ANALYSES OF
SLAG, IRON, CERAMICS AND ANIMAL BONES
FROM EXCAVATIONS IN MOZAMBIQUE

Eduardo Mondlane University, Mozambique • Central Board of National Antiquities, Sweden
Analyses of slag, iron, ceramics and animal bones from excavations in Mozambique

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Preface

During the last decade abundant quantities of archaeological finds have been recovered from excavations in Mozambique. Large amounts of this material have been analyzed with typological methods, while others for instance slag and osteological samples must be investigated more technically. As the results of these analyses are of special interest the editors of this series consider it important to present them as a whole. Accordingly in this issue of Studies in African Archaeology, examples are presented of analyses dealing with osteology, the chemical constituents of slag, the mineralogy of ceramics, conservation and computer simulation. These results have been gathered together in order to give scientists and others interested the chance to see how these groups of evidence have been treated in relation to the whole. The results of the analyses presented here will of course also be used in the separate reports.

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Prefácio

Ao longo dos últimos dez anos abundantes quantidades de espólios arqueológicos escavados em Moçambique têm vindo a ser processados. Considerável parte dos espólios têm sido analisados de acordo com usuais métodos de rotina envolvendo por exemplo o recurso a tipologias. Contudo, diversos materiais de natureza específica como escórias e ossos, exigem a aplicação de outros princípios de análise técnica ou científica. Tendo isto em conta, os editores da série «Studies in African Archaeology» acharam recomendável apresentar a última categoria de análises num volume separado.

Neste número são apresentados estudos efectuados com base no processamento informatizado de dados arqueológicos, análise de escórias, osteologia, mineraogia de argilas e conservação de espólios arqueológicos. A descrição destes permitirá melhor ou ao leitor, leigo ou especialista, uma melhor apreciação das metodologias empregues em relação ao conjunto da pesquisa arqueológica. Os resultados aqui apresentados são obviamente usados nos relatórios respeitantes à descrição e interpretação das estações arqueológicas de onde os respectivos materiais aqui referidos são provenientes.

David Damell
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Simulated slag distributions from Zitundo, 2632 D b 9

PAUL J. J. SINCLAIR

INTRODUCTION

At the request of Mr J. M. Morais of the department of Archaeology Eduardo Mondlane University, Maputo, a spatial analysis of the distribution of slag samples from Zitundo was carried out.

BACKGROUND

Zitundo is an early iron age settlement of the Matola tradition in Southern Mozambique. It was reported by P. I. Lindqvist in 1983. Although other Matola sites are known from South Africa, Swaziland, S. Mozambique and Zimbabwe, little is known of the economy of this initial early iron age phase. The site of Zitundo is especially important owing to an abundance of evidence relating to iron smelting activities.

The occupation of the site is clearly dated by five radiocarbon dates. Two of these (St 8909 175±105 AD and St 8911 190±105 AD) indicate an initial occupation of the site in the first to third century AD (Morais 1984:118). A third date (St 8912 265±105 AD) is also consistent with this view. Two other dates (St 8913 375±105 AD and St 8910 515±105 AD) the first from the middle occupation layers and the second away from the sample area provide an indication of the chronology for the later period of occupation. As Zitundo represents the earliest known occurrence of a major smelting site in Southern Africa, considerable interest is therefore attached to the excavations. These have been carried out by J. M. Morais, members of the Riksantikvarieämbetet team (L. Jonsson and P. I. Lindqvist), the present author and R. Duarte of Eduardo Mondlane University.

Details of the excavations are to be described in the site report by J. M. Morais (forthcoming). Briefly, previous work has entailed excavating a stratified sample at the 1% level of c. 2 000 square metre area of the living site. Excavation methods used were similar to those at Manyikeni (Morais and Sinclair 1980). At Zitundo, 105 samples of slag have been recovered from the occupation levels in 22 of the excavated trenches. The 105 samples were
grouped together by trench (see figure 1) as the present phase of analysis is operating under the assumption of a single continuous occupation of the site. This report will emphasize the methodology utilized in the spatial analysis of these slag samples.

A recent shape and decoration motif analysis of the pottery from Zitundo carried out by the author has confirmed the likelihood of two Early Iron Age occupation phases at the site (Morais 1984: 118–119). The earlier assemblage is similar to the material from Matola itself and the Eduardo Mondlane University campus. The later, although containing single line incision near the rims of vessels also contains some examples of cross hatching and alternating bands of incision. These latter motifs are known from Tembe near Maputo and also some of the early iron age sites from the Xai Xai and Bilene coastal areas. Judging from the situation at Zitundo it seems likely that the two ceramic collections are closely related, the typical Matola material being antecedant to the assemblage with cross hatching.

At Zitundo the question naturally arises as to whether the iron smelting debris belongs to either or both of the occupation phases. Judging from the overall trench stratigraphy there is little doubt that iron smelting debris occurred in both occupation levels. All five of the carbon dates were taken from carbon in close association with slag.

The distribution of the trenches in the stratified random sample provides a good coverage of the area being investigated. It was thought worthwhile to at-
of analysis is of the site. Analysis of Zitundo Iron Age assemblage at the rims of ting bands of to and also areas. `slef provides a `ichael to at-

tempt to simulate a best fit contour map onto the values of the slag. The aim of this was twofold, first in order to assess whether or not the slag distribution came from one furnace and secondly to predict the most likely situation of smelting activities.

Surface II, a spatial analysis package produced by Sampson of the Kansas Geological Survey was used for this analysis and the programmes were run on the IBM mainframe computer in Uppsala University Centre. More aspects of Surface II are described in the programme handbook (Sampson 1978) and further archaeological applications are discussed in (Zubrow and Harbaugh 1977).

Given the large variation in weights of the slag samples it was decided to use the square root of the values. This was only done in order to facilitate fitting the range of variation into the contouring limits of the programme.

The GRID option of Surface II (Sampson 1978: 91) was used. This entailed requesting the calculation of the values of an even grid estimated from the values of slag from the random sample of trenches. Grid values are calculated using a distance weighted average of the 8 nearest neighbours to the point being estimated. The weighting function is used in order for the influence of sample data points to decline with increasing distance from the point being estimated.

Results of the experiment are shown in figure 2. The contour map was produced on a matrix printer attached to an IBM PC microcomputer.
The two questions asked at the beginning of the experiment appear to have been answered. From the contour map only one peak is apparent and this is very clearly defined. Given the very high value for slag from trench 8 it could be argued that this value affects all others disproportionately. However the use of the square root transformation and the weighting factor which is distance dependent counts against this last interpretation and the contour map probably presents an accurate picture of the slag variation in the ground on the basis of a 1% stratified sample excavated from the area.

The slag samples do not appear to have been derived from more than one slag pile and we appear to have only one source of slag in this part of the site. These results allow us to predict the most likely areas of concentration of slag and this will be useful when deciding future excavation strategies. The method provides a useful tool in predicting sub surface locations from excavated samples and if present indications are confirmed with further work the method holds some promise for helping to reduce excavation costs.

BIBLIOGRAPHY


Zitundo contém extensos vestígios de fundição de ferro que remontam ao período entre os séculos 1 e 3 AD., os mais antigos até agora registados na África Austral. O primeiro período de ocupação representado por duas datações (175±105 e 190±105) indicam uma estreita afinidade com a tradição Matola. O período subsequente é representado por duas datações adicionais (375±105 e 515±105), e documenta a evolução dos padrões de oficina para tipos semelhantes aos das estações arqueológicas de Tembe, Xai-Xai e Bilene, essencialmente caracterizados por uma decoração onde predominam bandas alternadas de incisão. Estas duas tradições estão possivelmente relacionadas, sendo contudo a da Matola cronologicamente a mais antiga. As evidências de fundição de ferro estão associadas aos dois períodos acima referidos, já que todas as amostras de radiocarbono foram processadas a partir de carvão recolhido em contacto com escória de ferro.

