td>Unit 8</td>
<td>Light brownish sand</td>
<td>Qk</td>
</tr>
<tr>
<td>Light red sandstone with basal gravel</td>
<td>Unit 7</td>
<td>Light red sand</td>
<td>Qct_2b</td>
</tr>
<tr>
<td>Dark brown muddy sandstone</td>
<td>Unit 6</td>
<td>Sandy pebble gravel</td>
<td>Qct_2a</td>
</tr>
<tr>
<td>Caliche</td>
<td>Unit 5</td>
<td>Dark brown sand</td>
<td>Qct_1b</td>
</tr>
<tr>
<td>Pale grayish orange sandstone</td>
<td>Unit 3</td>
<td>Caliche pebble-gravel</td>
<td>Qct_1a</td>
</tr>
<tr>
<td>Greenish/brownish gray sandy claystone</td>
<td>Unit 2</td>
<td>Dark greyish-brown sand</td>
<td>Qco_1c</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greenish gray clayey sand</td>
<td>Qco_1b</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Greenish gray sandy clay</td>
<td>Qco_1a</td>
</tr>
</tbody>
</table>

*Units not observed to occur at the site but that occur in the region are not included.

The assignment of Mwanganda’s Village as a ‘Sangoan butchery site’ rests on several assumptions that could not be tested using the methods and techniques available at the time the elephant and associated artefacts were originally excavated. The MEMSAP has identified these problems as issues that warrant further investigation, and includes resolution of these issues in its broader research agenda.

Target Problems

In spite of its significance as a potentially early central African MSA site in association with fossil fauna, five major issues about the Mwanganda’s Village site remain unknown or open to question, thus undermining its research value:

1) **What is the chronometric age of the artefactual and ecofactual assemblages?** A single date of ca. 300 ka has been reported from Mwanganda’s Village. It was a rubidium-strontium date on the caliche horizon immediately overlying the artefact- and fossil-bearing palaeosol (Kaufulu 1990). This date was only cited as personal communication from Clark to Kaufulu, and typically the method is only applied to magmatic rocks millions to hundreds of millions of years old (Walther 2009). This suggests that the date should be taken with a serious grain of salt, and furthermore only provides a minimum age estimate for the sediments overlying the archaeological occurrences. Even if the Rb/Sr age is reliable, the caliche horizon itself
has been interpreted as deposition that took place after a major erosional event that truncated the palaeosol containing the artefacts. Given these factors, and given that the palaeosol itself was reportedly formed on the top of the Pliocene Chiwondo Beds, the age of the artefacts and fossils at Mwanganda’s Village remains open to question. Good chronological control has rarely been obtained for early MSA sites, which makes it difficult to discern the timing and nature of the important behavioural and technological changes that took place at this time (Clark, 2001; Tryon, et al., 2005; Tryon & McBrearty, 2006). Obtaining multiple reliable dates from Mwanganda’s Village will improve this situation and allow consideration of how assemblages from the site fit into the larger picture of MSA behaviour.

2) **What was the functional relationship of the stone tools to the fossils that were recovered from the site?** Several purported Palaeolithic proboscidean hunting and/or butchery sites have been systematically re-evaluated on the basis of taphonomic research (Villa et al. 2005), but the fossil assemblage from Mwanganda’s Village has never been examined for hominin modification or other indications of a behavioural association with the MSA artefacts. This casts doubt on the entire site interpretation as an ‘elephant butchery site’ (Clark and Haynes 1970). A systematic taphonomic analysis is necessary before any behavioural association between the artefacts and fossils at the site can be inferred and further perpetuated in the literature.

3) **What are the technological attributes of the stone tool assemblage?** In some cases early MSA lithic assemblages include a large core tool component similar to the preceding Acheulean, while in others they include finely-made lanceolate points indicative of a high degree of craftsmanship. Collectively, they are referred to as the Sangoan-Lupemban complex, but their wider function and chronology are poorly understood outside of east Africa (Clark 1964; Clark 2001; Clark and Haynes 1970; Cornelissen 1995; Kingston and McBrearty 1993; Kuman et al. 2007; McBrearty 1987; McBrearty 1988; McBrearty 1990; McBrearty 1992; McBrearty and Clark 1991; Van Peer et al. 2003). The Mwanganda’s Village assemblage was assigned to the Sangoan industry based on the relatively large size of cores, the absence of large cutting tools (handaxes and cleavers), and the presence of “crude core-axes and high frequency of concave, notched, and denticulate pieces” (Clark & Haynes 1970:402).
trip in 2009 to the Mwanganda site confirmed the presence of a core-axe tip but the find was a surface occurrence. Furthermore, the use of ‘fossil directeurs’ such as these is largely a typological approach, and a full technological analysis is needed to address how the tools were made, their probable function, and how they relate to other reported Sangoan assemblages.

4) What fine-scale site formation processes were in operation? Mwanganda’s Village has been interpreted as a braided stream edge with minimal disturbance (Kaufulu 1990), but this work is based on sedimentary attributes that can be resolved with the naked eye and requires refinement using micromorphological and geochemical analyses. Detailed plans of the original excavations show the horizontal arrangement of fossils and stone tools that were found within the same sedimentary horizon (Clark & Haynes, 1970). However, it has been shown that piece-plotting and taking orientations for materials by hand to draw such plans can result in the misleading interpretation of materials being contemporaneous, when in fact they have been deposited within potentially time-averaged fine sedimentary sequences (McPherron et al. 2005). A refitting study would partially address this issue (Clark & Haynes, 1970; Kaufulu, 1990), but although such a study was initiated it was never completed or published (N. Stern pers. comm. 2009; K. Schick pers. comm. 2010).

5) What was the larger behavioural, depositional, and palaeoenvironmental context of Mwanganda’s Village? In order to understand larger processes that drove the emergence of modern human behaviour, the archaeological data must be situated within their regional and palaeoenvironmental contexts. Such a study will also provide valuable data about the economic relationship of the site to the changing palaeoshore of Lake Malawi, and contribute to an understanding of larger patterns of early MSA site distribution and functionality. This work was begun by Kaufulu (Kaufulu 1990; Kaufulu 1983), who provides an excellent general overview of the facies present in the area. However, this work was done at a time before the development of fine-resolution mapping instrumentation and software that can generate highly detailed maps of sample locations, surface topography, and palaeotopography of lithofacies (as inferred from correlation of deposits from test exposures). The study was also done prior to the widespread application of methods such as X-ray Florescence (XRF) that can be used to chemically characterize and
correlate sediments, and sediment micromorphology that can be used to generate micro-scale data about sediment movement and soil formation events across the landscape.

Excavations

In July and August 2010 the MEMSAP spent a week exploring the potential for new excavations at Mwanganda’s Village to address the five major problems identified above. We initiated test excavations at three localities. The first was a 1 x 1 m test pit into the stony ground ca. 5 m directly west of Kafulu’s (1983) Trench 3 and ca. 15 m south of the southern edge of Clark and Hayne’s (1970) “Area 1” excavation. This pit was used to understand how far the two previous excavations had extended, and to see if additional fossil bone could be recovered. Because the original pits had not been backfilled, it was difficult to discern how much of the modern topography was comprised of spoil heap or material that had ‘melted’ down into the open pits. In 2009 we mapped what we believed to be the extent of the previous trenches, and our small test excavation here was used to confirm this.

We also excavated a 1 x 2 m test pit in almost exactly the same place as our 2009 ‘Surface Sweeping 2’ (Thompson et al. 2009). This was done mainly because an ivory flake had been found on the surface of the field in this area in 2009, and it was hoped that a layer of bone would be located here that could clarify and complement the findings from Clark and Hayne’s (1970) excavation. Also, we hoped to use this excavation to map the buried stratigraphy and topography across the larger extent of the site, since this locality lies ca. 140 m to the southwest of elephant locality. No excavations were undertaken to the north of the elephant site because steeply increasing erosion in this direction (moving toward the modern creek bed) has removed and dislocated the artefact- and bone-bearing deposits.

The final test excavation, called the “Deep Pit”, is located about 46 metres southeast of Clark’s original excavations. The surface of the deep pit was ca. 2.3 m higher than the surface at Clark’s excavation, and the sediments were comprised of a soft silty sand that was very different from the hard exposed carbonate layer or the stony gravels exposed
near where the elephant was discovered. This 1 x 1 m test pit was excavated in order to
gain an understanding of the overall stratigraphy of the area, including the material that
had eroded away in the area containing the elephant. A full stratigraphic section from a
depth pit such as this could guide future decisions about where to excavate and inform
correlations between different excavation areas.

Stratigraphy and Results

Kaufulu (Kaufulu 1990; Kaufulu 1983) shows substantial change in microfacies over the
extent of the Mwanganda site, and we also observed this. At the time of our test
evacuations it was difficult to know what to expect, but post-excavation analyses and
examination of the data have clarified two major points: 1) We never reached the
palaeosol that contained the elephant (and other) fossils; and 2) In all test pits we did
not penetrate deeply enough in our excavations to allow full correlations between
excavation areas. However, we did obtain several OSL and micromorphology samples
from the south wall of the Deep Pit, and the test pits have provided an extraordinary
amount of guidance for future work at the site.

The first test excavation only proceeded about 10 cm before we ceased excavating
there. This was because we reached a layer of hard carbonate nodules below the stony
surface sediment. These carbonates are abundant across the modern surface north of
the elephant site, and our initial expectation was that this represented the base of the
Clark and Haynes (1970) excavations. However, it is now clear that all fossil material
was recovered below the carbonate (otherwise called ‘caliche’) horizon, which could
achieve depths of up to ca. 80 cm. Moreover, the fossil- (and artefact?) bearing palaeosol
is laterally discontinuous and often interrupted by sandy palaeochannel deposits. Based
on Kaufulu’s (1983; 1990) reconstruction, the palaeosol should continue to the
southeast of Area 1, but is less likely to be present in the southwest where we placed
our test excavation.

The second test excavation, ca. 140 southwest of Area 1, presented a similar
stratigraphic sequence to that reported from Area 1, except no palaeosol was noted
(Figure 29). Modern grey sediment had been worked into agricultural ridges. This
overlaid an intact reddish-brown stony horizon, from which a few artefacts were recovered (analyses pending). Below this was a thin (ca. 5 cm) horizon of carbonate nodules, and within the top of this horizon some large nodules of consolidated yellow clay (ochre?) had formed. Brown sediment with occasional carbonate nodules formed the base, and was still continuing when excavations stopped after penetrating about 20 cm into this horizon. Now that it is clear that the horizon that bore the elephant fossils was located just below the carbonate horizon, it does not seem that this test pit was dug deep enough to fully correlate the two areas.

It is interesting that in this test pit artefacts were recovered only above the carbonate horizon. This was not reported to be the case at Area 1, which was described simply as a single-component site where artefacts and fossils were associated with one another and present only in a single layer. This then raises the possibility that younger artefacts were present across a large area at Mwanganda’s Village above the bone-bearing horizon, which in turn suggests one of two scenarios. First, an upper artefact-bearing horizon could have provided a source for younger artefacts to move downward through the sediment to become associated with the fossils. This was a key piece of information that was missing from the report by Clark and Haynes (1970). Second, Mwanganda’s Village could have been a stratified site from which the upper artefact horizon had been eroded in Area 1, leaving behind only an older deposit with both fossils and artefacts present.

Figure 29 East section of the southwestern excavation. Note the white caliche horizon.

Kaufulu (1983: 273) provides a regional cross-section trending SE – NW through the site, but he does not detail the stratigraphy to the southeast of Area 1. He (1990)
describes several lithological units that are present in the larger area, and almost certainly his ‘Unit 7’ (described as “light red sandstone”) comprises the uppermost 1.5 m of the Deep Pit. Several subfacies can be identified within this larger unit, including a transition from reddish to greyish sand, progressive enrichment with clay down the section, and a mottled horizon that indicates some bioturbation has moved upper red sands into the lower grey sediments (Figure 30).

Figure 30 South section of the Deep Pit. Boxed areas are enlarged at right. Unit designations are from Kaufulu (1990: 20).

