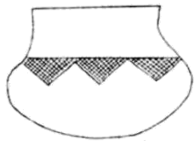

A TECHNOLOGICAL STUDY AND MANUFACTURE OF CERAMIC VESSELS FROM K2 AND MAPUNGUBWE HILL, SOUTH AFRICA

By

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For the degree of Magister Artium (Masters)

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Declaration

I declare that this thesis is my own unaided work. It is submitted for the degree of Master of Arts at the University of the Pretoria. It has not been submitted before for any other degree or examination at any other university.

19 August 2013
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Date

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Signed

Abstract

This thesis investigates the technology of twenty-six complete vessels from the ceramic assemblages of K2 and Mapungubwe in the Limpopo Province of South Africa, from the early second millennium (AD 1000 - AD 1300). Mapungubwe is a significant pre-colonial archaeological site of social and political complexity, which lead to the emergence of one of the first known states in southern Africa. Ceramics are commonly associated with these nationally significant sites and have served mainly as chronological and regional markers to determine the cultural sequence of the Shashe Limpopo Confluence Area. Previous studies on these ceramics have paid little consideration to ceramic technology, as research for decades has focused largely on stylistic typologies. Non-invasive methods, compositional materials analysis, and macroscopic analysis provide a broad technological characterization of physical evidence left by the potter on the complete vessels, and are used to interpret aspects of the *chaîne opératoire* or sequence of ceramic manufacture. Though primary traces of forming and shaping techniques have often been erased by secondary forming processes such as smoothing, scraping, wiping and finishing, the fundamental technology of the vessels can nevertheless be elucidated based on a range of technical variables. This study is the first of its kind in South African archaeology, where complete vessels from a valuable research assemblage are used as a basis for understanding ceramic technology. The results enhance archaeological views of Iron Age ceramic technology, which are pertinent to the interpretation of how the ceramics were manufactured and contributes to a wider understanding of social and technical choices made by potters and related social implications. Vessels from the K2 and Mapungubwe ceramic repertoire serve to answer questions about ceramic research that relate to (a) characterization of complete archaeological ceramics, (b) evidence of technology (c) compositional data of the vessels (d) to provide anatomical data on the technological and morphological attributes of ceramic manufacture. The preliminary results point to evidence of local manufacture of K2 and Mapungubwe ceramics by means of the analysis of four steps in the *chaîne opératoire*: fabric, forming, firing and finishing. Tentative conclusions further demonstrate technological continuity and variability of raw materials for ceramic manufacture at K2 and Mapungubwe. The broader archaeological perspective, which emerges is one of an expanding technological society, changing technical commonalities, forms and decorative styles, and in the process, making if only subtle technological choices in the manufacture process of early second millennium AD Iron Age ceramics.

KEYWORDS: MAPUNGUBWE, K2, CERAMIC TECHNOLOGY, TECHNICAL CHOICES, CHAÎNE OPÉRATOIRE, FABRIC ANALYSIS, IRON AGE, ARCHAEOLOGY, SOUTH AFRICA

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List of Abbreviations

B	Block
BB	Beast Burial
C	Core Collection
CS	Casual skeleton
EGAE	Eastern Grave Area Extension
EIA	Early Iron Age
Exc.	Excavation
JS	John Schofield
KS	K2 skeleton
LIA	Late Iron Age
MIA	Middle Iron Age
M1	Mapungubwe ceramics classification
M2	K2 ceramics classification
MS	Mapungubwe skeleton
N	National Heritage Collection
Skel.	Skeleton
S	Section
ST	Southern Terrace
TP	Test pit / trial pit
UP	University of Pretoria
XRD	X-ray diffraction
XRF	X-ray florescence

Element abbreviations - Fe (iron) - K (potassium)- Ca (calcium)- Rb (rubidium)- Sr (strontium)- Ti (Titanium)- V (vanadium)- Cr (chromium)- Mn (manganese)- Ni (nickel)- Cu (copper)- S (Sulphur) -Th (thorium) - Zn (Zinc) - Zr (zirconium)

Glossary*

* Glossary of terms extracted from multiple sources, e.g. Gibson, A. and Woods, A. 1990. *Prehistoric Pottery for the Archaeologist*, Leicester University Press: London; Shepard, A.O. 1980. *Ceramics for the Archaeologist*, Carnegie Institution of Washington, Publication 609: Washington; D.C. Sinopoli, C. 1991. *Approaches to Archaeological Ceramics*, Plenum Press: New York:

Appliqué	Decorative technique that involves the addition of moulded clay to vessel surface
Bevel	A flat, sloping area inside the rim of a vessel; can be used as a platform for decoration
Black core	The dark zone that sometimes occur in the middle of sherds found in many open-fired pots, and which is the result of incomplete oxidation of the carbonaceous matter present in the clay; the latter is an indicator of short firing (as there has been insufficient time to burn out this material) and therefore, frequently, of pit or open firing
Burnish	The smooth, sometimes faceted, effect on the surface of a vessel produced by rubbing leather-hard clay with a rounded tool to create a shiny and polished surface
Burnishing	Finishing technique, rubbing a leather-hard vessel with hard tool, such as a stone or potsherd, to produce a glossy surface, with irregular lustre and polishing marks. Burnishing and polishing both fall under the same general category of 'finishing'
Coiling	Hand-building technique, involves forming and joining narrow coils of clay to build up vessel walls
Core	Interior portion of vessel wall, often different in colour than interior or exterior surface (see 'black core' above)
Fabric	Fabric or total composition of the ceramic, including clay, inclusions and pores. Also referred to as ceramic paste or ceramic substrate
Fire cloud	Black patches of colour on the surface of the vessels produced in open pit firing as a result of the deposition of carbon on the vessel. This occurs when the ceramic has been in direct contact with the smoky part of the flame or with incompletely burnt fuel
Fracture	The nature of the broken section of the vessel or sherd edge
Incised	A decorative surface treatment by dragging a sharp instrument through clay

Inclusions The term used to describe all non-clay or non-plastic materials present or visible in the ceramic fabric (clay body) for example mineral grains, rock fragments or aggregates, temper or crushed shells

Lug Projections, either raised or applied, protruding from the sides of vessels and which may or may not be functional. Some lugs may be either vertically or horizontally perforated and it has frequently been suggested that the perforations are to allow the suspension of the vessel. Lugs can also act as handles

Neck Part of a restricted vessel between body and rim, marked by constriction and change in orientation of vessel walls