As escavações compreenderam uma amostragem estratigráfica e aleatória de 1% de cerca de 2.000 m² da área englobada no levantamento, tendo sido aplicados métodos anteriormente testados no Zimbabwe de Manyikeni (Morais e Sinclair 1980). Em Zitundo 105 amostras de escória foram recolhidos em 22 das sanjas escavadas. Partindo do pressuposto que a estação documenta uma ocupação contínua no tempo, as 105 amostras foram agrupadas por sanja. Os objectivos da simulação espacial destinam-se a avaliar se a escória é proveniente de um ou mais fornos de fundição, bem como poder prever a sua respectiva localização. O programa "Surface II" e a opção "Grid" foram aplicados, e os dados processados por um computador IBM. Tendo em conta consideráveis diferenças quantitativas das amostras, optou-se pela aplicação de raízes quadradas aos valores inicialmente obtidos. Os valores produzidos foram además calculados na base de uma rede uniformemente distribuída, bem como basedas nas quantidades de escória provenientes das sanjas escavadas.

Os resultados desta aplicação são apresentados na figura 2. O mapa foi produzido a partir de uma impressora matricial apoiada num microcomputador IBM-PC.

Os resultados parecem ser consequentes, tendo em conta que contempla somente uma amostragem estratificada de 1%. A escória de ferro parece derivar de uma única fonte, constituindo assim esta informação uma indicação útil no sentido de prever as áreas onde uma maior concentração de escórias deverão ocorrer, e consequentemente sugerir as estratégias de escavação a serem posteriormente aplicadas. Adicionalmente, e se os presentes pressupostos forem confirmados, o método oferece a vantagem de poder reduzir consideravelmente os meios financeiros investidos em escavações arqueológicas.
Analysis of iron reduction slag from Zitundo

MILLE TÖRNBLOM

Morton and Wingrove (1969) have drawn up a method to determine the compositions and the fusion temperatures of slags formed in primitive reduction furnaces. According to this method the slags are chemically analysed and from the results the original compositions are determined. It is possible to get some information about the process of reduction in the furnace.

SAMPLES

Eight samples of slag have been submitted by J. M. Morais from the site Zitundo in the province of Maputo, where a joint team of Riksantikvarieämbetet and Eduardo Mondlane University personnel have been conducting a programme of excavation.

Sample 1 is a dark grey, rounded to rather flat piece of slag. The top face shows a solidified sticky slag, blue-grey and metal lustrous in colour. The size is 10.0×7.5 cm, 1.0 cm in thickness. Weight 274.4 g.

Sample 2 consists of 17 fragments of different sizes, two of which are relatively large. One is 4.0×3.5×2.0 cm with an even thickness and is porous and grey-brown in colour. The other is 4.0×3.0×1.5 cm also with an even thickness. The top face has a sticky and metallic appearance. The other fragments are rather small, porous and grey-brown in colour. Total weight 180.2 g.

Sample 3 consists of 11 fragments of different thickness. Most of them are porous and grey-brown in colour. Three small pieces have a blue grey surface with metallic lustre. Total weight 16.0 g.

Sample 4 consists of 51 small fragments of varying thickness. The majority are grey-brown in colour and porous. Three of them, however, show a sticky top face and are blue-grey in colour. Total weight 29.2 g.
Sample 5 consists of 42 slag fragments of varying thickness grey-brown in colour and porous. Total weight 33.8 g.

Sample 6 consists of 6 fragments of different size and thickness. Some of the smallest pieces are blue-grey in colour with a sticky lustrous metallic surface. Remaining fragments are grey-brown in colour and with a porous structure. Total weight 28.1 g.

Sample 7 consists of 35 small fragments most of which are grey-brown in colour and porous. Two of them have a lustrous metallic surface and are blue in colour. The upper surface shows a sticky slag. Total weight 24.8 g.

Sample 8 consists of 32 small fragments, rather even in size, 0.5x1.0x0.5 cm. Total weight 212.9 g.

METHOD OF ANALYSIS

In order to calculate the composition of the slag when it was formed in the furnace, the following compounds must be determined: Fe\text{tot}, Fe\text{net}, FeO, Fe\text{2}O\text{3}, SiO\text{2}, Al\text{2}O\text{3}, CaO, MnO, P\text{2}O\text{5}, as well as the loss on ignition.

Fe\text{tot}, Fe\text{net} and Fe\text{2}+ are determined by titrimetric analysis. FeO and Fe\text{2}O\text{3} are calculated from the above mentioned Fe-analysis.

SiO\text{2}, CaO, MgO, Al\text{2}O\text{3} and NiO are determined by atomic absorption spectrometry using a Perkin-Elmer model 460 instrument. P\text{2}O\text{5} has been determined by spectrophotometry.
RESULTS

The results from the eight analysed samples are presented in table I. In table II are listed the three phases that are necessary to know before determining the temperature in the furnace during the process. Anorthite is a phase with the composition CaO\( \times 2 \)Al\(_2\)O\(_3\)\( \times 2 \)SiO\(_2\) and can be calculated from the results in table I.

<table>
<thead>
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<th>Table I</th>
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<td>Results of analysis</td>
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<td>Fe(_{2+})</td>
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<td>P(_2)O(_5)</td>
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<td>Loss on ignition</td>
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<table>
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<th>Table II</th>
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<td>Calculated slag composition and fusion temperatures</td>
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In calculating the FeO content in the slag it has been assumed that all the Fe₂O₃ content has been formed by oxidation of the FeO from the reduction process, as Morton and Wingrove presume. Other possible explanations of the Fe₂O₃ content are that it either was formed in the furnace or that it was added as a fluxing agent, all of these possibilities have been discussed by Morton and Wingrove.

Serning et al (1982) have another explanation. In the slags from Vinarhyttan they have found that the Fe₂O₃ has been formed by oxidation of the metallic iron inclusions and thus does not belong to the slag at all. In this investigation, however, it has been assumed, as mentioned above, that all Fe₂O₃ has been formed from FeO after tapping off the slag.

Serning et al have compared some investigated furnaces from iron production sites. One of them, Sunnanäng, was in use c. 900–1000 AD, and of a direct reduction type. The other three were early blast furnaces: Vinarhyttan, 1200–1300, Lapphyttan 1200–1300 and Harhyttan 1700.

The diagram shows the connection between the total iron content and the SiO₂ content. From the diagram it is obvious that the relation between these two slag components is of great importance, and related to the furnace type. However the figures for the Mozambique slags do not fit into this diagram. The mean value for the Fe tot content is 40.87%, and for the SiO₂ content it is 40.33%. The two values are almost the same. From the type and the fusion temperatures of the slag it is however obvious that it must be the result of a direct reduction furnace, probably with a comparatively good efficiency, as indicated by the rather low content of iron in the slag.
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RESUMO

Oito amostras de escória de ferro provenientes da estação arqueológica do Zitundo foram analisadas. O método de análise incluiu cálculos diversos da composição da escória quando da sua formação no forno, bem como das temperaturas de fusão ali atingidas.

Os resultados são apresentados em quadro, assim como comparados com dados existentes para processos de redução analisados na Suécia, com os quais aqueles se não identificam.

O autor conclui ser a escória proveniente do Zitundo produto de um forno de redução directa de eficiente extração, a julgar pelo reduzido conteúdo de ferro presente na escória.
The conservation of iron objects from Manyikeni

CAROLA BOHM

Three wrought iron objects excavated from the site of Manyikeni in South-central Mozambique were handed in to the Technical Institute at the Central Board of National Antiquities for conservation. It was understood that this commission was meant to be something of an experiment. The costs and results of treatment of this limited material would give an indication as to whether it was practicable to include a certain amount of conservation in the Swedish-Mozambiquian co-operation program. Regardless of how the demands for conservation in Mozambique are met in the future, it is imperative that they be recognized. Clearly, the need will be ever accelerating as archaeological activity increases.

The objects in question were (figs. 1 and 2):

1) a spear-head with slightly bent tang, length: 19.6 cm, max. breadth: 3.5 cm.

2) a gong, max. length: 23.5 cm, max. breadth: 10.5 cm. The top end is shaped into a rounded backward loop. Along the sides, all the way up towards the top, the edge is sharply doubled. It may be assumed that the object has been made in two pieces - the loop-end springing out into two arms, which have then been hammered on along the edges of the concave "blade". Or, alternatively, the "blade" may have been hammered out widely, the edges bent over and hammered down, but the former assumption appears more convincing. The object was damaged at the broad end, but the basic shape was quite clear.

