MALAWI EARLIER-MIDDLE STONE AGE PROJECT

2011 Interim Project Report

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CONTENTS

LIST OF FIGURES

LIST OF TABLES

I. INTRODUCTION

The Malawi Earlier-Middle Stone Age Project

The Malawi Earlier-Middle Stone Age Project (MEMSAP) is a cross-disciplinary project aimed at understanding changes in human technology, subsistence, and demography across the time period known as the Middle Stone Age (MSA – from ~ 280 – 30 thousand years ago [ka]). This is only possible with the establishment of long archaeological and palaeoclimatic sequences embedded within a well-understood chronometric framework. Because individual sites do not cover this entire time period, MEMSAP uses a landscape approach to build a long sequence from different sites present within the exceptional archaeological record of northern Malawi. Ultimately, this sequence will 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 if populations moved 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:** Discernible 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.

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 have begun with what is known about the MSA of northern Malawi and are working towards the unknown. This ensures a useful result at the end of each field season regardless of the scale of the investigations.

Summary of MEMSAP Activities to Date

Most project activities to date have taken place near the town of Karonga (Figure 1). In 2009 a pilot survey in Karonga identified key areas for further research (Thompson *et al.* 2009), including the 'elephant butchery site' at Mwanganda's Village reported by Clark and Haynes (1970) and the Airport Site near Chaminade (Thompson *et al.* In press). The first full MEMSAP season took place in July/August 2010 (Thompson *et al.* 2011). Excavations during this season at the Airport Site recovered over 2500 sharp-edged artefacts from at least two different depositional contexts: an iron pan stratified between two sandy units and the top of a buried cobble horizon. The most current presentation of data from the Airport Site can be found in Thompson *et al*. (In press).

Survey in 2010 demonstrated that MSA artefact assemblages of the same abundance as around Chaminade are also present in the Lufira and Songwe River catchments to the north. Many of these are demonstrably *in situ*, and are made on a variety of raw materials found mainly in the form of river cobbles. In contrast, survey in the Nkhata Bay District to the south showed that available raw materials are predominately quartz and that artefacts diagnostic of the MSA are not abundantly distributed across the landscape.

In 2010 test excavations were undertaken at Mwanganda's Village (Thompson *et al.* 2011). The fossil- and artefact-bearing palaeosol unit reported by Clark and Haynes (1970) and Kaufulu (1990) was not relocated in 2010, but a test pit on a higher terrace ca. 60m to the southeast revealed a lithic assemblage buried under 1.5m of overburden. This discovery prompted the production of three optically-stimulated luminescence (OSL) ages analysed in 2011 and reported here. It also stimulated excavations in 2011 (reported here) that resulted in the recovery and analysis of a larger sample of artefacts.

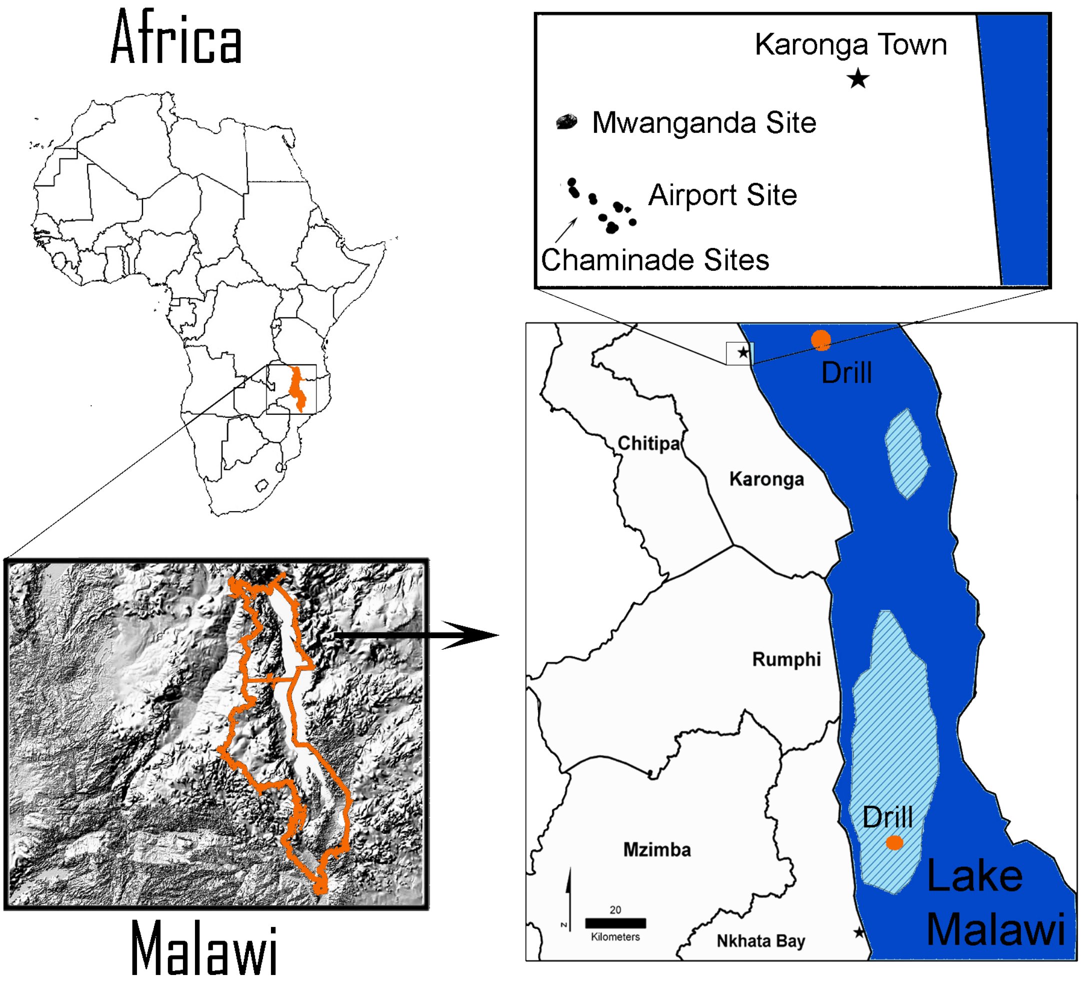

Figure 1 Location of study area showing where the majority of work has been conducted to date. Parts of Lake Malawi with diagonal lines indicate maximum extent of lake reduction during periods of 'megadrought' and dots represent drill core sites. Redrawn from Scholz *et al.* (2007).

In April 2010 a portion of the original fossil assemblage from Mwanganda's Village was examined at the Stone Age Institute in Bloomington, Indiana (Clark and Haynes 1970). Uranium-Thorium analysis on elephant tusk fragments from the original assemblage yielded an age of ca. 282 ka, which confirms at minimum a Middle Pleistocene age for the site. However, the faunal assemblage exhibits rounding and weathering consistent with fluvial alteration and all identified surface marks are best interpreted as the result of carnivore – and especially crocodilian – damage. This suggests that the elephant fossils and the artefacts originally reported from the site may not have been behaviourally associated. This is a result that demands new, tightly-controlled excavations with full recovery that can be investigated with modern sediment and chronometric analyses.

The Stone Age Institute study resulted in the first radiometric ages and taphonomic analysis of the fossil assemblage for the site, although the majority of the elephant skeleton from the original excavations has still not been located. Unsuccessful attempts have been made to relocate the skeleton at institutions in Malawi (Malawi Museums in Lilongwe and the National Repository in Nguludi), and in the United States where materials collected from Malawi by J. Desmond Clark are known to have been held (the University of California at Berkeley, the Phoebe A. Hearst Museum of Anthropology in California, the Stone Age Institute in Bloomington, Indiana, and the Field Museum in Chicago).

Summary of 2011 Activities

This report updates the information provided in the 2009 field report (Thompson *et al.* 2009) and the 2010 field report (Thompson *et al.* 2011). MEMSAP activities in 2011 fall into five major categories:

1) Establishment of control points for mapping, especially of the Chaminade area.
2) Geomorphological survey and landscape sampling to contextualise the archaeological deposits, including emplacement and recording of geological trenches in the Chaminade area.

3) Excavation of two sites, Mwanganda's Village and Chaminade Site I between 1 July – 23 August 2011. The first two weeks of this period also had archaeological field school instruction as a specific component.
4) An 'off-season' excavation of Chaminade Site II led by Malawi Department of Antiquities personnel.
5) Analyses of materials and samples recovered during the 2010 and 2011 field seasons.

This report describes the activities in the context of on-site work at the excavation localities and landscape work at other localities.

Personnel

Personnel who partook in the July and August 2011 fieldwork are listed in Table 1.

In addition, a local field crew was recruited. The number of local participants was normally between 10 - 15 people, although 40 people were hired for two days of the excavation to assist with the clearance of overburden across a large area. Several personnel did not participate in fieldwork but were engaged as collaborators and analytical specialists in other ways. These people included:

- Dr. Elizabeth Gomani-Chindebvu, Director of the Malawi Department of Culture
- Mr. Potiphar Kaliba, Director of the Malawi Department of Antiquities
- Ms. Chrissie Chiumia, Chief Historian at the Malawi Department of Antiquities
- Prof. Steven Forman, an OSL dating specialist at the University of Illinois at Chicago (under analysis, some analysis complete)
- Prof. Jon Olley and Dr. Timothy Pietsch, OSL dating specialists at Griffith University (under analysis)
- Ms. Amanda Greaves, a UQ Honours student in geoarchaeology
- Ms. Alison Moroney, a UQ Honours student in Geographical Information Systems

Table 1 Personnel who directly took part in the 2011 excavation season

Name	Role / Specialty or Background (if applicable)	Affiliation
Researchers / Instructors		
Dr .Jessica Thompson	Chief Investigator /Zooarchaeology	University of Queensland
Mr. Menno Welling	Partner Investigator / Historical Archaeology	African Heritage - *Research and Consultancy*
Dr. David Wright	Partner Investigator / Geoarchaeology	Seoul National University
Prof. J. Ramón Arrowsmith	Partner Investigator / Geomorphology	Arizona State University
Prof. Andrew Cohen	Partner Investigator / Palaeoenvironments	University of Arizona
Dr. Alex Mackay	Partner Investigator / Lithic Analysis	Australian National University
Ms. Clair Harris Davey	Teaching Staff Support / Lithic Analysis	University of Queensland
Ms. Rachel Warren	Teaching Staff Support / Lithic Analysis	Catholic University of Malawi
Professional Staff		
Mr. Harrison Simfukwe	Senior Officer / Palaeontology + Archaeology	Malawi Department of Antiquities
Mr. Oris Malijani	Senior Officer / Archaeology	Malawi Department of Antiquities
Mr. Malani Chinula	Senior Officer / Archaeology	Malawi Department of Antiquities
Research Students with MEMSAP Projects		
Mr. Scott Robinson	PhD Student / Fluvial Geormophology	Arizona State University
Ms. Marina Bravo Foster	PhD Student / Tectonic Geormophology	Arizona State University
Mr. Andrew Zipkin	PhD Student / Ochre	George Washington University
Archaeological Volunteers		
Ms. Emma James	PhD Student / Zooarchaeology	University of Queensland
Mr. Victor de Moor	Recent Graduate / Masters in Lithic Analysis	Leiden University
Mr. Edward Turner	Honour's Student / Zooarchaeology	University of Queensland
Mr. Corey O'Driscoll	Honour's Student / Zooarchaeology	University of Queensland
Undergraduate Field School Students		
Ms. Jacqueline Matthews	y3 Bachelor's Major	University of Queensland
Ms. Jordan Clarke-Vote	y3 Bachelor's Major	University of Queensland
Angela Nye	y3 Bachelor's Major	University of Sydney
Mr. Kingsley Pamanda	y3 Bachelor's Major	Catholic University of Malawi
Ms. Anna Weisse	y2 Bachelor's Major	University of Queensland
Ms. Rommy Cobden	y2 Bachelor's Major	University of Queensland
Ms. Julia Maskell	y2 Bachelor's Major	University of Queensland
Mr. Nicholas Wiggins	y2 Bachelor's Major	University of Queensland
Mr. Jacob Davis	y2 Bachelor's Major	University of Queensland
Ms. Sperecy Chigwale	y2 Bachelor's Major	Catholic University of Malawi
Ms. Chimwemwe Phiri	y2 Bachelor's Major	Catholic University of Malawi
Mr. Adriano Ndazela	y2 Bachelor's Major	Catholic University of Malawi
Ms. Margaret Wowa	y2 Bachelor's Minor	Catholic University of Malawi
Mr. Lloyd Mdala	y2 Bachelor's Minor	Catholic University of Malawi

II. CONTEXT OF RESEARCH

Theoretical Background

Research aimed at understanding the origins and dispersal of modern humans has fuelled one of the most prominent lines of research in palaeoanthropology over the last two decades (d'Errico and Stringer 2011). Theoretical debates over the origins of modern humans began among physical anthropologists (Aiello 1993, Pearson 2008), with geneticists later demonstrating that the diversity of all modern populations can be traced to a single origin in Africa as recently as 200 ka (Relethford 2008, Weaver and Roseman 2008). Archaeologists then developed two major competing models for the origins of human *behavioural* modernity (Henshilwood and Marean 2003, d'Errico and Stringer 2011). The Late Upper Pleistocene (LUP) model posits that a rapid change in behaviour and technological change occurred at some point between 40 – 50 ka, facilitating the spread of modern humans out of Africa and into Eurasia (Gamble 1994, Klein 2008). The Gradualist model regards the advent of modernity as an accretionary process of behavioural change and technological innovation that spanned the MSA rather than a sudden final burst (Chase and Dibble 1990, McBrearty and Brooks 2000, Mellars 2007).

Recent improvements to the empirical record have shown that many of the important changes leading to the modern behavioural suite occurred in Africa during the Middle Stone Age. However, major unresolved issues remain regarding whether the emergence of modern people took place over a short or a long chronology (Henshilwood and Marean 2003), if behavioural change was punctuated or gradual (d'Errico and Stringer 2011), and how behavioural change and/or population movements may have been structured by major shifts in palaeoclimate (Basell 2008). Unfortunately, efforts to resolve these issues are frustrated by an empirical record that has few stratified sites (McBrearty and Brooks 2000), poor geochronological control (Tryon and McBrearty 2006), and few localities with well-understood Middle and Late Pleistocene artefact-bearing deposits and accompanying high-resolution palaeoclimatic records (Marean and Assefa 2005). Further detailed discussion of these issues and how they relate to the work reported here can be found in Thompson *et al.* (2009), Thompson *et al*. (2011), and Thompson *et al.* (In press).

Previous Related Scholarship

Cumulative learned behaviour purposefully taught and expressed through extrasomatic culture is extraordinarily developed in modern humans (Hill *et al.* 2009), marking us as a "spectacular evolutionary anomaly" in the natural world (Boyd and Richerson 2005). Technological change is one arena where such social transmission occurs. When expressed through the durable lithic artifact record it provides a way to measure behavioural change with few problems of sample size or taphonomic bias. A major technological shift occured across the Earlier to Middle Stone Age boundary ca. 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 (Van Peer *et al.* 2003, McBrearty and Tryon 2005, Tryon and McBrearty 2002, Tryon and McBrearty 2006, Morgan and Renne 2008). However, most of these early MSA data derive from northeastern Africa and little is known about changes in the intervening ca. 150,000 years between this time and the Late Pleistocene MSA (Gowlett 2009). Recent work in Zambia and Mozambique suggests that central Africa has a rich MSA record, but these sites stand in relative isolation (Barham 2000, Barham and Robson-Brown 2001, Barham 2002a, Clark 2001, Mercader *et al.* 2009, Mercader *et al.* 2008).

Modern human origins research in Africa has been dominated by the Late Pleistocene portion of the MSA, from ca. 128 – 30 ka. Recent discoveries of incised pigments, shell beads, and elaborate stone tools from MSA sites across Africa demonstrate that modern cultural complexity and symbolic behaviour were well-established by ca. 100 ka (Yellen *et al.* 1995, Henshilwood *et al.* 2004, Henshilwood *et al.* 2009, Henshilwood *et al.* 2011, Vanhaeren *et al.* 2006). However, modern behaviours from the Middle Pleistocene portion of the MSA (from ca. 280 – 129 ka) are also implied by pigment use, microlithic stone tool technology, and advanced hunting ability (Marean *et al.* 2007, Barham and Robson-Brown 2001, Thompson 2010).

During periods of extreme cold and aridity in the late Middle Pleistocene sea levels lowered (Waelbroeck *et al.* 2002), potentially pushing human settlement onto the coastal plain or other ephemeral refugia (Basell 2008). Rising sea levels during the Last Interglacial at 128 ka then drew an arbitrary taphonomic line across the MSA in many key localities (Marean *et al.* 2007). This presents an enormous problem in modern human origins research because the timing and tempo of the development of behavioural complexity and technological variability is only now becoming well understood, and even then the sites normally post-date ca. 128 ka. Similarly, the climate-driven hypothesis of early modern human demography is partially based on a poor record of well-dated sites rather than on clearly identified occupational hiatuses at central African localities with long sequences (Cohen *et al.* 2007).

Northern Malawi lies at an important crossroads for ancient demographic movement between the better-known eastern and southern African subregion. The Karonga landscape imposes specific constraints on human population movement: Lake Malawi is a physical barrier to the east and high plateaus rise to nearly 2500 m within 100 km to the west. Today the Northern Province of Malawi falls within the Zambezi ecozone vegetational community (White 1983). Variable climate has rendered this area at certain times a biogeographic barrier between endemic faunas of eastern and southern Africa (Klein 1984), and at others a natural funnel for large mammal (including hominin) populations (Bromage *et al.* 1995a). During periods of maximum aridity the region may have become an important refugium for MSA populations as vegetation boundaries and biotic communities followed the retreating lakeshore (Beuning *et al.* 2011). This is suggested by the high degree of endemic species diversity indicative of long-term refugia for biotic communities (Danley *et al.* 2000, Dudley 2005).

In spite of its potential, since the 1970s human origins research in Malawi has been mainly restricted to the early portion of our prehistory at the Plio-Pleistocene boundary (Bromage and Schrenk 1987, Schrenk *et al.* 1993, Bromage *et al.* 1995a, Bromage and Schrenk 1995, Bromage *et al.* 1995b, Schrenk *et al.* 2002, Clark 1995). The majority of archaeological work on the early prehistory of Malawi was undertaken by J. Desmond

Clark in the 1960s and 1970s (Clark 1966, Clark 1968, Clark *et al.* 1967, Clark *et al.* 1966, Clark 1972, Clark and Haynes 1970), with occasional reports since (Juwayeyi and Betzler 1995, Kaufulu 1990, Kaufulu and Stern 1987). Some aspects of the Malawian MSA have become propagated in the literature and require updating, for example, where the Mwanganda's Village site (Clark and Haynes 1970, Kaufulu 1990) is cited as evidence of early MSA megafaunal hunting dating to nearly 300 ka (Mussi and Villa 2008, Surovell and Waguespack 2006, Surovell *et al.* 2005, McBrearty 1988, McBrearty 2001).

Initial investigations in the 1960's (Clark *et al.* 1970, Clark *et al.* 1966, Clark and Haynes 1970) 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 palaeoenvironmental 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, Henshilwood *et al.* 2011, Watts 2009, Barham 2002b).

Work conducted under MEMSAP highlights the significance and potential of Malawi to modern human origins research by contributing to this body of scholarship in two primary ways: 1) it provides a rare opportunity to test two major competing models of the rate of behavioural change during the MSA that cannot be falsified with shorter sequences; and 2) it allows the first direct tests of the climate-driven model for central African megadroughts and their impact on MSA populations.

Palaeoenvironmental and Depositional Context

The Malawian landscape 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.* 1995a), and likely also guided major human population dispersals that ultimately led out of Africa. Understanding the mechanisms behind these dispersals is one of the largest questions in modern human origins research.