Oxidized Oxidized means having been fired in an atmosphere 'in which the amount of oxygen is more than required to combust the fuel'

Pinching Hand-building technique, involves forming the vessel by opening a clay ball and pulling vessel walls up between the fingers

Pit firing Firing technique in which fuel and vessel are placed together in an excavated pit, sometimes covered with stones or earth

Restricted A vessel in which parts of the body are of greater diameter than the mouth

Rim Upper part of vessel at mouth or orifice

Scored A decorative surface treatment that consists of rough, random, shallowly incised decoration. This technique is usually executed with a sharp, fine implement just scratching the surface

Scraping A finishing technique which involves scraping a leather-hard vessel with an implement such as a shell, bone, stone or other type of tool held perpendicular to the vessel to thin or shape it

Smoothing A quality of surface texture and surface treatment. Since there are degrees of smoothness, smooth is proposed for the texture obtained by creating a finer more regular surface than results from forming alone. The carefully wiped surface of fine-textured, plastic clay may appear smooth, but the burnished surface is much smoother to the touch. This process or surface treatment is usually done with a soft, 'yielding tool' which is an extremely smooth tool and results in a matt finish on the vessel

Spalling The surface of the vessel flakes or pops as clay is pushed from the porous surface of a vessel; often typical of charred vessels, and are the result of expanding particles during the firing process or if vessels contain damaging insoluble salts

Surface treatment A technological, decorative or functional method used to alter the surface of the vessel

Tooled	A term referring to a decorative technique that has been very lightly executed with a smooth, blunt object, similar to incised and scored, except that the tool only lightly scratches the outer surface of the vessel
Trace elements	Chemical elements found in very small quantities in clays and vessels
Unrestricted	Vessel form or profile characterized by an open form with no narrowing or constrictions between base and rim
Use-wear	Traces on vessel formed as a result of use, i.e. charring on cooking vessels
Variable	A property, characteristic, feature, or attribute of a vessel

CHAPTER 1

1. 1. Introduction

This research examines ceramic technology of early second millennium AD 1000 – AD 1290 ceramics from two Iron Age archaeological sites, K2 and Mapungubwe Hill, situated within the Shashe Limpopo Confluence Area in the Limpopo Province of South Africa. Owing to the widespread manufacture of ceramics, their reasonably imperishable quality, and their persistence through time, enables them to be used as valuable research tools for understanding ceramic technology in the archaeological record. Furthermore, ceramics are arguably the most abundant material found on archaeological sites in later prehistory and occur in southern Africa during the last few thousand years. Decorated ceramics as material culture are also frequently used as chronological and identity markers to determine typological sequences and recognise groups of people in cultural sequences of the Shashe Limpopo Confluence Area. Therefore, clues about the potter, as to why and how ceramics were made, needs to be investigated in order to appreciate their meaning in past societies. This study investigates technological evidence from complete vessels in the K2 and Mapungubwe ceramic assemblages.

1.2. Background

The archaeological sites of K2 and Mapungubwe Hill are important as they represent the development of rank-based societies at K2, which advanced into class distinction at Mapungubwe Hill, bringing about the emergence of the first states in southern Africa (Huffman 2009:37). Excavations have yielded immense quantities of ceramics made and used by agro pastoralist communities from approximately AD 1000 to AD 1300, marked by the southern Africa Iron Age. Research was initially under the institutional aegis of the University of Pretoria following the discovery of the sites in the early 1930s (Eloff 1979, Fouché 1937; Gardner 1963, Meyer 1980, 1998, 2000). As a result, thousands of ceramics have been excavated and have been used as indicators to determine settlement patterns, regional relationships and chronological sequences, which were determined by social, political and economic changes (e.g. Calabrese 2005; Huffman 1986, 2000, 2009).

In this study, complete ceramics will be investigated from a technological viewpoint, which will draw substantially on the concepts of technological choice and the *chaîne opératoire* (e.g. Dobres 2009). This thesis supports the views put forward by Lindahl and Pikirayi (2010), stating that:

> "Iron Age archaeologists have so far been content with the typological differences, putting emphasis on shape and decoration and ascribing the differences in pottery assemblages to ethnicity and factors such as migration… current typological approaches ignore the value of ceramic technology in understanding change in ware over time". Lindahl and Pikirayi (2010:133-134)

Despite the fact that wider archaeological scholarship has been debating ceramic technology (e.g. Dobres and Hoffman 1994; Dobres 2009; Lechtman 1977; Lemmonier 1993; Miller 2006; Pfaffenberger 1993; Schlanger 1994; Sillar and Tite 2000), southern Africa lags behind, as there has been little focus on manufacturing and technological aspects. But since most ceramic studies focus on stylistic approaches, typology continues to lead Iron Age ceramic analysis at K2 and Mapungubwe (Calabrese 2005; Huffman 1974, 1978, 1980, 1989, 2007; Meyer 1980, 1998).

More recently there has, however, been some emphasis on ceramic technology, mainly as a means of understanding technological aspects such as raw materials and manufacturing techniques. For example, the Zulu ceramic production studies of Fowler (2008), Rosenstein's (2002, 2008) examination of changes in technology of BaTswana ceramics, Jacobson's (1994, 1995, 2005) experimental geochemical studies well as the research on ceramic production techniques using South Africa and eastern Zimbabwe as case studies by Lindahl and Pikirayi (2010). This study is therefore necessary as very few technological analyses have been undertaken on archaeological ceramic studies in southern Africa.

1.3. Research orientation

Other than the few studies mentioned above, southern Africa archaeology has not actively answered questions about ceramic technology, such as the identification of clay sources, the location of ceramic production sites and the technological processes of ceramic manufacture. There is currently more known about ceramic style and decoration, than how archaeological ceramics were made and for what purpose. This poses a clear problem, and shows a gap in South African ceramics research in particular. As a result, relatively little is known about the technology of the K2 and Mapungubwe ceramic assemblages, which are significant comparative markers for any study in the southern African archaeology. With more than eight decades of scholarship on the K2 and Mapungubwe ceramics, while producing immense knowledge about typologies, extant research offers surprisingly few insights into how the ceramics were made and by whom. Even less is known about the function of ceramics, why they were made and how they were appreciated and why.

Such questions are of course some of the most difficult to ask and to answer, and although this research will not answer them definitively, it does open an avenue of new research. This technological study is primarily descriptive in nature and attempts to understand the physical properties of whole K2 and Mapungubwe ceramics, in order to better shed light on the manufacturing process and as a means of interpreting the choices of potters.