The gong is a particularly interesting object in that it is a representation of power that lends high prestige to its owner. It is unique also, since very few have been found in this area.

3) a very large loop, length: 27.5 cm, breadth: 5.5 cm, cross-section of iron bar: 11×12 mm. After cleaning, the welded joint could be clearly discerned (see fig. 2 bottom, left). A 2.5 cm long section had been sawn off the loop for metallographical examination. A comment by Mille Törnblom on the analytical report is included at the end of this article.

All three artifacts were found in middens, the loop and the gong in relatively close proximity to one another. In the absence of a clearly defined context, a preliminary dating (based on C14-analyses) indicates late 15th to mid 16th century A.D.

The excavation site is located in a dry area of the country, a circumstance which may be expected to be favourable for preservation of metallic objects.
CONDITION OF THE OBJECTS

The objects were seen to be in a relatively good state of preservation, particularly in the case of the loop the corrosion was fairly superficial, leaving a substantial metal core.

The surface had, however, been attacked, causing eruptions and underlying craters in the remaining metal. There were no clear signs of any “original surface” retained in the corrosion layers, which can sometimes be the case.

The extent of the corrosion on the gong and the spear-head was determined by radiography and it could be seen that no metal remained at the edges. The contours were therefore only indicated in the corrosion layers.

It was also noted that there was very little sign of active corrosion having been initiated after excavation, e.g. in the form of spalling surfaces or rust globules.

The predominant corrosion product was a dense, black mineral, presumably magnetite, closely attached to the metallic surface. Only locally on the gong and the loop were there patches of reddish rust in conjunction with flaking corrosion layers. Superficially the corrosion products were mixed with sand particles and soil.
The spear-head and the gong were cleaned by means of an air-brasive unit with aluminium oxide powder. The unit is fitted with a very fine nozzle, diam. 0.45 mm, that allows for excellent precision when removing soil remains and corrosion products. The objects were cleaned to where only a thin, smooth corrosion layer remained above the metal core or, where the corrosion was extensive, to a point where the original shape was retained. Particularly thick and hard corrosion lumps were abraded with an electric hand-drill fitted with a carborundum head. In the case of the loop, being generally sturdier and in a better state of preservation, a somewhat larger air-brasive unit that emits a fine powder of plastic pellets, was employed.

The objects were then treated in an alkaline sulphite solution (0.5M sodium sulphite + 0.5M sodium hydroxide) to remove salts, above all chlorides, which in combination with high relative humidity can initiate a renewed corrosion process. The method was devised for iron artifacts excavated from the sea, where the salt problem is extreme, but has been found to work well also for iron from land sites (Rinuy & Schweizer 1982).

The objects were treated at 60°C for a period of 12 weeks, during which the
solution was changed as necessary and the chloride levels were regularly tested by titration. The process was terminated when the chloride level had reached 130 ppm, whereafter the objects were treated briefly in a saturated barium hydroxide solution to inactivate any remaining sulphites, then rinsed in de-ionized water and dried.

They were then given a protective coating of wax after having been thoroughly dried in a vacuum oven at 80°C. They were allowed to soak in molten microcrystalline wax at 115°C for approx. 48 hours. Excess wax was finally removed with a hot-air blower. This wax (Shell Microwax HMP) is very hard and flexible and has a so-called drop point of 91°C. It should therefore be able to stand up well also in the hot climate of Mozambique.

Note: Information about the objects and dating and generally about the excavation site has been kindly provided by Paul Sinclair.

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RESUMO

O artigo aborda um primeiro passo para avaliação dos requisitos técnicos e custos envolvidos na conservação de espólios arqueológicos escavados em Moçambique, no âmbito da cooperação bilateral estabelecida entre o Departamento de Arqueologia e Antropologia, Universidade Eduardo Mondlane, e o Serviço Nacional de Antiguidades da Suécia.

Três objectos de ferro escavados no Zimbabwe de Manyikeni foram experimentalmente analisados e tratados: uma ponta de lança, um gongo, e uma larga argola oblònguia. Todos os objectos encontravam-se em relativo bom estado de conservação, sendo pouco notórios os indícios de corrosão após terem sido escavados. A ponta de lança e o gongo foram radiografados para análise de índices de corrosão, e posteriormente limpos através de jactos de ar contendo
The micro structure of one of the objects, described by C. Bohm above, has been analysed and reported by D. V. Wield. A cross section and a length section of the loop was prepared and examined microscopically and by hardness tests. Both sections show a mixture of areas with different carbon content. Wield distinguishes between three main compositions viz. carbon free iron, i.e. ferrite, iron with carbon content between 0.1 and 0.35 % and iron with 0.35–0.60 % carbon. The carbon is found as perlite. In his discussion Wield is surprised to find such high carbon content in an object made of iron from the bloomery process. He tries to explain the high carbon figures with either a deliberate carburization process or another method for reduction, than the direct reduction process, yet unknown.

In my opinion, however, the structure of this object is representative for an object manufactured from a piece of bloomery iron. The bloomery process gives a very inhomogeneous product consisting of iron with varying carbon content, slag and pieces of unburnt charcoal (Tylecote 1979). Parts of a bloom can contain as much as 1 % carbon, while other parts are pure iron. In the bloomery process the iron is never in a liquid state, but the reduction of the ore takes place in a solid state. Equalization of the carbon content, for instance, under heat, will not occur. In zones in the furnace with high CO/CO₂-ratio the iron will be carburized. In other zones pure iron is produced and in still others carburized iron might be decarburized again if the atmosphere happens to be oxidizing. I have myself analysed a number of small iron lumps, which were, at the time of manufacturing, cut from a bigger bloom. These lumps, in Sweden
The faunal remains from Manyikeni
An osteological examination of parts of the remains, autumn 1982

BERIT SIGVALIUS

Approximately 50 km away from the coast of the Indian Ocean lies the stronghold of Manyikeni. It belongs to the same late Iron-Age culture as the Great Zimbabwe in Zimbabwe (Garlake 1976) and was inhabited from the 12th to the 16th or 17th century A.D. (Barker 1978).

The area, in which the stronghold is situated, is today very dry and sterile. The vegetation consists of dense thicket.

During 1975 and 1976, archaeological excavations were carried out inside, immediately outside and on several spots around the enclosure. During autumn 1982 I had the opportunity to examine parts of the faunal remains taken care of from inside the enclosure and the adjacent stone platform area.

The two most essential problems were: 1) to find out whether the main meat production came from stock or game, 2) from the species identified try to find out if the climatic conditions were the same as today during the time the site was inhabited.

MATERIAL

The material examined weighs a little less than 25 kg and consists of approximately 9,700 fragments. Very few complete bones were found.

2,664 fragments, or 27% of the total number, were identified. Their total weight was a little more than 13.5 kg, or 55% of the total weight. In other words: it was mainly the large fragments that were identified.

During the excavation the faunal remains were obtained both with and without sieving. Only dry sieving was used (Barker 1978).

During the examination of the bones, it was established that previously they had been handled rather carelessly: fresh breaks were plenty, and most of the broken-off parts could not be found.
often called osmunds, were of medieval origin. The structure of the cross sections were in almost every case the same. The part of the iron lump, which had been the upper part of the bloom, consisted of pure, carbon free iron, the other side, the lower part of the bloom, had considerable carbon content, sometimes as high as 1%.

The big loop from Manyiken was in my opinion manufactured from a typical bloom, with varying carbon content, resulting in the mixed structure reported by D.V. Wield.

**BIBLIOGRAPHY**


**RESUMO**

A micro-estrutura da larga argola oblonga mencionada no artigo de C. Bohm foi previamente analisada por D. Wield em Maputo. O presente autor comenta os resultados do relatório preliminar então apresentado, comparando-os com informações obtidas na Suécia para ocorrências de semelhante teor. D. Wield sugere que o elevado índice de carvão presente no objeto por si analisado implica a utilização de um método ainda desconhecido de redução, diferente do comum processo de redução directa, ou, alternativamente, uma deliberada utilização de meios de carbonização.

No presente relatório o autor conclui que a estrutura do objecto em causa tem contado as características de ter sido produzido a partir do método de redução directa. Os produtos resultantes da sua aplicação são geralmente hétérogènens, e formados por uma parte de ferro com variado teor de carvão, escória, e pedaços de combustível não carbonizado.