One of the longest and most detailed terrestrial palaeoclimate records in Africa is derived from cores taken in the northern basin of Lake Malawi (Cohen *et al.* 2007, Scholz *et al.* 2007, Scholz *et al.* 2011). These records show 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, Stone *et al.* 2011). As local environments underwent dramatic change (Beuning *et al.* 2011), MSA populations would have been fragmented, reconfigured, and possibly displaced into local refugia (Basell 2008). This has implications for the degree of inter- and intra-group contact and conflict (Choi and Bowles 2007, Bowles 2009), as well as the possibility that central Africa became almost completely depopulated (Cohen *et al.* 2007). Recent modelling has suggested that changes in demographic parameters drive socio-technological changes that may be visible archaeologically (Powell *et al.* 2009), and the human palaeontological record also suggests a complex history of multiple source populations in Africa for modern humans (Gunz *et al.* 2009). Testing these climate-structured demographic models of modern human origins can be achieved only where a long, *in situ* MSA record of human behaviour can be paired with a high-resolution palaeoclimatic dataset. Both records are available in the Karonga District of northern Malawi.

The Karonga Basin comprises the footwall of the Livingstone Fault, with a strip of Quaternary sediments bordering Lake Malawi along a ca. 140km stretch from the Chiweta Escarpment (south) to the Tanzania border (north) (Biggs *et al.* 2010). The Middle-Late Pleistocene Chitimwe Beds outcrop along this stretch in areas of up to 20km^2, unconformably overlying Pliocene lacustrine/near-shore sediments known as the Chiwondo Beds (Kaufulu *et al.* 1981). The Chitimwe Beds are also a rich source of Earlier and Middle Stone Age artefacts (Thompson et al. 2011), and are located within 20 km of one of the drill sites for the Lake Malawi palaeoclimate record (Figure 2).

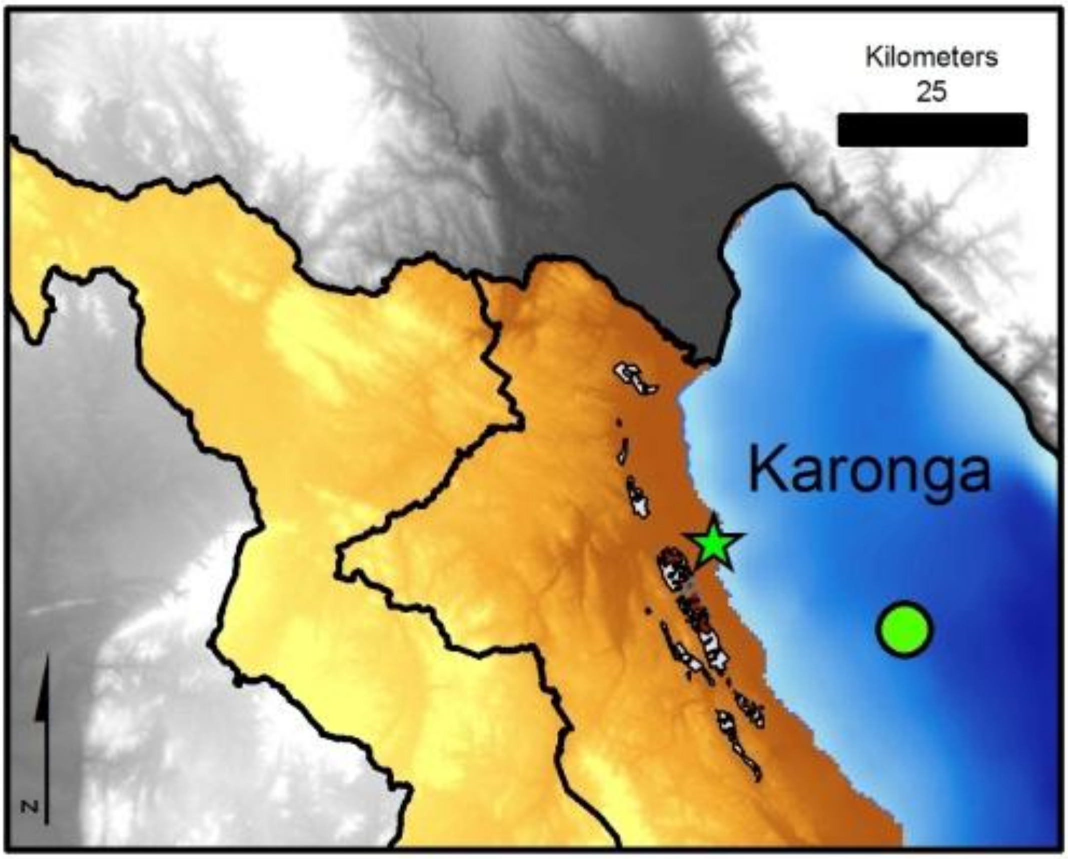

Figure 2 Map of Karonga (star) relative to drill site 2 (circle) with lake bathymetry indicated as a gradient. Known locations of Chitimwe Beds (red) and Chiwondo Beds (grey) are shown for northern Karonga.

The Chitimwe Beds represent a dissected alluvial fan originating in the western highlands. Major drops in base level at Lake Malawi would have initiated incision of the fan. As local conditions became more humid and lake levels rose two things would have happened 1) erosion would have increased where sediments exposed by previous aridity became subjected to rainfall; and 2) aggradation of sediments would have proceeded from the rising lakeshore back toward the foothills (Harvey 2002). Therefore, over the course of the MSA access to resources such as lithic raw materials and water would have been constantly in flux, thus constraining initial site formation and deposition of artefacts. Periods of incision and erosion would have resulted in the erasure of sites and transport of artifacts toward the lake while periods of aggradation would have resulted in burial and preservation of sites. Thus, the buried MSA landscape is likely a fragmented one representing quite different intervals of time that can only be teased apart through detailed and strategic examination of subsurface deposits.

The Chitimwe Beds of northern Malawi preserve a rich MSA record. Initial reports of deposits near the Chaminade Secondary School in the Karonga District described *in situ* earlier and later MSA deposits (Clark 1966, Clark *et al.* 1966, Clark *et al.* 1970, Clark and Haynes 1970). The Chaminade exposures are representative of a subset of MSA deposits that are rich in both lithic raw materials in the form of cobbles and artefacts manufactured on those cobbles (Clark 1966, Clark 1968, Clark *et al.* 1967, Clark *et al.* 1966, Clark 1972, Clark and Haynes 1970). This phenomenal abundance of artefacts means that large, meaningful samples can be excavated to compare human adaptations throughout time and across space (Figure 3).

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Figure 3 Chaminade area (left) and typical appearance of Chitimwe-Chiwondo contact points in exposures.

III. 2011 LANDSCAPE WORK

Overview

Geomorphological survey and mapping are discussed together here because they are essential elements for tying together archaeological occurrences across the larger landscape. Permanent control points were established based on the network begun in 2010 (Thompson *et al.* 2011). These allow sites and landscape features to be related to one another to within ca. 5cm of accuracy in all dimensions – including elevation in true metres above sea level. Geomorphological survey was concentrated in the Chaminade area and included the emplacement of 14 geological trenches to understand variability in subsurface stratigraphy. These trenches also allowed MEMSAP to explore options for dating different depositional facies that relate to the Middle Stone Age landscape. Broader reconnaissance was undertaken in the region, at targeted regions along the lakeshore from the foothills of the Chiweta Escarpment to the Songwe River. This regional survey was not undertaken systematically, and its main purpose was to provide pilot data for the development of future research design.

Mapping and Control Points

The major objective of mapping by MEMSAP has been to create a single master grid system based upon UTM coordinates and with real elevations within which any mapped object or feature within the study area could be known within 1 – 5 cm accuracy of any another object or feature and in any dimension. The use of permanent control points that can be relocated year after year allows for not only mapping by MEMSAP; it also establishes a basis for mapping of sites that are located and/or investigated by any researcher in the future who works in the area.

Three sites (Mwanganda's Village and Chaminade I and II) were subjected to intensive investigation in 2011, including excavation and sub-surface sampling of sediments for dating and geochemical correlation. In 2010 a network of permanent control points had been established using a total station (Thompson *et al.* 2009). Data between all sites excavated within this network will be accurate relative to one another to within ca. 5 cm. Some loci of interest to MEMSAP could not be seen from any permanent control points but knowing their elevations relative to other points in the landscape was essential (e.g. several geomorphological trenches in the Chaminade area). Therefore, their positions were mapped using a differential GPS. This allowed values to be obtained in three dimensions that were accurate to within a few centimetres of one another even outside the control point network (in contrast to a hand-held GPS).

Control points established in 2010 were recorded in UTM coordinates using the ARC 1950 map datum so as to be located on existing topographic and geological maps produced by the Malawi Geological Survey. This map datum is not commonly used in modern global positioning, and is not compatible with Google Earth. It was also not compatible with the differential GPS. Therefore, in 2011 a decision was made to make the commonly-used WGS 1984 datum the standard for MEMSAP recording. These coordinates can easily be transformed into coordinates based on the ARC 1950 datum and sites will still be reported to the Department of Antiquities using Malawi map grid coordinates.

The conversion of existing control points is an ongoing process. Field-checking of key points in the network must be completed in 2012. Using standard survey methods and equipment, obtaining the desired degree of accuracy could only be achieved by establishing control points one after the next in lines across the entire Karonga landscape. By using the differential GPS this will no longer be necessary because any point in the landscape across the entire study area (including the larger region) can be mapped within a few centimetres of another point through the use of satellites and differential correction. However, maintaining the control point network in areas of intense research focus will still be an essential requirement for detailed mapping of archaeological sites because they are necessary for calibration of the differential GPS and a total station set up based on these points is much faster and more accurate at smaller scales.

In 2011 several control points were re-confirmed from the 2010 season and transformed into UTM coordinates using the WGS 1984 datum. Several additional control points were added, and some of these were shot directly into the network of existing points using a total station. Some points were established but time constraints did not allow their mapping during the regular season. All points are displayed in Figure 4 and their current MEMSAP coordinates are given in Table 2.

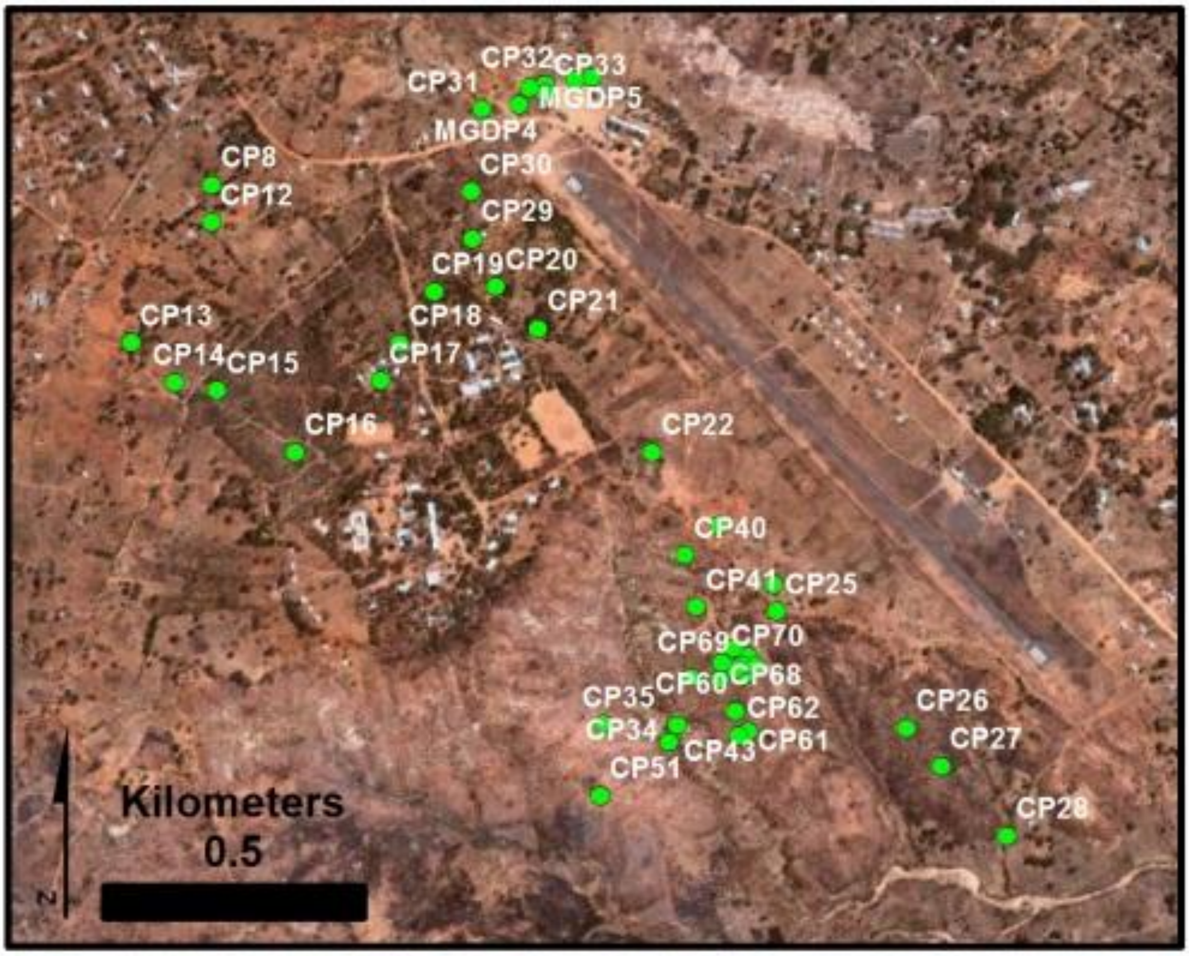

Figure 4 Satellite image of the study area around the Karonga airport showing locations of control points (green dots). Satellite image from Google Earth.

Table 2 Locations and descriptions of all current control points established by MEMSAP.

Point Name	Easting WGS84	Northing WGS84	Elevation	Location	Year Set
CP8	596791.690	8900332.542	536.143	At beacon on the road side in front of CCAP church	2010
CP12	596791.690	8900259.610	535.453	On the side of a track in front of a very big baobab SE of the CCAP church	2010
CP13	596637.040	8900028.610	536.744	On the North Side of a track that runs from the CCAP church W	2010
CP14	596720.231	8899951.729	535.583	At the edge of a mango tree	2010
CP15	596802.568	8899936.478	533.478	Under a tree at a carpenters home	2010
CP16	596952.886	8899818.039	529.691	On the S side of the road that immediately branches from the Chaminade school turn off	2010
CP17	597116.646	8899955.583	523.251	Some 20m from the first right on Chaminade school road, S side	2010
CP18	597154.496	8900027.189	521.820	E road edge of the Chaminade school road some 40m from junction with airport road.	2010
CP19	597220.268	8900126.409	520.219	Infront of a small grocery on the airport road	2010
CP20	597339.047	8900136.541	524.172	On the high road side at the NW tip of the airport	2010
CP21	597420.266	8900056.082	530.067	Some 30m along airport fence	2010
CP22	597639.968	8899818.176	531.428	Along the airport fence	2010
CP23	597769.721	8899677.394	532.048	Along the airport fence	2010
CP24	597873.503	8899563.997	532.322	Along the airport fence	2010
CP25	597878.367	8899511.935	531.792	Some 14m away from fence at the edge of a gulley	2010
CP26	598129.108	8899287.800	531.670	Along the airport fence	2010
CP27	598195.333	8899214.772	531.549	Along the airport fence	2010
CP28	598322.909	8899080.680	531.146	SW corner of airport fence	2010
CP29	597293.297	8900228.089	520.449	Edge field and gully on a path	2010
CP30	597291.321	8900319.053	515.220	In field; 20m from stream	2010
CP31	597312.637	8900477.767	511.422	Along path	2010
CP32	597433.387	8900524.624	511.832	on path in Mwanganda village	2010
CP33	597433.612	8900509.009	512.754	a few meters up from p32	2010
MGDP1	597523.768	8900539.121	514.326	On top of small spoil heap S of Clarks excavation	2009
MGDP3	597490.817	8900533.456	513.276	In front of NW corner of house	2010
MGDP4	597383.677	8900485.295	513.087	along the E side of a path through a cassava field S of the area where the flake was found. Easily covered with sand	2010
MGDP5	597403.222	8900519.042	511.704	at the SW corner of the house closest to where the ivory flake was found	2010
FDH CP1	589872.999	8920692.999	999.995	False Disappearing Hill top of hill	2010
FDH CP2	589873.000	8920700.317	1000.489	False Disappearing Hill ca. 6 m to south of FDH1	2010

Table 2 (cont.)

Point Name	Easting WGS84	Northing WGS84	Elevation	Location	Year Set
KRW1 CP1	589785.737	8920633.307	989.418	On south side of gully containing conjoin	2010
KRW1 CP2	589740.363	8920646.262	996.536	On hill on north side of gully containing conjoin	2010
CP34	597672.547	8899260.015	534.691		2010
CP35	597546.168	8899294.317	530.618		2010
CP40	597702.088	8899619.493	533.995		2011
CP41	597724.802	8899520.402	535.447	Near airport outpost building	2011
CP42	597714.978	8899384.586	536.374	Along road near eroded edge	2011
CP43	597688.154	8899292.546	536.151	To north of CP34	2011
CP51	597540.477	8899157.177	533.732	Chaminade on top of tall hill	2011
CP60	597800.848	8899320.105	539.484	Under tree at road intersection near CHA-I	2011
CP61	597824.337	8899281.840	540.242	Under bushes on road to pig house near CHA-I	2011
CP62	597805.415	8899273.934	540.219	Along road near CHA-I	2011
CP63	597813.418	8899387.575	536.614	On southeast side of big trench at CHA-II	2011
CP64	597823.688	8899425.322	535.471	On northeast side of big trench at CHA-II	2011
CP65	597811.968	8899408.381	535.884	On east side of big trench at CHA-II	2011
CP66	597795.979	8899440.896	535.484	On north side of big trench at CHA-II	2011
CP67	597837.820	8899407.089	536.105	On east side of big trench at CHA-II	2011
CP68	597769.549	8899381.223	537.045	On southwest side of big trench at CHA-II	2011
CP69	597799.432	8899400.467	536.219	On west side of big trench at CHA-II	2011
CP70	597774.167 8899412.442	535.936	On northwest side of big trench at CHA-II	2011	

Note: Some are missing from previous years as they have been destroyed or cannot be relocated.

Geomorphological Testing of the Chaminade Area

Rationale

Understanding the broader geomorphological context of the archaeological deposits is essential for achieving the project goals. The majority of excavated materials have derived from sites within 1 km of the area southwest of Chaminade Secondary School. Here, the slopes have eroded into the Chitimwe and even the Chiwondo Beds, offering exposures that can be used to explore the relationship between the two beds and the archaeological materials contained therein.

Methods

Erosion in the Chaminade area is in the form of parabolic hill slopes dominated by gravity processes rather than occurring as sharp exposures. The Chitimwe Beds contain large quantities of clasts, which deflate downward as finer sediments are removed and form an 'armour' on top of the Chiwondo Beds. Therefore, geological trenching was the only way to observe subsurface stratigraphy (Kaufulu 1983). Thirteen geological trenches were emplaced in the eroded Chaminade area, each measuring approximately 50 cm wide and ranging from 1.5 – 3m in length (Figure 5).