Although several research questions direct this study of the K2 and Mapungubwe ceramics, the overall rationale is to elucidate aspects of ceramic technology. The main objective is to determine what physical technological evidence can be gathered from complete or intact K2 and Mapungubwe ceramic vessels and, on a broader level, how this relates to our understanding of ceramic technology as an approach. In this study, it is intended to further demonstrate that evidence of technology lies in primary forming techniques, secondary forming, firing conditions and finishing traces, which possibly reflect technical choices that are nested within the wider K2 and Mapungubwe society. This objective will be achieved by means of ceramic fabric analysis used in combination with macroscopic and non-invasive analytical methods.

The goal of the technological analysis is therefore to characterize the physical properties of clay, which in turn influence form, firing conditions and final surface treatments as fundamental properties in order to manufacture the K2 and Mapungubwe ceramics. I will also attempt to address contextual questions, such as whether there is a distinct K2 and Mapungubwe ceramic technology. What are the differences or similarities in techniques between the two, and are changes in technology visible over time? On a much broader level, the theoretical emphasis also critiques southern African ceramic approaches, particularly the inattention to ceramic technology as a research field. In addition, the *chaîne opératoire* (e.g. Lemmonier 1993) is explored conceptually, by examining what ceramic variables or attributes (other than form and style) enhance our understanding of ceramic technology.

A selection of complete vessels from a permanent museum collection is used for this study, and any restrictions, constraints and limitations on this study are outlined later in Chapter 4. The vessels form part of a much larger ceramic assemblage recovered at both sites between 1933 and 1940 and are held at the University of Pretoria. Over several decades these ceramics have been identified, described, classified, analysed, researched (Calabrese 2005; Eloff 1979; Fouché 1937, Gardner 1963; Huffman 2007; Meyer 1980), and have since been formally accessioned into a curated University museum collection .This technological study is therefore the first of its kind on whole K2 and Mapungubwe vessels and signifies a stride forward in southern African ceramic archaeology.

For the purposes of this thesis, twenty-six complete ceramic vessels (see Fig. 1.1.) from the broad period ±AD 1000 – AD 1300 form the basis of this research. The scope of the study assemblage includes Zhizo and Mambo ceramics (± AD 1000 – AD 1025) excavated from K2, eight K2 ceramics (AD 1030 – AD 1220), four Transitional K2 ceramics (AD 1220 – AD 1250) and twelve Mapungubwe ceramics (AD 1220 – AD 1290). For a summary of chronology and contextual data of all ceramics refer to Appendix 1 and detail of vessel descriptions and typology refer to Appendix 2.

Although K2 and Mapungubwe sherd assemblages have successfully contributed to develop vessel typologies, technological data is limited on sherd samples. Using whole vessels maximises the interpretative value and the evidence of technical data, which cannot fully be inferred from decorated or even undecorated sherds. While much more quantitative data can be produced from sherds on future research, the entire vessel contains more technological attributes and physical manufacture evidence from its production sequence.

1.4. Thesis outline

Chapter 2 outlines the archaeological setting and context of the sites, providing an archaeological background to the broader research issues outlined above. This chapter also consists of an overview of previous ceramics research, and provides a typological and chronological baseline for this study. The literature review offers a theoretical foundation for the thesis, other approaches to ceramic technology as well as, outlines current southern African ceramic approaches and their relevance to understanding ceramic technology. The theoretical framework also addresses other social approaches, developed to understand the role of ceramic technology. The dynamics of technology and style is also addressed, as well as the concepts of the *chaîne opératoire* and technical choices in the manufacture process, providing a conceptual background to this study.

Chapter 4 comprises the methodology, and outlines a three-pronged approach, using contextual data and a set of defined variables to characterize the technological analyses, supplemented with non-invasive analysis as an aim of gathering compositional data. Information is further provided on all analytical methods, laboratory procedures and equipment used, as well as the limitations of the materials analysis on this study. Chapter 5 details the, typological, technological and compositional research data for each vessel, and investigates all twenty-six ceramics as separate analytical units ordered within a typological and chronological sequence beginning with the earliest Zhizo and Mambo ceramics, K2, Transitional K2, then followed by Mapungubwe Hill ceramics.

Chapter 6 provides a summary of the results of this study and outlines the preliminary data and technological findings, which mainly focus on the ceramic fabric, forming, firing conditions and finishing techniques to demonstrate evidence of raw materials and methods of manufacture. In addition, several lines of technological continuity and compositional variability, which possibly infer social and technical choices of potters in manufacturing ceramics, are further explored. A conclusion is drawn in Chapter 7, and summarizes the extent to which the research questions were answered, as well as outlining future research directions in ceramic technology for southern African archaeology.

Figure 1.1: All twenty-six complete ceramic vessels used for this study

CHAPTER 2

2.1. Introduction

In order to place the aims of this thesis, as outlined in Chapter one, into perspective an introduction will be provided to place the ceramics in a contextual framework. This will include an overview of the study area (see Figure 2.1.), the Shashe Limpopo Confluence Area (SLCA) the sites, as well as a brief review of the excavation history, site chronology, ceramic sequences and outline of previous research on the K2 and Mapungubwe ceramic assemblages.

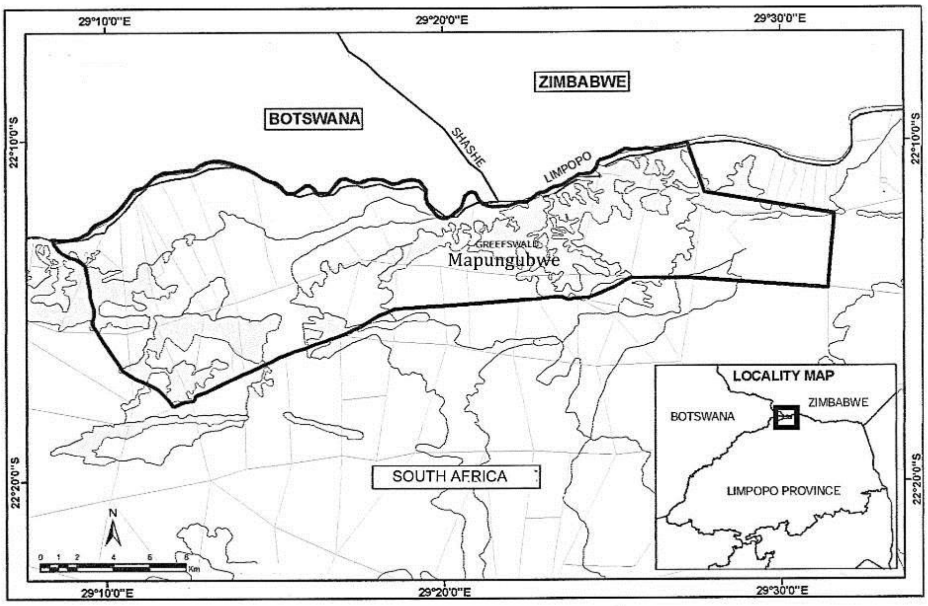

Figure 2.1: Regional map locating the Shashe Limpopo Confluence Area within a southern Africa context (Götze *et al.* 2008)