22
METHOD

The osteological examination has been carried out at the Osteological Research Laboratory at the University of Stockholm and financed from SAREC.

The comparative collection available turned out to suffer from considerable deficiencies as far as the African fauna was concerned. The comparative skeletons available were incomplete and there were uncertainties regarding sex and sometimes even species.

Consequently, there have been difficulties in identifying the fragments. These problems have not been possible to solve during the short period of time which was given for identification.

In table 1 is shown the distribution of the faunal remains over the area, both number of fragments and their weight. In table 2 is specified the number of identified fragments from different species or groups of species over the area. In table 3 are shown the identified parts of the bodies of the animals.

It would of course be desirable to be able to identify every fragment to species, but this is not possible. In this material relatively few fragments have been identified to species, but other systematical levels – genus, family, order – have been used when no closer identification was obtainable.

IDENTIFIED SPECIES/GROUPS OF SPECIES

Out of the 2,664 identified fragments 1,167 come from mammals, 1,271 from reptiles, 5 from frogs, 111 from birds and 110 from fishes. The size of the fragments varies: the average weight of an unidentified fragment is approximately 1.6 g while the average weight of an identified fragment is approximately 5.1 g.

MAMMALS (Mammalia)

Totally 1,167 fragments of animals out of 9 orders of mammals have been identified. Only 100 of those have been identified to species.

Cloven-hoofed animals (Artiodactyla)

The majority of the identified fragments come from animals in this order.

From pigs (Suidae) 54 fragments have been identified.

From warthog (Phacochoerus) only one fragment has been identified; a tooth.

From hippopotamus (Hippopotamus amphibius) also only one fragment has been identified; this time from a toe.

From the bovides (Bovidae) 911 fragments have been identified. Unfortunately it is within this family that the largest difficulties of identification arise.
At the Osteological Research Laboratory in autumn 1982 only a few antelopes were available in the comparative collection. Most of them were not complete.

From the 911 fragments, 475 pieces have not been identified further. Out of the remaining 436 pieces there are:

- 61 fragments from *cattle* (Bos taurus)
- 10 fragments from *buffalo* (Syncerus caffer)
- 14 fragments from *sheep* (Ovis aries)
- 10 fragments from *goat* (Capra hircus)
- 18 fragments from either *sheep* or *goat* (Caprinae)
- 323 fragments from different antelope species.

Today there are approximately 20 species of antelopes in the area. (Smithers and Tello 1976; World of animals 1984).

When taking into account the value of the animals in meat production, it is of course essential to separate at least the small and the large antelopes.

Attempts were made to separate the fragments after body sizes, but the uncertainties of the comparative collection were so many that they made the result dubious.

An attempt to rank the fragments through making series of measurements after von den Driesch 1976, could not be carried out throughout the entire material.

Out of the 911 fragments, 436 pieces (47.9%) were identified to either stock or game. Out of these 436 fragments 333 pieces (or 76.4%) are from game and 103 from stock.

**Odd-toed animals** (Perissodactyla)
- From *rhinoceros* (Diceros bicornus) one fragment from a toe has been identified.
  - From *horses* (Equidae) are 10 identified fragments, 2 of those from *zebra* (Equus burchelli).

**Elephants** (Proboscidea)
- 8 fragments from *African elephant* (Loxodonta africana) have been identified, all of them from feet.

**Rodents** (Rodentia)
- 17 fragments of this order have been identified, four of them from *some rat* (Muridae).

**Hares** (Lagomorpha)
- Of this order 8 fragments have been identified.
Carnivores (Carnivora)
27 fragments of dogs (Canidae) have been identified, 26 of these from the genus Canis. There are several species of this genus and at least two of them, except domesticated dogs, live in the area today. (World of animals 1984). Since there is no complete comparative collection available for these species in Stockholm, the identification has reached no further.
6 fragments from hyena (Hyaenidae) have been identified, 4 of them teeth. 29 fragments come from cats (Felidae). They come from different species, which is obvious to judge from the size of the bones. How many and what species they are has not been possible to determine. There are however at least two, possibly three, different species of large cats.

Primates (Primates)
There are 4 fragments identified from some species of monkey. It might be more than one individual.

Insectivores (Insectivora)
Of this order there are only two identified fragments.

Bats (Chiroptera)
37 fragments are identified from animals of this order. The bones seem to come from animals equal in size. Possibly they all belong to the same species of large bats. It is at least highly probable that they all belong to the suborder Megachiroptera. Also concerning this order the deficiency of the comparative collection made all further identification impossible.

REPTILES (Reptilia)
The number of fragments of reptiles is large: 1.271 pieces.

Snakes (Ophidia)
83 fragments come from this order. The bones identified are vertebrae and ribs. There are probably more than one species, some of the bones come from quite large snakes.

Tortoise/Turtle (Testudinata)
The largest number of fragments of reptiles come from tortoises/turtles: 1.187 pieces. Of those no less than 1.149 pieces consist of dorsal plates. Some of these plates have round holes which look as if they were drilled.

FROGS (Anura)
5 fragments from one or more species of frogs have been identified.
BIRDS (Aves)
In the area, there are today approximately 1,000 species of birds. The 111 fragments of birds which have been found represent but a tiny part of those. No determination of species has been conducted.

FISH (Pisces)
110 fragments of fish have been identified.

ECONOMY
The majority of the bones come from animals killed for food. Traces of cutting, chopping and breaking are frequent.

One of the main problems of the investigation was to find out whether the people of Manyikeni based their meat production mainly on stock or game.

It could of course be hazardous to make any more precise conclusions based on a material which is impaired by so many uncertainties and which consists of just part of the total remains. There are, however, some indications concerning stock-breeding and game, which are worth noticing.

The large group of bovids has not been divided into stock and game to more than 47.9%. The majority of the fragments, 52.1%, belong to the undivided group. The fragments which have been identified to either stock or game consist to 76.4% of game.

The question is, how should the undivided group of bovide fragments be divided between stock and game?

It isn't necessarily so that the distribution between stock and game is the same in the undivided group of the material. If one divides the undifferentiated fragments equally between the two groups, the number of fragments originating from game is still in majority (62.6%). To reach a majority for stock almost all undifferentiated fragments must be taken into that group. Such a procedure is hardly likely to be correct. It would be more probable that the majority of the undifferentiated fragments belong to wild animals. The reason is of course that, in the comparative collection, the skeletons of wild animals were insufficient, while there were complete skeletons of stock available. Maybe, this would mean that game dominates the bovide group.

However, it isn't only animals from the bovide group that are captured and hunted for food. To this group belong most of the identified animals, such as elephants, rhinoceros, horses, pigs, hippopotamus, hares, birds, fish, tortoises/turtles and possibly even rodents, snakes, frogs and bats.
LARGE GAME

Elephant, rhinoceros and hippopotamus belong to the real large game which has been identified in the area. It could of course be argued that a few fragments of feet not necessarily are leftovers from hunting. My opinion is that they are.

Barker (Barker 1978) has also found bones from elephant and rhinoceros in the material from Manyiken, and those fragments were also from feet. In the calculations of meat yield these large animals are excluded because they are too few and because the fragments don’t come from parts of the body which yield a lot of meat. Barker believes these finds upset the conclusions concerning the living conditions of the people if they are taken into account.

However – one bone from an elephant toe comes from one complete once living animal with an enormous amount of meat. You cannot take it for granted that each fragment represents one individual, but there is in Iron-Age Manyiken at least one elephant, possibly more.

Barker estimates the weight of one elephant and one rhinoceros together at 6 tons. Together with one hippopotamus the total bodyweights are 8 tons. With Barker’s method of calculating the yield of meat, these animals would give 4 tons of meat, which must be considered quite a lot.

As Elisabeth Voigt writes about the investigation of Matope Court in southern Malawi, it is difficult to prove that the elephant meat was on the menu, since the people wouldn’t carry the bones to their sites, but cut out the meat on the spot where the animal was killed. (Voigt 1973). From Matope Court there is only one tooth and one tusk from elephant.

There are in Africa today elephant hunters who behave in exactly the same way as Voigt described. But one interesting detail is that the feet of these large animals are carried back to the sites because they are considered to be delicacies (E. and P. Verhaegen 1980). At a possible future archaeological excavation of the sites of these populations, what bones of elephant would be found if not bones from the feet?