The underlying horizon consisted of a dark brown, moist, sandy clay capped by a pebble horizon. The pebble horizon contained artefacts, and although the sediment became progressively more difficult to screen it also became apparent that no larger artefacts were present below this layer. The most likely candidate for this underlying horizon is
Kafulu's (1990: 18) ‘Unit 6’, which is described as “dark brown muddy sandstone”. However, because the lateral extent of the Mwanganda elephant site stratigraphy (including the distinctive caliche layer) is unknown, the basal deposits are less easily correlated with Kafulu’s written descriptions. The distinctive caliche layer (Kafulu’s ‘Unit 5’) that would facilitate correlations was not discovered in the Deep Pit. Furthermore, Kafulu’s (1990: 18) ‘Unit 2’, the uppermost Chiwondo Beds, is described as “greenish/brownish gray sandy claystone” topped in some places by a crumbly palaeosol layer that contains fossils and artefacts. This is also similar to what we discovered, particularly because of the presence of artefacts (but no fossils) from a discrete ca. 5 – 10 cm zone on top of the dark brown lowermost horizon in the Deep Pit.

Thus, as with the southwestern test pit, two possible scenarios emerge. First, the Deep Pit could have been sunk in an area where Kafulu’s Units 3 – 6 had been truncated or perhaps never even deposited. This would explain why Unit 7 potentially rests directly on top of Unit 2. However, we believe the more likely scenario is that the pit was not dug deeply enough to encounter the caliche horizon. The base of the Deep Pit was ca. 90 cm higher than the top of the carbonate horizon where it is exposed at Area 1, which suggests that the caliche should still be present below the current base of the Deep Pit. Below the caliche, according to Clark and Haynes (1970), a second artefact (and fossil) horizon should be present that correlates with the elephant fossils and associated stone tools. It is not unfeasible that there is a substantial palaeoslope in the caliche (for example, in the southwestern test pit the carbonate horizon was nearly 2 m lower than where it was exposed at the elephant site). However, this can only be tested by digging the Deep Pit even deeper in future field seasons.

It would be highly significant if Mwanganda’s Village was found to be a stratified site with more than one archaeological component, particularly if one of those components truly is a Sangoan elephant butchery site. There are very few stratified Sangoan sites, and even fewer with preserved fossils. This early part of the Middle Stone Age is very poorly understood, and is best approached through study of stratified sites that may show change over time at a single locality.

The fossil-bearing palaeosol was technically formed on the top of the Chiwondo Bed deposits, and is subsequently overlain by finer-grained sands. At Mwanganda’s Village
the Chitimwe-Chiwondo contact does not take the form that is more typical of the nearby Chaminade region, where iron-rich pebble and cobble deposits have incised into and/or truncated fine-grained grey sediments. This suggests that a more complete sequence characterised by gentler aggradational processes is present at the site, which further supports the inference that Mwanganda’s Village may in fact have stratified archaeological occurrences that further increase its scientific significance.

**Future Work**

Because the first test pit was placed in an area that is likely to intersect a palaeochannel rather than the fossil-bearing palaeosol, no further work is recommended here. However, a similar 1 x 1 m test pit should be placed to the southeast of Area 1, near where Kaurulu (1983: 271) reports the presence of the palaeosol in his Trench 1 and from which he recovered the distal humerus of a large ungulate. A micromorphology sample should be taken from this palaeosol to discern the nature of its formation, and what role subaerial exposure and/or bioturbation played in the distribution of artefacts and fossils within it. This will also allow very detailed plotting of artefacts and stratigraphy in a way that will help determine if there is an association between the fossils and stone tools.

Future work at the southwestern part of the site should extend a 1 x 1 m portion of the existing test pit down until no carbonate nodules are present. This would ensure that any potential bone-bearing horizons that correlate with the elephant site would not be missed, and it would further explore the possibility that a second artefact-bearing layer might be found. It is also recommended that geological test pits be dug further to the west, near where several exposed iron pans were mapped and sampled for palaeomagnetometry.

We recommend that the Deep Pit be re-opened and excavated further. For safety reasons, this would require a ‘stepping out’ of the excavation area, so that 1 x 1 m squares are partially excavated around it to prevent collapse. Indeed, the deepest part of this pit should also be extended laterally by an additional 1 – 3 m², in order to obtain a good sample of artefacts from the pebble horizon. This material should be fully...
screen-washed to ensure that a representative sample of the size range of artefacts is recovered, because on site dry-screening of the sticky clay will surely result in a size bias toward larger artefacts. This sample will allow an understanding of site formation processes, artefact taphonomy, and perhaps even refitting.

**Kafula Ridge West 1**

**Overview**

KRW1 was initially excavated as part of a salvage operation of what appeared to be a potential *in situ* conjoining unit of lithic artefacts. Three large flakes on fine grey-green quartzite had been observed in a section actively eroding into a pathway near a steep erosion gully (Figure 10). The artefacts were lying flat at the contact point between an upper grey horizon and a lower red horizon, and they all appeared to be on the same raw material. A section ca. 5 cm in thickness and ca. 20 cm in length was cut back into the erosion face to recover the artefacts and provide a clearer picture of the stratigraphy. However, as the face was cleaned several more flakes manufactured on the same raw material type came to light. All the flakes were extremely sharp and unweathered, and the surrounding sediments were fine and appeared to represent a low-energy depositional environment. Cutting back of the section only revealed more flakes, until eventually 57 artefacts on the same raw material had been recovered from an area ca. 20 x 80 cm. No other raw material types were present in the assemblage. At the laboratory several refitting pieces were discovered, proving that at least one fairly extensive lithic reduction event was preserved at this locality with excellent spatial integrity. At this point it was determined that because of the site's high potential to yield *in situ* activity areas, and because of the high probability that additional conjoining pieces would be lost during the wet season, it would be subjected to a 1 x 1 m test excavation.

**Target Problems and Excavations**

Work at KRW1 fell into two main categories. First, more potentially conjoining pieces were desired so that the full extent of the stages of the knapping sequence represented at the site could be reconstructed. This required excavation of the area immediately
around the recovered pieces (called 'Test Pit 1'), and it required detailed searching of the scree slope below the section to recover conjoining artefacts that had already become dislodged via natural process of erosion. An area 3 x 8 m along the pathway downslope of the eroding section was swept and screened on site. This resulted in the recovery of several lithics that refit back onto the conjoining pieces recovered \textit{in situ} (Figure 31).

\textbf{Figure 31} Examples of conjoining units from Test Pit 1 and the scree slope. Note the similarity in raw material indicates that these likely also refit back to one another.

Second, the sedimentary context of the recovered lithics needed to be better understood. Extensive termite burrowing had been observed as the erosion face was progressively cut back, and so the role of termites in potentially redistributing artefacts needed to be assessed. Two micromorphology samples were taken from near the conjoining unit, and these will aid in determining the extent to which the containing sediments had been subjected to termite bioturbation.

Dating and sediment samples were also desired, so that greater context could be given to this potentially highly significant site. The conjoining units had been produced by a relatively generic reduction sequence, and knapping had been hindered by a major flaw along the interior of the stone. Therefore, there were no technological features about the lithics themselves that could indicate their age. The nearby cobble deposits capping
the colluvial fan (KRW2 Section locality) contained several elements that were distinctly Middle Stone Age in character, but the complex geomorphological and tectonic history of the area could feasibly have displaced older material and redeposited it over younger sediments. Therefore, radiometric ages for the KRW1 site are essential. Two OSL samples were taken, one from the sediments immediately above the conjoining unit and one from the sediments immediately below.

**Stratigraphy and Results**

Two main depositional units were apparent in Test Pit 1 (Figure 32). Loose, grey silt with abundant small (< 3 cm) angular fragments of quartz caps the sequence. A few small artefacts were recovered from this material, which was dry-screened on site through a 2 mm sieve. Below this, the sediment becomes finer and has fewer inclusions. At the level of the conjoining units, the sediment is nearly free of inclusions and much more compact. No confirmed conjoins were recovered here, suggesting that most of the material had already eroded down the pathway or had been resting within ca. 20 cm of the erosion face.

![Figure 32 South section of Test Pit 1 at Kafula Ridge West 1. Note the two distinct horizons.](image)

A few quartzite flakes were found, lying flat amongst three large cobbles (Figure 33). All of these cobbles were clearly out of size grade with the surrounding fine sediments,
suggesting human transport. This inference is further strengthened by the fact that one of these cobbles was a clear hammerstone, with modifications from lithic reduction on at least two aspects (Figure 34).

**Figure 33** Plan view of Test Pit 1. Note fine sediment and large cobbles. The centre cobble is a hammerstone.

Termite burrows appear around this level, bringing reddish sediments up from below. Some of these burrows are quite large, up to 5 cm in diameter. However, the burrows are clearly different from the surrounding sediments and the two sedimentary units have not been homogenized by these processes. The sediments that contained the lithics and cobbles were compact and intact. Some individual artefacts may have fallen down through the termite burrows, as exhibited by one conjoining fragment found *in situ* at the base of the sequence encased within loose red sediment. However, apart from localised bioturbation, the majority of the artefacts could be found to be resting near the top of the red horizon and within the grey sediments. At this stage of investigation, termite activity is considered to be relatively recent amongst the artefacts, perhaps as erosion moved them closer to the active erosional face.
Future Work

KRW1 has been demonstrated to be a site with very high potential to provide high-resolution information about lithic reduction strategies and the spatial distribution of activities of people in the past. If it is in fact a Middle Stone Age site, this further increases its significance. Open-air sites of this antiquity with such high resolution are rare, and it could offer unprecedented insight into the spatial organization of tasks during this time period. This would also be the case if KRW1 is a Later Stone Age site, although its significance to the MEMSAP as well as the rarity of such sites in the archaeological record would be increased if it was older.

The ideal way to explore the potential of the site is through high-resolution mapping technology and excavation of a wide lateral extent sufficient to reveal discrete activity areas and their relationships to one another. The main artefact horizon is quite discrete, the sediments that overly it are relatively shallow, and they contain only small numbers of unrelated artefacts that can be time-consuming to recover. In addition, the two main sedimentary units are easily distinguished from one another. These logistical factors make the site a ready candidate for wide lateral excavation, and the active erosion face nearby adds further reason to do this as soon as possible.
V. LABORATORY ANALYSES

Overview

In addition to the fieldwork undertaken in 2010, several preliminary results are now available from laboratory analyses on samples from Karonga. Some of these analyses are further advanced than others, and these are in preparation (or have been submitted) as separate detailed articles to scientific journals. Samples taken in 2009 provided general guidance for a strategy in 2010, when the first systematic sampling programme was undertaken for analysis of lithics, sediments, and other materials from the deposits in Karonga. Samples from the 2010 field season are now in progress at various institutions around the world. In addition, a visit was made to the Stone Age Institute to examine collections held there. Results of all these analyses will be made known to the Malawi government as they become available. Here, we detail all results to date, with results from the Stone Age Institute materials provided in the following section.

Lithics – Airport Site

Objectives and Methods

Results from the lithic analysis are only currently available for the Airport Site, with all other collected lithics under study by Dr. Alex Mackay at the University of Cape Town in South Africa. All lithics from the 2010 excavation season will be returned to Malawi in 2011 for study by Davie Simengwa as part of his Bachelor’s thesis for the Catholic University of Malawi.

Description of the artefact assemblages involved categorical and metric data. Categorical data focused on classifying systems used in the reduction of cores and the production of flakes, as well as considering the types of retouched artefacts present in the assemblage. Metric data focused on quantification of flake and core size, as well as other aspects of artefact character such as cortical coverage. Representative samples of piece-plotted artefacts from both main excavation areas were included in this analysis to obtain a preliminary characterisation of the assemblage and provide an assessment
of site formation processes. Future presentations will examine finer details, such as the spatial distribution of different raw material, size class, and technological types between excavation areas. These will include all the piece-plotted and sieved elements of the assemblage.