2.2. The study area and geological environment

The ceramics from this study come from the farm *Greefswald 37MS* located at 29° 22'S; 22° 12'E in South Africa's Limpopo Province (Meyer 2000:4-5). The main settlement sites of K2 and Mapungubwe Hill (Figure 2.2) lie in a shallow valley within two kilometres of the Limpopo and Shashe River systems, confluencing on the northern boundary (Limpopo Province) of South Africa, and the southern boundary of Zimbabwe and northeastern Botswana. These two Iron Age sites form part of the central core area of what is today known as Mapungubwe National Park World Heritage Site, within the greater Shashe Limpopo Transfrontier Conservation Area of southern Africa. The study area lies within the geological area referred to as the Limpopo Mobile Belt (Chinoda *et al.* 2009:24-26).

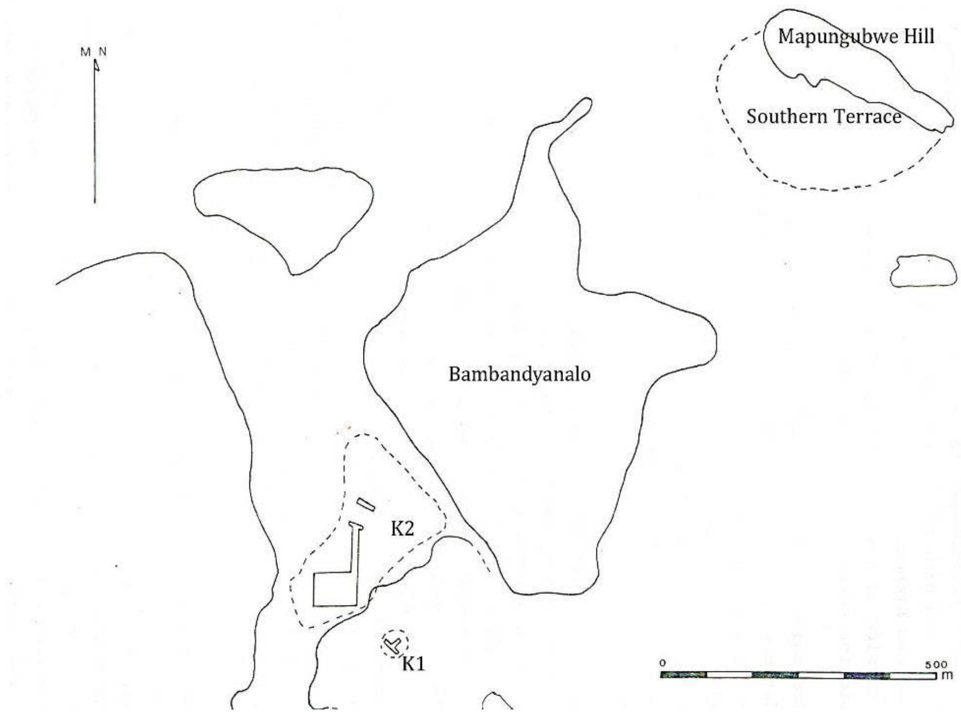

Figure 2.2: Study area of sites within the farm *Greefswald 37MS* (Meyer 1980)

The geology of the region is well-documented (Bumby 2003; Krige 1937) and is characterized by the Kaapvaal and Zimbabwe cratons comprising mainly of sedimentary rocks and mafic intrusions (McCarthy and Rubidge 2005). The term 'mafic' in this context, relates to a group of dark-coloured minerals mainly composed of magnesium and iron that frequently occur in igneous rocks. Geologically, all the igneous rocks are shallow-level intrusive rocks, and are a rock type called dolerite (Bumby 2003:7). The igneous rocks exposed in the Mapungubwe area are those which have been injected as molten magma into host rocks at fairly shallow levels (intrusive rocks-mafic) or have erupted at the surface (extrusive or volcanic rocks-ultra mafic) (McCarthy and Rubidge 2005).

These rocks are in the form of either sills or dykes, and a good example of a sub-vertical dyke can be seen cross-cutting the sedimentary strata clearly visible north of Mapungubwe Hill, as well as a sill that can be found on Bambandyanalo Hill where the hard dolerite sill acts as a resistant cap on the plateau of the hill. Mapungubwe Hill is immediately visible behind Bambandyanalo Hill, which lies just to the northeast of K2, surrounded by rocky ridges and sandstone cliffs within a sandy valley. These main sites form entrances to the Shashe Limpopo Valley (Meyer 1998:3-6).

The wider landscape and its rock formations have an important bearing on soil types and underground water, significant not only for the cultivation of sorghum and pearl millet to flourishing Iron Age communities, but particularly for the sourcing of raw material for ceramic manufacture (Manyanga 2007). Within this natural landscape, dominant features include the typical Karoo sandstone and floodplains of the Limpopo River and its many tributaries as well as the "advantages brought by the underlying geology and the resultant soils must have been noticeable to the communities, which inhabited and used this landscape" (Manyanga 2007:23-24). This Mapungubwe landscape (both natural and cultural) incorporates an extensive valley system around the Shashe Limpopo Confluence Area, as well as the surrounding plateaux, but it is the major sites of K2 and Mapungubwe Hill that represent a cultural sequence of settlement (Meyer 2000:4), subsistence farming and state development where stratified societies first developed in southern Africa (Huffman 2009:37).