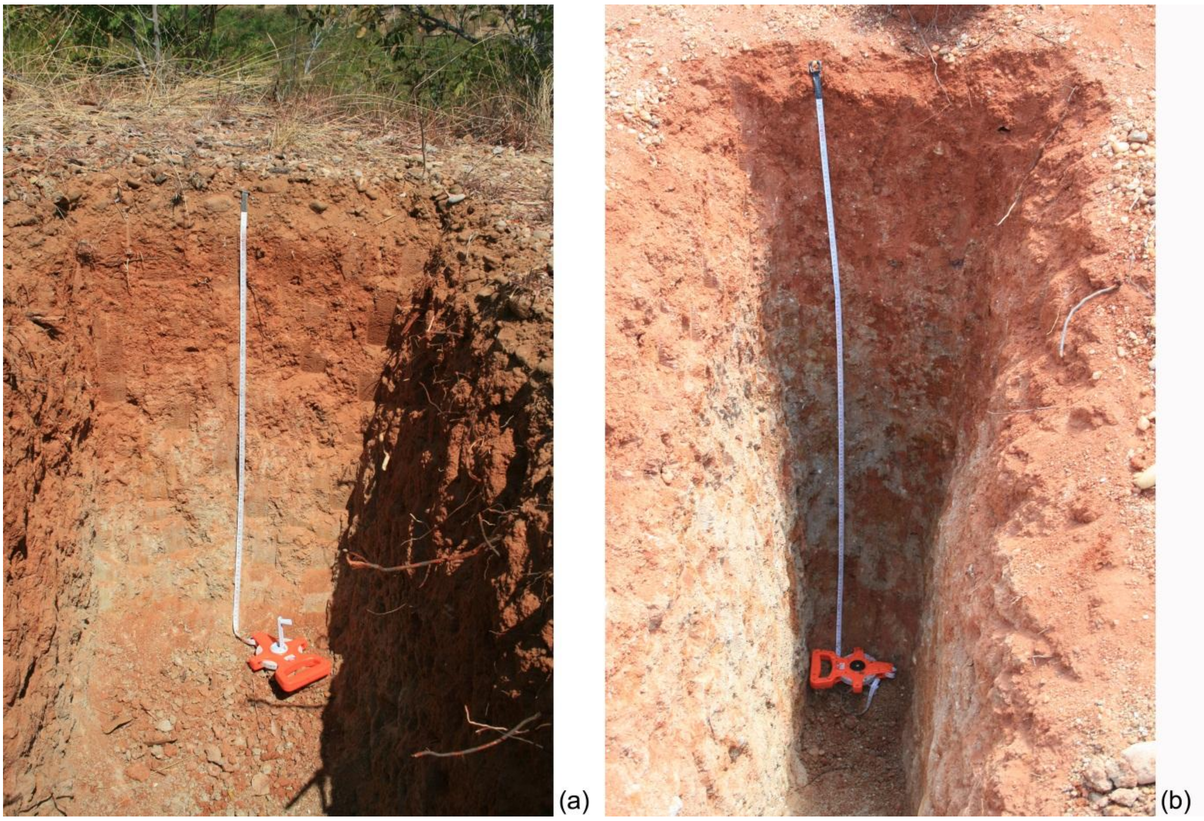

Figure 5 Examples of geological trenches 4 (a) and 5 (b) in the Chaminade area. Note the exposures of the red Chitimwe Beds on top and the Grey Chiwondo Beds below.

Cosmogenic burial dating is a method of estimating the age of buried deposits. It is based on the radiometric decay of nuclides formed through extraterrestrial bombardment by cosmic rays of the earth's exposed surface. This bombardment causes certain nuclides to be produced within rocks that are of cosmogenic origin. 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. In order to do this, initial 'burial profiles' must be established using deeply buried stratigraphy. A fourteenth geological trench was therefore excavated in the deposits near the Karonga airstrip where previous erosion had not taken place. This was the way to observe and sample the 'top-down' stratigraphy of the pre-erosion sequence with the highest certainty. Because the trench was 5m deep, the excavation was stepped to each side for safety purposes (Figure 6). Samples of gravel and sand were taken at 0.5m intervals down the profile of this trench for cosmogenic dating (Figure 6). Over the course of excavation a discrete layer of MSA artefacts was discovered about 2.5m below the present surface. This formed the basis for later excavations at the Chaminade II locality, reported here.

Figure 6 Chaminade Geological Trench (CGT) 14, showing sample locations at the rear profile. The artefact horizon was located near the person's head standing in the trench.

Results

Many of the geological trenches showed a poor contact between the Chitimwe and the Chiwondo Beds, indicating more prior erosive processes than was apparent at the surface. Where contact points appeared intact, OSL samples were taken from both beds. Under the working model of a fragmented and buried palaeo-land surface the contact points between the two beds should be of different ages across the landscape because the Chitimwe Beds would have been deposited and eroded into the Chiwondo Beds at different times in the past. This in turn means that in some localities the top of the Chiwondo Beds would be much younger than in others. Similarly, the basal Chitimwe Beds may have greater antiquity at some sites than others. This is supported by scattered reports of Earlier Stone Age tools from both the Oldowan (Kaufulu and Stern 1987) – although also refer to Juwayeyi and Betzler (1995) - and the Acheulean (Clark *et al.* 1970), as well as our analysis of the elephant tusk from Mwanganda's Village (Thompson *et al.* 2011). Results of dating samples taken across the landscape are currently pending. Construction of a geomorphological map of the area is also currently in progress.

Geomorphological Regional Survey

Rationale

The landscape approach taken by MEMSAP requires contextualisation within the broader depositional regime of the area. The surficial processes responsible for the preservation and/or erosion of the artefact-bearing deposits in Karonga are controlled by both the structure of the tectonically active Karonga basin (Biggs *et al.* 2010) and fluctuations in lake base level (Stone *et al.* 2011). The primary control for the younger (Pleistocene and Holocene) sediments is likely to have been lake base levels. Although the Lake Malawi Drill Cores provide excellent data on past lake conditions there are no corresponding detailed studies of the response seen on the adjacent landscape. A systematic program of geomorphological survey and landscape sampling is required to develop the landscape side of what is known about the 'lakescape' during the Middle and Later Pleistocene. The first step in developing this program is preliminary assessment of the land surfaces likely to date to this time period across the entire Karonga Basin.

Methods

Targeted excursions were taken with the geomorphological team to a series of localities in Karonga where good exposures of Chitimwe and Chiwondo Beds were known. These included, from north to south, Ighembe Ridge, Kafula Ridge, Malema Camp, Uraha Hill and the Chitimwe River. General archaeological observations about lithic abundances, technology, and lithic raw material availability were made in tandem with the geologists, with the aim of developing a specific research design for this aspect of the anticipated 2012 field season.

Results

Cobble deposits occur wherever Chitimwe Beds have been mapped in Karonga, and also in many places where they do not appear on geological maps. Ighembe Ridge was one such locality where Chitimwe Beds are not visible on the geological map (Bulletin 42E of the Malawi Geological Survey). It was briefly identified in 2010 (Thompson *et al.* 2011) and also only quickly revisited in 2011 to familiarise the geological team with the characteristics of the artefact-bearing beds in the northern part of Karonga. Cobbles from Ighembe Ridge are mainly comprised of quartzite with some quartz and occasional other materials. They most commonly range in size between 3 – 15cm and are highly suitable for the manufacture of flaked stone artefacts. Indeed, artefacts are abundantly distributed across the surface in the entire region where cobbles occur. Radial and other forms characteristic of the MSA are present, and these have been subjected to a range of weathering processes. Some are extremely fresh and retain sharp edges while others are barely identifiable as artefacts (Figure 7).

Figure 7 Examples of the different weathering stages of MSA cores identified within a 5m radius of one another at Ighembe Ridge.

The latter have extremely rounded and polished edges typical of fluvial transport. This range suggests that there was a variable depositional environment across the time span encompassed by the MSA. In other words, in this part of Karonga artefacts were deposited, re-worked, re-deposited, and fresh assemblages manufactured on top of them – all within the time slice represented by MSA technology. In some ways, this constrains the ages of the landforms associated with the Chitimwe Beds because MSA artefacts were only known to have been deposited at other localities in Africa between ca. 285 – 30 ka.

Kafula Ridge was also only briefly re-visited in 2011 after its initial identification in 2010 (Thompson *et al.* 2011). The site of Kafula Ridge West 1 could not be accessed in 2011 because of poor road conditions, so a brief excursion was taken into the adjacent foothills. Holocene alluvium covers most of the base of the foothills, and cobble deposits only became apparent by moving upslope (Figure 8). Then, as at other localities where Chitimwe Beds occur, extensive cobble deposits also provided extensive evidence of MSA stone artefact manufacture (Figure 8).

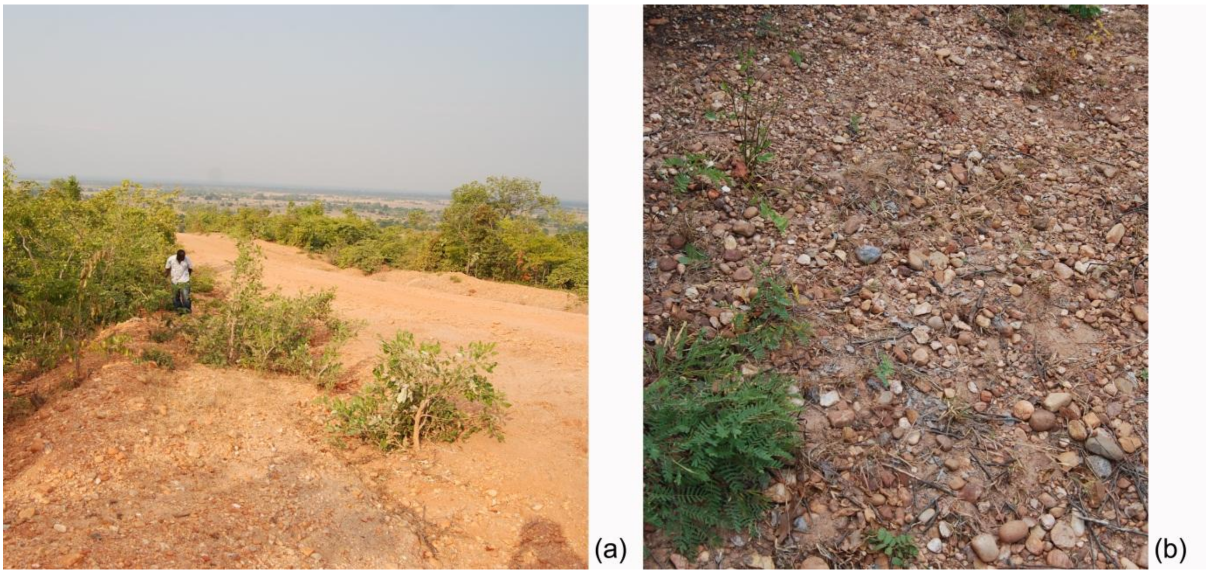

Figure 8 View of the alluvial plain adjacent to Lake Malawi from the band of cobbles leading up to the foothills near Kafula Ridge (a) and examples of the cobble surface (b).

Moving completely into the foothills resulted in an abrupt disappearance of the cobbles and exposure of bedrock. This area was vegetated with open miombo woodland, and exploration resulted in the discovery of several quartzite stone artefacts manufactured on river cobbles typical of the Chitimwe Beds (Figure 9). These could not have been transported upslope above the existing cobble beds by natural processes, and therefore likely represent human movements upwards into the catchments and subsequent occasional artefact discard.

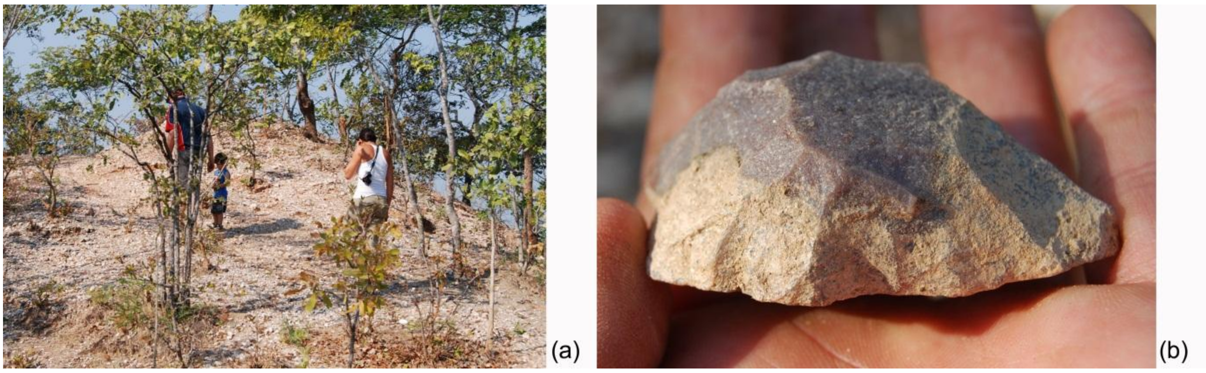

Figure 9 Example of landscape in foothills near Kafula Ridge (a) and quartzite artefact with cobble cortex found there (b).

The area around Malema Camp has both Chitimwe and Chiwondo exposures, but in this area the Chitimwe Beds are also observed to directly overlie bedrock. A similar situation is seen at a stone quarry by the North Rukuru River near Chaminade, where a fault zone has resulted in large exposures of Chitimwe Beds overlying Chiwondo Beds on the north side of the fault and Chitimwe Beds directly overlying bedrock on the south side (Figure 10). Near Malema Camp artefacts, including Levallois products, are common where the Chitimwe Beds outcrop. Raw materials are again predominately quartzite and quartz cobbles. The condition of these artefacts did not seem to be as fresh as those observed further north, although no systematic recording of artefact taphonomy was undertaken.

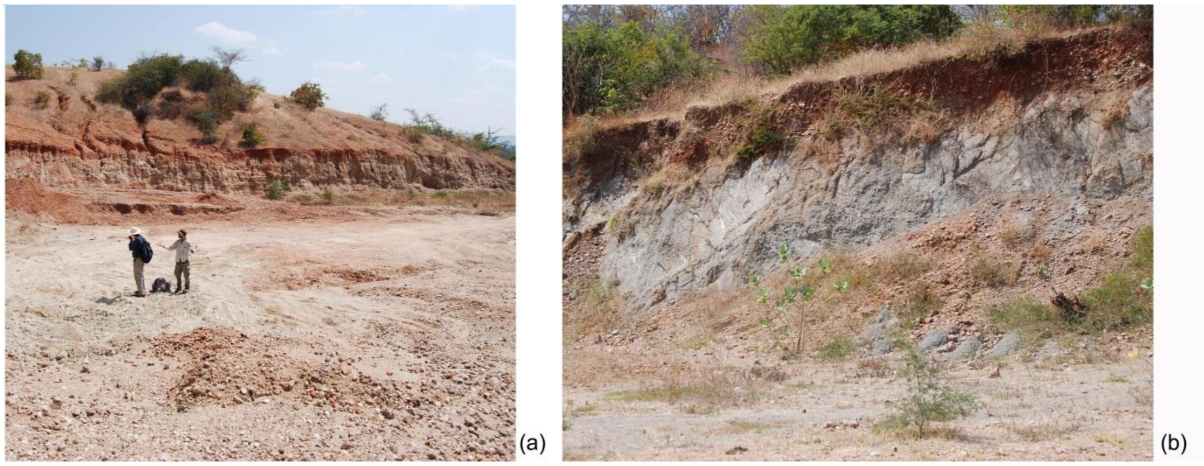

Figure 10 View north (a) and south (b) from the same position on a fault line, illustrating how the Chitimwe Beds are variably positioned on top of the Chiwondo Beds or directly on bedrock.

At Uraha Hill cobble and red sand deposits cap large exposures of Chiwondo Beds (Figure 11). However, cobbles in this area are not quartzite but instead present mainly as small (ca. 2 – 5cm) quartz cobbles. Artefacts are also rare. Where they do occur they appear to have been made on the larger quartz cobbles that were available, rather than on smaller pebbles or on large blocks of seam quartz (Figure 11). Very occasional quartzite flakes with cobble cortex occur as isolated finds across the landscape, and it is possible that these were transported from an adjacent catchment where such materials were naturally present. No technologically diagnostic pieces were observed that could inform about the age of the stone artefacts. This may be a consequence of their manufacture on quartz, which tends to fracture along natural crystalline planes and can be challenging to analyse.

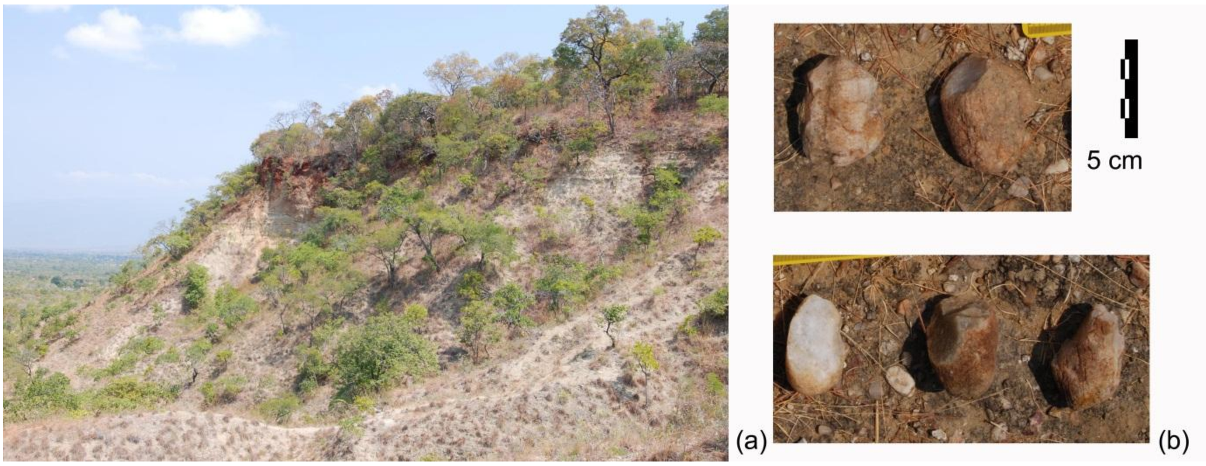

Figure 11 View of the large Chiwondo exposures capped by red sand and cobble deposits at Uraha Hill (a) and examples of quartz artefacts found in the area (b).

At the foothills of the Chiweta Escarpment, near the type site of the Chitimwe Beds (Stephens 1966), the Chitimwe Beds are present in the form of large conglomerates that unconformably overly the Dinosaur Beds (Figure 12). These cobbles are largely rounded basement rocks such as gneiss, and they are not good raw materials for stone artefact manufacture. No artefacts were observed in this area, although survey was minimal.

Figure 12 View of the fluvial deposits capping the Dinosaur Beds at the Chitimwe type site.

Discussion

In elevated areas (e.g. foothills of the western plateau) the Chitimwe Beds typically occur almost as 'bands' around prominent land features. Higher places normally do not contain the cobble beds, and are frequently expressed as exposed bedrock. The cobble beds then occur, and where they occur in the north of the study area (e.g. at least from Malema Camp to Ighembe Ridge) they also contain MSA artefacts. There is then frequently a scree or transitional area where artefacts and cobbles have been displaced down slope, followed by more bedrock, Chiwondo Beds, or alluvial deposits that do not contain the cobbles. Mapping the elevations and extents of these cobble beds through systematic geomorphological survey using differential GPS will be a key goal for the 2012 fieldwork.

The presence of cobbles entrained within red-coloured sediment is a diagnostic feature of the Chitimwe Beds as they were originally defined (Stephens 1966), although the grey clay at the elephant butchery site at Mwanganda's Village was also included in this sedimentary unit (Clark and Haynes 1970). Even though the Chitimwe Beds have been defined on the basis of their sedimentary characteristics rather than their age, the two are frequently assumed to be synonymous. However, although the red cobble-bearing beds represent periods of similar past depositional conditions, it may not be the case that they are of the same or even broadly similar age. One of the priorities of MEMSAP is to contextualise the archaeological deposits by obtaining absolute and relative ages for the Chitimwe Beds across their range of occurrences. Systematic mapping and sampling is required to understand if all cobble deposits are in fact representative of the same phenomena and time period, and how they relate to the MSA deposits. Given the differences observed between the southern and northern cobble deposits, it may be that the definition of the Chitimwe Beds requires revision. Furthermore, the abundant cobble deposits containing MSA artefacts in the Songwe catchment are not mapped as Chitimwe Beds on the geological maps and this also requires re-assessment.

A major result of the preliminary survey was the discovery that although cobble deposits occur south of Malema Camp, they contain fewer and fewer quartzite cobbles that make up the majority of MSA artefact occurrences in the north. At Uraha Hill the cobbles were mainly quartz and at the Chitimwe River they were mainly basement rocks unsuitable for artefact manufacture. No MSA artefacts were observed at the Chitimwe River and few were apparent at Uraha Hill. Those that were apparent were still manufactured on cobbles. These differences could simply be because suitable raw materials were not as abundant as they were in the northern catchments. However, only systematic exploration of the relationships between artefact reduction, artefact curation, and lithic raw material availability can address this question.

Pilot Survey Transects

Rationale

An important component of reconstructing some of the demographic attributes of MSA populations is investigating how people may have moved across the landscape in the past. The movements of stone artefacts may be used as a proxy for the movements of people, particularly when the artefacts in question are not rare or 'exotic' materials that may have made their way across the landscape via trade. 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. 2008, Braun et al. 2009). However, this is challenging on a landscape in which lithic raw materials were abundantly available in the form of secondary sources (ie: river cobbles from active beds or conglomerates/terrace deposits). Therefore, more subtle means of sourcing materials have to be envisaged.