The first stage of analysis of flaked stone artefacts from APS is reported here. This had three primary objectives. The first of these was to provide a basic description of the assemblage, such that would allow comparison with other potentially like-aged assemblages from the region. The second was to assess the role and extent of taphonomic agents in the formation of the assemblage. As noted, APS lies in a low energy drainage zone, making it possible that the composition of the assemblage had been modified since deposition. The third objective, with some consideration of site taphonomy required beforehand, was to explain why artefacts had accumulated at APS and what the assemblage might thus signify in terms of past human behavior.

Clark (1968; 1970) has asserted that the Chitimwe Beds contain high potential for sites with degrees of spatial preservation suitable for larger interpretations of Middle Stone Age technology and behaviour. The nature and extent of site taphonomy were assessed by considering evidence for post-depositional fluvial transportation of artefacts in the form of edge rounding. Edge rounding was classified into four groups: 0, where no edge rounding was evident; 1, where edge rounding was visible under light magnification; 2, where edge rounding was visible to the eye but where no features of the artefact were obscured; and 3, where edge rounding obscured features of the artefact, including blurring of dorsal scar patterns and possible modification of artefact dimensions. Artefact size was also thought to be relevant to site taphonomy, given that fluvial and colluvial forces have been observed to winnow assemblages over time (Fanning et al. 2009) preferentially removing smaller assemblage elements. However, this work was undertaken with the caveat that the present sample consists mainly of piece-plotted surface and near-surface specimens that may have biased the current analysis toward larger pieces either through preferential selection or sub-recent disturbance of shallower deposits.

Explanations for the concentrations of artefacts at APS were expected to derive from an assessment of the relative prevalence of implements, flakes and cores. Specifically, was
APS a procurement site, where people exploited existing cobble beds in the manufacture of artefacts? In that case we might expect relatively large numbers of cores and an assemblage wherein both cores and flakes had high proportions of cortex. We might also expect materials to occur in the assemblage in roughly the same proportions as they occur in the local gravels. Alternatively, was APS a site were foragers came to exploit (non-stone) riverine resources? In that case we might expect higher proportions of implements and fewer cores. Moreover, if rocks used in the manufacture of the assemblage were not locally derived, we might expect to see little cortex or cortex of a type not found in the local area.

Assemblage composition

A total of 1595 artefacts was analyzed from the present sample. Most of these artefacts (90.7%, n=1447) came from excavations and the 1-m buffer zone surface collections in the iron pan area. Only 105 artefacts (6.6%) were recovered from the long section, with the remainder coming from the geological trenches. Because of the small sample size from locations other than the iron pans and associated difficulties in comparison between locations, the assemblage is considered in this analysis as a single entity.

Table 3 Technological classes of lithics and their proportions in the APS sample.

<table>
<thead>
<tr>
<th>Technological class</th>
<th>n</th>
<th>%</th>
<th>Combined %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flakes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>338</td>
<td>21.2</td>
<td>84.1</td>
</tr>
<tr>
<td>Broken</td>
<td>1003</td>
<td>62.9</td>
<td></td>
</tr>
<tr>
<td>Retouched flakes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>3</td>
<td>0.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Broken</td>
<td>5</td>
<td>0.3</td>
<td>0.5</td>
</tr>
<tr>
<td>Cores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete</td>
<td>24</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Broken</td>
<td>5</td>
<td>0.3</td>
<td>1.8</td>
</tr>
<tr>
<td>Flaked pieces</td>
<td>199</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Small flaking debris (pieces &lt;10 mm)</td>
<td>18</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1595</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

The basic composition of the assemblage is detailed in Table 3. As would be expected, flakes dominate, with a reasonably high ratio of broken to complete pieces (~10:3). Retouched flakes are very rare at APS, accounting for around 0.5% of the artefact total. While cores were by no means abundant, they were still considerably more common.
than retouched flakes (1.8%, n=29). Flaked pieces – those with no positive percussion features or complete negative scars – account for the remainder of the assemblage.

**Lithic Raw Materials**

Quartzite was the dominant material in the assemblage, accounting for 63.2% of the assemblage (n=1038). The quality of the quartzite varied from relatively coarse to quite fine in crystallinity. Quartz was the next most common rock type, accounting for a further 27.6% (n=434). This includes crystal quartz, which comprised 6.0% of the total (n=95). A diverse array of other materials includes fine-grained and crypto-crystalline silicate rocks, silicified wood, and sandstone. Coarse volcanics and rocks of unknown type account for most of the remainder. Most of these rocks could have been sourced within the local gravels, particularly the locally abundant quartzite and quartz. One rock type which could not be located in the gravels was a material tentatively identified as silcrete. A total of 51 silcrete artefacts is included in the analysed sample.

At 90.8%, the prevalence of quartzite and quartz in the assemblage generally reflects their prevalence in rocks found APS. In a sample of 496 cobbles and pebbles greater than 20 mm recovered from the site 53.8% were quartzite and 41.5% were quartz. The remaining 4.6% were of unknown material but did not include silicified wood, volcanics or silcrete. The artefactual data suggest some slight over-representation of quartzite relative to quartz in the artefact assemblage when compared with their prevalence in the local cobbles. This may in part be explained by differences in size. Quartzite cobbles were overall slightly but significantly larger than quartz cobbles (mean$_{\text{quartzite}}$=51.6 mm, s.d.=18.9; mean$_{\text{quartz}}$=45.7, s.d.=17.5; d.f.=489, p<0.001).

**Cores**

Typologically, the range of cores at APS was quite small. Radial forms were the most common type (n=9), followed by cores classified as ‘tested’ (n=8). Tested cores were classified as such when only a few flake scars occurred on a large cobble. Scarring was generally confined to a single platform and the bulk of the cobble retained cortex. Many of the cores (n=7) in the assemblage, including broken pieces and those with an irregular pattern of scar distribution, could not be classified to any particular type.
Among the remaining types were three platform cores and a single Levallois core. Quartzite and quartz were the only materials identified among cores.

Assuming that cobbles were locally acquired for flaking, the sizes of cores at APS suggests preferential selection for larger pieces. Figure 35 plots the sizes of quartz and quartzite cores against the size of unworked cobbles of the same materials from the buried cobbles horizon at the long section. Most notable is the difference in size range between quartzite cores and unworked cobbles, where there is no overlap in interquartile range. It should also be recalled that all of the cores in the figure have been reduced to some degree and thus under-represent the sizes of the cobbles on which they were made.

Another interesting point to make is that all of the cores recovered from APS in 2010 had some cortex. The vast majority (19 of 25) of complete cores had cortical coverage equal to or exceeding 25% of their exterior surface. Only four cores had very minor (~5%) cortical coverage.

![Figure 35](_sizes_of_unworked_APS_cobbles_relative_to_cores_of_the_same_material_.jpg)

**Figure 35** Sizes of unworked APS cobbles relative to cores of the same material. Unworked cobble data courtesy of Davie Simengwa.
All of the radial and Levallois cores exhibited preferential reduction of one surface, with cortex present on one hemisphere only. Cortex coverage on the ‘platform’ surface of these cores ranged between 10% and 100%. This pattern of cortex distribution suggests establishment of a platform on the upper surface of a cobble from which a radial pattern of centripetal scars were struck. In some cases scars were also directed back onto the upper surface and in others they were not. In all cases the upper platform surface was more convex than the lower exploitation surface. The method used for assessment of convexity is shown in Figure 36.

**Figure 36** Measurement of core surface convexity for hemispheric cores. Surface heights are measured at two pairs of opposed points around the perimeter. Values are averaged to give an indicative height for each face. As the distances between measurement points are the same for both surfaces, relative convexity of upper to lower surfaces = average height upper surface / average height lower surface. Where this value exceeds 1 the upper surface is more convex.

Given that some radial and Levallois cores exhibit reduction of both upper and lower surfaces while others do not, it is interesting to consider whether there is a relationship between scar coverage on the upper surface and core size for Levallois and radial cores. Specifically, if scar coverage to the upper surface increased as the extent of reduction increased – that is, if more of the overall core surface was exploited through the course of reduction – then we might expect to see a positive relationship between core size at discard and cortex coverage on the upper surface.
In contrast to this expectation there is in fact a weak negative relationship between core size and upper surface cortical coverage (Figure 37; Pearson’s Correlation = -0.508, n=9, sig=0.163). That is, larger (heavier) hemispheric cores tend to have less cortex on the upper surface – and by inference more exploitation of the platform surface – than smaller cores. While the correlation is weak and the sample size small the data when taken at face value suggest that people tended to remove flakes from both surfaces on larger cores and only from the lower exploitation surface on smaller cores. Interestingly these data include a large retouched flake with a Levallois core-like morphology, which was included because other than its discernable ventral face its morphology was indistinguishable from a Levallois core. Thus the pattern, such as it is, derives from both cores on cobbles and on large flakes.

**Figure 37** Scatterplot showing relationship between core size (g) and cortical coverage (%).
Retouched flakes

As noted earlier, retouch was rare at APS. Of the eight complete and broken retouched flakes in the assemblage, one could be classified as an end scraper and another as a notch. Two further pieces may have been retouched to serve as cores (including the one mentioned earlier). The remaining retouched flakes were not classifiable to type, and indeed one of these pieces may have been modified by incidental damage rather than by retouch *per se*. It is worth specifying that no points, either retouched or Levallois, were observed in the APS assemblage, and nor were any handaxes.

Unretouched flakes

With respect to flake types, distinctively Levallois products (n=8) were rare, though flakes with faceted (n=39) or 'chapeau de gendarme' platforms (n=31) attest to the use of prepared core reduction methods. Between them these platform types account for 14.5% of all complete platforms in the assemblage. Cortical platforms are also very common in the assemblage (24.1%) – perhaps unsurprising given the presence of cortex on all complete cores. This high prevalence of cortical platforms also supports previous inferences about core reduction whereby a cortical upper cobble surface was preferentially worked in the initial production of flakes. Overall, some cortex was present on most (55.9%) of complete flakes in the assemblage, with six flakes having 100% cortical coverage. Almost all cortex in the assemblage (98.1%) was of river cobble form.

Sixteen of the flakes recovered from APS in 2010 were classified being products of laminar reduction. Interestingly, six of these were made from silcrete. The high proportion of silcrete among blades (37.5%) contrasts with its overall infrequency among flakes (3.2%). Pearson's chi-square test suggests that this distribution departs significantly from expectations (df=1, sig.<0.001). It might also be noted that while 10 of the silcrete flakes had cobble cortex, a further three had cortex suggestive of having been sourced at an outcrop. In contrast, only two of 368 cortical quartzite flakes had outcrop cortex, while this was exhibited on none of the 142 cortical quartz flakes. Again, this distribution departs significantly from expectations (df=1, sig.<0.001).
Differences in reduction tendencies between silcrete and other materials suggested by the prevalence of laminar products are reinforced by metric data. It was noted during analysis that the silcrete flakes at APS were relatively thin. Given the large number of transversely broken flakes, thickness relative to length cannot readily be used. Thickness relative to width can be used on transversely broken flakes, so long as they are not longitudinally broken. This measure gives some sense of the proportions of the pieces available for analysis. Boxplots of thickness / width (Figure 38) confirm the impression gained during analysis. The silcrete flakes are not only disproportionately laminar, they are also unusually thin. T-tests suggest that the differences between silcrete and quartzite flakes (df=526, p=0.036), and between silcrete and quartz flakes (df=171, p=0.001), are statistically significant at p<0.05.

![Boxplots showing thickness / width for quartz, quartzite, and silcrete.](image)

*Figure 38* Boxplots showing thickness / width for quartz, quartzite, and silcrete.
Evidence of taphonomy

APS is situated in a palaeo-drainage feature which has been responsible for the transportation of rounded cobbles into the area. Given this, it is important to consider whether a) fluvial transportation might also be responsible for introducing some/many of the artefacts, and b) whether similar processes might have acted to remove some assemblage elements. This may also help to inform if MSA people were sourcing toolstone from active river edges (where post-depositional transport of lithics would be facilitated by stream migration or increases in discharge) or abandoned river terrace deposits (where post-depositional fluvial transport is less likely).