2.3. The archaeological sites of K2 and Mapungubwe Hill

2.3.1. The site of K2

The approximate five-hectare site known as K2 (Fouché, 1937; Gardner 1963; Meyer 1998) is situated in a small river valley among the Karoo sandstone cliffs, with the elongated hill known as Bambandyanalo lying between K2 and the adjacent site of Mapungubwe Hill, less than a kilometre away (Figure 2.3.). The site of K2, which acted as the political centre according to Huffman (2009) partially lies above a lower valley and is characterized by a conspicuous large ash midden. On the perimeter of K2, to the north-east, is a small residential midden area forming the southern slope of Bambandyanalo Hill[1]. Archaeologically, K2 has a central cattle pattern (CCP) layout, with a central kraal and court area surrounded by a residential area, which includes Bambandyanalo (Huffman 2000, 2009; Meyer 1980, 1998, 2000). A smaller midden, known as K1 is also located to the south-eastern entrance of K2 (Meyer 1998:8). Ten of the ceramic vessels from this study come from the large excavation grid of Blocks 1-5, sections, 1-15 (see Gardner 1963). Although stone walls are absent from K2, there are 18th and 19th century Birwa stone walling on the summit of Bambandyanalo (see Huffman 2012).

[1] Recent archaeological literature utilises the name Bambandyanalo as preference over the site name K2, yet historical reports from the 1930s distinguished the site of K2 in the valley and Bambandyanalo Hill as separate localities. For the purposes of this study, the terms K2 and Bambandyanalo will be used, as the two sites are geographically distinguished and since the ceramic assemblages are also separated.

K2 is associated with 95 human burials (see Steyn 1994) distributed within the cattle kraal, ash middens or within the vicinity of the residential homesteads. Bambandyanalo is also associated with four juvenile graves as well as six so-called 'beast burials', which were cattle burials, ritually interred with grave goods, and particularly associated to spouted ceramic vessels (Gardner 1963). The excavations at K2 and Bambandyanalo have accumulated a vast amount of material culture over decades (Eloff 1979; Fouché 1937; Gardner 1963; Meyer 1980, 1998, 2000, Voigt 1978, 1981, 1983). Characteristic material culture from the site of K2 are clay figurines (indicative of ritual activity), clay animals, humans, and conical figurines (Voigt 1983), trade glass beads, garden roller beads (Wood 2000, 2011), ceramic vessels (Meyer 1980), bone and ivory fragments (Voigt 1983), iron and copper implements (Miller 1991, 2001, 2002, 2003), faunal and floral remains (Voigt 1978) as well as 'beast burials' and human remains (Steyn 1994). A wealth of such evidence reflects a developing community, that used technology to produce ceramics, indigenous glass beads (i.e. garden roller, as well as ostrich eggshell and stone beads) and metallurgical skills, together with the domestication of cattle, goats and sheep, as well as seasonal farming of sorghum, millet and beans (Meyer 1998).

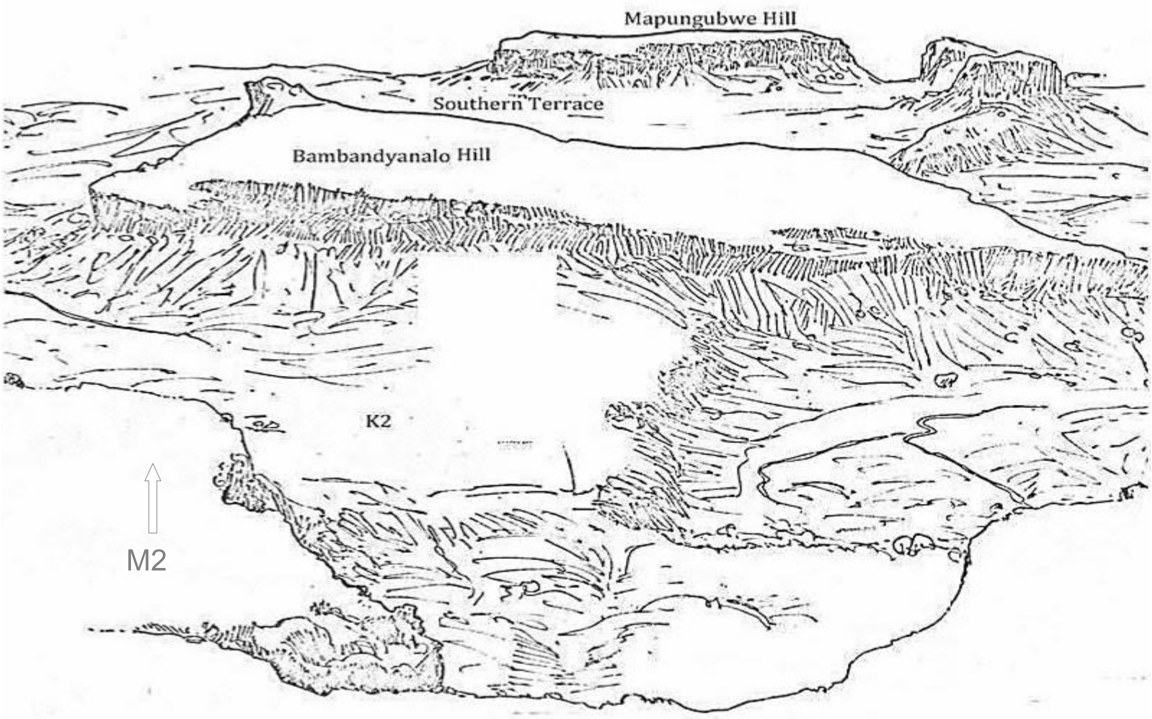

Figure 2.3: Locality and proximity of the sites K2, Bambandyanalo Hill and Mapungubwe Hill (Voigt 1978:2)

2.3.2. The site of Mapungubwe Hill

Mapungubwe Hill is a flat-topped, elongated hill, thirty metres high, three-hundred metres in length, and is encircled by vertical sandstone cliffs that are situated within surrounding floodplains and flat plateau areas (Meyer 1998). The base of the hill, marked by residential deposits to the south, is known as the Southern Terrace. This is a large settlement deposit of 260 years, with a mainly zoned area for the elite on the terraces around the hill, and commoners on the lower levels (Huffman 2000; Meyer 1980, 1998, 2000). Huffman (2009: 43) speculates that the base of the hill served as an official court area and the western portion of the hilltop consisted of residential housing for the elite, while the eastern section of the hill forms part of a palace area. This occupation of the Southern Terrace by the commoners, and the hilltop by the elite, provides the earliest evidence for class distinction (Huffman 2009).