Considering this it must be concluded that game has played an important part in the support of the people at Manyiken.

ENVIRONMENT

According to verbal information from Paul Sinclair, the area of Manyiken is very dry today, the vegetation mainly consisting of dense thicket.

Out of the approximately 20 species of antelopes which live in the area today, there are several species living in that specific terrain. Those species could very well be among the faunal remains from Iron-Age Manyiken. The find of bones from elephant doesn’t mean very much in this connection, since the animals move over quite large areas.
Neither the find of rhinoceros nor of hippopotamus proves a different climate. The rhinoceros can manage to survive 4–5 days without water during the dry season and lives in very varying environments. (World of Animals 1984.) The hippopotamus could not have been living in close vicinity to the site if the climate had been the same as today. But 2 tons of living animal would, according to Barker, give 1 ton of meat. So much meat from one single hunting occasion could very well be worth while to carry a long distance. The river Govuro lies only about 30 km east of the stronghold.

It would of course have been tempting to draw conclusions about the environment from the finds of large fruit-eating bats living in the area. Many of these species live in warm, damp forests and feed on juicy fruits (Vallardi 1959).

There are, however, species which are more depending on a good place to sleep than on the nearness to food. They often fly very far to feed. There is also information about fruit-eating bats being captured and eaten as delicacy (Rosevear 1965; Smithers and Tello 1976).

The finds of frogs are few, but even few frogs demand damp environment. It is however quite possible for some species of frogs to move over considerable distances during the wet periods, and if this is not the case, it isn't very hard to carry a frog quite a long way in order to eat it or for some other reason.

CONCLUSIONS

The faunal remains of Manyikeni show that the Iron-Age people had an economy where the hunter's bag, both small and large game, was of great importance by the side of stockholding.

There is nothing in the remains that points out a climate, very different from what it is today.

ACKNOWLEDGEMENT

I want to thank Rita Larje M.Sc., the Swedish Museum of Natural History, Stockholm, for being of great help during the entire investigation.
**Table 1. Number of fragments and their weight.**

**Quadro 1. Distribuição dos vestígios osteológicos no espaço, incluindo número de fragmentos e peso.**

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<tr>
<th></th>
<th>Number of fragments</th>
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<tr>
<td>MUE/A</td>
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<tr>
<td>MUE/C</td>
<td>41</td>
<td>40</td>
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<tr>
<td>MUE/D</td>
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<td>29</td>
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<tr>
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<td>4</td>
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<tr>
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<td>MUE/W</td>
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</table>
Table 2. Number of identified fragments from the different species/groups of species, and their distribution from the stone enclosure and adjacent platform area.

Quadro 2. Número de fragmentos identificados de acordo com diferentes espécies ou grupo de espécies.

| Species/Group       | Midlen 1 | MUE/IA | MUE/C | MUE/D | MUE/E | MUE/F | MUE/G | MUE/H | MUE/I | MUE/J | MUE/K | MUE/L | MUE/M | MUE/N | MUE/O | MUE/P | MUE/Q | MUE/R | MUE/S | MUE/T | MUE/W | S:a |
|---------------------|----------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Pig                 | 6        | 2      | 1     | 2     | 2     | 1     | 1     | 1     | 3     | 3     | 1     | 1     | 1     |       |       |       |       |       |       |       |       |       | 54    |
| warthog             | 1        |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 1     |
| hippopotamus        |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 1     |
| bovide              | 37       | 29     | 22    | 11    | 12    | 1     | 52    | 83    | 13    | 69    | 47    | 32    | 30    | 4     | 12    | 6     |       |       |       |       |       |       |       | 475   |
| cattle              | 4        | 1      |       |       |       |       | 5     | 11    | 2     | 7     | 6     | 5     | 4     | 2     | 10    | 4     |       |       |       |       |       |       |       |       | 61    |
| buffalo             |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 10    |
| sheep               |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 14    |
| goat                |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 10    |
| sheep/goat          | 2        | 2      |       |       |       |       | 6     | 1     | 2     | 1     | 1     | 1     |       |       |       |       |       |       |       |       |       |       |       |       | 18    |
| antelopes           | 49       | 36     | 20    | 22    | 8     | 3     | 39    | 42    | 9     | 3     | 20    | 19    | 11    | 14    | 2     | 3     | 15    | 8     |       |       |       |       |       |       | 323   |
| rhinoceros          |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 1     |
| horses              | 2        | 1      | 1     | 2     | 1     | 2     | 1     | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 8     |
| Burchells zebra     | 1        | 1      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 2     |
| elephant            |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 8     |
| rodents             | 1        | 1      | 2     | 3     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 13    |
| rats                |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 1     |
| hare                | 1        | 3      | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 9     |
| carnivores          | 38       | 4      | 2     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 49    |
| canidés             | 1        |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 1     |
| dog                 | 19       | 4      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 26    |
| hyena               | 2        | 2      |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 6     |
| cats                | 26       |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 29    |
| monkey              | 1        | 1      | 2     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 4     |
| insectívoros        | 1        |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 2     |
| bats                |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 37    |
| reptiles            |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 1     |
| snakes              | 82       |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 83    |
| tortoises/turtles   | 1        |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 1187  |
| frogs               |          |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 3     |
| birds               | 2        | 2      | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 111   |
| fishes              | 6        | 72     | 3     | 3     | 3     | 7     | 3     | 12    | 1     |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 110   |
| bovide/horse        | 1        |        |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       |       | 1     |
Table 3. Number of identified fragments of different parts of the bodies.

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<th>Parts</th>
<th>Pig</th>
<th>Warthog</th>
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<th>Bovine</th>
<th>Cattle</th>
<th>Buffalo</th>
<th>Sheep</th>
<th>Goat</th>
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<th>Rhinoceros</th>
<th>Horses</th>
<th>Burghella zebra</th>
<th>Rodent</th>
<th>Rat</th>
<th>Hare</th>
<th>Carnivores</th>
<th>Canids</th>
<th>Feline</th>
<th>Insectivores</th>
<th>Bats</th>
<th>Reptiles</th>
<th>Snakes</th>
<th>Tortoises/turtles</th>
<th>Frogs</th>
<th>Birds</th>
<th>Fishes</th>
<th>Bovine or Horse</th>
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Quadr 3. Partes animais identificadas.
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RESUMO

O artigo apresenta resultados da análise osteológica levada a efeito no Laboratório de Osteologia da Universidade de Estocolmo, como parte do projeto arqueológico do amuralhado de Manyikeni (Morais e Sinclair 1980). A autora incorpora igualmente materiais derivados de anteriores campanhas de trabalho (Barker 1978, Garlake 1976). O material foi estudado com vista à satisfação de duas questões iniciais: a percentagem comparativa de espécies bravias e domésticas presentes na alimentação dos habitantes do amuralhado, bem como avaliar as características climáticas então prevalecentes.
O material estudado compreende cerca de 9.700 pedaços de osso em grande estado de fragmentação totalizando cerca de 25 kg. Destes, somente 2.664 fragmentos (i.e. 27% do total da amostragem, e correspondendo aos fragmentos de maior dimensão) foram identificados. Para este efeito foi utilizada a colecção comparativa oferecida pela U.E.M., contudo dificultada pelo facto de estar muito incompleta e ser de classificação ocasionalmente incerta. Dos fragmentos identificados 1.167 são provenientes de mamíferos, 1.271 de répteis, 5 de sapos, 111 de aves e 110 de peixes.

A maior parte das amostras processadas são provenientes de animais abatidos para alimentação. Esta actividade é evidente nas numerosas marcas de corte, retalho e fractura deliberada encontradas nos fragmentos analisados. Destes, os mais numerosos são resultantes de espécies bravias (62,6% do total) incluindo todas as espécies acima indicadas. Sob o ponto de vista climático a autora conclui não haver indicações de mudanças notórias.
Report on a pilot investigation of ceramics from Mozambique and Zimbabwe

BIRGITTA HULTHÉN

At the request of Mr Paul Sinclair, Uppsala, and as part of a SAREC-project, involving Eduardo Mondlane University, Mozambique, the Swedish Central Board of National Antiquities and Uppsala University, a pilot investigation of pottery from some sites in Mozambique and Zimbabwe has been performed at the Laboratory for Ceramic and Clay Mineral Research, Dept. of Quaternary Geology, University of Lund (Sinclair 1984).