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 may 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 particularly the case for catchments in the south of Karonga where quartzite cobbles do not appear to have been readily available.

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. 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 by characterised by a few rare rock types (perhaps from geological sources that may 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.

Approach

Based on the results of the general geomorphological survey, several new approaches to understanding the movements of MSA people were identified for future research. These nest at a hierarchy of scales:

1) Regional – A major goal of MEMSAP is to understand where people were during different past climatic regimes. Population movements into and out of central Africa as whole will be investigated after the overall landscape chronology has been established and target archaeological sites have been dated and correlated with the Lake Malawi drill core sequences.
2) Between catchments – Several river catchments drain the highlands of northern Malawi, transporting materials from the west towards the lake to the east. Each of these catchments is predicted to have slightly different lithic raw material representation, based on the uneven distribution of raw material sources across the landscape. For example, catchments that drain areas of the highlands with relatively more quartz should have more quartz cobbles naturally represented in river terraces and conglomerates downstream. Movements of people between

catchments may therefore be detected using the movements of lithic raw materials as a proxy.

3) Within catchments – Resource availability changes along the axis of a single catchment, meaning that resources unavailable in the lowlands may be available in the highlands, and vice-versa. It is predicted that population movements along a single catchment would be shorter-term in duration and may be part of the foraging rounds of individual hunter-gatherer groups. It is also predicted that as people moved along this axis and away from areas of abundant lithic raw materials (in most cases cobble deposits), their artefact reduction strategies would change. Such movements would therefore likely be detected in changes in measures of lithic reduction such as cortical coverage, artefact mass, lithic raw material curation and selection, and/or number of flake scars.
4) Single geological/topographic transect – The configuration of lithic raw material deposits across the landscape is such that "bands" of cobbles occur near the tops or partway up many of the taller hills. As one moves upslope, therefore, one also moves across a geological transect. Artefacts may have become moved down slope as a result of gravity or other natural forces, but upslope movements can be attributed to human behaviour. Therefore, single transects across this geological variability may inform about two issues that are highly relevant to achieving the project goals. First, post-deposition movement and surficial processes may be reconstructed through a taphonomic survey (ie: size and weathering) of the artefacts themselves. Second, movements of people and changes in their reduction strategies may be detectable across short distances through an investigation of the technological attributes of the artefacts.

As a preliminary trial of the final one of these approaches, three days were allocated for a series of archaeological survey transects across representative landforms and geological exposures that had been traversed by the geological team northwest of Chaminade (Figure 13). Artefact collection may be important in certain circumstances, e.g. for a specific comparative study where it is important to record and analyse the full range of artefact characteristics or where rare or especially significant pieces are located and in immediate danger of being destroyed. However, it was determined that recording artefacts without collecting them would be the most logistically feasible approach for collecting large quantities of data across the broader area. This not only reduced weight and storage space, but it is an approach that has the smallest potential impact on existing archaeological deposits.

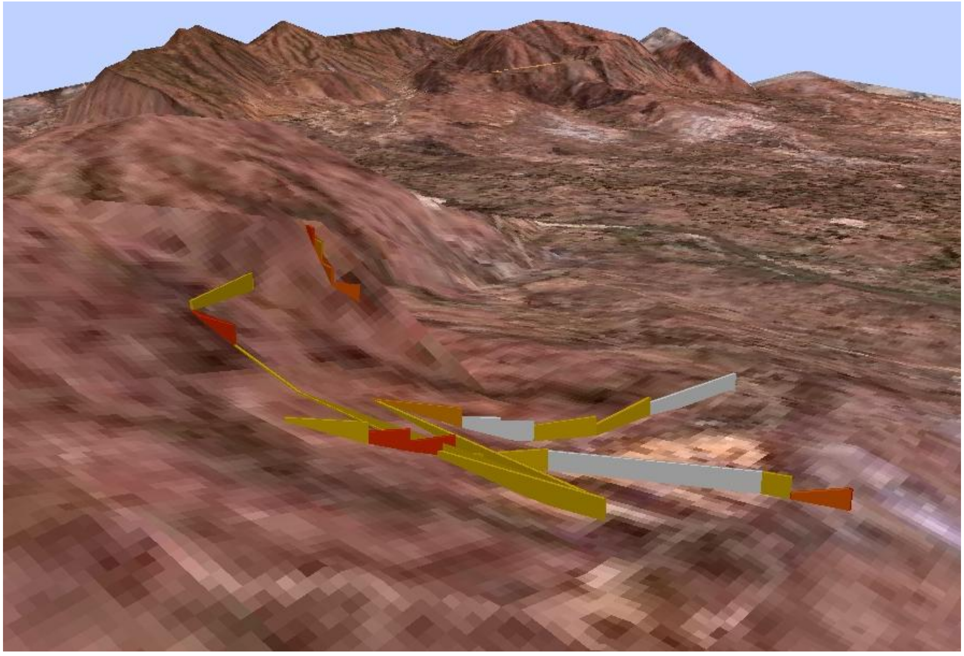

Figure 13 3D Visualisation of how survey transects move across the landscape. The distance across the longest transect in the foreground is approximately 800m.

This trial was the start of a recording program 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. Only cores were recorded (rather than, for example, interesting flakes). This was partially for practical reasons; artefacts are too numerous to be able to feasibly analyse them all as they are encountered. Furthermore, size data for all artefact classes would be meaningless unless completely recovered samples were taken along the entire transect that also included the smallest flake sizes. Finally, recording only cores limits 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. The cores are data-rich, and provide a wealth of information about reduction strategies, artefact taphonomy, and artefact curation.

Across the survey transect the following characteristics of cores were recorded as they were encountered (Table 3):

Table 3 Variables and character states recorded for cores on the transect surveys.

Character/ Variable	State 1	State 2	State 3	State 4	State 5	State 6	Notes
Artefact number: 001, 002, etc.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Length (Maximal Dimension)	N/A	N/A	N/A	N/A	N/A	N/A	in mm
Width	N/A	N/A	N/A	N/A	N/A	N/A	in mm
Thickness	N/A	N/A	N/A	N/A	N/A	N/A	in mm
Type of material	Quartzite	Quartz	Chalcedony	Chert	Ochre	N/A	Other
Outer surface (Cortex)	None	< 25%	25 - 50%	50 - 75%	75%	N/A	N/A
Degree of weathering	None	Slightly	Moderately	Heavily	Extremely	N/A	only scars ≥ 10 mm
Number of platforms	One	Two	Three or more	N/A	N/A	N/A	N/A
Dominant scar pattern	Amorphous	Radial	Parallel	Convergent	Bifacial	Opposed	N/A
Number of photos	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Remarks	N/A	N/A	N/A	N/A	N/A	N/A	N/A

All recorded cores were photographed and their transect numbers were recorded so that artefact characteristics could be related back to the spatial and geological context of the finds. Some representative cores were also illustrated (Figure 14).

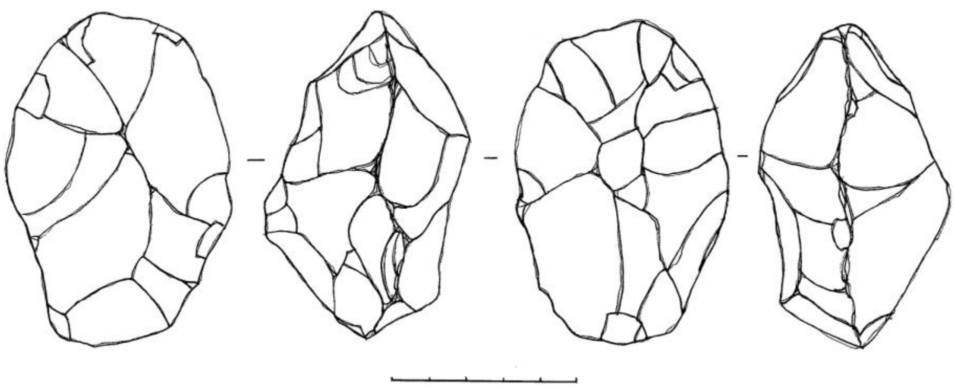

Figure 14 Example illustrations of cores recorded during the pilot survey.

Results

The trial series of transects illustrated the potential for a systematic study to yield information about how artefact deposition and taphonomy varies across landscape units. Figure 15 shows examples of how artefact characteristics such as cortical coverage, raw material type, core size, and weathering stage varied across space.

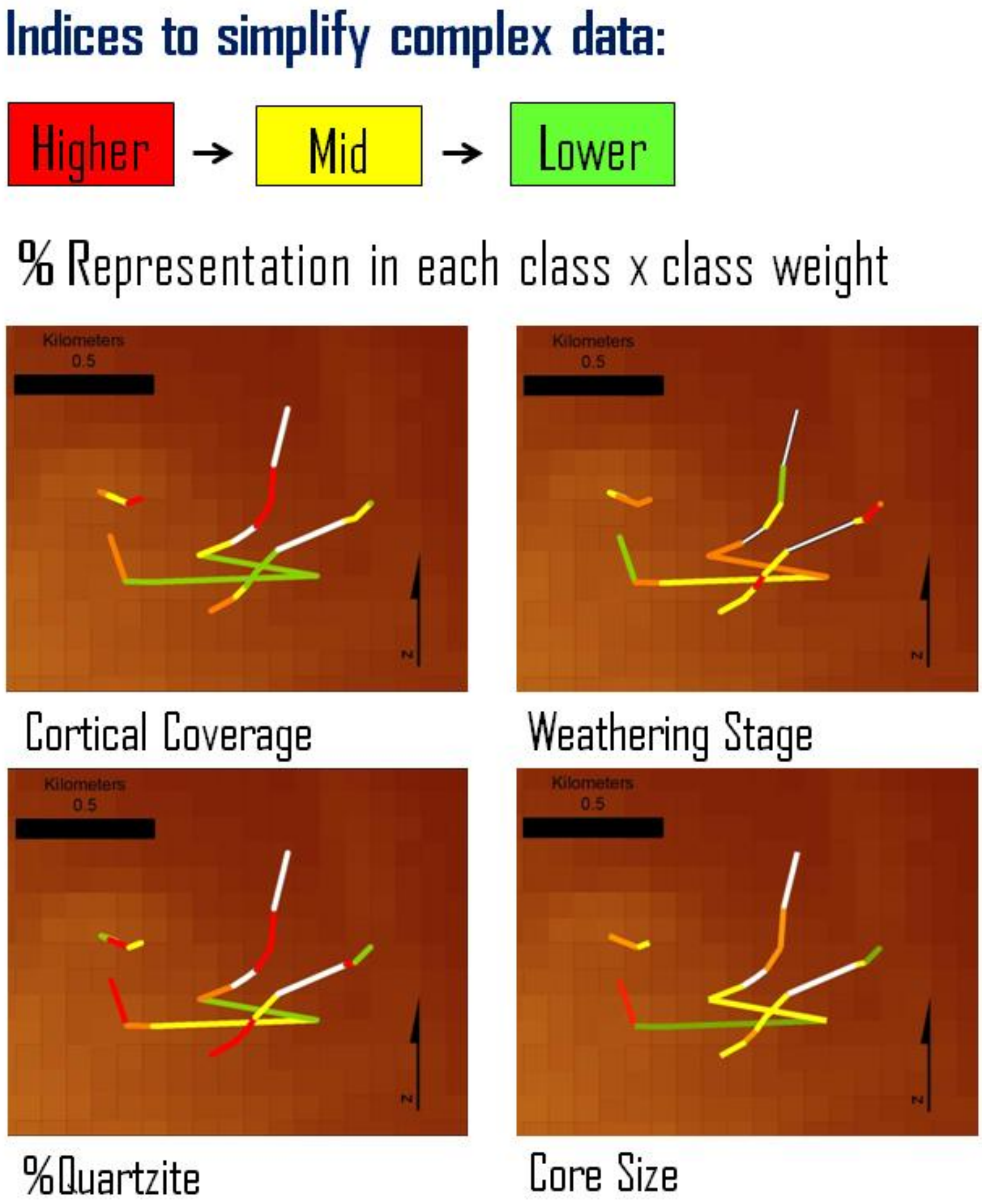

Figure 15 Examples of how artefact characteristics varied between transects.

IV. 2011 EXCAVATIONS

Overview

A major project aim for 2011 was to continue excavations at the Airport Site in Karonga as the site had left us with unanswered questions (Thompson *et al.* In press, Thompson *et al.* 2011). In April, however, work was begun to have the runway extended across the site. MEMSAP's interventions could not prevent this. Two other sites within the Chitimwe Beds were thus investigated via excavation over the course of the regular field season in 2011. These were Mwanganda's Village and Chaminade I. After the regular season had ended a second 'off-season' excavation took place at the site of Chaminade II, within a few metres of Chaminade Geological Trench 14 (Figure 16). All work to date indicates that MSA artefacts in the Chitimwe Beds are extremely common across the entire land surface and in many cases they are vertically concentrated. Both past human activities and geomorphological processes are likely responsible for these concentrations. The relatively continuous nature of the deposits makes it challenging to define a 'site' as a discrete area of archaeological deposit. Therefore, the definition of a 'site' used here is as an excavation area into these deposits, made in part to explore the spatial variability of artefact distributions.

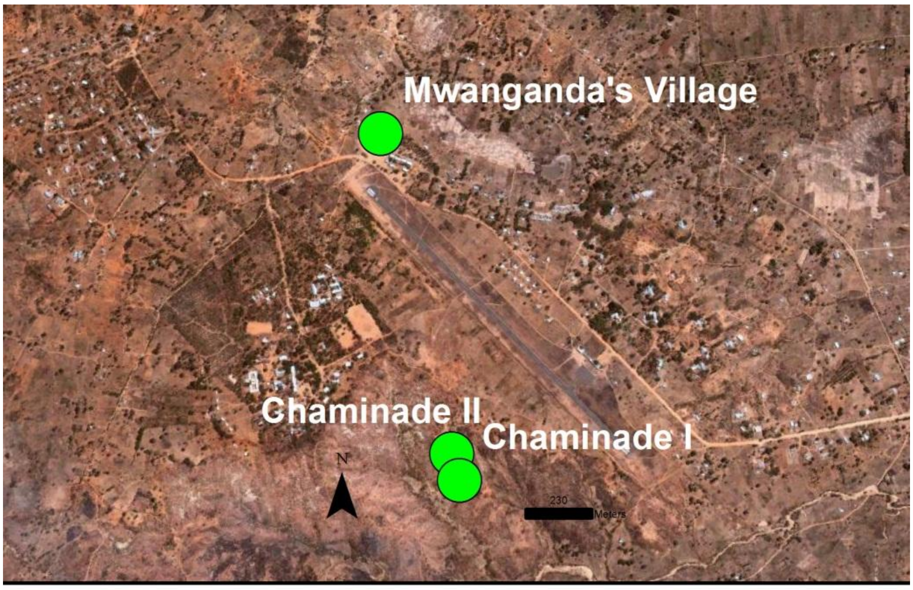

Figure 16 Map of the locations of the Mwanganda's Village, Chaminade I, and Chaminade Ii excavation areas.

Methods and Protocols

All site mapping, including piece-plotting, was conducted with a total station following the protocols developed by Marean *et al*. (2010). All samples and artefacts identified *in situ* were piece-plotted with a Nikon Nivo total station running Survey Pro software to ensure precise spatial control of all excavated materials (McPherron *et al.* 2005), and orientations were taken on artefacts with a long axis to determine the nature of any post-depositional movement (McPherron 2005). Plotted finds were emplaced in resealable plastic bags with pre-printed, barcoded, archive-quality labels (Marean 2010). A Bluetooth barcode scanner was used to associate each artefact number with its coordinates and point attributes as the artefact was mapped to reduce human transcription error. All context data (including sedimentary attributes, photographs, disturbances, and elevations) were recorded on standardised project context forms for which there are both digital and archive copies. Data were stored and analysed in an Access database and an interactive ArcGIS database that were updated daily.

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.

Screen-washing of 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. Samples were taken from larger excavations for screen-washing and the remainder was dry-screened on site through a 5mm mesh. Artefacts recovered in the screen were given specimen numbers in the lab using the same sequential numbering system as the piece-plotted artefacts. Unless designated for further study in 2012, all 2011 excavations were backfilled using the residue that had passed through the screen.

Excavation areas were defined for each site and excavation proceeded by natural layers in 1 x 1 m squares. Grid coordinates for the squares were based on the master grid but an alphanumeric system with letters increasing to the east and numbers increasing to the south was used. For example, the second square in the first row would be named B1. In some cases natural layers were subdivided into arbitrary spits. Spit thickness depended on artefact densities and the thickness of the layer. For example, where few artefacts were found in a thick layer, spit thickness would be greater. Each spit, layer, or feature was designated as a context and a complete record of the geological and archaeological characteristics of each Context was kept on a Context Form and entered into a Microsoft Access database. A bulk sediment sample was taken of each context as it was opened, and kept as an archive. Where appropriate, sediment micromorphology and OSL samples were also taken from the profiles after excavation. Recording and total station protocols are provided in Appendices I and II.

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, Kaufulu 1990, Kaufulu 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 *et al.* 2005, Surovell and Waguespack 2008). It is also only one of two systematically published MSA sites from Malawi and one of a handful from central Africa. These factors make Mwanganda's Village an important reference point for workers seeking to understand larger patterns of behavioural change during the MSA.

Previous Research

Prior to the inception of MEMSAP 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 17).

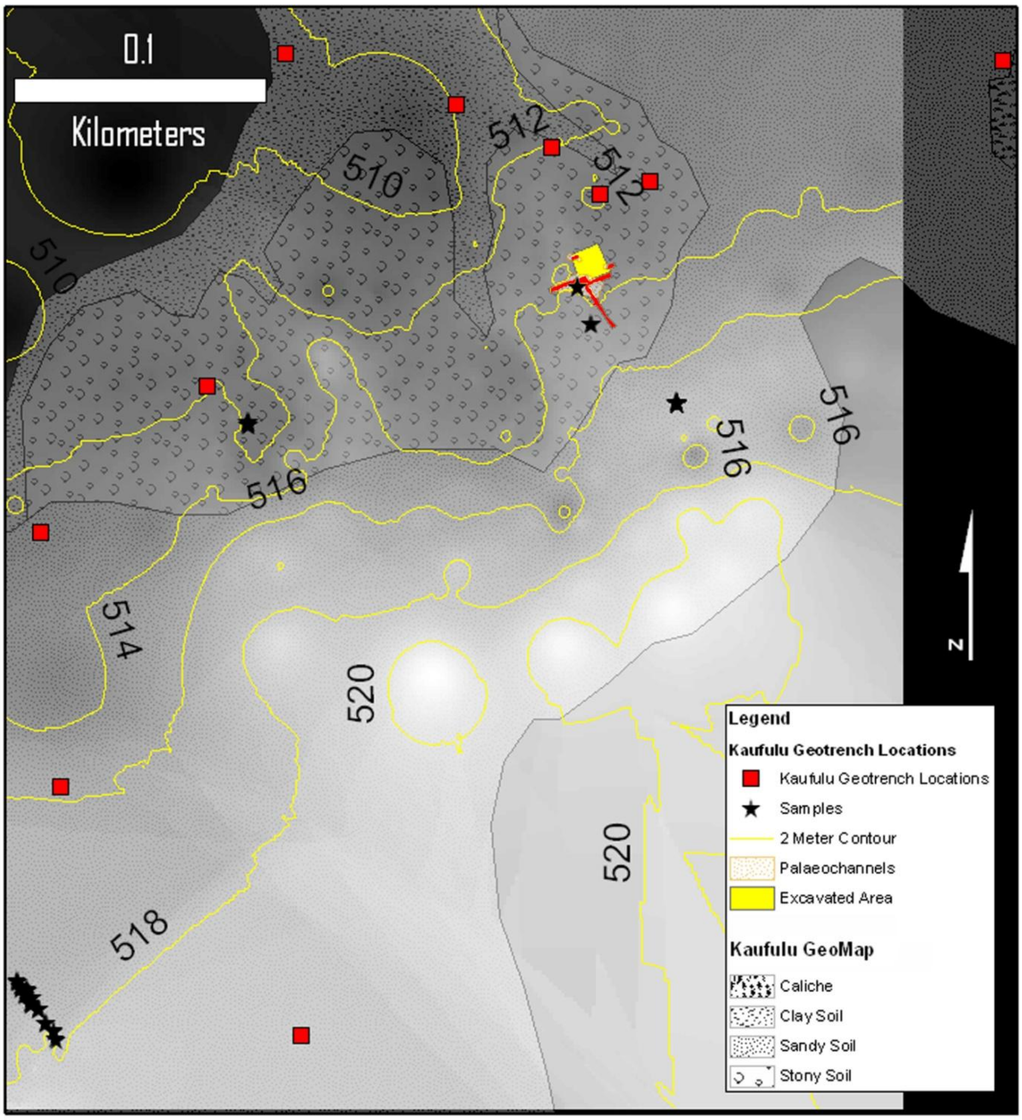

Figure 17 Digital Elevation Model (DEM) of Mwanganda's Village (lighter areas are higher), overlain with a basic geological map created by Kaufulu (1983). Not all of Kaufulu's geological trenches are within the map boundaries. Stars represent various samples (e.g. sediment, micromorphology, dating) taken by MEMSAP in 2010. Excavation areas are from Clark and Haynes (1970) and Kaufulu (1983, 1990). Note that Kaufulu's trenches are illustrated here with the original 90 degree rotation error introduced by Clark and Haynes (1970) and the long axis should actually be pointing to the southwest rather than the southeast.