The proportions of artefacts with differing degrees of edge rounding are presented in Table 4. The overwhelming bulk of artefacts in the assemblage display no evidence of edge rounding, such as might have been caused be fluvial redeposition. Approximately 1 in 11 artefacts display some very minor edge rounding, visible under light (10x hand-lens) magnification. It seems probable that this degree of modification could have been produced by minor redistribution of artefacts within the assemblage, rather than their redeposition at APS from some other starting location. The proportions of artefacts at the site which may have been introduced from elsewhere (edge rounding classes 2 and 3) is very small overall (2%). These data suggest that most of the APS assemblage was probably discarded at the site. Future analyses that include the sieved material will show if post-depositional winnowing might have subsequently removed smaller assemblage elements.

Table 4  Edge rounding classes and proportions in the APS sample.

<table>
<thead>
<tr>
<th>Edge-rounding class</th>
<th>n cases</th>
<th>Assemblage proportion (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1419</td>
<td>89</td>
</tr>
<tr>
<td>1</td>
<td>144</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>23</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td>9</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Discussion

Consideration of potential taphonomic factors suggests that the APS assemblage is largely an in-situ accumulation. It is thus reasonable to interpret the site in behavioural
terms, albeit that because all of the contexts of recovery have been conflated for this analysis it is best to consider these interpretations as time-averaged.

Two potential explanations for the accumulation at APS were posited in the methods section. One of these was that the site reflected the discard of artefacts brought in from other locations by foragers exploiting non-stone riverine resources. The other was that the site accumulated as the result of the local manufacture of artefacts from available cobbles. Both explanations receive some support from the available data, although support for the latter is stronger.

There is considerable evidence that reduction of locally available stone (most likely from abandoned river terrace deposits) accounts for much of the assemblage. Material prevalence among artefacts is consistent with availability in the local cobbles, and cobble cortex is by far the dominant form. Cortex occurs on the majority of flakes and on all cores, and primary cortical flakes are present. The prevalence of cortical platforms in particular is consistent with inferences about the mode of reduction for the cobbles from which the cores were made. That at least some of these cobbles were locally procured is reinforced by the presence of cobbles with small numbers of flake scars, classified here as ‘tested’. While cores were not abundant in the assemblage, they were still far more common than retouched flakes. This reduction may have been opportunistic in pursuit of other resource acquisition, rather than APS representing a defined ‘source’ site specifically visited to obtain new toolstone.

Comparison of core size with a sample of unmodified cobbles from the same deposits suggests that larger cobbles were preferentially selected and perhaps even brought to the site from elsewhere (particularly quartzite). There is further evidence of the transport of lithics to the site (as opposed to restricting flaking activities to cobbles present in the immediate vicinity), most notably in the presence of silcrete artefacts. Silcrete was not observed among the local cobbles, and a reasonable percentage of the silcrete flakes in the assemblage exhibited cortex that was suggestive of procurement from outcrops rather than from cobbles beds. Perhaps the most interesting aspect of the silcrete artefacts at APS was that many of them appear to have been produced by reduction methods that were not otherwise common at APS. Specifically, there is some
evidence for the preferential use of laminar reduction in the manufacture of silcrete flakes, expressed in the prevalence of blades and in the relative thinness of the flakes. There is a general lack of evidence of curation in the form of very heavily reduced cores and extensive retouch, which is expected in a landscape where raw materials are abundant and sources (in this case in the form of cobbles) are distributed at relatively regular intervals. However, in spite of this abundance some lithic elements – namely those manufactured on silcrete – were clearly carried across the landscape and introduced from elsewhere. At the long section, artefacts are almost exclusively distributed upon and within the first 5 – 10 cm of the uppermost cobble horizon, and artefacts are relatively sparse. This implies a general ‘background scatter’ of lithic distribution upon a cobble surface that was probably directly exploited for new raw material packages. However, at the nearby iron pans the artefact abundances increase dramatically. Further work is required to understand if this is because of post-depositional factors (ie: different sedimentation and/or deflation rates) or if the site captures two different activity areas, perhaps mediated by the presence of particular resources that encouraged groups to return frequently as part of their foraging round.

Regional and Temporal Affiliations of the Airport Site

A final consideration that can be made with respect to APS is the question of where the site fits in the regional technological / temporal context. The presence of radial and some Levallois reduction and the absence of handaxes allows the site to be classified as Middle Stone Age, suggesting a lower age of probably less than 285 ka based on east and central African data (Barham and Smart 1996; Tryon et al. 2005). Refined assignation of the APS assemblage to industries within the Middle Stone Age is largely hampered by the absence of distinctive fossil directeurs. For example, points and backed pieces are associated with Lupemban or Sangoan assemblages noted nearby at Mwanganda’s Village and in Zambian sites to the west (Barham 2002; Clark and Brown 2001; Clark and Haynes 1970), yet no such implements occur at APS. Recently presented stratified sequences from Mozambique lack distinctive elements that would allow ready comparison with APS (Mercader et al. 2009). As such, a better understanding of the place of the APS site in the local and broader regional contexts awaits radiometric dating of the site and the development of a more detailed local technological sequence.
Four OSL samples were taken in stratigraphic order from a profile about 2.5 metres in overall depth at the long section, and these are currently under analysis. Radionuclide dating and palaeomagnetic samples were also taken across the site in 2010, with these analyses pending.

Regional palaeoclimatic datasets provide the basis for hypotheses about when people are expected to have occupied the Airport Site, which lies only 32 km from the Site 2 Lake Malawi drill core. Cohen et al. (2007) proposed that periods of megadrought during the Late Pleistocene of central Africa would have driven human populations into ephemeral refugia or out of the region Africa entirely. Scholz et al. further (2007) suggested that subsequent amelioration into wetter conditions ca. 70 ka positioned early modern human populations for expansion and dispersal out of Africa. Beuning et al. (in press) further specified that the period between 109 – 90 ka was particularly inhospitable to human habitation in the pollen catchment for northern Lake Malawi. Pending dates from the Airport site will be used to test the hypothesis that MSA people were driven from what is now northern Malawi by these conditions.

The palaeoclimatic data also suggest when major changes in mobility and/or technological adaptation might have occurred in the region. Harsh conditions fragment and increase selective pressures on populations surviving in refugia, and this may have underpinned biological and behavioural evolution during the Middle Stone Age (Basell 2008). These hypotheses about the impacts of such climatic fluctuations and the timing of human movements within and out of central Africa can only be tested using in situ archaeological data from the same region that yielded the palaeoclimatic data. The Airport Site demonstrates the potential of the Chitimwe Beds to contain those data, and to become the first in a series of sites upon which a regional chronology of MSA behaviour can be built.

**Conclusions from the APS Lithic Assemblage**

The Chitimwe Beds of northern Malawi have been described by Clark (Clark 1968; Clark et al. 1970) as excellent repositories for evidence of human technological adaptations during the Middle – Late Pleistocene. Recent excavations at the Airport Site near the Karonga airstrip confirm that this is the case. The Airport Site contains a lithic
assemblage that fits comfortably within the definition of Middle Stone Age technology. Taken together, the available evidence suggests that APS was a location where people exploited locally available cobbles to make artefacts. Reduction of local rocks involved removal of flakes from a cortical platform in a centripetal pattern, with some more developed radial and Levallois reduction occurring later in the process. Lithic reduction took place on site, and the artefacts have not been secondarily transported. Some of the flake production occurred on cobbles while some involved the reduction of large cortical flakes. An alternative pattern of flake production may have been pursued in exploitation of silcrete cobbles which were probably not procured on site, but which were transported there by foragers.

**Dating**

**Optically-Stimulated Luminescence**

The primary method of dating the sites under investigation is optically-stimulated luminescence (OSL). Sediment samples were taken from Mwanganda's Village and APS in 2009 to determine their potential for providing OSL ages. Preliminary results from Dr. David Wright at the Luminescence Lab at the University of Illinois at Chicago indicated that quartz grain sizes from the Chitimwe Beds at both sites were generally quite large, and that smaller grains would be preferable. In order to obtain sufficient numbers of quartz grains in the best size range, Dr. Wright recommended that we take larger samples. He also indicated that the sediments at APS would be much more challenging to date than those at Mwanganda's Village, owing to secondary soil formation and iron movement through the sediment profiles. This would have been particularly pronounced in the 2009 APS samples sent to the lab, because they were taken from directly below the iron pans, where soil formation processes are macroscopically evident.

In 2010 we took a total of 12 OSL samples (Table 5). In some cases the sediments were so intractable that the samples had to be obtained by driving a metal pipe into the sections rather than using a large PVC pipe cut into pointed sections. At other sites, such as KRW1, the PVC pipe was adequate.
Mr. Thomas Jones, a private benefactor with an interest in palaeoanthropology, made a charitable donation to the MEMSAP to facilitate post-fieldwork analyses of samples taken in 2010. This enabled all samples to be sent to their respective facilities for study, and placed the OSL samples in particular in a good position to have results by mid-2011. The four samples taken from the long section at APS have been sent to a newly-established OSL facility at Griffith University in Brisbane, Queensland. There, they will be studied by Prof. Jonathan Olley and Dr. Timothy Pietsch. Prof. Olley has worked on sediments from Tanzania (Eriksson et al. 2000) and has a background in radiochemistry. The latter is particularly valuable for understanding how soil formation processes and iron movement may have affected any OSL ages obtained from sediments such as those at the Airport Site.

Prof. Steven Forman and Dr. David Wright will study the remaining samples, which have been sent to the Chicago Lab for analysis. Eventually, it is envisioned that results from the two labs can be used to cross-check one another, particularly as the Griffith Lab relies primarily on single-grain analysis while the Chicago Lab adheres to the use of aliquots.

**Table 5** List of OSL samples taken during the 2010 field season.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Site</th>
<th>Square</th>
<th>Context</th>
<th>Date</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>KRW2</td>
<td>N/A</td>
<td>Base/upper cobbles</td>
<td>27-Jul-10</td>
<td>OSL sample taken at base of cobble unit, north section of KRW2 Section</td>
</tr>
<tr>
<td>563</td>
<td>APS</td>
<td>E98N107</td>
<td>APS10A</td>
<td>22-Jul-10</td>
<td>bottom of APS10A series coarse sand</td>
</tr>
<tr>
<td>564</td>
<td>APS</td>
<td>E98N107</td>
<td>APS10A</td>
<td>22-Jul-10</td>
<td>top of APS10A series fine sand</td>
</tr>
<tr>
<td>565</td>
<td>APS</td>
<td>E98N106</td>
<td>APS10U</td>
<td>22-Jul-10</td>
<td>Chiwondo</td>
</tr>
<tr>
<td>566</td>
<td>APS</td>
<td>E98N106</td>
<td>APS10B</td>
<td>22-Jul-10</td>
<td>under artefact horizon</td>
</tr>
<tr>
<td>571</td>
<td>APS</td>
<td>E98N107</td>
<td>APS10A</td>
<td>24-Jul-10</td>
<td>very top fine sand</td>
</tr>
<tr>
<td>574</td>
<td>APS</td>
<td>E78N113</td>
<td>N/A</td>
<td>26-Jul-10</td>
<td>Chitimwe cobbles from geotrench</td>
</tr>
<tr>
<td>683</td>
<td>MGD</td>
<td>E7525N835</td>
<td>N/A</td>
<td>05-Aug-10</td>
<td>Upper sand (red)</td>
</tr>
<tr>
<td>684</td>
<td>MGD</td>
<td>E7525N835</td>
<td>N/A</td>
<td>05-Aug-10</td>
<td>Above pebbles + artefact layer</td>
</tr>
<tr>
<td>685</td>
<td>MGD</td>
<td>E7525N835</td>
<td>N/A</td>
<td>05-Aug-10</td>
<td>Below pebbles + artefacts</td>
</tr>
<tr>
<td>1001</td>
<td>KRW1</td>
<td>TP1</td>
<td>KRW1B</td>
<td>31-Jul-10</td>
<td>Upper grey + red mix, above artefacts</td>
</tr>
<tr>
<td>1002</td>
<td>KRW1</td>
<td>TP1</td>
<td>KRW1E1</td>
<td>31-Jul-10</td>
<td>Lower red, below artefacts</td>
</tr>
</tbody>
</table>
Palaeomagnetics

Other methods for dating and/or correlating the deposits will be explored. For example, when the iron pans (e.g. those found at the Airport Site or in the Chaminade area) were formed, the iron inside the nodules would have become permanently fixed in a direction aligned with wherever magnetic north was at the time. This does not provide an absolute form of dating, but if different occurrences of iron pans are similarly aligned then they should have been formed around the same time. This can inform about landscape-wide processes of soil formation, as well as provide a way to correlate deposits where physical linkages cannot be easily traced. Palaeomagnetic samples from the Airport Site, Chaminade, and near Mwanganda’s Village were taken (in the form of oriented in situ iron nodules), their precise locations were mapped, and then they were sent to the Palaeomagnetic Lab at the University of Liverpool for study by Dr. Andy Herries. In addition, Dr. Herries received the large cobbles excavated from the test pit at KRW1. He will be able to determine if these stones had been heated beyond a certain point, perhaps if they had originally been part of a hearth that has since been destroyed by taphonomic processes.