The aim of this project was to investigate possible relations concerning ceramic craft traditions and techniques between different sites in Mozambique and between them and some sites in Zimbabwe.

INVESTIGATION MATERIAL

For this purpose 20 sherds from vessels of different origin, age and quality was selected to be subject to petrographic microscopy and thermal analyses. The 20 sherds were classified into 6 main groups A—F, representing the following ceramics:

A. Site of origin: MATOLA, Mozambique.
   Dating: Ca 100-500 A.D.
   Archaeol. per.: Farming Communities of early first millennium.
   Industries: Agriculture, iron production.

   Pottery: Two different vessel types (fig. 1).
      Diameter ca 18 cm. Height ca 15 cm.
      Decoration: Fluting are the most common ornamentation.
      Total amount: 70 sherds.
   b. Vessels with convex body and abrupt transition to an everted rim. Mouth diameter ca 18 cm. Height ca 40 cm. Decoration consists of single or double lines of broad line-incisions under the rim and cord-stamp impressions on the shoulder. Total amount: about 300 sherds. Pottery of this kind also occurs in neighbouring territories.
B. Site of origin: NHACHENGUE, Mozambique.
Dating: 630–1000 A.D.
Archaeol. per.: Farming Communities of later first millennium.
Industries: No information available.
The area has a limestone bed-rock. The clays are calciferous and the pottery ware is very poriferous.
Pottery: Two different vessel types (fig. 2).
Jars with everted rim, decorated with strokes. Total amount: 4 reconstructable vessels.
The same kind of pottery appears also at Chibuene with identical dating.

C. Site of origin: HOLA-HOLA, Mozambique, situated about 300 km from the coast.
Dating: 800–900 A.D.
Archaeol. per.: Farming Communities of later first millennium.
Matola,
Aa e Ab.

... and the pot-
amount: 4
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Fig. 2. Sherds B1 and B2 from Nhachengue, Mozambique.

Fig. 3. Sherds Ca and Cb from Hola Hola and sherd CC from Dundo, isle of Bazaruto, Mozambique.

Figura 3. Fragmentos de olaria provenientes de Hola Hola (Ca e Cb) e do Dundo (CC).
Industries: Agriculture, stock-breeding, iron production, trade via Chibuene (Sinclair 1982).

Pottery: Two different vessel types (fig. 3).
   a. Vessels with horizontal lines on the neck and comb or shell impression decoration on rim and shoulder.
   b. Very shallow bowls with painted interior and finely executed ornamentation on the graphited (?) rim.

CC. Site of origin: DUNDO, isle of Bazaruto, Mozambique.
   Dating: 600—1000 A.D.
   Archaeol. per.: Farming Community of the later first millennium.
   Industries: Shellfish collecting and trade.
   No other information available.
   Pottery: The same types as occur at Hola Hola (Fig. 3).

D. Site of origin: MANYIKENI, Mozambique (situated 10 km from Chibuene).
   Dating: 12—1650 A.D.
   Archaeol. per.: Farming Communities of the second millennium. Outlier of the Zimbabwe Tradition.
   Industries: Agriculture, stock-breeding, hunting, iron production and trade. Also spinning is indicated.
   Pottery: Jars with convex body, without or with conical neck and everted rim. (Fig. 4).
      a. Undecorated. About 1200 A.D.
      b. Decorated with bands of oblique, comb-stamped strokes. 1400—1650 A.D.

E. Site of origin: CHIVOWA HILL, Zimbabwe.
   Dating: 850—950 A.D.
   Archaeol. per.: Farming Communities of later first millennium. Gumaneye tradition.
   Industries: Agriculture, stock-breeding, hunting, iron production and trade. Spinning is indicated.
   Granite is the most common rock but serpentine, talc and shales also occur.
   Pottery: Very standardized ware with few vessel shapes and without decoration. Vessel surface is often rough. (Fig. 5). Anthropomorphous and domestic animal figurines occur.
   About 10,000 sherds available.

F. Site of origin: The same as E.
   Dating: Ca 1800 A.D.
   Industries: See under E.
   Pottery: Jars with everted rim decorated with bands of cross-hatching on the shoulder (Fig. 6).
Figura 4. Fragmentos de oária de Manyiken: reconstrução das diferentes partes dos fragmentos Da, Db₁ e Db₂.
Fig. 5. Sherds $E_1$ and $E_2$ from Chivowa Hill, Zimbabwe

Figura 5. Chivowa Hill Zimbabwe: fragmentos $E_1$ e $E_2$. 
METHODS

Thin sections for petrographic microscopy were prepared from 12 of the 20 sample sherds. Under a polarizing microscope at magnifications of 25—1000 X the structure and impurities of the ceramic clays were studied. The presence or absence of diatoms was examined. Further, type, grain size and amount of temper of the different ceramics were determined.

All 20 sherds were subject to thermal analyses in a laboratory furnace with a maximum temperature of 1000°C. By means of TCT (Thermal Colour Test, Hulthén 1976) the colour changes during firing of the pottery clays were studied. The approximate original firing temperature was estimated. The sintering interval of each individual clay was analysed (High temperature furnace. Maximum temperature: 1450°C), and the melting point was determined. 15 TCT and sintering interval diagrams were plotted (Fig. 7.)

Fig. 7. The diagrams show the results of the TCT and Sintering interval analyses. Clays from the same site have more or less the same thermal properties, indicating the same raw material sources. Note the dissimilarity of the refractory clay Db2 from Manyikeni. $S =$ swelling. • = melting point.

Figura 7. Os diagramas ilustram resultados do teste TCT ( teste de cor térmica) e de «Sintering interval analysis» (análise de porosidade intervalar), expressos em duas variáveis: tom, valor, croma (Hue/Value/Chroma) e temperatura. As argilas provenientes da mesma estação arqueológica têm mais ou menos as mesmas propriedades térmicas, o que indica a utilização de matéria-prima proveniente das mesmas fontes. De notar = dissimilaridade da argila refractária Db2 de Manyikeni. $S =$ inchaça; • = ponto de fusão.
12 of the 20 of 25—1000 The presence of the amount of furnace with Colour Test, of clays were tested. The sinter furnace determined. 15 analyses. Clays of the same raw site Mnaykeni. S=

Fig. 7 The diagrams show the results of the TCT and Sintering interval analyses. Clays from the same site have more or less the same thermal properties, indicating the same raw material sources. Note the dissimilarity of the refractory clay Db2 from Mnaykeni. Swelling, m = melting point.
### Table I. Investigation results from petrographic microscopy and thermal analyses. Codes: • present: + abundant: - sparse: o a few grains only: Accessory minerals: Amph = amphibole; Tit. = titanite. NATURAL = The clay contains sand, which constitutes a natural temper.

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<tr>
<th>TEST SHERD</th>
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<th>SIERRA SHERD</th>
<th>MAX. MP</th>
<th>DECORATION</th>
<th>CLAY</th>
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**Notes:**
- Parallel orientation of particles
- Temper material dissolved leaving a porous ware.
- Temper: probably limecrete.
- Refractory clay
RESULTS (Table 1)

MATOLA

Sherd Aa

Clay: Sorted, silty, fine clay containing grains of ore and conglomerates of iron hydrate. The clay is poor in mica.

Temper: 8% of quartz sand with a uniform grain size of about 1.5 mm (Fig. 8). Some grains of chamotte (crushed pottery) were observed.

Firing: Reducing atmosphere at temperatures between 500 and 600°C. The final phase of firing went on in oxidizing atmosphere. Though the TCT-diagrams indicate correspondence between the clays of Aa and Ab pottery, the Aa-clay had a lower melting point than had the Ab-clay (1300 and 1350°C). Moreover during the melting process the Aa-clay swelled and a poriferous structure resulted.

Sherd Ab

Clay: The same composition as was found in the Aa sherd. The clay has a distinct parallel orientation of particles which may indicate coiling as vessel-building technique (Fig. 9).