Kaufulu (1983, 1990) reassessed the stratigraphy as outlined by Clark and Haynes (1970) and provided an overview of the lithological sequence of the region (Table 4). 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 4 Lithology of the Mwanganda site (modified from Kaufulu [1990:18]).

Lithology (Kaufulu 1990)*	Designation	Lithology (Clark and Haynes 1970)	Designation
Stony soil	Unit 8	Light brownish sand	Qk
Light red sandstone with basal gravel	Unit 7	Light red sand	Qct_{2b}
		Sandy pebble gravel	Qct_{2a}
Dark brown muddy sandstone	Unit 6	Dark brown sand	Qct_{1b}
Caliche	Unit 5	Caliche pebble-gravel	Qct_{1a}
Pale grayish orange sandstone	Unit 3	Dark greyish-brown sand	Qco_{1c}
Greenish/brownish gray sandy claystone	Unit 2	Greenish gray clayey sand	Qco_{1b}
		Greenish gray sandy clay	Qco_{1a}

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

Kaufulu (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. Kaufulu (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 (Kaufulu 1990).

The fossil-bearing palaeosol was technically formed on the top of the Chiwondo Beds, and 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 observations made by the geomorphological team during the broader landscape survey.

However, the interpretation of the palaeosol at 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. These problems formed the original basis for renewed investigations at Mwanganda's Village and are further detailed in Thompson *et al.* (2011). These are:

1) What are the chronometric ages of the artefactual and ecofactual assemblages?
2) What was the functional relationship of the stone tools to the fossils that were recovered from the site?
3) What are the technological attributes of the stone tool assemblage?
4) What fine-scale site formation processes were in operation?
5) What was the larger behavioural, depositional, and palaeoenvironmental context of Mwanganda's Village?

In pursuit of addressing these questions, test excavations by MEMSAP in 2010 were aimed at relocating the palaeosol and identifying other potential related subsurface deposits. Three areas were tested in 2010. One of these, referred to as the 'Deep Pit', was located ca. 50m to the southeast of Clark's original excavations on a terrace slightly higher than where the elephant had been recovered. This revealed a buried artefact horizon embedded within a thin, distinctive cobble and pebble layer (Figure 18).

Kaufulu (Kaufulu 1983, Kaufulu 1990) shows substantial change in microfacies over the extent of the Mwanganda site, and this was also a result found in 2010. Post-excavation analyses identified two important field objectives that had not been met in 2010. First, the palaeosol that contained the elephant (and other) fossils was never located. This is essential for recovery of a sample of fossils and artefacts that have been excavated with enough control to determine their fine-scale spatial associations and interpret their potential functional relationships. It is also essential for dating and micromorphological analyses of the purported Sangoan layer because samples must be taken from the same palaeosol identified by Clark and Haynes (1970) and Kaufulu (1990) in order to confidently associate the ages with any recovered specimens. A priority for the 2011 excavations was therefore the identification of this palaeosol and a small excavation to better understand its age, microstratigraphy, and spatial relationships of the artefacts and fossils it has been reported to contain.

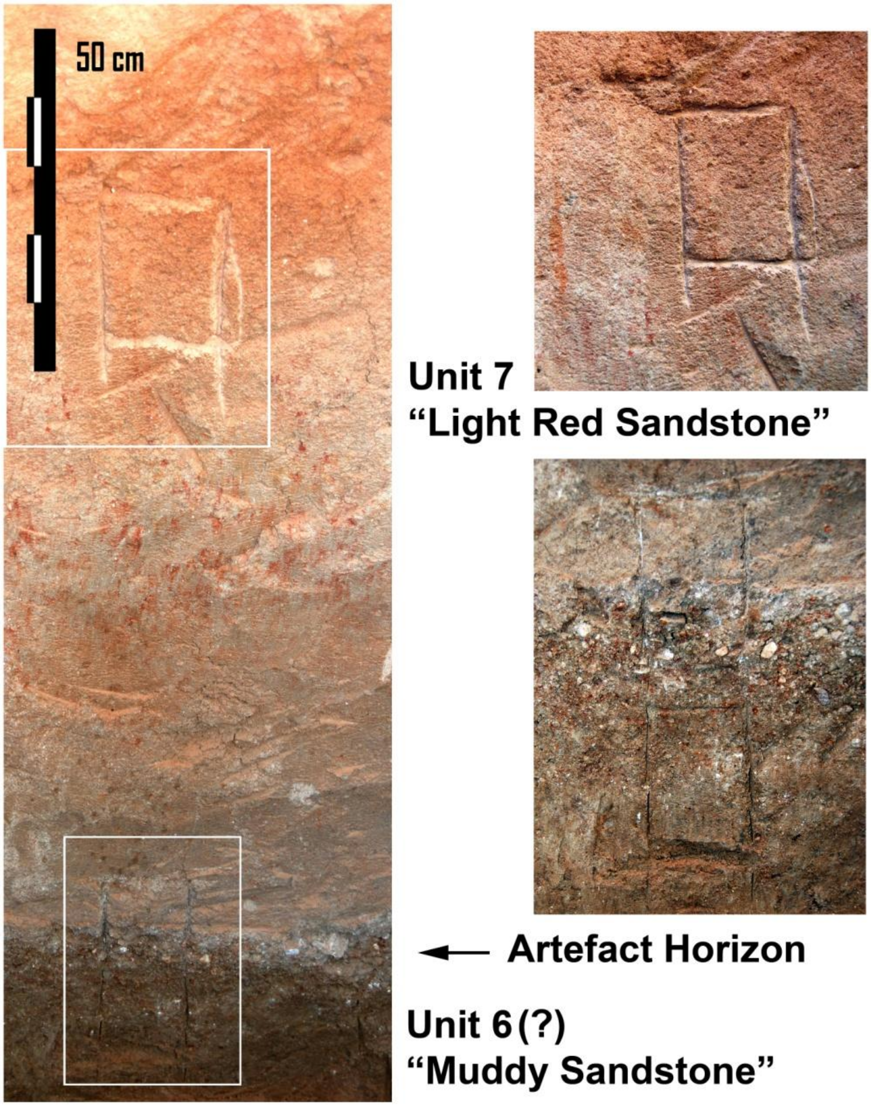

Figure 18 South section of the Deep Pit. Boxed areas are enlarged at right. Unit designations are from Kaufulu (1990: 20). OSL ages were taken from the top of the sequence, above, and below the artefact horizon (refer to enlarged boxes).

The second objective that was not met in 2010 was correlation of the elephant butchery site stratigraphy with that identified by MEMSAP in the Deep Pit test excavation. There is a distinctive caliche layer (Kaufulu's 'Unit 5') that occurs at and near the elephant site, but this was not discovered in the test excavations in 2010. However, the 1 x 1m test pit was not considered safe for further excavation without lateral expansion, and time was not available at the end of the season. A second priority in 2011 was therefore to establish a stratigraphic context for the site that could be interpreted at a scale somewhat more localised than that reported by Kaufulu (1983, 1990). This would be achieved via geological trenches and through further excavation into the basal stratigraphy in the location of the Deep Pit.

A final priority in 2011 was spurred by the discovery of artefacts at the base of the Deep Pit in 2010. The artefacts from the test excavation were recovered only *higher* in elevation than the carbonate horizon described by previous researchers as *overlying* the elephant skeleton. This suggested that Mwanganda's Village was a stratified or multi-component site with MSA artefact horizons separated by a natural layer that was characterised by caliche formation. This could have the potential to further increase the global significance of the Mwanganda site, especially if the upper artefact horizon was found to be intact. It was also therefore an aim in 2011 to open a larger area where a substantial sample of artefacts from the pebble horizon could be recovered and a significant sample could be wet-sieved to maximise the recovery of small artefacts.

Excavations

In July and August 2011 MEMSAP excavated three new Areas at Mwanganda's Village. Area I was a 3 x 4m excavation (squares A1 – C3) approximately 10m southeast of the 'Deep Pit' from the 2010 excavation season. Ideally, this Area would have been adjacent to the test pit from 2010 but construction of a house over the site of the test excavation made this impossible. Fortunately, the same stratigraphy was identified in 2011 as in the 2010 test excavation and in fact the cobble and pebble horizon was somewhat closer to the modern land surface. Although it was still found more than 1m deep, it did mean that less overburden had to be removed before the layers containing artefacts were uncovered. The squares A4 – C4 were wet-sieved from top to bottom to ensure that a sample was retained that had the most complete recovery possible.

Area II was a 3 x 2m excavation (squares A1 – C4) approximately 15m southwest of Clark's original excavations. The fossil- and artefact-bearing palaeosol identified by Clark and Haynes (1970) and Kaufulu (1990) is described as laterally discontinuous and often interrupted by sandy palaeochannel deposits. 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." Based on Kaufulu's (1983; 1990) reconstruction, the palaeosol should have continued to the southeast of Clark's Area 1 (Figure 19). This guided our placement of MEMSAP's Area II excavation, which was designed to intercept the palaeosol.

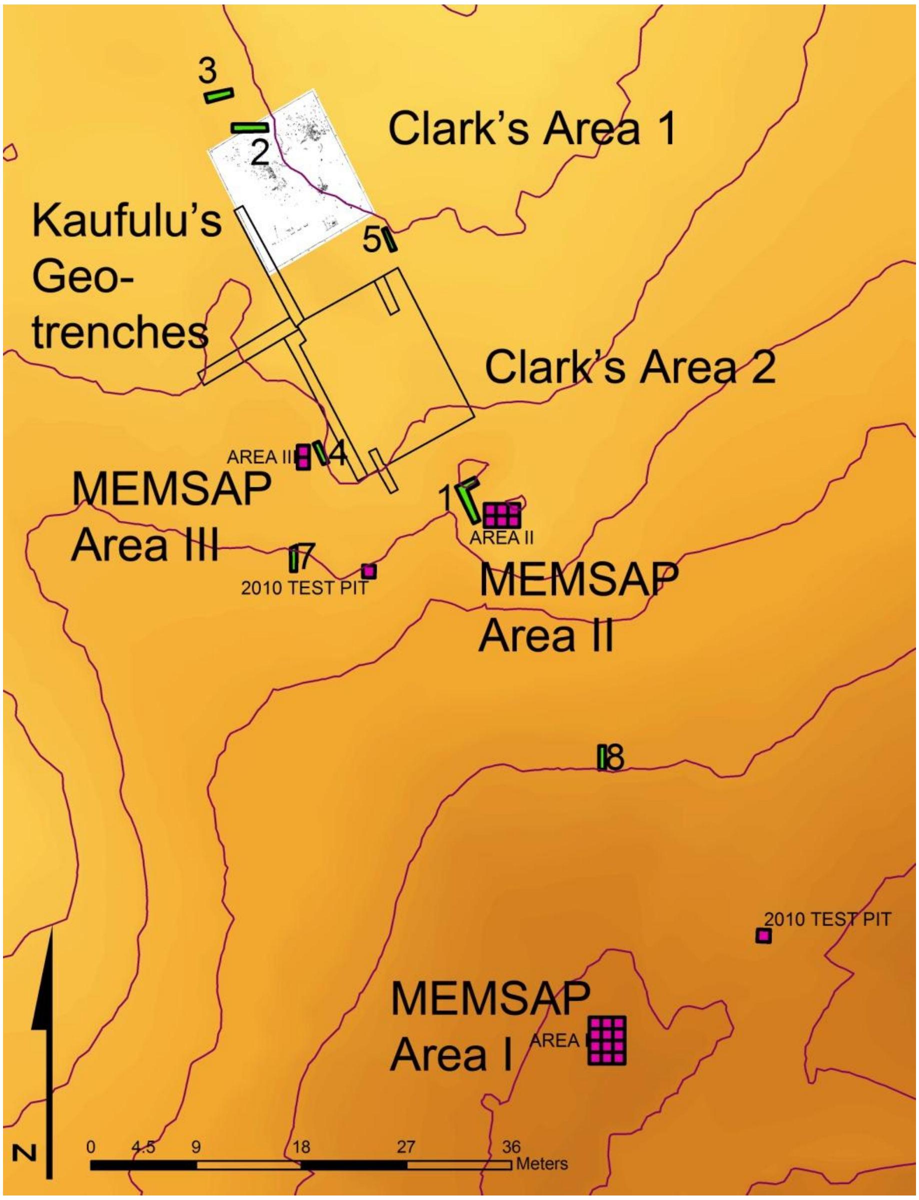

Figure 19 Location of Clark's excavations (white square is a georectified plan of the elephant butchery site from Clark and Haynes [1970]), Kaufulu's geological trenches associated with the excavations, and MEMSAP Areas I, II, and III. Test excavations by MEMSAP in 2010 are also shown.

Thirteen 0.5 x 1m geological trenches were also emplaced around the site from the modern streambed to a land surface elevation approximately 2m higher than the Area I excavations (Figure 20). Area III was excavated when the palaeosol was not found in Area II but discovered in a nearby geological trench. Area III was a 1 x 2m excavation (squares A1 – A2) that was located under the backdirt from Kaufulu's (1983, 1990) geoarchaeological excavations. This was initially confusing until careful scrutiny of published maps showed that the north arrow had been incorrectly placed to be facing east in the site plan given by Clark and Haynes (1970) and reproduced faithfully (ie: also incorrectly) by Kaufulu (1983, 1990). By rotating the maps 90 degrees the position of Kaufulu's geological trenches on the map, still visible at the site because they had never been backfilled, lined up perfectly with the modern topography. This greatly facilitated interpretations of the stratigraphy in Area II.

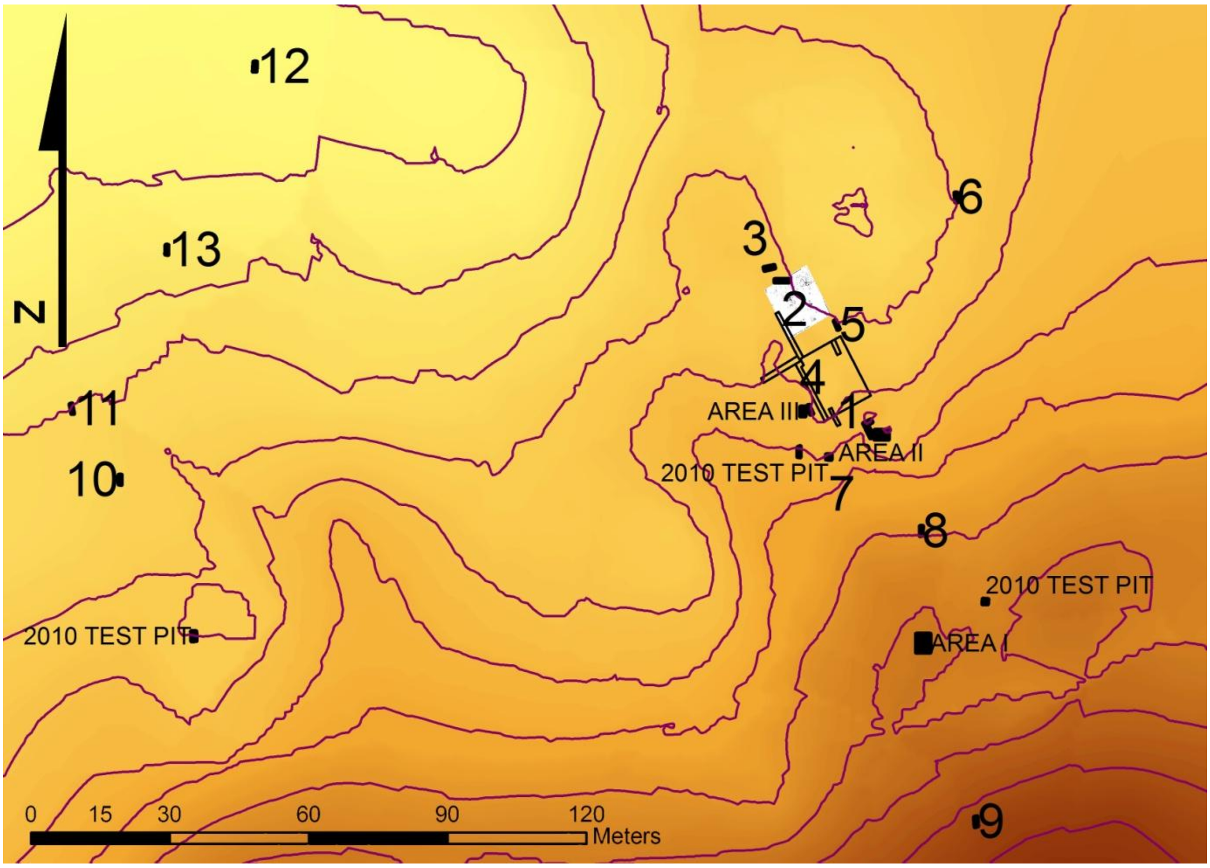

Figure 20 Locations of the geological trenches (numbers) relative to the original Clark excavations (white square).

Stratigraphy and Results

The stratigraphy in Area I was the same as that observed in the 2010 Deep Pit test excavations (Figure 21; Figure 22). A series of sands overlay a clay layer, both of which only contained occasional artefacts or clasts larger than 2cm. A cobble/pebble horizon containing artefacts was very clearly defined below, followed by a layer of coarse sand. Below this was a series of archaeologically sterile deposits. These began with brown clay interspersed with sandy lenses, then became a waxy olive clay. Below this was clay with caliche nodules that could be correlated with the basal stratigraphy at the elephant site.

Figure 21 Composite section photograph of the stratigraphy seen in the eastern wall of squares C1-C4.

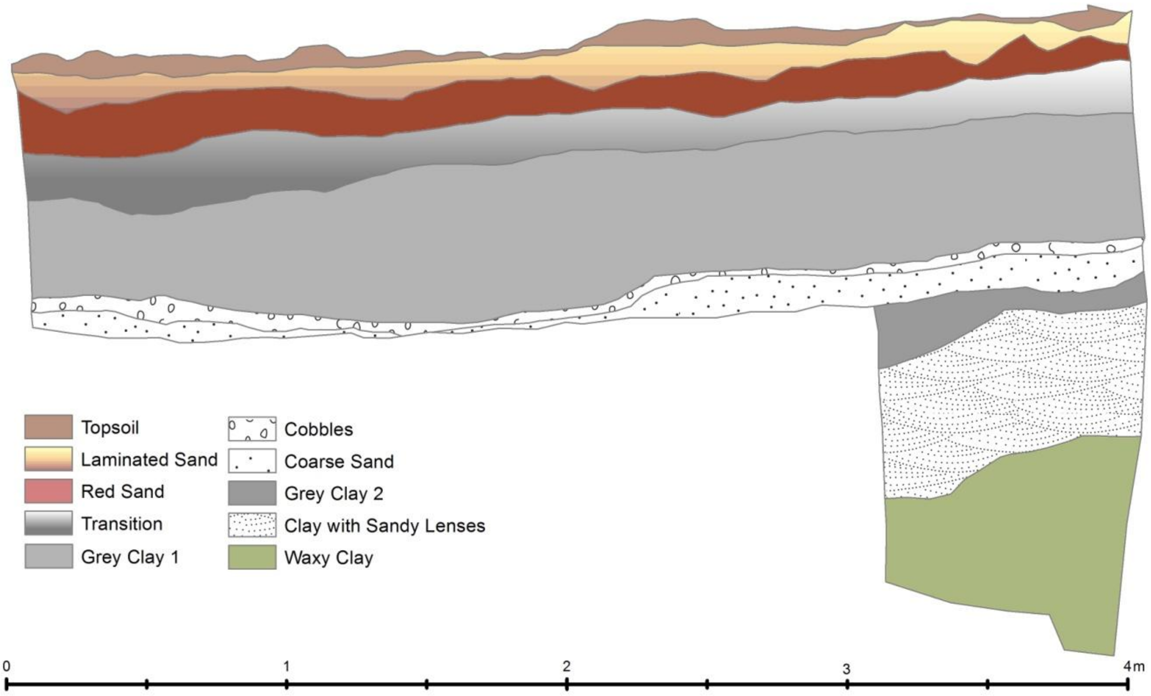

Figure 22 Section drawing of the stratigraphy on the eastern wall of squares C1 – C4.