![Figure 39 Palaeomagnetic samples (white spots are gypsum plaster attached to in situ iron nodules and inscribed with a north arrow) at APS (a), near Mwanganda (b), and at Chaminade (c).](image)

Cosmogenic Burial Dating

Bulk samples of gravel and sand were taken from sections at the Airport Site in hopes that they can be submitted in the future for cosmogenic nuclide dating (especially burial dating). This method is based on the fact that the Earth’s surface is subject to a steady stream of extraterrestrial bombardment in the form of cosmic rays. This bombardment causes certain nuclides of cosmogenic origin to be produced within rocks. When these
rocks are deeply buried, some of the nuclides are subject to radioactive decay. Thus, both exposure rates and times since burial can be estimated. The method is only beginning to see use in archaeological contexts, but has frequently been employed by geomorphologists to estimate erosion rates and to date buried landforms. It is anticipated that it will prove useful for dating the evolving palaeolandscape in Karonga, and collaborations are currently being investigated between the MEMSAP and various experts in this technique.

**Uranium-Series Dating**

The materials recovered in the Chitimwe Beds of Karonga are generally unsuited for analysis using the U-Series, or U-Th method. However, it can be used to obtain minimum ages on bones and teeth. This method, its uses in the context of the MEMSAP, and other analyses conducted on bones and teeth from Karonga, are described in the next section with results from the Stone Age Institute study.

**Residues**

In 2009 a pointed MSA flake measuring 4.5 x 3.0 cm was recovered from the colluvium at Chaminade locality AAQ (located at WGS 1984 UTM 36L 0597891 mE 8899445 mN). This was subjected to examination for residues by Dr. Gail Robertson at the University of Queensland on 22 March 2010, who provided all images and most text in this section.

**Methods**

The artefact was initially photographed (Figure 40) and then examined at both low and high magnification. An Olympus SZ microscope with 6.7x to 45x magnification and a DP10 digital camera was used for identification of macrofractures and use-wear features, and for locating and recording residue distribution. A high magnification microscope (Olympus BX51) with 100x and 500x magnification, darkfield/brightfield illumination and cross-polarising capability, and an attached DP70 digital camera for recording images was used to identify residues and locate some less obvious use-wear features such as polish and fine striations if present.
Results

This artefact is manufactured on a type of quartzite, making use-wear features such as striations, edge rounding and edge fracturing difficult to assess. The tip exhibits a transverse snap fracture with a bending initiation and a large step termination (Figure 41) with several small step fractures ‘chattering’ across the ventral surface at the snap. There is also a small lateral step fracture initiated from the tip. The proximal end exhibits shearing damage which has produced a large flake scar with a hinge termination and possibly also some of the lateral bending fractures. All edges exhibit slight abrasive wear, probably the result of movement in the soil, although the ‘tang’ and proximal dorsal ridge appear to be moderately rounded with a slight polish on the ‘tang’ itself. There is a range of small flake scars along the lateral margins, including a few step and bending scars, none of which are diagnostic of a specific function.

![Figure 40](image) Ventral (a, on left) and dorsal (b, on right) views of ‘tanged’ point.

High magnification residue analysis reveals minimal residues on the ventral surface but masses of plant residues, including plant tissue, fibres, pollen grains and/or spores on the dorsal face, often mixed with sediment (Figure 42). Of most significance is the presence of several small patches of resin on the proximal dorsal ridge and on one of the wings of the ‘tang’ (Figure 43). The most significant use-related damage occurs on the tip and is probably the result of impact (Dockall 1997; Lombard 2005). Damage on the proximal end may also have been caused by the force of impact on the stone tool while in a haft (Lombard 2005).
The type and distribution of most residues indicate they are not related to use and are most likely environmental. However, resin on the distal proximal end, in combination with probable impact damage, suggests this artefact was a hafted element in a composite tool possibly used as a projectile.
Future research

There is generally poor organic preservation in the Chitimwe Bed deposits from the Chaminade area. Fossil bone, charcoal, shell, and other materials that are sometimes preserved alongside Middle Stone Age lithics are absent from the observed deposits. However, the results of the preliminary residue analysis suggest that at a microscopic level there may be a wider variety of preserved materials. Furthermore, the open-air context suggests that a diversity of ancient activities carried out on the landscape, such as hunting or lithic raw material procurement (activities not represented at cave or rock shelter sites), can be reconstructed.

The presence of resin on the point, in spite of it being recovered from an open-air colluvial context, illustrates the potential for excavated materials to reveal much about ancient hafting practices. The presence of a diagnostic impact fracture in conjunction with the resin distribution further suggests that ancient hunting practices may be examined even in the absence of well-preserved faunal materials. Finally, care should be taken in collecting and handling lithic materials so as to not introduce modern contaminants to the artefact surfaces. We have therefore adopted the practice of not washing recovered lithic specimens. Rather, we dry-brush them only sufficiently to observe diagnostic features necessary for technological analysis.

In the future, a systematic examination of the lithics should be undertaken for residues. The preliminary lithic analysis from APS showed that there are no points in the
assemblage, but that does not mean that hunting and/or hafting was not conducted using alternative means – possibly with the aid of residue or even ochre, which has also been reported from the Chaminade area (Clark et al. 1970).

**Pollen**

Samples of iron pan nodules from the Airport Site were collected in 2009 and submitted to Dr. Patrick Moss at the University of Queensland for analysis of pollen content. Dr. Moss was unable to locate any pollen in the samples, and suggested it could be because of extreme oxidation in the microenvironment. However, it is possible those areas with less oxidation (ie: away from the iron pans or even at sites such as KRW1 that had little evidence of iron formation), will contain pollen. Sediment samples have now been taken from all contexts excavated in 2010 and these will be submitted for further examination by Dr. Moss.

**Phytoliths**

Samples of iron pan nodules from the Airport Site were collected in 2009 and submitted to Dr. Lynley Wallis at the University of Queensland for analysis of phytolith content. Dr. Wallis was unable to locate any phytoliths in the samples, but emphasised that the samples were small and that other contexts may contain pollen. Sediment samples have now been taken from all contexts excavated in 2010 and these will be submitted for further examination by Dr. Wallis.

**Sediment Analysis**

Samples have been taken for sediment micromorphology from sections at all three excavated sites. Bulk sediment samples have been taken from every context for particle size analysis, loss on ignition (to determine organic content), and X-ray Florescence (to chemically characterise the sediments). These analyses will provide more precise ways to characterise the physical and chemical properties of the sediments, facilitating correlation of deposits and guiding interpretations of site formation histories.
VI. STONE AGE INSTITUTE STUDY

Curation

A sequence of queries was made to various institutions in the United States to ascertain the whereabouts of the materials excavated in Malawi by Prof. J. Desmond Clark during the 1960's and 1970's. Initial contact was made to the Phoebe A. Hearst Museum of Anthropology at the University of California, Berkeley. This institute has listed 132 lithic and haematite specimens from Karonga that are likely MSA, but it was made clear that this was a sample donated by Prof. Clark and not part of his excavated collection. This is reflected in the catalogue information, which lists the majority of the specimens as derived from the surface gullies of Chaminade locality 1A (Appendix I). According to Prof. Tim White at the University of California, Berkeley, Clark’s excavated collections were all gifted, upon his death in 2002, to Profs. Nicholas Toth and Kathy Schick on the condition that they be curated and available for research at the Stone Age Institute in Bloomington, Indiana (Figure 44).
The Mwanganda’s Village Collection and much of the Chaminade 1A collection are stored in dust-sealed moveable cabinets (Figure 45). In some cases the lithics are still stored in paper bags bearing Clark’s handwriting while in others they are labelled and some refitting has been attempted on them. Although Kafulu (1990) refers to use of the original notes and photographs of the original Clark excavations, these notes and photographs have not been relocated since they were loaned to Kafulu (K. Schick and N. Toth, pers. comm. April 2010). In addition, although Kafulu (1990: 24) refers to personal communication in 1984 from Clark that full details of the site would be produced in a monograph, the whereabouts and status of this work is unknown. C. Vance Haynes is currently a Professor Emeritus at the University of Arizona. In a meeting with Thompson (pers. comm. November 2009) he related that all of his notes from Malawi had gone to Prof. Andrew Cohen, also at the University of Arizona. Some of these have now been copied and made available to the MEMSAP through the efforts of Dr. David Wright.

Figure 44 The Stone Age Institute in Bloomington, Indiana, affiliated with the University of Indiana.
In April 2010 Thompson spent a week visiting the Stone Age Institute. There were two primary goals to this visit. The first was part of the general goal of collating information on where collections from Malawi are housed around the globe, and documenting what each collection contains. The second was to initiate study of the materials, particularly of the Mwanganda’s Village faunal collection.

**Mwanganda’s Village Fossil Assemblage**

**Basic Description**

No time was available during the visit to examine the Chaminade or Mwanganda’s Village lithics in any detail. However, a brief inventory shows that 117 trays contain materials from Malawi and that the vast majority of these are lithics. Twelve of these trays are devoted to the curation of the Mwanganda’s Village material, and only a single...
one of these trays contains faunal remains. These were the focus of the April 2010 study and will be the main subject of the results presented here. It should be emphasised that the entire faunal collection that was originally recovered is not housed at the Stone Age Institute. Clark and Haynes (1970: 393) state that, “Most of the remains belong to a single elephant. They occurred dispersed on the edge of a small gully in three concentrations – at least ten ribs, two cervical and five or six thoracic vertebrae, fragments of tusk and mandible, and, perhaps, of skull, the proximal end and shaft of a femur and of a humerus and the distal end and shaft of a radius.” None of these identifiable fragments were present in the collections at the Institute, and it is supposed at this stage that the majority of the elephant skeleton still resides in Malawi. This was apparently the case up until at least 1973, as indicated by the following reference in the foreword by Cole-King (1973:16): “Owing to lack of storage space available to the Department [of Antiquities] at present, the material assembled by Professor Clark’s team in Karonga district in 1965 and 1966 is stored at the Museum of Malawi”.

![Figure 46 Clarias spp. frontal from the original Mwanganda’s Village fossil assemblage.](image)

The faunal collection at the Stone Age Institute was comprised 12 bags of bone fragments, amounting to 156 fragments in total (Table 6). Of these, one was a turtle carapace fragment from the family Pelomedusidae and another was a partial catfish frontal from the genus *Clarias* (Figure 46), estimated at around 1 m in length at the time of death (K. Stewart, e-mail to Thompson, May 2010).
Clark and Haynes (1970) indicate that two large areas were excavated, but only provide details of the excavation and recovered artefacts from Area 1, which is where the elephant skeleton was discovered. Excavation Areas 1 and 2 are both represented in the sample of fauna presented here, with the two identified specimens listed above derived from Bags 9 and 7, respectively – both from Area 2. This is important, because in their brief mention of Area 2 Clark and Haynes (1970: 393-394) suggest that this part of the site may not be contemporaneous with Area 1.