Temper: 15% of quartz sand with a uniform grain size of about 0.3 mm. Maximum grain size 1 mm.

Firing: See under sherd Aa. The firing temperature had been between 600 and 700°C. No swelling at the melting point.

NHACHENGUE

Sherds Ba, Bb

Clay: A sandy, silty, ferruginous clay which contains grains of a yellow, undeterminable mineral.

Temper: The temper material is totally dissolved leaving a highly poriferous ware. The temper probably consisted of crushed limestone (Fig. 12).

Firing: Oxidizing atmosphere. Temperatures between 500 and 600°C. The TCT-diagrams of Ba and Bb clays are identical. Sintering interval of Ba started at 900°C and the melting point was 1300°C. The clay contained in sherd Bb had a sintering interval between 1000 and 1350°C.

HOLA-HOLA

Sherd Ca1

Clay: Unsorted, sandy, silty with a coarse structure. The clay is rich in iron and contains ore and conglomerates of iron hydrate.

Temper: Extra temper besides the natural sand has not been added. One grain of chamotte is observed (Fig. 15).
Fig. 8. Microscope photo of sherd Aa from Matola. The ware is composed of a sorted, silty fine-clay which has been tempered with 8% quartz sand with medium grain size of 1.5 mm. — Figura 8. Fotografia microscópica do fragmento Aa proveniente da Matola. A sua textura é composta de argila muito fina e diferenciada, a qual foi temperada com 8% de areia quartzítica de grãos com uma média de 1.5 mm.

Fig. 10. Microscope photo of sherd CC from Dundo on the isle of Bazaruto. The fine clay is sorted and somewhat silty. A great amount of diatoms in the clay has been recorded and among other genus also Melosira sulcata (Fig. 13). 4% of fine-grained sand with medium grain size of 0.1 mm makes up the temper. — Figura 10. Fotografia microscópica do fragmento CC proveniente do Dundo na ilha do Bazaruto. Consideráveis quantidades de diatomos ocorrem na argila de textura fina, entre outras do genus Melosira sulcata (V. fig. 13). A tempera é obtida através da utilização de 4% de areia fina com uma média de 0.1 mm de grão.

Fig. 11. Microscope photo of sherd Db from Manyikeni. The sorted, silty fine-clay, containing diatom fragments, has been tempered with 10% of fine-grained sand with medium grain size of 0.5 mm. The clay is refractory. Melting point above 1450°C. — Figura 11. Fotografia microscópica do fragmento Db2 proveniente de Manyikeni. A argila utilizada é de natureza muito fina e diferenciada, contendo fragmentos de diatomos, e temperada com 10% de areia fina com uma média de 0.1 mm de grão. A argila é refratária. Ponto de fusão acima de 1450°C.
of sherd Ab from to that of sherd of particles can be location of coiling. quartz lens inser-

Fig. 9. Fotografia 10. A b proved-
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Fig. 12. Microscope photo of the ware of sherd Ba and Bb from Nhachenge. A sandy, silty coarse clay has been tempered with limestone. The temper is totally dissolved and has left a highly poriferous ware (Black areas = empty pores). — Figura 12. Fotografia microscópica do fragmento Ba e Bb proveniente de Nhachenge. A argila tem textura arenosa e indiferenciada, à qual que se juntou tempera de calcário. A tempera está completamente dissolvida restando somente uma textura com elevado teor de porosidade (áreas a negro = poros vazados).

Fig. 13. SEM-photo (6000 X) of the diatom Melosira sulcata, a marine type. The same kind of diatoms were found in sherd CC (Fig. 10). Photo: H. Håkansson. — Figura 13. Fotografia SEM (microscópio eletrônico, ampliado em 6000 x) do diatomo Melosira sulcata, um tipo marinho. O mesmo tipo de diatomes foram encontrados no fragmento CC (V. Fig. 10).


Fig. 15. Microscope photo of sherd Ca from Hola-Hola. Extra temper has not been added to the coarse, unsorted, sandy and silty clay. — Figura 15. Fotografia microscópica dos fragmentos Ca e Cb provenientes de Hola Hola. Não foi utilizada tempera adicional para uma argila de textura indiferenciada, arenosa e fina.
Firing: Oxidizing atmosphere at temperatures between 600 and 700°C. The sintering started at 900°C and ended at the melting point 1300°C. At this stage the clay swelled.

Sherd Ca₂ (No thin section)

Firing: Original firing temperature had been between 500 and 600°C in reducing atmosphere. Oxidizing atmosphere during the final stage of firing. Sintering interval: 1050—1300°C. Swelling occurred at the melting point.

Sherd Cb

Clay: Unsorted, sandy and silty with a coarse structure. It is rich in iron, poor in mica and contains fossils such as spicules. Temper: 5% of chamotte has been added to the naturally tempered clay. Grain size about 1.5 mm (Fig. 17).

Firing: Temperature about 600°C. The atmosphere was reducing at the beginning of the firing and oxidizing during the final phase. At 900°C the clay started to sinter and at 1250°C it melted while swelling.

DUNDO
Sherd CC

Clay: Sorted, somewhat silty, fine clay which contains mica and is rich in iron. The clay contains a great amount of diatoms of which the analysis was performed by Dr H. Håkansson, Dept. of Quaternary Geology, Lund University. Three different genus could be identified: Amphora, Achnantes and Melosira. Of Melosira also the species could be determined: sulcata (Fig. 13). Both Amphora, Achnantes and Melosira sulcata are genuine marine types. Besides these three diatom genus the clay also contained an abundance of indeterminate diatom fragments.

Temper: 4% of fine-grained sand of which the mean value of grain size is 0.1 mm and the maximum 1.2 mm (Fig. 10).

Firing: Temperature between 500 and 600°C. The atmosphere has been reducing. The vessel has been subject to a secondary firing with oxidizing atmosphere. Sintering interval started at 1000°C and ended with the melting at 1250°C.

MANYIKENI
Sherd Da

Clay: Unsorted, sandy, silty and coarse, rich in mica and iron. Conglomerates of iron hydrites occur abundantly.

Temper: Except for 3 grains of chamotte no extra temper besides the natural sand has been observed. The coarse sand fraction contains grains of granite, sandstone and quartzite (Fig. 16).

Firing: Firing temperature has been between 500 and 600°C in reducing atmosphere. Sintering started at 1000°C. The clay melted at 1300°C.
The synthesis stage the 1300°C in re-firing. Sin-

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Fig. 16. Microscope photo of sherd Da from Manyikeni. The clay is unsorted, coarse, sandy and silty. Grains of granite, sandstone and quartzite occur in the sand fraction. No extra temper is added.

Fig. 17. Microscope photo of sherds Cb from Hola-Hola. 5% chamotte has been added to the natural sand in the coarse clay. Figura 17. Fotografia microscópica do fragmento Cb proveniente de Hola-Hola. 5% chamotte foi adiado à areia natural na argila de textura indiferenciada.

Fig. 18. Microscope photo of sherd Db from Manyikeni. The unsorted and vary coarse clay is sandy and silty. The natural sand constitutes the temper. — Figura 18. Fotografia microscópica do fragmento Db proveniente de Manyikeni. A argila de textura indiferenciada é arenosa e fina. Areia natural constitui a única forma de tempera.

Fig. 19. Microscope photo of sherd F from Chivova Hill, Zimbabwe. The sorted, coarse, silty clay has been tempered with 25% of crushed sandstone with maximum grain size of 4 mm. — Figura 19. Fotografia microscópica do fragmento F proveniente de Chivova Hill, Zimbabwe. A argila de textura diferenciada, gрослá e fina foi temperada com 25% de grãos reduzido a pó com um grão com tamanho médio de 4 mm.
Sherd Db₁

*Clay:* Unsorted, sandy, silty and very coarse. It is micaceous and ferruginous and contains titanite and amphibole as accessory minerals.

*Temper:* The natural sand constitutes the temper (Fig. 18).

*Firing:* The temperature has been between 500 and 600°C. The atmosphere has been reducing until the final stage when it was changed to oxidizing. The clay started to sinter at 1050°C and melted at 1300°C while swelling.

Sherd Db₂

*Clay:* Sorted, silty, fine clay which contains some mica, iron, indeterminet fragments of diatoms, spicules and other fossils.