Preliminary OSL ages of samples taken from the test pit adjacent to Area I in 2010 were analysed in 2011 and provided an absolute chronology for this sequence. Sample locations were illustrated in Figure 18, and ages are in stratigraphic order from top to bottom. These preliminary dates were provided by the Luminescence Laboratory at the University of Illinois at Chicago (Table 5).

The ages 42,550 ± 3550 and 22,065 ± 1920 bracket the cobble/pebble horizon, placing its deposition at the terminal MSA. In other parts of Africa transitional MSA-LSA industries have been dated to ca. 40 – 20 ka (Clark 1997, Ambrose 1998). This is a very interesting result, especially if the earlier part of the MSA is represented by the palaeosol unit from which artefacts and fossils were recovered during Clark's original excavations. The age of 15,610 ± 1280 on the upper sands near Area I show a rapid aggradation of sediment during the Late Pleistocene. Further upslope to the south a geological trench shows that these sands thicken up to at least 2m, likely as part of the Late Pleistocene to Holocene Karonga Formation (Stephens 1966). These recent dates are in line with Malawi's oldest LSA date, being from Mt. Hora dating to 14.7 ka (Sandelowsky 1972, Cole-King 1973).

Table 5 Optically-Stimulated Luminescence dates analysed by Prof. Steven Forman at the University of Illinois at Chicago.

Sample	LabNumber	Aliquots	Equivalent Dose (Gray)[a]	Over-dispersion (%)[b]	U (ppm)[c]	Th (ppm)[c]
S683	UIC2854	30	37.99 ± 2.31	25.2 ± 3.4	1.4 ± 0.1	9.4 ± 0.1
S684	UIC2857	30	48.58 ± 2.50	19.7 ± 2.6	1.6 ± 0.1	9.6 ± 0.1
S685	UIC2856	30	82.70 ± 4.19	21.4 ± 2.8	1.8 ± 0.1	9.6 ± 0.1

Sample	LabNumber	K (%)[c]	H2O (%)	Cosmic Dose (mGray/yr)[d]	Dose Rate (mGray/yr)	OSL Age (yr)[e]
S683	UIC2854	1.41 ± 0.02	5 ± 2	0.20 ± 0.02	2.43 ± 0.12	15,610 ± 1280
S684	UIC2857	1.54 ± 0.02	20 ± 5	0.18 ± 0.02	2.20 ± 0.11	22,065 ± 1920
S685	UIC2856	1.39 ± 0.02	30 ± 5	0.17 ± 0.02	1.94 ± 0.10	42,550 ± 3550

[a]150 to 250 µm quartz fraction (2 mm plate area) analyzed under blue-light excitation (470 ± 20 nm) by single aliquot regeneration protocol (Murray and Wintle 2003).

[b]Values reflect precision beyond instrumental errors; values of ≤ 25% indicate low spread in equivalent dose values with an unimodal distribution.

[c]U, Th and K20 content analyzed by inductively coupled plasma-mass spectrometry analysed by Activation Laboratory LTD, Ontario, Canada.

[d]From Presott and Hutton (1994).

[e]Ages calculated using the central age model of Galbraith *et al.* (1999).

All errors are at 1 sigma and ages from the reference year AD 2010.

The Area I lithic assemblage is currently under detailed analysis and being subjected to a refitting study. Preliminary results show that it likely has three components, even though it derives from a vertical band that is only ca. 15 cm in thickness (Figure 23). One component is clearly not *in situ*, and is incorporated into the pebble horizon as highly rounded clasts. Many of these are barely identifiable as flaked artefacts and likely have nothing to do with any of the activities that took place on site at Mwanganda's Village. The second component is slightly weathered to fresh in appearance, and may have a high proportion of quartzite relative to quartz. Both larger (up to 10cm) and smaller (at least 1cm) pieces are present. Preliminary observation indicates that this component may derive from the coarse sand underlying the cobble horizon. When all analyses are complete, including the sieved portion of the assemblage, this will be tested.

Figure 23 Section photograph showing the south wall profile of Area I with the cobble horizon containing the majority of the artefacts clearly apparent.

The third component is the most interesting. This comprises flakes and cores mainly manufactured on small quartz cobbles < 5cm in the maximum dimension. Several of these are radially flaked but lack platform preparation typical of the MSA. This suggests that lithic technology at this time was undergoing a transition in both reduction strategies and raw material selection. However, some elements of previous approaches to the manufacture of stone artefacts were being retained. This fits well with the bracketing OSL ages, which indicate the artefacts were deposited between ca. 22 – 42 ka. Further refinement of these ages through a direct date on the pebble horizon itself is desired. An intact sediment block was taken from the section of Area I for this purpose.

The stratigraphy in Area II was relatively shallow (Figure 24). A series of alternating fine lenses of stony sediment and caliche capped the deposits to the southeast. Artefacts, many of them exhibiting signs of rolling and weathering, were located in the stony lenses. A red channel fill of sand in a fining-down sequence was then apparent. This contained occasional heavily weathered fragments of fossil bone and clay root casts but few artefacts. Below this a layer of brown clay capped a waxy olive clay with caliche nodules.

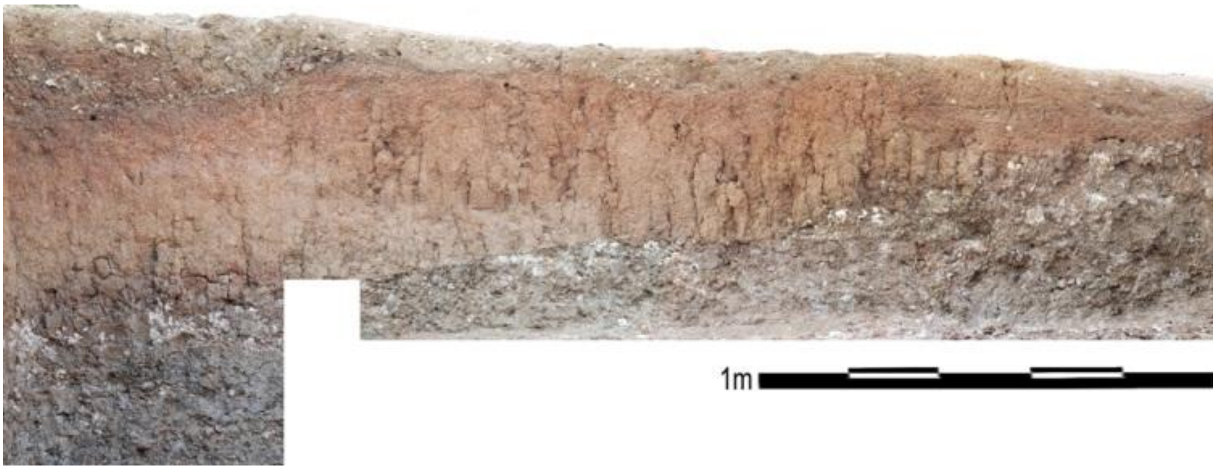

Figure 24 Section photograph showing the south wall profile of Area II.

A test excavation was continued in square C3 down to ca. 2.5m but only more sterile waxy clay was found (Figure 25). At the very base of the sequence an auger hole in a nearby geological trench revealed a very clean fine sand that marked the termination of all recorded stratigraphy. The same sand was also located in an auger hold in square C4 in Area I, further confirming the stratigraphic correlation.

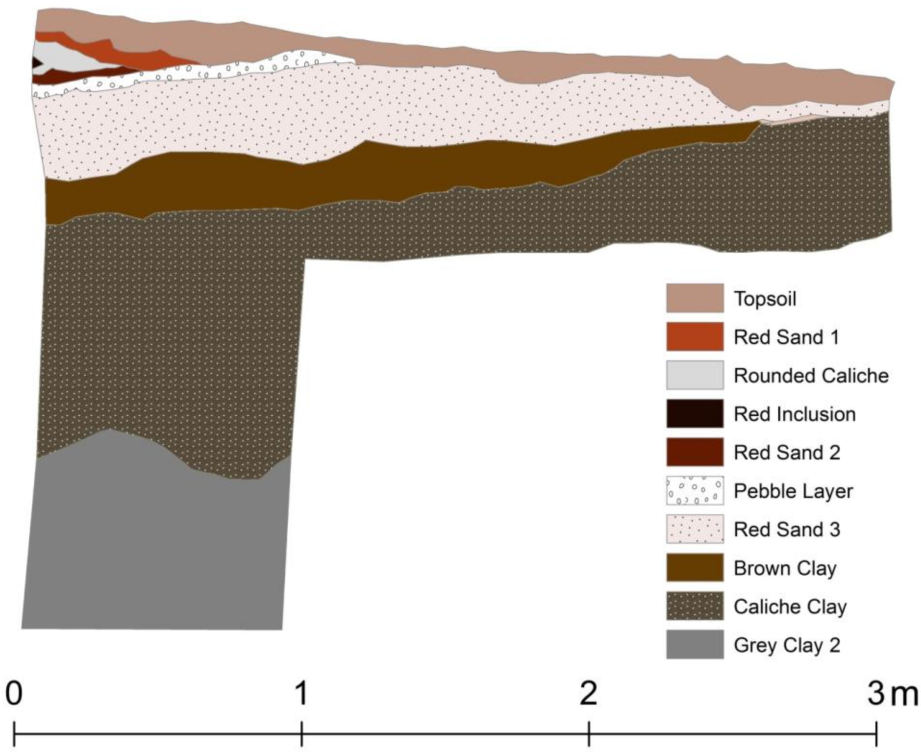

Figure 25 Section drawing of the stratigraphy as seen in the south wall of Area II.

The bulk of the stratigraphy in Area III was comprised of ca. 1m of Kaufulu's backdirt. Under this a layer of stony sediment capped the palaeosol, which yielded only six small fragments of fossil bone and a few artefacts (Figure 26; Figure 27). Below this a sterile clay completed the sequence, which was identical to that reported by both Clark and Haynes (1970) and Kaufulu (1990). An OSL sample was taken from directly within the palaeosol, and micromorphology samples were taken at its upper and lower contact boundaries. The results of these analyses will be instrumental in guiding any future work at Mwanganda's Village.

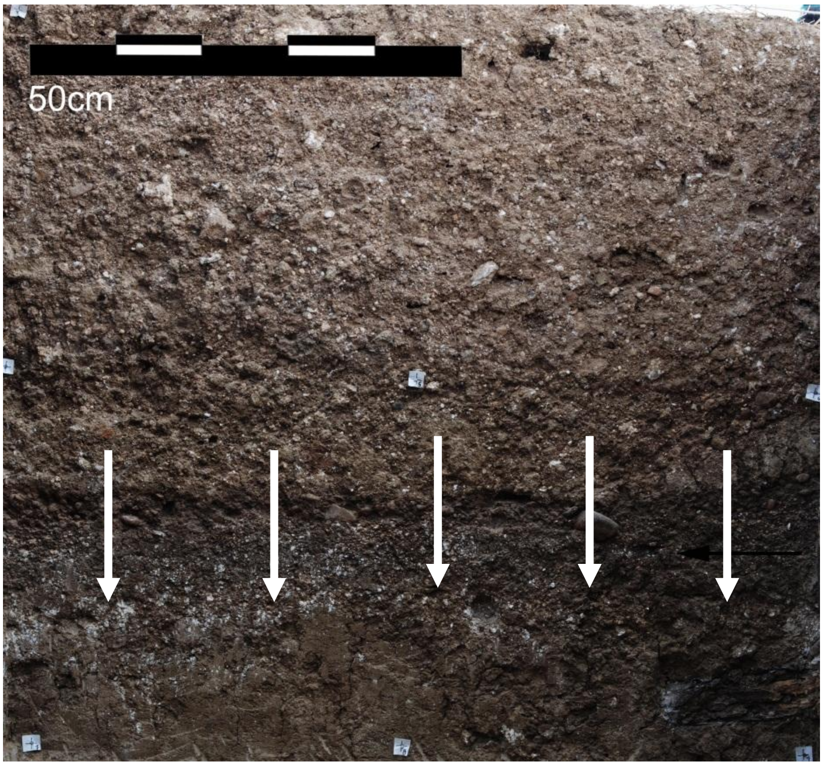

Figure 26 Section photograph showing the south wall profile of Area III. The arrows indicate the location of the palaeosol.

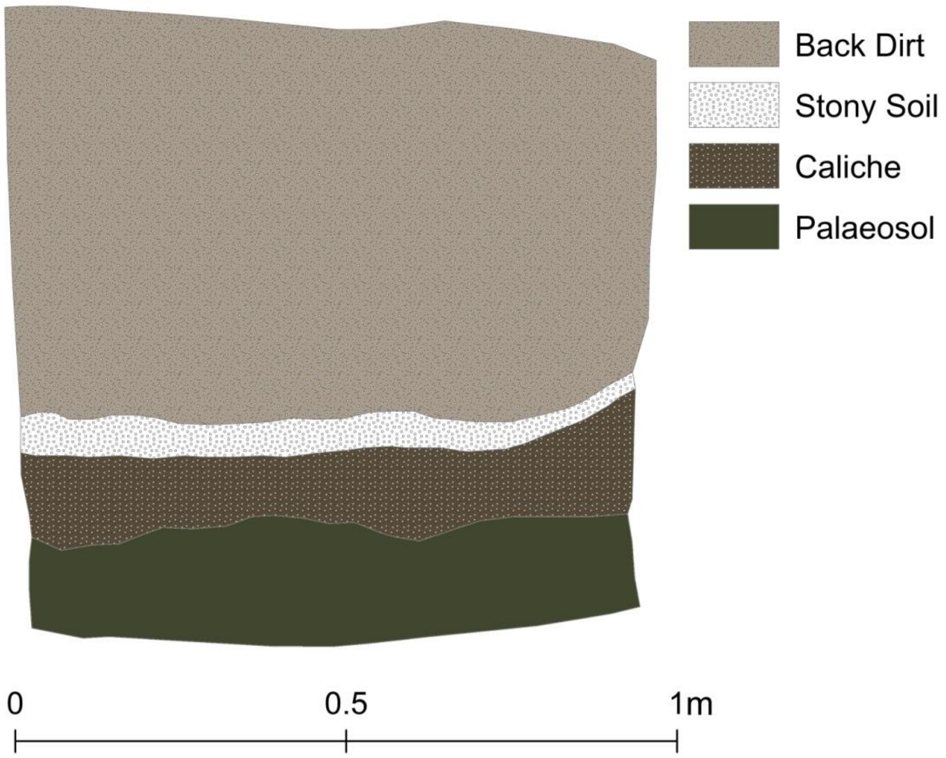

Figure 27 Section drawing of the stratigraphy as seen in the south wall of Area III.

Discussion and Conclusions

The re-location of the palaeosol, the correlation of deposits between areas, and the establishment of a local sedimentary and terrace sequence were all significant outcomes from the 2011 excavations at Mwanganda's Village. In the future it will likely be useful to excavate more of the palaeosol in order to map the spatial distributions of artefacts and fossils and to obtain a complete sample with wet-sieving of these materials for analysis. However, this work would best proceed once results of dating and microstratigraphic analyses are available.

It is highly significant that Mwanganda's Village was found to be a stratified site with more than one archaeological component. If one of those components truly is a Sangoan elephant butchery site, or even an early MSA site, then the significance is further increased. 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 in behaviour at the same locality over time.

The transitional MSA-LSA assemblage recovered from Area I is also highly significant in its own right. Again, there are few sites across the continent that record this transition and most are located in eastern and southern Africa. In addition to its transitional nature, the assemblage is also of great interest because most assemblages from this time period are from cave sites that record palimpsests of human activity over extended periods of time. In contrast, Area I at Mwanganda's Village is a rare snapshot of human behaviour in an open-air locality. Its high spatial integrity gives us not only a glimpse into artefact reduction strategies during a very interesting time interval; it allows us to examine spatial patterning in the behaviour of what may be a single human group on the open landscape where they likely spent most of their time.

Chaminade I

Overview

Clark (Clark *et al.* 1970, Clark 1968) demonstrated the richness of the Chaminade area and the potential for it to yield stratified and intact Middle Stone Age deposits. Investigating variability in the nature and age of these deposits is an important part of reconstructing the past fragmented landscape and building a sequence of MSA behaviour. Test excavations were undertaken at Chaminade I to begin building this sequence.

A 3m-deep pit measuring approximately 5 x 5m had previously been excavated by local villagers in order to obtain clay for brick manufacture. This was identified by the geomorphological team as a prime area for understanding the entire stratigraphic sequence of the artefact-rich deposits seen eroding ca. 50m to the west. Because the brick pits had already exposed a profile, this was used as a guide for excavating archaeologically (Figure 28).

Figure 28 Overview of the artefact-bearing excavations at Chaminade I with the brick pit clearly visible in profile as the slumped deposit.

Excavations

A total area of 12 m² was excavated in adjacent 1 x 1 m test pits. The first ten metres (A1 – A10) were excavated from north to south in a row to create a long section and to sample spatial variability in artefact locations and depositional units. No artefacts were recovered in the upper red sands in the first 7m, so excavations were halted after achieving only ca. 1m in depth and efforts were focussed on the deeper sediments exposed by the brick pits in order to maximise time and effort. After artefacts were discovered at the base of the brick pits in A8 – A10 the B9 and B10 squares were also excavated. The artefact sample therefore derives from only 5 m².

Stratigraphy and Results

The top of the stratigraphic sequence at Chaminade I comprised red sands with no artefacts recovered. Topsoil development was evident within the uppermost 20cm, and roots or holes that once contained tree-sized roots were present throughout (Figure 29). The sands appeared to fine upwards, with slightly coarser sand mixed with clay at the base. A series of brown clays were then apparent, also containing no artefacts.

Figure 29 Composite section photograph of the east wall of squares A1-A8 at Chaminade I.

Below this was a coarse grey deposit characterised by small black nodules of either iron or manganese (Figure 30).

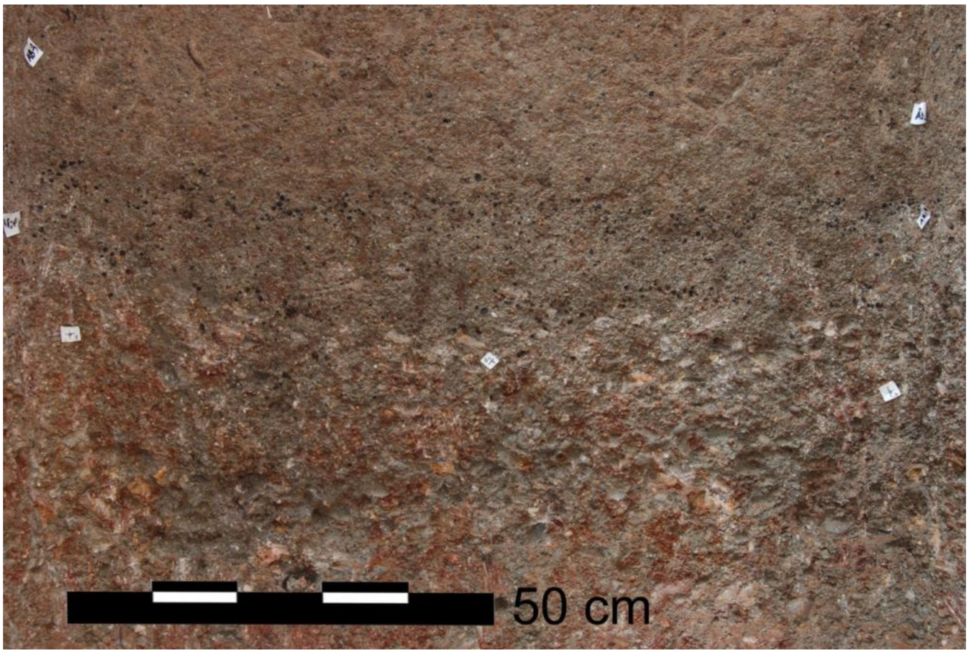

Figure 30 Close-up of black nodule deposits from which most of the artefacts were recovered.