The other 154 fragments from the collection were from unidentified larger mammals – e.g. body size greater than 4.5 kg live weight (Table 7). For 96 of these specimens it could be discerned that the animal was in the ‘very large’ or ‘size 5’ body size class following Brain (1981), and the remainder were of indeterminate body size (Figure 47). This suggests that most of the fragments do come from the elephant that was reported from the site, particularly in light of the heavy fragmentation of the elephant fossils illustrated in Plates 2 and 3 in Clark and Haynes (1970).

**Table 6** Summary of bags containing faunal remains from the original Mwanganda collection.

<table>
<thead>
<tr>
<th>Bag</th>
<th>Date</th>
<th># of Frags</th>
<th>Excavation Area</th>
<th>Information on bag (copied verbatim)</th>
<th>Description of curation at time of study</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>None</td>
<td>9</td>
<td>Unknown</td>
<td>MWG - Bone frags various</td>
<td>Paper bag within the cloth bag labelled &quot;odd bone fragments&quot;</td>
</tr>
<tr>
<td>2</td>
<td>None</td>
<td>11</td>
<td>Unknown</td>
<td>Surface bone frags 8’2&quot; from no. 6 peg along west line 5’3&quot; from no. 6 peg along south line</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Frags by E end of rib by femur (sketch on bag showing rib perpendicular to femur with E at the left and the femur head to the south and two X's above and below the E end of the rib)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>27-July-1966</td>
<td>5</td>
<td>Area 1</td>
<td>Frags by E end of rib by femur (sketch on bag showing rib perpendicular to femur with E at the left and the femur head to the south and two X's above and below the E end of the rib)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Paper bag within the cloth bag labelled &quot;odd bone fragments&quot;</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>None</td>
<td>68</td>
<td>Area 1</td>
<td>MWG Main Area 1 Femur - Under 2 Chs (?) sent to Vance Haynes on 18 December 1968*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Paper bag</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>None</td>
<td>2</td>
<td>Unknown</td>
<td>Surface Bone</td>
<td>Paper bag within the cloth bag labelled &quot;odd bone fragments&quot;</td>
</tr>
<tr>
<td>6</td>
<td>27-July-1966</td>
<td>18</td>
<td>Area 1</td>
<td>Fragments at south end of femur</td>
<td>Paper bag within the cloth bag labelled &quot;odd bone fragments&quot;</td>
</tr>
<tr>
<td>No.</td>
<td>Date</td>
<td>Area Code</td>
<td>Area Description</td>
<td>Notes</td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>------------</td>
<td>-----------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>None</td>
<td>28</td>
<td>Area 2 Western half 66/14</td>
<td>Small open box within a larger open box with four washed/labelled fragments (66/14) in the larger box and unwashed fauna in the smaller box</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>27-July-1966</td>
<td>6</td>
<td>Area 1 Fragments North end of exposed femur</td>
<td>Paper bag within the cloth bag labelled &quot;odd bone fragments&quot;</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>None</td>
<td>1</td>
<td>Area 2 Eastern Area 66/13</td>
<td>Small open box</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>None</td>
<td>3</td>
<td>Area 2 Area B Western Half 66/15 (bones inside are labelled 66/7)</td>
<td>Small open box with washed and labelled fragments</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>None</td>
<td>2</td>
<td>Area 2 Flaked Bone</td>
<td>Small open plastic tray with cotton wrapped around one fragment</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>None</td>
<td>3</td>
<td>Area 1 None (paper bag containing two lithics was inside the box - it says &quot;Surface N of Area 1 not more than 50 yds)</td>
<td>Four small open boxes within a larger box, none labelled - bag 13 sitting in this box as well</td>
<td></td>
</tr>
</tbody>
</table>

*C.V. Haynes stated that he could not recall receiving any bone fragments from Clark in 1968, but he no longer has his notes from that time with him (pers. comm. April 2010 to Thompson).

Figure 47 All fauna from the original Mwanganda’s Village excavation that was cleaned during this study. Numbers refer to bag numbers listed in Table 6.
Taphonomy

“The association of the stone artefacts with the dismembered, broken and dispersed remains leaves no doubt that this is a site where an elephant was butchered by man, the implements for this being made on the spot and discarded when the work was over. Area 2 material, moreover, suggests that it was a site visited by hunting groups on other occasions also.”

Clark and Haynes (1970: 394)

Taphonomic analysis of these remains is essential for reconstructing the accumulation history of the faunal assemblage and testing the hypotheses put forth by Clark and Haynes (1970) that there was a behavioural association between the elephant and the lithic artefacts described from the excavation. Of the 156 specimens in the total collection, 108 (or 69%) displayed some evidence of smoothing. In the Mwanganda assemblage all bones that exhibited some smoothing displayed at least some of it on the edges, rather than in localised patches of the bone. Fifty-six (or 36% of the assemblage) displayed surfaces that were severely smoothed on the edges following the coding system presented by Thompson (2005). This category of alteration to the bone surface is analogous to edge-rounding, and is generally considered to be the process by which sharp edges and protrusions are removed from bones. This contrasts with polish, which is smoothing on a finer scale and can result in a visible sheen on the fossil surface.

There is some ambiguity within the taphonomic literature about what exactly causes smoothing. Haynes (Haynes 1980) conservatively suggested that edge rounding is the result of mechanical processes without specifying those processes. Brain (Brain 1967) noted that smoothed bone edges can be created by extensive animal trampling, and Backwell and d’Errico (2001) found that they also occur in carnivore dens, probably as a result of digestion. Modern bones deposited on floodplains or in river gravels often exhibit smoothing, and in many ways the default assumption in a fluvial context is that water-borne abrasive particles have played some role (Lyman 1994). The fluvial context of the containing sediments at Mwanganda make this the most parsimonious candidate
for the cause of the smoothing, although the possibility of animal trampling during the period of encasing palaeosol formation cannot be excluded (Kaufulu 1990).

Table 7 Breakdown of fragment types in the Mwanganda sample.

<table>
<thead>
<tr>
<th>Bag Number</th>
<th>Long-Bone Fragment</th>
<th>Non-ID Fragment</th>
<th>Tooth Fragment</th>
<th>Vertebra?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>5</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>0</td>
<td>68</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>13</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Area 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>27</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unknown</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>1</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

There were some differences between excavation areas. In Area 1 34% (N = 34) and in Area 2 53% (N = 18) of specimens were heavily smoothed. This suggests that bones from both areas spent time in a system full of moving, abrasive particles, but that there was some variability in the degree to which individual bones were subjected to this taphonomic environment. The abraded fossil assemblage creates an apparent mismatch with the lithic data. Clark and Haynes (1970: 394) report that 99% of the stone tools from Area 1 were unabraded, although they also (1970:395) report that, “Signs of utilization are very extensive in the form of minute scarring of the edges, crushing, and rubbing”. It is possible that lithics require more exposure than fossils to abrasive particles to show extensive smoothing, and that the reported “utilization” is actually the result of movement of stone tools by trampling. Heavily-worn artefacts are common on the modern surface deposits at Mwanganda’s Village, suggesting that in the vicinity artefacts were being actively transported as clasts in the fluvial system. This is consistent with the observations by Kafulu (1990; 1983) that the elephant site was deposited within one of many microfacies within the overall sedimentary sequence at Mwanganda’s Village.
The surface smoothing data are further supported by the size grade of the fragments, in which only 11/135 (8%) were less than 2 cm in the maximum dimension. As a rough guide, fragments from cave deposits that have not experienced post-depositional size winnowing will have > 90% of fragments smaller than 2 cm when non-identifiable fragments are included (Clark 2009). Again, there are some differences between the two excavation areas: larger fragments in general were recovered from Area 1. Note that the Mwanganda data exclude the twenty-one specimens that exhibited some form of excavation breakage, as this prevents accurate assessment of the degree of fragmentation prior to excavation and recovery of the assemblage (Figure 48).

According to Clark and Haynes (1970), the sizes of lithics from Area 1 begin with a maximum length of about 15 mm. This is in agreement with the sizes of the faunal remains, but it is not clear what screen size (if any) was used and if this could account for the apparent large starting size of the recovered materials. Kaufulu (1990:24) noted that, “the sediments that occur with archaeological debris on the bank of the paleochannel consist of clay to fine sand particles. These were deposited by paleocurrents with competence values not exceeding 63 mm/sec, which could have transported sediment grains up to 20 mm in diameter.” We therefore consider the three lines of evidence to converge on the interpretation that Area 1 experienced winnowing away of smaller particles, deposition of some components from elsewhere, and some redistribution of larger fragments.
The summary evidence based on preservation of the Mwanganda's Village faunal sample is that the area from which the elephant was derived was a depositional context closer to the extreme of a channel-lag deposit than a channel-fill deposit (Behrensmeyer 1988). Clark and Haynes (1970: 393) state that “Also associated were a heavily worn upper molar, a complete scapula and tusk fragments of hippopotamus and a heavily worn upper molar of giraffe.” The presence of a partial elephant skeleton with few other identified vertebrates in association suggests some degree of spatial integrity, but the amount of abrasion and the fragment size distribution indicate some post-depositional movement. None of the specimens from other taxa were identified in the collection at the Stone Age Institute, but their reported presence further supports the inference that the fossil assemblage contains allochthonous elements transported by water.

If hominin hunters were responsible for the butchery of the elephant, then these events should be recorded in the form of cut marks. In fact, no examples of stone tool-inflicted modification were observed on the bone surfaces of the small sample from Mwanga’s Village. However, periosteum is very thick on elephant bones and experimental butchery has shown that fewer cut marks – and indeed sometimes no cut marks at all – are inflicted on the bone over the course of butchery (Grader et al. 1983; Haynes 1991). Moreover, the high degree of surface abrasion of the fossil assemblage

**Figure 48** Size distribution of the maximum length of fragments.
might be expected to have further erased evidence of hominin butchery that may have once been present.

However, in spite of extensive smoothing many of the bones still preserve clear evidence of carnivore activity (Figure 49). 13% (N = 13) of the fossils from Area 1 and 15% (N = 5) from Area 2 preserve tooth marks. Most of these marks are deep punctures that would be expected to be preserved even under heavy levels of surface destruction. This still leaves open the possibility that the marks represent carnivores scavenging after hominin food debris, with the more subtle indicators of hominin butchery erased by post-depositional processes. However, one final line of evidence argues against this scenario. Most of the tooth marks have morphology that involves deep punctures rather than furrows and scores, and several are ovate in shape. In some cases there are bisected pits and small emanating areas of damage suggestive of a bicarinated tooth. These features, in addition to the lacustrine-fluvial context of the containing sediments, suggest that the tooth marks are derived from crocodiles rather than mammalian predators (Njau and Blumenschine 2006).
Figure 49 Tooth marks from far (left) and close-up of mark with arrow on right. Figures a – f correspond to the following specimen numbers, respectively: 4.24, 4.24 (second aspect), 4.18, 4.23, 450, 10.3. Note extreme smoothing of edges and surface of (f).
Kafulu (1990; 1983) presented strong support for the original interpretation by Clark and Haynes (1970) that the artefacts and fossils found at Mwanganda’s Village were embedded within a palaeosol horizon that had formed in overbank deposits of the upper Chiwondo Beds. Kafulu (1983: 299) concluded that the depositional situation was one of a “non-derived context site”, where “artefacts could not be introduced by currents”. However, he did propose that the artefacts and fossils are not in their original positions relative to one another, and he noted that the distribution of elongate elements in the elephant skeleton suggests stream flow across the site (Kafulu 1990). He also (1990: 24) indicated that, “Distribution of bones and artifacts may have resulted from obstruction of fast currents by the immobile, large elephant bones, very much in the manner that sand shadows develop.”

Clark and Haynes (1970:393-394) reported that: “In Area 2, immediately upslope to the south, was a further light scatter or artefacts, a lower molar of Equus, some fragments of turtle carapace and vertebrae and one or two scraps of the bone of smaller animals. No more elephant bones were found here. Associated with these bones in Area 2 were six or seven bone splinters and flakes from what is probably a large bovid. From the morphology of the specimens and their juxtaposition with the artefacts they provide clear evidence of intentional bone breaking by man”. The taphonomic analysis from both excavation areas does not provide any evidence to support this.