Figure 2.4: Ceramic vessels *in situ* in 1939 from the residential area on Mapungubwe Hill (Gardner 1963)

Archaeologically, the summit of the hill is covered in a substantial deposit, with occupational or residential areas (see Figure 2.4.), palace areas, compacted gravel floors, and features such as cisterns, stone platforms, and free-standing mortar stones as well as a centralised burial area or royal cemetery (Huffman 2000; Meyer 1998; Steyn 2007). The Mapungubwe cemetery yielded twenty-seven human burials three, of which contained gold, trade glass beads, iron and copper (Steyn 1994, 2007). Evidence of gold production, spindle whorls, specialised bone tools and ceramics dominate the material culture of Mapungubwe's summit. Minor low-rise defence walling are isolated and free-standing at the east and western ascents with major stone walling, steps and passages beneath deposit on the Southern Terrace (Meyer 1998).

It is estimated that the Mapungubwe and the Southern Terrace occupation covers about 10 hectares, almost double, if not more, of the occupation size of K2, and carried a population of about 5000 (Huffman 2005; Du Piesanie 2008). The transition from K2 to Mapungubwe Hill is indisputably associated with an elite context, which serves to mark sacred leadership, express class distinction and is closely tied to rainmaking (Calabrese 2005; Huffman 2009). Political and economic control of a growing population, the exploitation of gold resources and well-established trade networks with the East Coast distinguished this hierarchical settlement at the peak of its occupation for the period AD 1250 -AD 1300, a short but concentrated 80-year period of power and socio-political control (Huffman 2009).

2.4. Excavation history

K2 was first excavated under the aegis of the University of Pretoria, by Reverend Neville Jones in 1933 and 1934, and larger seasonal excavations were then led by Capt. Guy Gardner from 1935 until 1939 (Fouché 1937; Gardner 1963). In 1935, Gardner excavated two very large trenches at K2, bisecting the central midden area and further dividing Trench (TR) 1 into thirty-four sections. From 1936 to 1940, Trench 2 was sub-divided into five equal blocks adjoining Trench 1, and deposits were stripped away in arbitrary levels of 12 inches or 30cm (Meyer 1998:21). Gardner recorded relative context according to the locations in which they were excavated, for example TR 1. B.5.S.1. 14" 10" 6" indicating test trench 1, block 5, section 1, 14" inches from the extreme left of the section, 10" inches across the section from left to right and 6" inches below the surface (Gardner 1963:3). He also further excavated 13 trial pits around the perimeter of K2 with the main aim of recovering artefacts and skeletal material, with little heed for stratigraphy.

Gardner has also been heavily criticised for his unsound methodology and lack of proper archaeological recording (Fagan 1964). At K2, Gardner (1963:37) also reportedly found hearths made of stones, and thirty-two pits which were interpreted as cooking pits or ceramic firing kilns. Meyer (1998:99-102) describes finding similar shallow pits during his excavations at K2 in the late 1970s, also possible ceramic firing pits lined with potsherds, bone fragments and ash. Between 1933 and 1940, Gardner's (1963:62) early excavations yielded about 195 complete or partially complete ceramic vessels from K2 (see Figure 2.5). Due to the historically bad recovery methods, lack of proper recording and recorded contexts, it was later estimated that a conservative estimate of 412 complete or partially complete ceramic vessels were found in total at K2 (Meyer 1980).

Figure 2.5: Representative vessels excavated in 1935 by Gardner from K2 and Mapungubwe (Gardner 1963:197)

The ceramics from Mapungubwe Hill's early 1933 exploratory excavation seasons, directed by Rev. Neville Jones, were first identified and classified by John Schofield (1937, 1942, 1948). Thereafter, excavations on the summit continued in 1934, and were led by Leo Fouché (Fouché 1937) under the directorship of Clarens Van Riet Lowe (Van Riet Lowe 1936). Assumptions were based on qualitative ceramic classifications, essentially determined by Schofield who indicated similarities between the K2 and Mapungubwe ceramic assemblages and those found in Zimbabwe (Fouché 1937; Schofield 1937).

Between 1935 and 1939, large-scale excavations were then conducted by Gardner and Van Tonder at both Mapungubwe and K2 (Gardner 1963). However, their work focused on the mass accumulation of finished artefacts, human burials as well as ceramics (see Figure 2.6), but within no stratigraphic contexts (Meyer 1998:197). In addition, many of Gardner's observations and hypotheses, particularly his 'Boskopoid ceramics' were criticised and rejected by Walton (1956) and Fagan (1970:19). During this time, the human remains excavated by Gardner from both sites were extensively examined and investigated by Galloway (1937, 1959). From 1940 onwards, for at least twenty years, very little research was undertaken, with the exception of H F Sentker's (1969) excavations in 1953-1954.

Only with improved archaeological methodology and the first radiocarbon dating (see Vogel 1998:296) of the Iron Age sites, did the research and interpretations of K2 and Mapungubwe. Today there is an increasing body of knowledge about the archaeology of the Shashe Limpopo Confluence Area emanating from Botswana and Zimbabwe, and in South Africa numerous institutions continue research (Manyanga 2007:7).

Figure 2.6: Selection of Mapungubwe burial vessels in 1935 from Mapungubwe Hill (Gardner 1963:177)

2.5. Chronology

Over decades of research (Calabrese 2000, 2005; Eloff, 1979, 1980, 1981, 1982, 1983; Eloff and Meyer 1981; Fagan 1964; Fouché 1937; Gardner 1949, 1955, 1956, 1959, 1963; Huffman 1980, 1989, 2000, 2005, 2007, 2009; Meyer 1980, 1994, 1997, 1998, 2000; Schofield 1937, 1948; Voigt 1978, 1981, 1983), a large number of radiocarbon dates were produced for K2 and Mapungubwe, yet the dating sequence still remains complex and inadequate (Vogel 1998, 2000). For the purpose of simplification Vogel's (2000) chronology sequence for the ceramics in this study will be followed (see Table 2.1). Archaeologically, the ceramics fall within the broad period of the early second millennium AD of southern Africa (AD 1000 - AD 1300). In general, K2's date range is generally accepted from c. AD 1000/1030 to about c. AD 1220, and the main or 'classic' period for Mapungubwe Hill according to Huffman (2009:45) is only from AD 1250 to AD 1290. Transitional K2 (TK2) falls within the date range of AD 1220 to AD 1250 (Huffman 2007, 2009) and its start date is essentially constrained by the presence of K2 and its end date by Mapungubwe. Transitional K2 (TK2) occurs in the very upper levels of K2 and the lower occupation areas on the Southern Terrace and on the summit of Mapungubwe Hill (Huffman 2007:283). While the dating of Transitional K2 requires a revision of the dating sequence for Mapungubwe it still needs to be more widely researched (see Van der Walt 2012:23).