The black nodule layer contained the majority of artefacts, as seen in the plotted finds in Figure 31. It is apparent that the people who dug the brick pits stopped just above the artefact horizon, likely because the sediment was becoming coarser and not as suited to brick manufacture.

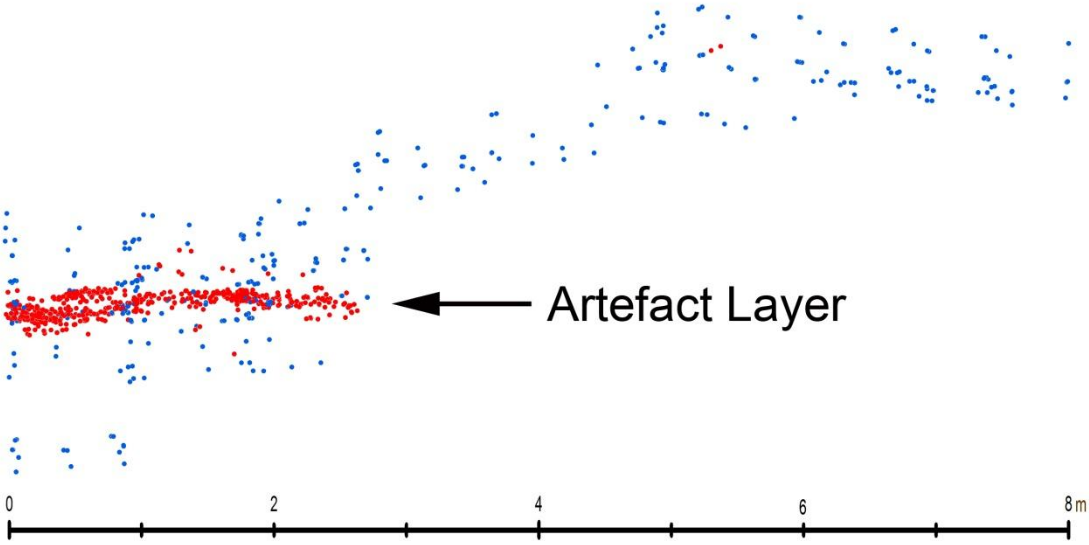

Figure 31 Side view of plotted finds in the Chaminade I excavations, showing artefact concentrations around the black nodule layer. Blue dots indicate depths of excavated contexts. Red dots indicate plotted finds (note that most, but not all, plotted finds are stone artefacts).

Below the black nodule layer a pebble horizon became apparent, and this contained some artefacts. Thereafter, a series of cut and fill channel deposits without artefacts continued to nearly 3m total depth from the top of the red sands to the base of the excavated sequence (Figure 32).

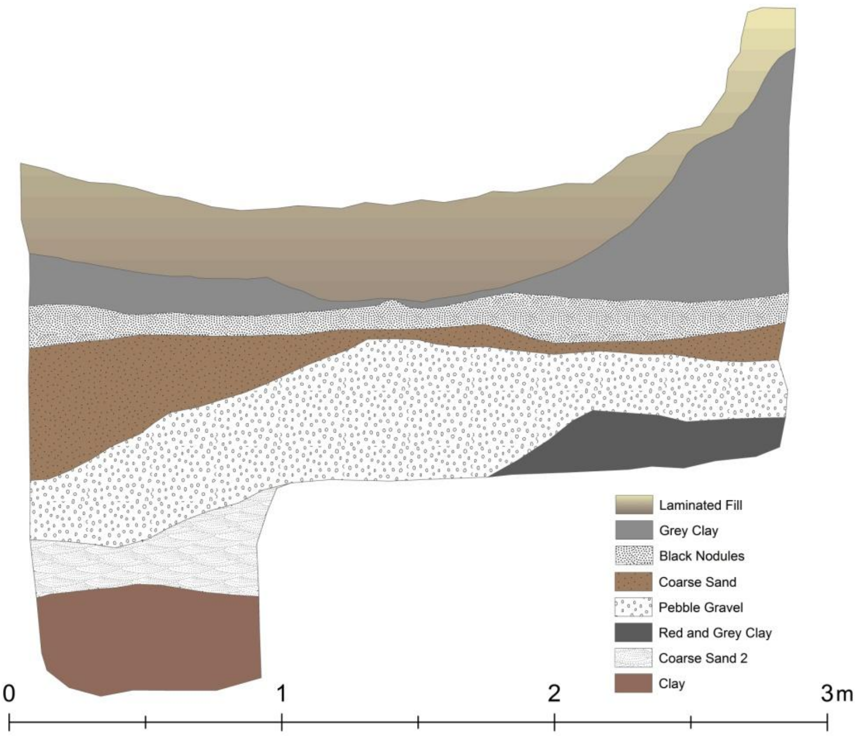

Figure 32 Section drawing of the stratigraphy as seen in the west wall of squares A8-A10 at Chaminade I.

Discussion and Conclusions

Preliminary examination of the artefact assemblage from Chamimade I shows that it includes radial technology indicative of the MSA. Both cores and flakes are represented. Raw materials include quartz and quartzite. There appears to be a mixture of fresh and slightly weathered edges on the artefacts, suggesting a varied taphonomic history. Refitting and size class analysis will assist in making this final assessment, but it is clear that a range of sizes from at least 2 – 10cm are represented.

The Chaminade I excavations revealed new variability in the depositional environments in which MSA artefacts are found. Because of the way in which the Chitimwe Beds weather, surface survey would not have shown that these artefacts derive from a coarse grey facies rather than the red sandy or pebble facies such as the type deposits of the Chitimwe Beds (Stephens 1966). This supports preliminary geomorphological observations that there is more variability within the Chitimwe Beds than has previously been acknowledged. In this area it is the Chiwondo Beds that are normally identified as the fine-grained grey beds underlying the red sands, which shows that simply identifying beds based on their colour characteristics can be misleading.

Chaminade II

Overview

The results of the geological trenching in the badlands portion of the Chaminade area led to the realisation that many of the deposits in this area are highly disturbed. Even shallow subsurface deposits have been subjected to deflation and hillslope processes. The discovery of a discrete MSA artefact horizon in Chaminade Geological Trench 14 (CGT14) further confirmed that in order to understand spatial variability in MSA artefact distributions, a large excavation had to be undertaken where the entire stratigraphic sequence was known. This was determined to be most usefully emplaced as a long cut with the long axis running north-south. By being positioned roughly parallel to Lake Malawi chances of encountering subsurface depositional variability owing to drainage from the foothills would be maximised. The configuration of the trench as a long cut would provide a rare opportunity to observe how intact MSA artefacts are spatially distributed relative to one another and relative to the palaeo-land surface.

An extension season was organised to explore this depositional variability and investigate the artifact horizon near the geological trench. These excavations were undertaken by senior Antiquities officers Simfukwe, Malijani, and Chinula. They were supported with loaned equipment (including a total station) from UQ and MEMSAP to ensure consistency of data collection. In addition to field checks their data were emailed to the project director and checked regularly over the course of the season. The results were emailed back to the crew with a map of their daily data, any corrections, and any questions. All actions the team undertook could be monitored directly through the .RAW data file and daily excavation progress could be observed in the datapoints. Any errors that were made were corrected the following day via the recursive data-checking process, and the team's corrected margin of error was < 0.5%. A sample screen shot from this data-checking process is provided in Figure 33.

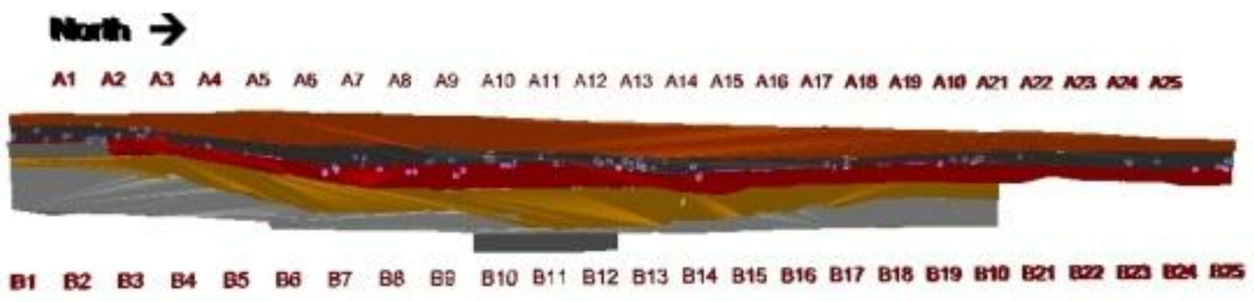

Figure 33 Sample screen shot of the Chaminade II excavations in progress, showing how datapoints were checked daily for spatial consistency.

Excavations

The CGT14 test trench showed that few artefacts were recovered in the uppermost 2.5m of red sand. Therefore, prior to the 2011 extension season the uppermost 2m of overburden was removed with a mechanical excavator along a 4 x 50m trench parallel to the mountains and lake (Figure 34). All excavation was monitored by archaeological personnel.

Figure 34 Mechanical excavation in progress.

Overburden was placed in ten separate piles by the excavator, with each pile representing approximately 4 x 5 x 2m of sediment along the trench. All overburden was then sieved through a 5mm mesh (Figure 35). Only half the prepared trench (50 m^2, extending as a 2 x 25m trench) could be excavated archaeologically in the allocated time. If necessary for the research goals the remainder will be excavated in 2012, and if not it will be backfilled with the underlying sediments left intact.

Figure 35 Overburden sieving in progress.

The overburden found to contain on average only < 1 artifact/m^3. This confirmed what was found in CGT14 and further justified the use of the mechanical excavator. With the mechanically-excavated trench providing a safe step, a 2 x 25m trench was hand-excavated down the middle, with a total of 50m^2 excavated to a depth of 2.5m. Excavation proceeded in 1m squares and by natural stratigraphy. All sediments were sieved through a 5mm mesh, with the full column wet-sieved every ten meters to provide a control sequence with complete recovery. A bulk sediment sample was taken from each context and mapped with the total station.

Stratigraphy and Results

The top of the sequence at Chaminade II comprised red sands with few artefacts. This was underlain by an iron pan deposit with a coarse red sand underneath. Artefacts were heavily concentrated immediately above, below, and within the iron pans (Figure 36). In many ways, the stratigraphy was similar to that found at the nearby Airport Site (Thompson *et al.* In press). In some small pockets a coarse grey sandy deposit also occurred, with a cobble/pebble horizon underlying the entire sequence. A few artefacts were recovered from this layer, indicating that the site has two discernible artefact horizons. Below this is a transitional grey clay layer that is representative of the Chiwondo Beds.

Figure 36 Image of the plotted finds in profile view with 5X exaggeration, showing the two artefact horizons.

Because the stratigraphy was excavated in natural layers and mapped using a total station, it can also easily be represented in a 3D GIS environment with real volume measurements of each layer (Figure 37). This facilitates the identification of spatial patterning within the artefact assemblage and will be supported with more traditional methods of artefact refitting and analysis.

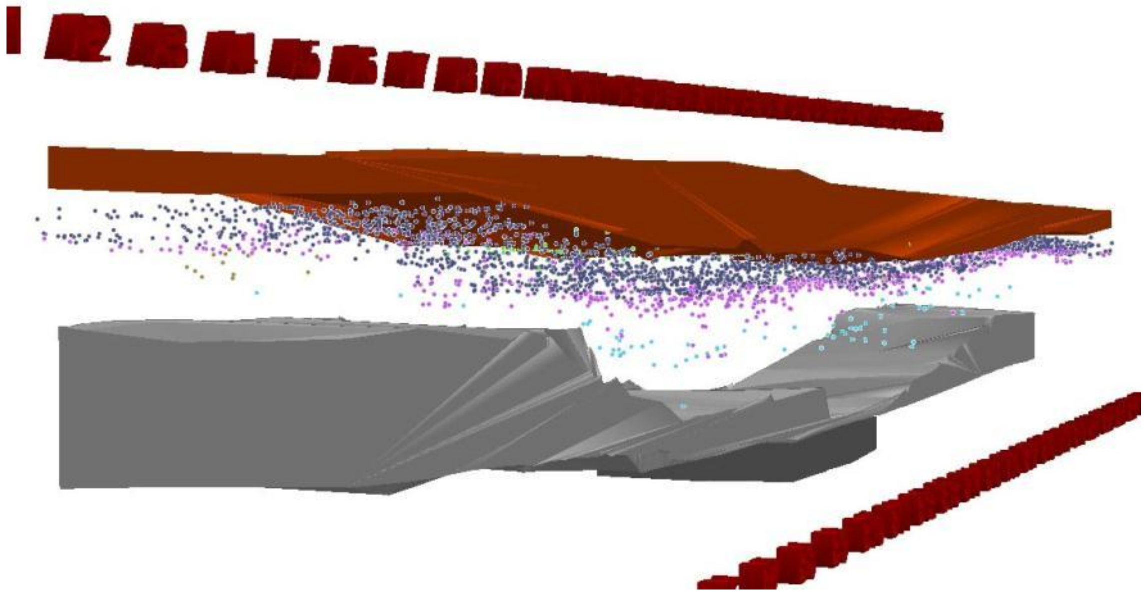

Figure 37 3D GIS representation of the stratigraphy at Chaminade II. North is to the right.

Discussion and Conclusions

In 2011 over 3000 piece-plotted and oriented MSA artefacts were recovered, (screened finds have yet to be counted), 100 contexts were excavated, and over 100m^3 of sediment was excavated to produce a long profile of subsurface sedimentary variability for geoarchaeological mapping and sampling. Analysis of the artefact assemblage will commence in 2012. Because excavations at Chaminade II were conducted partially through remote direction, they provide an excellent lesson in the use of modern technology for international collaboration. Much emphasis was also placed on the representation of these excavations in a 3D environment, to aid in visualisation for MEMSAP team members who were not present at the excavations.

Further integration of all excavations into a master 3D GIS for the study area is currently underway. This will collate geological, topographic, and archaeological data into a single interactive database for all MEMSAP localities, so that all excavations can be virtually toured across the sampled landscape.

Initial excavation of sediments to the east of the Chaminade badlands terrain in 2011 sampled buried MSA deposits on the 'lake side' of the alluvial fan. Testing the model of landscape incision, fan aggradation, and MSA site formation/preservation requires a partner excavation to the west, on the 'foothills side' of the fan. Given the success of the 2011 'off-season' work, this partner excavation is planned as a potential 'off-season' study for 2012. As in 2011, relating finer-scale depositional contexts – and the artefacts they contain – will be most effectively achieved via a long trench parallel to the foothills and the lake. This will capture spatial and depositional variability in three dimensions, with data directly linked (within 5cm accuracy) to every other investigated site near Karonga via the MEMSAP network of established, permanent control points.

V. OUTREACH AND DISSEMINATION

Professional Publications

Thompson, J.C., Mackay, A., Wright, D.K., Welling, M., Greaveas, A. Gomani-Chindebvu, E. and Simengwa, D. (2012). "Renewed Investigations into the Middle Stone Age of northern Malawi". *Quaternary International*. doi:10.1016/j.quaint.2011.12.014

Conference Presentations

Thompson, J.C., A. Mackay, A., de Moor, V., Zipkin, A., Moroney, A., Welling, M., and Gomani-Chindebvu, E. (2011). "A landscape approach to understanding human population movements during the Middle Stone Age of northern Malawi". Paper presented at the 34th annual Australian Archaeological Association Conference, Toowoomba, Australia.

Thompson, J.C. Welling, M., and Mackay, A. (2010). "Archaeological tests of palaeoecological models of central African demography during the Pleistocene". Paper presented at the 33rd annual Australian Archaeological Association Conference, Bateman's Bay, Australia.

Thompson, J.C., Welling, M., and Mackay, A. (2010). "Renewed Investigations into the Middle Stone Age of northern Malawi". Paper presented at the 13th Congress of the Pan African Association for Archaeology and Related Disciplines/Society for Africanist Archaeologists meeting, Dakar, Senegal.

Thompson, J.C., Welling, M., Pargeter, J., and Wright, D.K. (2010). "The Malawi Earlier-Middle Stone Age Project: Preliminary Results from 2009 Fieldwork". Poster presented at the Paleoanthropology Society conference, St. Louis, Missouri. Abstract: *PaleoAnthropology* 2010: A34.

Professional Invited Presentations

Thompson, J.C. (June 2010). "New investigations into the Middle Stone Age of Malawi". Seminar given at the University of the Witwatersrand, Johannesburg, South Arica.

Thompson, J.C. (April 2010). "New investigations into the Middle Stone Age of Malawi". Seminar given at the Stone Age Institute, Bloomington, Indiana.

Thompson, J.C. (August 2009). "A new multidisciplinary research project on the early prehistory of Malawi". Seminar at the Catholic University of Malawi (CUNIMA).

Outreach

MEMSAP considers public outreach of critical importance. The public dissemination of MEMSAP's goals, objectives and methods, is crucial for obtaining social relevance. Increased understanding of the importance of the sites will further result in increased sense of local ownership and thus custodianship. Improved site preservation is a logical consequence. For this reason MEMSAP always recruits local staff from the surrounding villages. Moreover, its academic staff and students are encouraged to take time to present the project to visitors. For the same purpose MEMSAP gave a public lecture and artefact manufacture demonstration in 2010 at Karonga Cultural and Museum Centre entitled "The Earliest Archaeology of Karonga – Why the World Wants to Know!". In 2011 MEMSAP organised a guided tour for the most senior management of the department of Antiquities, Lilongwe, and for Paladin Africa –a potential sponsor.

Attention is also brought to the richness of the archaeological record in northern Malawi via the project's Facebook website:

http://www.facebook.com/#!/pages/Malawi-Earlier-Middle-Stone-Age-Project/257887127623607

Starting in 2012 a new blog called "Dispatches from the Field" will be implemented for the project via the School of Social Science website at the University of Queensland. This blog will contain weekly updates of field activities in the words of project participants, and through photographs and video uploads.

VI. SUMMARY

Summary and Conclusions

The 2011 MEMSAP field season saw a solid start to the geomorphological contextualisation of the archaeological deposits. This represents the first concerted examination of the Chitimwe Beds since researchers such as Stephens (1966), Haynes (in Clark *et al.* 1970), and Kaufulu (1983, 1990) incorporated them into their pioneering work on the Quaternary deposits of the Karonga region. Importantly, several new approaches to pairing the geomorphological and landscape data with the archaeological data were developed. These show specific promise for deposits such as those in Karonga, where lithic raw materials were readily available as cobbles across much of the exposed Pleistocene land surface.

The season also continued a program of excavation designed to investigate new sites (e.g. Chaminade I and II) and to answer existing questions about known sites (e.g. Mwanganda's Village). Several goals that remained after the 2010 field season were met in 2011, and as with any field endeavour new questions were also raised. The first OSL ages for the project also became available, providing additional significance to artefact assemblages excavated by MEMSAP. A new approach to fieldwork was developed in collaboration with the Malawi Department of Antiquities that allowed for maximisation of data collection and project resources through the development of both regular and 'off-season' components to the project. It is hoped that this continuity of effort can continue in the future, as there is no shortage of information to be gained from the MSA deposits of the Karonga District.