**Analyses of Dental Elements**

The tooth fragments reported here all had a layered aspect to them that suggested dentine from a large mammal, such as an elephant tusk. Three specimens were loaned from the Stone Age Institute to the University of Queensland (UQ), where they were carefully sectioned. One half of each specimen was sent to Drs. Arun Banerjee and Jürgen Tuckermann at the University of Mainz. Banerjee confirmed that all three specimens were fossil elephant ivory and obtained Carbon and Nitrogen isotope values for them. However, the dentine as a whole and particularly the collagen component of all three samples were found to be strongly changed due to diagenesis. Because of this, it is difficult to draw any proper conclusions on the food or habitat of the elephants.
from which the ivory was derived. The results of this analysis are provided in Table 8 and the visual diagnosis of the ivory is illustrated in Figure 50.

Table 8 Carbon and Nitrogen analysis of the elephant ivory from Mwanganda, courtesy of Dr. Arun Banerjee.

<table>
<thead>
<tr>
<th>Sample #</th>
<th>%C</th>
<th>%N</th>
<th>Delta C</th>
<th>Delta N</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.13</td>
<td>1.90</td>
<td>0.18</td>
<td>-12.15</td>
<td>not significant</td>
</tr>
<tr>
<td>6.18</td>
<td>1.84</td>
<td>0.20</td>
<td>-12.4</td>
<td>not significant</td>
</tr>
<tr>
<td>6.7</td>
<td>1.89</td>
<td>0.50</td>
<td>-11.64</td>
<td>not significant</td>
</tr>
</tbody>
</table>

The other halves of the three sectioned specimens (specimen numbers 6.7, 6.8, and 6.13) were retained at UQ for U-Th dating by A/Prof. Jian-xin Zhao and Dr. Gilbert Price at the Radiogenic Isotope Facility at UQ. Analysis using a Multi-Collector Inductively-
Coupled Mass Spectrometer (MC-ICPMS) returned ages of 228.7 +/- 2.7 ka, 254.3 +/- 4.1 ka, and 282.3 +/- 2.4 ka, respectively (Table 9). Uranium-thorium (U-Th) dating (also known as Thorium-230 dating, $^{238}\text{U}-^{234}\text{U}-^{230}\text{Th}$ disequilibrium dating, $^{238}\text{U}-^{230}\text{Th}$ disequilibrium dating, U-series disequilibrium dating and U-series dating) is a radiometric dating technique commonly used to determine the age of carbonate materials such as speleothem and coral. The U-series dating method is based on the decay of $^{238}\text{U}$ (with a half life $T_{1/2} = 4.469 \times 10^9$ years) to stable $^{206}\text{Pb}$ via intermediate daughters such as $^{234}\text{U}$ ($T_{1/2} \sim 245\,000$ years) and $^{230}\text{Th}$ ($T_{1/2} \sim 75\,400$ years). In this decay series, $^{238}\text{U}-^{234}\text{U}-^{230}\text{Th}$ disequilibrium occurs when U is differentiated from Th during a particular geological or environmental event or process. In the case of natural aqueous systems, for example, in which U is slightly soluble, but Th is highly insoluble, carbonate precipitated from the aqueous system will contain trace amounts of U (usually 0.01 – 100 ppm), but virtually no Th, leading to excess U in the decay chain (that is, $^{238}\text{U}$ and $^{234}\text{U}$ activities >> $^{230}\text{Th}$ activity).

Once disequilibrium is established, it takes about seven times the half life of $^{230}\text{Th}$ (~500 ka) for the system to return to near secular equilibrium (that is, when the activities of the parent and daughter nuclides are equal), or to the level where the degree of disequilibrium is below the limit of detection by thermal ionization mass spectrometry (TIMS) or MC-ICPMS. The application of $^{238}\text{U}-^{234}\text{U}-^{230}\text{Th}$ systematics allows precise and accurate age determinations on materials such as detritus-free speleothem or coral spanning the last 500,000 years, covering ~7 times the half life of $^{230}\text{Th}$.

However, unlike speleothem or coral, teeth and bones of living animals contain very little U. Instead, U was taken up from the environment during fossilisation processes. Thus, the U-Th date of a fossil tooth or ivory sample records the mean age of the fossilisation process or U uptake history. In ideal cases, U uptake may reach saturation level during the early stage of the fossilisation process (early uptake mode). In this case, the U-Th date would approximate the deposition age of the fossil material. In most other cases, U uptake modes might be more complex. In such cases, the U-Th dates of the fossil are theoretically variable but always younger than the deposition age of the fossil.
material. The ages returned by the U-Th method provide, in this case, minimum dates for the fossilisation of the tusk fragments.

Table 9 Results of U-Th isotopic analysis on the three elephant tusk fragments. Errors are at 2σ. Ratios in parentheses are activity ratios.

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Sample Number</th>
<th>U (ppm)</th>
<th>$^{232}$Th (ppb)</th>
<th>$^{230}$Th/$^{232}$Th</th>
<th>$^{230}$Th/$^{38}$U</th>
<th>$^{234}$U/$^{238}$U</th>
<th>$^{230}$Th Age (ka)</th>
</tr>
</thead>
<tbody>
<tr>
<td>JT-1</td>
<td>6.7 (bag 6, spec. 7)</td>
<td>2.8027±0.0009</td>
<td>2.433±0.025</td>
<td>3539±39</td>
<td>1.0149±0.0036</td>
<td>1.1248±0.0011</td>
<td>228.7±2.7</td>
</tr>
<tr>
<td>JT-2</td>
<td>6.8 (bag 6, spec. 8)</td>
<td>2.6222±0.0006</td>
<td>11.216±0.034</td>
<td>753±04</td>
<td>1.0640±0.0044</td>
<td>1.1394±0.0013</td>
<td>254.3±4.1</td>
</tr>
<tr>
<td>JT-3</td>
<td>6.13 (bag 6, spec.13)</td>
<td>5.2161±0.0019</td>
<td>5.237±0.024</td>
<td>3338±16</td>
<td>1.1066±0.0019</td>
<td>1.1511±0.0010</td>
<td>282.3±2.4</td>
</tr>
</tbody>
</table>

Discussion

Because of the complex U uptake process even in different parts of a fossil material, the apparent U-Th dates from different parts of a single fossil material may vary, but should represent the minimum ages of the deposition age, with the oldest being the closest to the deposition age. All three specimens dated from the Stone Age institute collections came from Bag 6 because no tooth fragments were recovered from the other bags. Bag 6 bore a label that identified it as having been excavated from the south end of the elephant femur in July 1966. None of the specimens exhibited any polish or smoothing of the edges to suggest that they had been transported or otherwise altered by water or abrasive particles. The three fragments could not be refit together, but it is most parsimonious to infer that all three fragments derive from the same elephant tusk, and that this tusk was from the same elephant that was originally excavated by Clark and Haynes in 1966. Because of the complexity in U uptake, the range in ages is not unexpected for tooth specimens even from the same animal, especially where other analyses have revealed heavy diagenetic alterations (Eggins et al. 2003). For these reasons, we argue that the oldest of the three dates, 282.3±2.4 ka, should be the closest to the true age of the fossil. The fact that the sample (JT-3) of the oldest U-Th age also has the highest U concentration also supports this argument.
If we assume the three tusk fragments derive from the same individual the method has given a minimum age for the Mwanganda's Village elephant of ca. 280 ka. This represents the first formally reported radiometric age on Middle Stone Age artefact-bearing deposits in Malawi. It also represents one of a handful of radiometric ages for materials associated with Sangoan stone tool technology in the whole of Africa.

The minimum age for the fossils is intriguing for several reasons. First, Kaufulu (1990: 17) informally cites a rubidium-strontium age of ca. 300 ka on a caliche unit overlying the artefact and fossil horizon at Mwanganda's Village. This is not a dating method that is commonly applied to archaeological applications, and Kaufulu does not report the source of the sample, the type of material dated, the preparation methods of the sample, the source of the age, or the error ranges. However, it is surprisingly close to the minimum ages obtained on the underlying fossil elephant tusk. Furthermore, a minimum date of ca. 282 ka for a Sangoan site in central Africa is almost exactly where one might expect it to fall, if the Sangoan was in fact a transitional Earlier-Middle Stone Age industry.

Although the Sangoan is poorly understood it is broadly considered to date to the earlier part of the Middle Stone Age. The earliest radiometric ages for the Levallois technology that typifies the MSA are from the Kapthurin Formation in Kenya at around 285 ka (McBrearty and Tryon 2005). The transition from the Acheulean to the MSA is considered to have begun gradually at this time, culminating in a variety of MSA variants by ca. 200 ka (McBrearty 2001; McBrearty and Tryon 2005; Tryon et al. 2005; Tryon and McBrearty 2002). Radiometric ages reported for a Sangoan site are rare. At Kalambo Falls, Zambia, a U-Series age of 50 – 80 ka was produced on wood associated with Sangoan artefacts (Clark 2001). At Simbi, Kenya, a Potassium-Argon date on a tuff over a Sangoan horizon returned an age of 40 – 65 ka (McBrearty and Clark 1991). However, the Sangoan has been found stratified between the Acheulean and/or the MSA at several sites: Muguruk, Kenya (McBrearty 1988), Kalambo Falls, Zambia (Clark 2001; Sheppard and Kleindienst 1996), Isimila, Tanzania (Cole and Kleindienst 1974), Nsongezi, Uganda (Cole 1967), and Kudu Koppie (Kuman et al. 2007; Pollarolo et al. 2010).
Based on its position relative to the Acheulean and MSA the Sangoan is commonly inferred to have an age closer to the start of the Middle Stone Age. At Kalambo Falls, Zambia, Clark et al. (2001:234) state that, “The Sangoan Industrial Complex, therefore, is seen to represent the earliest manifestation of new technological traits in the long transition through several technological and other behavioural changes from the end of the Earlier Stone Age, through the fully developed to later lithic aggregates representing the lifeways of Middle Stone Age hominids in south-central and eastern Africa”.

However, it is possible that the ‘Sangoan’ was not a single penecontemporaneous entity that spanned Africa. Van Peer et al. (2003) report a Sangoan occurrence in Sudan that appears to be contemporaneous with the local Acheulean, dated to ca. 200 ka. They suggest that the Middle Stone Age may have been imported into northern Africa via a population replacement. This could have been the case, but there is no necessary need to call upon either population replacements or even contemporaneity to explain the Sangoan. Although the industry is defined by the presence of a ‘heavy-duty’ component such a core-axes, it is also largely defined by the absence of particular technological attributes that would otherwise sort it out into the Acheulean (ie: handaxes), or the Middle Stone Age (ie: Levallois technology). In the Kapthurin Formation, Kenya, Sangoan occurrences are interstratified with Acheulean and MSA technologies, recording a long series of technological changes that are not necessarily unidirectional over time (Tryon and McBrearty 2002). There is a very real possibility that assemblages have been identified as a single entity – the Sangoan – when in fact they represent a wide spread of instances in which there was a convergent need for (or a lithic raw material constraints on) the manufacture of heavy-duty tools without the accompanying ‘types’ that would otherwise define it as either Acheulean or MSA. There simply are not enough instances of well-dated Sangoan assemblages that have been studied using more technologically-based (rather than typological) methods of lithic analysis to be able to tell.
Future Work

In spite of the very sparse number of datapoints on the African continent, there is a growing impression that the Earlier – Middle Stone Age transition across Africa was achieved through a mosaic of patterns in different places and at different times: gradual transitions, periods of stasis, and sudden change. The dates from the Mwanganda elephant would appear to support the more traditional view that the Sangoan industry typified this transition. However, the issue of the association between the dated tusk and the stone tools is still one that remains to be satisfactorily resolved. The taphonomic analysis showed a great deal of abrasion, inferred to be the result of fluvial action. They bore marks that closely resembled crocodile damage but no hominin modification was apparent. However, the sample was small and hominin modification might not be expected to preserve under such conditions.