Nevertheless, the occupation periods for K2 and Mapungubwe are generally divided into phases (Eloff 1979; Meyer 1998; Vogel 2000), and taking into account the revised sequence for the Transitional K2, these phases and dates have been adapted (see Table 2.1.). For this study, only two ceramics excavated at K2 (Zhizo and Mambo) may represent Phase 1 (c. ±AD 900/1000 - AD 1025), but are essentially found in 'undated' contexts, as only a small number of Early Iron Age (EIA) sherds have been found and associated to this earliest phase (see Meyer 1980:181-183). The K2 ceramics for this study mainly reflect Phase Two, which is associated with the main occupation period from c. AD 1000/1030 to AD 1220 (Vogel 2000).

Mapungubwe (Phase 4) AD 1250 - AD 1290			
Mapungubwe Hill			
MK4	60 - 75 cm	Pta. 6692-bp 720±40	1285 - 1305
Skeletons	Gr7	Pta. 3480-bp 770±40	1265 - 1290
Gr6		Pta. 3480-bp 850±40	1200 - 1265
Southern Terrace			
H5	L2ii	Pta. 1138-bp 590±50	1320 - 1345
K8	L1ii	Pta.1209-bp 770±50	1260 - 1295
L2ii		Pta. 752-bp 790±50	1250 - 1290
Transitional K2 (Phase 3) AD 1220 - AD 1250			
Mapungubwe Hill			
MK1	L11	Pta. 1159-bp 840±40	1210 - 1270
165 cm		Pta. 1158-bp 850±50	1195 - 1270
Block 6/4		Pta. 372-bp 880±45	1170 - 1250
K2 (Phase 2) AD 1030 - AD 1220			
A6	L11	Pta. 0307-bp 930±45	1040 - 1200
TS 1	L2	Pta. 1214-bp 980±40	1025 - 1160
TS 3	L24	Pta. 1226-bp 950±50	1030 - 1190
TS4	L4	Pta. 6073-bp 920±50	1050 - 1175
TS 6	L7	Pta. 6080-bp 940±50	1040 – 1220
Middle Iron Age (Phase 1) c. AD 900			

Table 2.1: Radiocarbon dating sequence for Mapungubwe and K2
(See Huffman 2007:288; Meyer 1998:298; Van Der Walt 2012:23-24; Vogel 2000:56)

These K2 dates however are questionable, based on Calabrese's (2005:27) revised dates for the *Greefswal*d sites (see Calabrese 2005). He claims that a far more reliable range for K2 would be AD 1000 to about AD 1040, since the lower layers of occupation at Mapungubwe also contained K2 ceramics. According to Vogel (1998:296-297) it is not possible to clearly define whether the beginning of occupation at K2 was AD 1030, or even earlier i.e. AD 1000 and given the evidence of both Zhizo and Mambo ceramics at K2 (Meyer 1980:278). Therefore only a precise date for initial or early occupation at K2 can be derived from preceding phases within the ceramic sequence such as Zhizo (c. AD 900). For the purposes of this study, Vogel's (2000) generally accepted date range of AD 1030 to AD 1220 (Phase 2) for K2 will be retained.

Phase Three (Transitional K2) of the continued occupation period for the Southern Terrace and Mapungubwe Hill ranges from AD 1220 - AD 1250, with Phase Four or 'Classic' Mapungubwe (Huffman 2007) representing the final occupation period of Mapungubwe AD 1250 to AD 1290 (Vogel 2000). The gold burials as well as, the ceramics associated to the grave area have also been attributed to this later Mapungubwe occupation period (see Steyn 2007; Vogel 1998, Woodborne *et al.* 2009).

PHASE	DATE	OCCUPATION	CERAMICS
	Before AD 800	Settlement of Early farming communities	Rare occurrence of Early IA potsherds
PHASE ONE	c. AD 900 c. AD1000	Schroda Leopards Kopje/Early K2	Zhizo Leopard's Kopje
PHASE TWO	c. AD 1000 - AD 1220	K2 occupation	K2 ceramics
	AD 1220 - AD 1250	Transitional K2 (TK2)	TK2 ceramics Upright triangles in lower neck and upper shoulder, alternating triangles on beakers
PHASE THREE	AD 1220 - AD 1250	Mapungubwe Hill occupation	Mapungubwe ceramics
PHASE FOUR	AD 1250 - AD 1290	Mapungubwe final occupation Decline	Mapungubwe bowls i.e. particularly shallow bowls associated with gold burials

Table 2.2: Phases or periods of occupation regarding K2 and Mapungubwe, site settlement chronology and associated ceramics (Adapted from Eloff 1979; Meyer 1998; Vogel 1998, 2000)

2.6. Archaeological background

From about AD 900, early farmers known as Zhizo and Leopards' Kopje settled in the Shashe Limpopo Confluence Area region (Huffman 2009:42). The appearance of the early farmer ceramics (c. AD 900 – AD 1000) are placed within the Gokomere Tradition known as Zhizo, and the later ceramics (AD 1000 – AD 1200), placed within the Kalundu Tradition, are referred to as Leopards Kopje.

The Leopard's Kopje site was first identified by Robinson (1966) in southwestern Zimbabwe, and was distinguished as a ceramic style by Huffman (1984) into two distinct typologies, i.e. early comb-stamped ceramics and later incised ceramics. Zhizo ceramics, according to Huffman (1974), are characterized by vessels with bands of oblique incisions and comb-stamping on the lower rim, stamped triangles on the upper shoulder, followed by a horizontal line of stamping. This ceramic style spread into adjacent areas of Botswana, the Shashe Limpopo Confluence Area and over southwestern Zimbabwe (Hanisch 1980; Huffman 1974, 1984; Robinson 1966). Although Zhizo ceramics make their appearance earlier in eastern Botswana, by least AD 700, and also appear in southwestern Zimbabwe around AD 800 (Huffman 2007), in South Africa these ceramics are identified with the largest Zhizo settlement of Schroda by AD 900 (Hanisch 1980, 1981).