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. No fieldwork can ever be successful without a dedicated field crew. In 2011 the crew comprised a mix of specialist scientists, professional staff, volunteers, and students. All of these people worked extra hours without complaint, making it truly a team effort. Harrison Simfukwe, Oris Malijani, and Malani Chinula represented Malawi Antiquities from beginning to end, contributing a monumental four months of near-continuous fieldwork that would not have been possible without their enthusiasm and leadership. Particular thanks should go to the hard-working students from the University of Queensland, the University of Sydney, Leiden University, the Catholic University of Malawi, Arizona State University, and the George Washington University who paid fees or gave freely of their time for the opportunity to join our team. The support of the local community was tremendous, particularly from Chief Mwanganda. We were extremely pleased to have been able to work with a local field crew from Karonga who showed dedication, work ethic, and enthusiasm above and beyond the call of duty. The fieldwork was supported by National Geographic-Waitt grant 115-10 to Thompson, and by Australian Research Council Discovery grant DP110101305 to Thompson, Arrowsmith, and Cohen. Thomas Jones gave generously of his own resources to fund the transport and analysis of samples obtained during the 2010 fieldwork, some of which are reported here. Jessica Thompson undertook several weeks of archaeological consultancy and redirected her earnings to fund the project. She thanks Jacob Davis and Bryan Stevenson for their assistance and patience with her absences and late nights. Lilian Welling-Steffens was a logistical miracle-worker who kept the project running as smoothly as possible during many tight circumstances. Carly Jordin, the long-suffering finance officer at UQ, is to be thanked for all the extra work she put into the accounting for this project. We are very grateful to Jim and Robyn Nottingham at Paladin Energy, Ltd.:Paladin Africa for providing logistical advice and assisting us with the storage of our field equipment. Field recording forms and protocols were based on a system developed by Curtis Marean and the SACP4 team. Many of the analyses presented here were provided by specialists or students who contributed their time and expertise to help build the project, but who did not claim authorship of this report. These include contributions of lithic analysis (Dr. Alex Mackay), sediment analysis (Amanda Greaves), GIS digitisation (Alison Moroney), lithic illustration (Victor de Moor), OSL analysis (Prof. Steven Forman) and ochre collection (Andrew Zipkin).

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VIII. APPENDICES

Appendix I: MEMSAP 2011 Paperwork and Recording Protocols

Opening a Context

1. Get a **Context Recording Form**
2. Place a **Lot Number Sticker** on the back of the Context Form.
3. Record the Lot Number on the front of the Context Form.
4. Record the new Context on the **Lot Number Form**.
5. Take a plan **Photo** of your square with a scale and north arrow.
6. Record your **Photo Series Number** on the Context Form.
7. Record your Photo Series Number on the **Photography Form**.
8. Get a **Sample Sticker** from your trench leader.
9. Record the Lot Number on the Sample Sticker, and place the sticker in a small plastic bag.
10. Record the Sample Number on the Context Form.
11. Record sample number on the **Sample Form**.
12. Place the Sample Sticker in the bag that will contain the bulk sample.
13. Take a bulk sample from the designated area. Usually this will be the centre of the context.
14. Map the location of your bulk sample using the Total Station.
15. Record your **Opening Elevations**, keeping in mind that this may differ from the closing elevations of the previous context. Indicate with an "x" the approximate location of each elevation shot on the Plan Sketch at the back.
16. Map the **Opening Outline** on the plan of the Context Form.
17. Record the **Geological Characteristics** of the context such as colour, texture, moisture etc.
18. Ensure that your Munsell Colour is taken on dry sediment in the sunlight.
19. Make observations at this stage and during excavation of the Interpretation of the context you are excavating. Use the Explanation area to expand on your Interpretation.

FILL OUT AS MUCH INFORMATION AS POSSIBLE PRIOR TO EXCAVATING!

While Excavating

1. Continue making observations of the Interpretation of the context you are excavating.
2. Record the contents of the context, ie artefacts, bones, etc.
3. Tally your bucket count as you fill buckets.

Closing a Context

1. On the back of the form, draw a representation of the vertical **Relationships between Contexts**.
2. Record your **Closing Elevations** on the Context Form.
3. Map the **Closing Outline** on the Plan Sketch if it differs from the Opening Outline.
4. Record your **Final Bucket Count** and calculate the total using the formula 1 bucket =14 ltrs (measure to the bottom of the rings of the bucket).
5. Record the Final Bucket Count on the Lot Form.
6. Use a nail to attach a **Section Tag** to the wall of the Excavation Area indicating the location of the context and/or the corner of the square at the base of the context.
7. Check and double check that all sections have been filled out on your Context Recording Form. When you are satisfied that it is complete, take it to your trench supervisor for checking then get the Excavation Area supervisor to **Sign Off** on the form.
8. File the completed, checked, and signed form.
9. Begin again at Step One of Opening a Context.

As all forms are completed they should be scanned as pdf files and emailed!

Appendix II: MEMSAP Total Station Protocols

Setup over an UNKNOWN POINT (e.g. Resection)

ESTABLISH OCCUPY (START) POINT; i.e. TELL TOTAL STATION WHERE IT IS

1. Position the tripod in a location from which you can clearly see three control points.
2. Put the total station on the tripod platform (use two hands and don't screw it on too tightly at the base!!)
3. Level the instrument at gross level (using bubble on instrument).
4. Turn on machine and double click Survey Pro.
5. Fine level the instrument at all six positions in the horizontal plane using the digital bubble level in Survey Pro (which is the default opening screen).
6. Hit X in the far right corner to leave the digital bubble.
7. You should be now in the Quick Shot menu. Click the open folder icon and select NEW.
8. Create a new file, using the protocol YEAR MONTH (Spelled out) and TWO DIGIT DAY –SSID (Silver Barcode sticker) e.g. 2011Sept15-555
9. Tick the box USE OR IMPORT CONTROL FILE. Click NEXT.
10. Use external control file, browse to the file location SURVEY PRO JOBS/CHA-II-CONTROL2011.job. Click NEXT.
11. Keep defaults for new job, e.g. North Azimuth, Meters, Degrees. Click the box ADJUST FOR EARTH CURVATURE. Click NEXT.
12. Enter first point, point name will be 1. (Accept Defaults)
13. You should now be back in the Quick Shot menu. Cancel out of that using the green X.
14. Go to JOB → SETTINGS (2A) Click to right until you get to FILES. Browse for a feature code file called MEMSAP Feature File – Excavation and Survey 20 July 2011 and tick the green check mark in the upper right hand corner.
15. Go to FILE→ BACKUP/RESTORE (1F). Select NEW ARCHIVE and in the description type in the same name as the Job file (e.g. eg 2011Sept15-555). Hit the green check mark in the upper right of the box. Click NEXT. Click BACKUP.
16. Go to SURVEY →STATION SETUP (3A).
17. Set up type is over an UNKNOWN POINT/RESECTION.
18. Store point will be 1 (or the next foresight/shot number if this is not the first set up of the day).
19. Keep 2D survey unticked.
20. Shots per Resect Point should be 1 and Sequence should be Direct Only (from drop down menu).
21. The height of the instrument (HI) can be any value, but use 0 for consistency.
22. Click NEXT.
23. Agree to Overwrite Existing for point number 1. **Only** ever do this for point number 1 on the first setup of the day.
24. From the drop down box by Resect Point select the first control point for which you are aiming. Ensure Distance and Angle is selected in the Option box.
25. Set up your rod making sure that **the prism constant is set to 0** (physically check where the prism is screwed into its housing).
26. If using the large pole measure the actual height of the rod with a measuring tape and note if it is different from the reading on the range pole.

27. Enter the height of the rod in box HR.
28. Ensure Prism Icon is visible to the right.
29. Click OBSERVE. Target the prism and click TAKE SHOT from the following menu.
30. Values for the shot will appear. Send the rod to the next control point. Adjust rod height if necessary.
31. Repeat steps 29 and 30 until you have collected values for three points.
32. Click NEXT.
33. Record the store point and click ATTRIBUTES. Make the box next to Recently Used say "Start" from the drop down menu. Enter the Start Number in the box where indicated (e.g. 1 if it is the first one of the day).

SET BACKSIGHT; ie: TELL TOTAL STATION WHAT ANGLE IT IS FACING

34. Note in your notebook your current Setup (e.g. "Setup 1"), the control point you are backsighting to (e.g. "BS = CP64"), and the height of the rod (e.g. "HR = 1.3 m").
35. Click NEXT.
36. Select BS POINT from the drop down menu.
37. Select the backsight point you will be using from the list directly to the right.
38. Choose ROVING TARGET from the drop down menu.
39. Set up your rod making sure that **the prism constant is set to 0** (physically check where the prism is screwed into its housing and make sure a "0" is inscribed on the side of the housing facing the total station).
40. Enter the height of the rod in box HR.
41. Ensure Prism Icon is visible to the right.
42. If using the large pole measure the actual height of the rod with a measuring tape and note if it is different from the reading on the range pole.
43. Press READ CIRCLE. Press SEND CIRCLE. Select "Take New" from the dialogue box. Press NEXT.

CHECK SETUP

44. Select BY POINT in order to check your backsight and select point you are checking from menu below
45. Ensure rod height has not changed and press CHECK.
46. Check that the delta values (rms values) are within 3 cm in each direction, preferably within 1 cm if possible. If they are not, re-do the setup. Click FINISH.
47. Go to SURVEY →TRAVERSE/SIDE SHOT.
48. Make Description blank. Ensure your rod height is correct.
49. Press SIDE SHOT and click ATTRIBUTES. Select CHECK from the drop down menu and select the CP CHECK as the type and the point you are checking. (This is NOT your occupy point).
50. Tick the green check box. A sound will be made that is like a camera clicking. This is the sound of the data being entered – not the shot being taken.
51. Go to Results tab and check it against what is written down in your sheet of known co-ordiantes. Ensure that the error in any direction does not exceed 3 cm in any one direction, aiming for an accuracy of 1 cm. If they are not, re-do the setup.

If your setup does not fall within the acceptable range, check all your measurements, ie: if elevation is off check the rod height or if the XY is off, check you are level and that you selected the correct control points.

After approximately every 20 points, go to FILE→ BACKUP/RESTORE (1F), <u>ensure that you are backing up the correct day</u>, and click NEXT→BACKUP

Setup over a KNOWN POINT (e.g. Control Point)

ESTABLISH OCCUPY (START) POINT; i.e. TELL TOTAL STATION WHERE IT IS

52. Position the tripod directly over the control point nail.
53. Put the total station on the tripod platform (use two hands and don't screw it on too tightly at the base!!)
54. Ensure the circle in the sight is directly over the nail.
55. Level the instrument at gross level (using bubble on instrument).
56. Ensure the sight is still directly over the nail.
57. Turn on machine and double click Survey Pro.
58. Fine level the instrument at all six positions in the horizontal plane using the digital bubble level in Survey Pro (which is the default opening screen).
59. Ensure the sight is still directly over the nail.
60. Hit X in the far right corner to leave the digital bubble.
61. You should be now in the Quick Shot menu. Click the open folder icon and select NEW.
62. Create a new file, using the protocol YEAR MONTH (Spelled out) and TWO DIGIT DAY –SSID (Barcode sticker) e.g. 2011Sept15-555.
63. Tick the box USE OR IMPORT CONTROL FILE. Click NEXT.
64. Use external control file, browse to the file location SURVEY PRO JOBS/CHA-II-CONTROL2011.job. Click NEXT.
65. Keep defaults for new job e g North Azimuth, Meters, Degrees. Click the box ADJUST FOR EARTH CURVATURE. Click NEXT.
66. Enter first point, point name will be 1. (Accept Defaults)
67. You should be now be back in the Quick Shot menu. Cancel out of that using the green X.
68. Go to JOB → SETTINGS (2A) Click to right until you get to FILES. Browse for a feature code file called MEMSAP Feature File – Excavation and Survey 20 July 2011 and tick the green check mark in the upper right hand corner.
69. Go to FILE→ BACKUP/RESTORE (1F). Select NEW ARCHIVE and in the description type in the same name as the Job file (e.g. eg 2011Sept15-555). Hit the green check mark in the upper right of the box. Click NEXT. Click BACKUP.
70. Go to SURVEY →STATION SETUP (3A).
71. Set up type is over a KNOWN POINT.
72. Go to the drop down menu near Occupy Point, select from the list – and choose the control point over which you have set up.
73. Keep 2D survey unticked.
74. Enter height of instrument by measuring with a stiff tape measure from the cross on the side of the instrument to the ground – keep the tape straight and not wrapped around anything. It must be vertical.

SET BACKSIGHT; ie: TELL TOTAL STATION WHAT ANGLE IT IS FACING

75. Note in your notebook your Setup (e.g. "Setup 1"), current control point (e.g. "Setup over CP66"), the control point you are backsighting to (e.g. "BS = CP64"), the height of the instrument (e.g. "HI = 5.476 m") and the height of the rod (e.g. "HR = 1.3 m").
76. Click NEXT.
77. Select BS POINT from the drop down menu.
78. Select the backsight point you will be using from the list directly to the right.
79. Choose ROVING TARGET from the drop down menu.
80. Set up your rod making sure that **the prism constant is set to 0** (physically check where the prism is screwed into its housing and ensure that a "0" is inscribed on the aspect of the housing facing the total station).
81. If using the large pole measure the actual height of the rod with a measuring tape and note if it is different from the reading on the range pole.
82. Enter the height of the rod in box HR.
83. Ensure Prism Icon is visible to the right.
84. Press READ CIRCLE.
85. Press SEND CIRCLE.
86. Press NEXT.

CHECK SETUP

87. Select BY POINT in order to check your backsight and select point you are checking from menu below
88. Ensure rod height has not changed and press CHECK.
89. Check that the delta values (rms values) are within 3 cm in any direction (E, N, elev), preferably within 1 cm if possible. If they are not, re-do the setup. Click FINISH.
90. Go to SURVEY →TRAVERSE/ SIDE SHOT.
91. Make Description field blank. Ensure your rod height is correct.
92. Press SIDE SHOT and click ATTRIBUTES. Select CHECK from the drop down menu and select the CP CHECK as the type and the point you are checking. (This is NOT your occupy point).
93. Tick the green check box. A sound will be made that is like a camera clicking. This is the sound of the data being recorded – not the shot being taken.
94. Go to Results tab and check it against what is written down in your sheet of known co-ordinates. Ensure that the error in any direction does not exceed 3 cm in any direction, preferably within 1 cm if possible. If they are not, re-do the setup.

If your setup does not fall within the acceptable range, check all your measurements; ie:

If elevation is off, check the rod height and height of the instrument

If the XY is off, check you are level and over the nail in your control point. Check that the tripod has not been kicked

After approximately every 20 points, go to FILE→ BACKUP/RESTORE (1F), <u>ensure that you are backing up the correct day</u>, and click NEXT→BACKUP

Taking and Editing Points

STAKING OUT POINTS (USING THE TOTAL STATION TO FIND A POINT)

95. Setup your total station and daily files.

If you DO NOT already have a file with the coordinates you want to stake, do the following:

96. Go to JOB→EDIT POINTS (2B).
97. Click "Insert Point".
98. Under the "General" tab, name the new point you wish to stake using the last three digits of the Easting and Northing. For example, E597806 N8899432 will be named E806N432.
99. Click the "Location" tab and enter the full coordinates for the Easting and Northing. Elevation can be anything, but it is easiest to process later if you make it more or less the same elevation at which you are already working, for example around 535m in the Chaminade Area.
100. Hit the green tick and you will hear a whistle indicating the point has been entered.

If you ALREADY HAVE a file with the coordinates you want to stake, skip the above and do the following:

101. Go to FILE→IMPORT(1C).
102. Browse to the Survey Pro Job file called CHA-II-STAKEOUT. Press the green check mark in the upper right hand corner.
103. Accept the Layer "Points" and press the green check. You have now imported a series of points named according to the last three digits of the square corner coordinates.
104. Go to STAKEOUT→STAKE POINTS (4A).
105. Drop down next to "Design Point" and select "choose from list".
106. Select the point you wish to stake and either double click or hit the green check mark.
107. Increment will be "1" and ensure your rod height (HR) is entered correctly.
108. Press "Solve".
109. The next menu will show a picture of the total station pointing at a target and a reading in degrees with an arrow to the left of it. If you are far from the angle you need to achieve the arrow will be red. Move the total station in the horizontal plane only until you get closer to making the angle read 0°00'00". As you move closer the arrow will go yellow and eventually green.
110. Stop once you are within 10" of the angle and press "Stake".
111. Sight through the eyepiece and direct the person holding the rod to move the prism from left and right until it is in the centre of the target.
112. **IMPORTANT**: At this point you **DO NOT** move the total station anymore in the horizontal plane. You can move the sight up and down to find the prism but the point is to make the prism come to you – the opposite of what you normally do!
113. Once the prism is in the target press "Shot".
114. A result will appear in the upper right saying how much the person should move toward or away from the total station. For example, if the result says to move "FORWARD: 0.023" you should instruct the person to move in a direct line toward the total station about 2 cm. If it

says "BACK: 0.345" you should instruct the person to move in a direct line away from the total station about 34 cm.

115. Place the nail in the ground when the results are within 0.01 m (or 1 cm) in both directions.
116. Go to "Stake Next" and look at the coordinates for the next point. You may need to drop down the menu and select the new point from the list, depending on what you wish to stake next.

The elevation does not matter when you are staking x, y coordinate data!

Your field notebook should contain a map to instruct you on which point is next in line.

TAKING SIDESHOTS (USING THE TOTAL STATION TO FIND COORDINATES FOR A POINT)

1. Setup your total station and daily files.
2. Click SURVEY→TRAVERSE/SIDESHOT (3C).
3. Ensure your foresight is the next point number you will be shooting. For example, if you have already shot 5 shots in a day the foresight number will be 6.
4. Ensure the "Description" field is blank (the default will be "SS", so delete this).
5. Ensure you have the correct rod height entered in the "HR" box and that the prism target is selected if you are shooting to a prism.
6. Select the "Attributes…" box (if it is hidden behind the keypad drag the keypad down to reveal it).
7. Drop down to the type of shot you are taking. Common shot types and their protocols are listed below:

a. **Plotted Find:** Enter the Lot Number in the LotNumber box and in the Aspect1 box enter the Area-Square-Context; for example II-A4-3.

b. **Bulk Sample:** Enter the Lot Number in the LotNumber box and in the Aspect1 box enter the Area-Square-Context; for example II-A4-3.

c. **Context:** Enter the Lot Number in the LotNumber box and in the Ex Area-Square box enter the Area-Square; for example II-A4; then enter the Context Number in the Context Number box. Under Aspect3 select "Opening Outline" if you are opening a new context and taking outline shots and select "Open" if you are opening a new context and taking a centre shot or interior topography shot. You should have a **minimum** of 5 shots for each context you open. Closing a context is the same but use the terms "Closing Outline" and "Close". Note that mapping special features such as disturbances will also occur in the Context menu.

d. **Plotted Find – Rock:** Enter the Lot Number in the LotNumber box and in the Aspect1 box enter the Area-Square-Context; for example II-A4-3. Then under Aspect3 select the aspect you are mapping. This will be used for **non-artefactual stones** you wish to keep and assign a plotted find number to.

e. **Check:** Enter the type of thing you are checking, for example a Control Point, and then if applicable enter the Control Point number in the CP Number box below.

f. **Bad Shot:** Will be used for any shot that must be re-taken, and no other attributes or description will be assigned.

8. Once you have entered the attributes hit the green check box in the upper right hand corner.

9. For Plotted Finds and Bulk Samples **ONLY** then highlight the "Description" box and enter the sample number or plotted find number. Plotted find numbers **should be scanned** to avoid duplication.

Sometimes the scanner will only scan the first few digits. In this case highlight the ENTIRE DESCRIPTION FIELD and request a new scan to replace the partial scan.

You can view your day's data in the "Map" tab from the Traverse/Sideshot screen. You can view the coordinates for the point you just took from the same screen under the "Result" tab.

EDITING POINTS (IN CASE YOU ACCIDENTALLY RECORDED A POINT INCORRECTLY)

1. Go to JOB→EDIT POINTS (2B).
2. Double click the point you wish to edit.
3. Change the attributes and/or location as necessary under the "General" and "Location" tabs, respectively.
4. Press the green tick mark at the upper right hand corner to exit the screen and save your edits.

Never delete any points!!

If you recorded a point that has no meaning simply make it a "Bad Shot".