There is a great deal more work that can be done with the lithic assemblage that is housed at the Stone Age Institute. A lithic refitting program was begun in the 1970’s and 1980’s, most recently (but never completed) by an individual named Charlie McNutt. These efforts can be renewed and the degree of abrasion on the lithics can be more carefully quantified. However, the target problems identified at the outset cannot be resolved only by revisiting the curated collection. Identification of the nature of the erosion said to have truncated the artefact-bearing palaeosols is best done under the microscope, and new dates must be obtained using OSL and perhaps more U-Th on well-provenienced fossil specimens. Broad-scale mapping and detailed correlations that employ both geochemical and more traditional methods of characterisation are needed to understand the complex underlying depositional facies in which the artefacts and fossils are contained, and from which some have almost certainly been eroded. This can only be achieved by future excavations and sampling at the Mwanganda site, fine-resolution mapping that builds on the work of Kaufulu (1990; 1983), and careful attention to the micro-stratigraphy of the depositional history of the site.
VII. SURVEY IN NKHATA BAY

Rationale

The sites the MEMSAP has investigated in northern Karonga are currently all within 15 km of the modern lakeshore. However, it is clear that at certain times over the course of the Middle Stone Age the lakeshore was up to 85 km distant (Scholz et al. 2007). This reflects extreme aridity that would have had major impacts on overall hydrology and water availability in the region. The Karonga sites therefore offer an excellent opportunity examine human response to extreme climate shifts in the past. These responses are best understood in comparison to areas that had more or less continuous access to the lakeshore. Bathymetric data indicate that the area around Nkhata Bay was one such place, and four potential Middle Stone Age sites in the district have been reported by Clark (Clark 1968). All of these were within 10 km of the modern lakeshore, but one (Chikwina) was more difficult to access because it was located at a much higher elevation (ca. 500 m higher than the lake). Between 8 – 11 August 2010 a small team (Thompson, Simfukwe, Simengwa, and Turner) revisited all four sites and also surveyed the area around Nkhata Bay for new sites.

Sites in MAD Register

Mzuzu Road

Cole-King (1973) describes MSA artefacts in a gravel pit alongside the road between Mzuzu and Nkhata Bay, about 20 km outside of Mzuzu. We were unable to relocate the gravel pit, though we explored some of the area parallel to the road. The deposits are steep slopes covered in dense forest, and the only exposures appear to be in the form of road cuts. The surfaces along the road have abundant unmodified quartz chunks, and within the forest the deposits are made up of red clayey silts. In some areas at the tops of hills exposure to rainfall has resulted in small pedestals that hold flaked stone artefacts. They are all on quartz or crystal quartz, and it is difficult to assign them to any particular industry or time period.
Timbiri

Clark (1968: 40) describes several exposed sections at Timbiri, at an intersection with the road to Chikwina. He suggests that these might be roughly correlated with the Chitimwe-Chiwondo sequence in Karonga, but also indicates that he did not see any artefacts in the sections. Further geological work would be required to test the first observation, although we were able to relocate the sections and confirm the latter (Figure 51). It is of interest to note that we also located thick (at least 10 cm) iron pan formations in the area. More systematic survey might reveal artefact occurrences, and the area could warrant additional dating and geological work to determine the sedimentary context.

Figure 51 Harrison Simfukwe standing in front of the exposed section at Timbiri. Clark (1968) proposed that lithics might be recovered here but none were observed during cursory survey by his team or by ours.
Chikwina

Clark (1968: 40) reported a few LSA and potential MSA artefacts eroding from red colluvium near the village of Chikwina. When we revisited the area we found a few pieces of crystal quartz that had likely been worked. Some local children told us that the stone does not naturally occur around Chikwina, but that it could be obtained by walking ca. 6 km toward the lakeshore. It is unclear how Clark (1968) determined that an MSA component may have been present, as the materials appeared quite undiagnostic.

Figure 52 View of the area around Chikwina, within 100 m of Clark’s (1968) reported lithic finds.

Chikale Beach

The only potentially flaked raw material around Chikale Beach was quartz, which is also abundant in the area in unmodified form. This made it particularly difficult to identify artefacts, and extremely difficult to assign obvious artefacts to any particular time period or industry. A transect was walked from Chikale Beach to the top of the hills overlooking Nkhata Bay (Figure 53). A potential rock shelter was investigated in the steep slope, but it contained no deposit. Several clear cores and flakes were present in
the agricultural fields at the top, and a few of the cores were collected for future analysis. However, all were in highly disturbed contexts and manufactured on raw materials that were all different variations on quartz, which is also naturally present in the sediments. It did appear that the naturally-occurring quartz had a coarse, blocky fracture pattern that was not the case with the artefacts (which were on finer-grained milky or crystal quartz). However, this initial impression has not been confirmed and it was extremely difficult to identify particular 'sites', or to determine if any Middle Stone Age components were present.

**Figure 53** Steep terrain by the lakeshore at Nkhata Bay. Lithics are abundant in the fields at the top of the hills but they are all on quartz and crystal quartz.

**Assessment of Potential**

No discrete new sites were discovered, although many of the surfaces that were walked had artefacts in relatively higher or lower concentrations. The general impression in the surveyed areas is one of an upper sediment horizon that is highly disturbed by erosion, agriculture, deflation, or colluvial processes. Within this horizon lithic artefacts can be found at nearly any stop along the Mzuzu – Nkhata Bay road and at the tops of hills in agricultural fields. The ages of these artefacts are unknown, as is their potential subsurface extent. A listing of the localities that were recorded is provided in Appendix II.

Some localities in the cassava fields above Nkhata Bay had relatively greater densities of artefacts, but the agricultural context of the finds made it difficult to determine their context. A few 1 x 1 m test pits in this area might provide much information about the
underlying stratigraphy, and clarify if any potential Middle Stone Age deposits are present. If paired with a regional geomorphological study, areas with relatively higher archaeological potential could be identified. However, at this time the relative return of such a study is unclear, while we know that there is very high potential for very high scientific returns in Karonga. Therefore, further investigations in the Nkhata Bay area will not be a priority.
VIII. SUMMARY

Summary

Through survey, several new sites were discovered to the north of those already known in Karonga. New localities include the Ighembe Ridge locality, which is located in an area where geological maps do not show the Chitimwe Beds in which MSA artefacts are typically contained. Many of these will allow comparisons between the North Rukuru and the Lufira river catchments, including the development of new methods to track lithic raw material movements between catchments. The Kafula Ridge locality in the Lufira River catchment is of particular note because it contains a high degree of spatial integrity as demonstrated by sharp, unweathered and refitting artefacts. Finally, several localities were surveyed in Nkhata Bay to assess the potential for comparisons between different areas along the shores of Lake Malawi. The disturbed nature of the deposits and the difficulty in separating artefacts from background stone resulted in an initial impression that this area has low potential to contribute substantially to the project goals.

The 2010 excavations built effectively upon the results of the 2009 pilot survey. It resulted in the recovery of sediment samples that will be used for dating, landscape correlation, and an understanding of the microstratigraphy of artefact-bearing deposits. It also resulted in the recovery of a large sample of in situ artefacts from controlled excavations at the Airport site and a smaller sample from Mwanganda’s Village. An understanding of the significance and context of subsurface artefacts from the Airport Site is of immediate importance because of its location at the end of the Karonga Airstrip, which may see further development in the near future. Preliminary lithic analysis showed that the artefact at the site were probably deposited on top of existing river terraces, and that they had undergone minimal secondary depositional movement. The work at Mwanganda’s Village will provide data needed to address several outstanding questions about the age and depositional context of this important site. Test pits showed that a distinct layer of artefacts occurs at least 60 m southeast of the
area from which the elephant was recovered, and that this might be an artefact horizon that is even higher in the depositional sequence. Information gained from both sets of excavations in 2010 will be essential for guiding future work.

A trip to the Stone Age Institute in Bloomington, Indiana, resulted in the analysis of parts of the original faunal assemblage from Mwanganda’s Village. These analyses revealed aquatic fauna in association with fragments of elephant tusk and unidentifiable pieces of a very large animal (also likely part of the elephant). These fragments had been modified by a carnivore, likely a crocodile, and may have come into association with the artefacts solely through post-depositional processes. U-Th ages on the elephant tusk provide the first radiometric ages for any material associated with Middle Stone Age artefacts in northern Malawi, and these ages returned a minimum of 282.3±2.4 ka.

Analyses of the samples collected in 2010 are underway. Results available thus far have been formally presented at the joint Society for Africanist Archaeologists/Pan African Association for Prehistory and Related Studies meeting in Dakar, Senegal and the Australian Archaeological Association meeting in Bateman’s Bay, Australia. The collaboration has also resulted in the submission of a paper to Quaternary International. The content of these presentations and papers are contained within this report.

The fieldwork was also an important training opportunity for Malawian students and Antiquities Officers. They became involved in excavation, mapping, and survey using both conventional and technologically-aided methods. Two CUNIMA students are doing bachelor’s theses on materials from Karonga as a result of their involvement in the project. The inaugural public lecture for a new initiative by the Cultural and Museum Centre Karonga was provided by the MEMSAP team, which is the first step in many that we aim to take towards making our work accessible to the larger communities of Karonga and Malawi as a whole.

We hope to continue this trend of annual field seasons in Malawi, beginning with what is known and working toward discovering new sites and providing detailed interpretations of those that have already been examined. In 2010 we were successful
in obtaining two grants to support research in 2011, 2012, and 2013 from the National Geographic-Waitt Foundation (W115-10) and the Australian Research Council (DP 110101305). The Middle Stone Age record in Malawi is one of high potential significance both to local people and the international scientific community. It is hoped that through continued collaborations with the Department of Antiquities and vigorous training of Malawian workers we can set into place a long-term relationship that will include year-round research, employment opportunities, cultural exchanges, and dissemination of the results of these investigations back to the people of Malawi.

**Acknowledgements**

The authors firstly thank the Malawi government for their continued support for the project. Permits were provided by Dr. Elizabeth Gomani and Potiphar Kaliba. Harrison Simfukwe and Oris Malijani represented Malawi Antiquities during all fieldwork. The field crew in 2010 comprised 13 students from the Catholic University of Malawi and one student from the University of Queensland (UQ). We hope they learned as much about doing archaeology from us as we did about teaching archaeology from them. The fieldwork was supported by a UQ Early Career Researcher grant to Thompson, and field recording forms and protocols were based on a system developed by Curtis Marean and the SACP4 team. Thomas Jones gave generously of his own resources to fund the transport and analysis of samples obtained during the 2010 fieldwork. Many of the analyses presented here were provided by specialists or students who gave freely of their time and expertise to help build the project, but who did not claim authorship of this report. These include contributions of residue analysis (Dr. Gail Robertson), U-Th ages (A/Prof. Jian-xin Zhao and Dr. Gilbert Price), chemical analyses and micro-CT imagery of elephant teeth (Dr. Arun Banerjee and Dr. Jürg Tuckermann), cobble characteristics (Davie Simengwa), Pollen (Dr. Patrick Moss), Phytoliths (Dr. Lynley Wallis), and preliminary sediment characteristics for OSL (Dr. David Wright).
IX. REFERENCES CITED


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## Appendix I: Probable MSA Artefacts in the Phoebe A. Hearst Museum

All listed artefacts were collected in 1965 by Prof. J.D. Clark.

<table>
<thead>
<tr>
<th>Cat No.</th>
<th>Acc. No.</th>
<th>Material</th>
<th>Description</th>
<th>Size (cm)</th>
<th>Locality</th>
<th>Context</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-6446</td>
<td>2369</td>
<td>Quartzite</td>
<td>Whole waste flake</td>
<td>6</td>
<td>Karonga/Chaminade</td>
<td>Surface</td>
<td>CH. 1-A</td>
</tr>
<tr>
<td>5-6519</td>
<td>2369</td>
<td>Quartzite</td>
<td>Hand axe</td>
<td>6</td>
<td>Karonga/Chaminade</td>
<td>Surface</td>
<td>CH. 1-A</td>
</tr>
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<td>2369</td>
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## Project Report to the Malawi Ministry of Tourism, Wildlife and Culture

**Updated 18 February 2011**

**MALAWI EARLIER-MIDDLE STONE AGE PROJECT**

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Appendix II: New Localities Identified in Nkhata Bay District

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<td>0642199</td>
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