*Temper:* 10% of quartz sand with a maximum grain size of 0.5 mm (Fig. 11). One grain of chamotte has been observed in the sample.

*Firing:* The black ware had been fired in reducing atmosphere at temperatures of about 600°C. The thermal analysis has shown that a refractory clay had been used, probably without the potter's knowing. The sintering did not start until a temperature of 1100°C had been exceeded. The melting point is above 1400°C. When fired to 800°C the colour was pinkish white (7.5 YR 8/2 according to Munsell Color Chart System) and light gray/white after a temperature of 1200°C had been reached. After a firing temperature of 1400°C the ware was hard, sintered and transformed into stoneware. The medieval potter had had no possibility to profit from this valuable raw material due to the probable lack of a suitable furnace.

CHIVOWA HILL, ZIMBABWE

Sherd E₁ and E₂

*Clay:* Unsorted, sandy, silty with coarse structure. It is ferruginous and poor in mica. It contains conglomerates of iron hydrite. Amphibole occurs as accessory mineral.

*Temper:* The natural sand, containing grains of sandstone, constitutes the main temper (Fig. 14). Besides, 4 grains of chamotte have been observed in the sample.

*Firing:* The firing temperature has been between 500 and 600°C. The atmosphere was reducing except for the final stage of firing when the atmosphere has been oxidizing. The sintering started at 1000°C and ended with the melting at 1350°C.

Sherd F

*Clay:* Sorted, silty with a coarse structure. It is rich in mica and iron.

*Temper:* 25% of crushed sandstone with a maximum grain size of 4 mm (Fig. 19).

*Firing:* Firing temperature has been between 500 and 600°C in reducing atmosphere. The inside of the vessel has been subject to secondary firing. Sintering started at 1000°C and ended with the melting at 1350°C.
The ceramic craft of Iron Age and later periods of South-East Africa, exemplified by the pilot investigation material, contains manufacturing techniques which differentiate from each other in several respects.

Matola ceramics represent the earliest stage of pottery. The Matola potter worked with a fine-grained clay which she (or he) mixed with fine quartz sand. Wet leaves or grass probably covered the vessels during firing in order to get a reduced and thus dense ware. The desired red-brown colour was obtained by allowing free admittance of the air to the vessel pile during the very last stage of firing.

In an open fire with an ordinary amount of vessels, the temperatures will generally not exceed 600°C. This is due to the loss of energy caused by the evaporation of moisture from the vessel ware during firing. The temperature may be increased through additional supply of air, e.g. by using a bellows or by reducing the number of vessels in relation to the size of the fire (Hola-Hola, sherd Ca).

The same choice of raw materials and techniques as in Matola was made in later periods by the potters at Dundo island of Bazaruto and Manyikeni (Fig. 20).

A different ceramic tradition was practised at Hola-Hola and at Chivowa Hill during the 9th and 10th centuries and can be followed to the 13th and 17th centuries at Manyikeni. This pottery is based on an unsorted, coarse clay, which is not necessarily additionally tempered.

Concerning firing the methods seem to be very stable with only small variations.

The latest Zimbabwe pottery (19th century) represents a somewhat more elaborated manufacture indicated by a tempering with 25% of crushed sandstone.

A general observation is that independently of manufacturing technique the potters always chose a calcium-free clay. Through "trial and error" they had learnt how easily pots of calciferous clays crack during firing. This negative effect can be diminished by firing in reducing atmosphere. Mostly, however, ancient potters do prefer non-calciferous clays (Hulthen 1985: 331).

By using a coarse, sandy and silty clay as raw material, the potter obtained a porous ceramic ware. Such pottery has a certain permeability, which is a favourable property for a vessel, used as water tank (The cooling effect). Also a cooking pot needs to be somewhat permeable. The permeability must not be too great and this was avoided by firing the pottery in a reducing atmosphere. Primitive craft technology? No, on the contrary! The proper choice of certain raw clays, the ability to manipulate firing conditions in order to obtain the accurate density for a special function, demonstrate a manufacture, based on sophisticated techniques and long traditions.
Centuries  Chivowa  Manyikeni  Hola-Hola  Dundo  Matola  Nhachengue
0–100
200–300
400–500
600–700
800–900
1000–1100
1200–1300
1400–1500
1600–1700
1800–1900

Codes:  Coarse, sandy clay without added temper
- Argila de textura grosseira e arenosa, sem tempera adiccionada.
Sorted, silty fine-clay tempered with fine-grained quartz sand
- Argila de textura diferenciada e muito fina, temperada com areia de quartzo de grão fino.
Coarse, sandy, silty clay tempered with crushed limestone
- Argila de textura grosseira, arenosa e fina, temperada com calcário reduzido a pó.
Coarse, sandy, silty clay tempered with crushed sandstone
- Argila de textura grosseira, arenosa e fina, temperada com grés reduzido a pó.
The pottery from Nhachengue appears to be completely different with respect to raw materials. The vessel ware is highly poriferous. These facts could possibly depend on a particular geological environment. Without the results of a prospection of clays and rocks of the area, however, it is not feasible to discuss the problem whether the choice of calciferous raw material was due to a special purpose or to an unavoidable necessity.

In addition to the natural or added sand temper also a few grains of chamotte have been observed in most of the sample sherds. These grains do not constitute part of a voluntary chamotte temper. The amount is so exceedingly small that its technical importance for the ceramic quality can be ignored. Instead we have good reasons to believe that the sparse grains represent a custom based on irrational thinking (ibid: 335). Still today in some places in Africa the old, broken pot is believed to continue its "life" through some crushed sherds mixed into the clay of the new vessels under manufacturing.

The compiled investigation results indicate various possibilities to study and penetrate the background of different ceramic problems and pottery complexes in ancient Mozambique.

A valuable future complement would be the study of today's village pottery. Many still living craft traditions and techniques in Mozambique could then be documented and subject to comparative studies.

With a more complete sherd material, statistically selected from different regions and periods and complemented with raw test-clays from the individual site areas, a further and more comprehensive investigation project may contribute important information on one part of the puzzle called: The precolonial past of Mozambique.

BIBLIOGRAPHY


RESUMO

O artigo aborda um projecto piloto destinado a avaliar os potenciais de estudo das antigas tradições tecnológicas da fabricação de cerâmica, a partir de amostras de olaria seleccionadas de estações arqueológicas em Moçambique e Zimbabue. Nesse sentido, 20 fragmentos de olaria de textura, cronologia e provenientes de 6 estações arqueológicas distintas, foram submetidos a análise de microscopia petrográfica (Figuras 8 a 19) e análise térmica (Figura 7). As amostras foram classificadas em 6 grupos de A a F e incluíram as estações arqueológicas de Chivowa Hill no Zimbabwe, e as de Manyiken, Hola-Hola, Dundo, Matola e Nhachengu em Moçambique.

Os resultados são sumariados no Quadro I (Table I), e as respectivas relações interpretadas de acordo com um modelo hipotético de graus de afinidade e distinção entre os conjuntos das olargas analisados. O autor aponta como conclusão ser possível diferenciar tecnologias particulares de fabricação a julgar pelos resultados obtidos neste trabalho. A olaria da Matola representa, entre as amostras estudadas, o mais antigo estágio de fabricação de cerâmica. Detalhes referentes à possível tecnologia aplicada são descritos, identificando como parte da mesma tradição (pela utilização dos mesmos princípios de fabrico) a olaria de Dundo (Ilha de Bazaruto) e um dos tipos ocorrendo em Manyiken. O mesmo acontece com outro grupo distinto: a olaria de Hola-Hola e de Chivowa Hill datada dos séculos IX e X A.D., tem sequência em alguns conjuntos da olaria dos séculos XIII e XVII presentes em Manyiken. A olaria de Nhachengu, a julgar pela amostra analisada, pertence a uma terceira categoria distinta das anteriores.

Como observação geral resultante do conjunto das amostras processadas, a tecnologia utilizada na fabricação da cerâmica revela elevada mestria tecnológica baseada em tradições seguramente recuadas no tempo.

O autor conclui recomendando o alargamento das base empírica deste estudo através da futura aplicação do método a conjuntos mais diversificados de olargas, bem como da documentação de processos ainda hoje a serem implementados na produção cerâmica artesanal.