The Zhizo capital of Schroda has been most commonly interpreted as the political centre of the region between around AD 900 and AD 1000 (Calabrese 2005:122). The Schroda ceramic assemblages are part of the broader Zhizo style, and the combination of comb-stamping and incision techniques are a common feature of Schroda ceramics (Calabrese 2000; Hanisch 1980). Stylistically, the key features of Zhizo ceramics include a rim/shoulder layout with triangles and hatched bands of comb-stamping (Huffman 2007). Schroda's characteristic Zhizo ceramic style largely disappeared from southwestern Zimbabwe and other settlements with Zhizo-derived ceramics now, called Leokwe ceramics, which are considered contemporaneous with K2 (see Calabrese 2005). Calabrese (2005) has demonstrated that Zhizo ceramics transformed into Leokwe, which is contemporaneous with K2. According to Du Piesanie (2008:89), stylistically the major differences in style and shape between Zhizo and Leokwe ceramics reflect the influences of K2 on Leokwe. According to Calabrese (2005:266-237), Leokwe ceramics continues the layout and decoration technique with multiple lines of stamping on the neck and stamped triangles in a new position on the lower shoulder, therefore there can be no doubt that Leokwe ceramics developed out of Zhizo ceramics. Schroda maintained political control as a Zhizo capital until around AD 1000. Schroda's final occupation is generally thought to correspond with the initial occupation the site K2 (Calabrese 2005:122).

By AD 1000, agro-pastoralists had established communities who settled more permanently along the Shashe and Limpopo rivers, making use of the natural resources for agriculture, i.e. cattle grazing and crop farming, important resources for the growing, competitive, and increasingly 'hostile', Iron Age populations (Huffman 1978, 2005).

During this dynamic period, K2 was established as the new capital by people who expanded their territory, and whose networks of interaction may be traced by means of the Leopard's Kopje ceramics (Huffman 2000). The widespread distribution of K2 ceramics across the broader Shashe Limpopo landscape, suggests access to primary resources and agricultural land, dominated by the K2 community (Du Piesanie 2008).

K2 society was considered rank-based, socially organized around a central cattle kraal. This Central Cattle Pattern (CCP) shows that social and political ranking was based on the unequal distribution of cattle and other wealth (cf. Huffman 1996). The depth of stratigraphy at K2 also shows that the site was occupied for a long time by people who lived in large household units, and the presence of several more cattle kraals suggest that K2 was a large community who were probably based on kinship ties (Manyanga 2007:106). During the approximate 200-year K2 occupation, society underwent inevitable political, economic, ritual and technological changes. Huffman (2007, 2009) attributes this rise of increasing social complexity at K2 to control of the east coast trade, although no doubt K2 leaders also controlled wealth in cattle. It, it is against this background, that K2 and Mapungubwe developed and dominated the Shashe Limpopo Confluence Area from about AD 1000 to AD 1290. This period is marked by southern Africa's Iron Age and a dating sequence for the Mapungubwe region has thus already been well-established for the ceramics (See Figure 2.7).

2.7. K2 and Mapungubwe AD 1000 to AD 1300

By circa AD 1000/1030 a new capital was established at K2 (Eloff 1979; Fouché 1937; Gardner 1963, Huffman 2000; Meyer 1980). Similarly to Schroda, K2 people also practiced agro-pastoralism, and due to climate change and higher rainfall periods (see Smith *et al.* 2007), made use of floodplain agriculture for the cultivation of crops and animal domestication (Voigt 1978, 1981, 1983), thereby increasing in population size (Huffman 2000; Smith 2005). By at least AD 1060, available evidence suggests that K2 was the largest capital of the early Leopard's Kopje settlements (Calabrese 2000:188) in the Shashe Limpopo region, perhaps even a regional political centre due to the presence of having a central cattle pattern (CCP) layout, an apparent indicator of political activity (see Huffman 2000:16). K2 served as a major economic, trade and political centre for nearly two centuries, and was then later abandoned for a much larger settlement, nearby at Mapungubwe Hill by AD 1220. According to Huffman (2000:22) the abrupt abandonment of K2, coincides with an immediate increase of K2 settlement around Mapungubwe, which probably sheltered a new court and the absence of a nearby cattle kraal.

During this move from K2 to Mapungubwe Hill, a period of change was initially recognised by Meyer (1980), which Eloff and Meyer (1981) then attributed to an influx of new people. This change is now distinguished as a transitional phase (TK2) between K2 and Mapungubwe and has been confirmed by Leokwe Hill dates (Calabrese 2000), and is also reflected in the Indo-Pacific green trade glass beads as chronological markers (see Wood 2000). There is a marked change in the ceramics, which has now been formally defined by Huffman (2007) as Transitional K2 or TK2 (see Van der Walt 2012) with a date range between AD 1220 and AD 1250.

It is generally accepted that the K2 capital moved to Mapungubwe Hill, less than a kilometre away, where the elite were physically separated from the commoners below on the Southern Terrace court (Huffman 2000:21-22). After the capital was relocated to Mapungubwe, some people lived in the front court area, but some moved onto the summit. Following the rise of Mapungubwe, the K2 ceramic style began to change, although Huffman explicitly argues for population continuity between K2 and Mapungubwe. However, according to Huffman (2000:21), the ceramic differences are not stylistically abrupt…instead, the surface finish was merely enhanced, the earlier K2 designs became more complex, and the new types only gradually replaced others.

Huffman (2000) attributes these changes due to the emergence of full-time specialists who were a consequence of increasing populations and developing class structure. From AD 1220 to AD 1290, in this short time frame, the spatial organization continued to evolve into a distinct, new elite pattern, which 'probably crystallised by AD 1250', the new Mapungubwe ceramic style also probably evolved at this time (See Huffman 2000:21-22). This spatial shift away from the central cattle pattern (see Huffman 1996, 2000) and the introduction of gold technology also represents the materialization of class distinction (Huffman 2009:44). Mapungubwe Hill prospered and rose to power as a brief, yet intensive complex elite centre for about eighty-years before its abandonment by AD 1300 (Vogel 2000). These two early second millennium Iron Age settlements of K2 and Mapungubwe are significant ceramic identity markers for the Shashe Limpopo Confluence Area. They provide evidence of ranked-based society at K2, and later a stratified community, separating the elite from the commoners at Mapungubwe Hill, thus bringing about not only complex political changes but also significant social and technological developments in southern Africa (Huffman 2009).

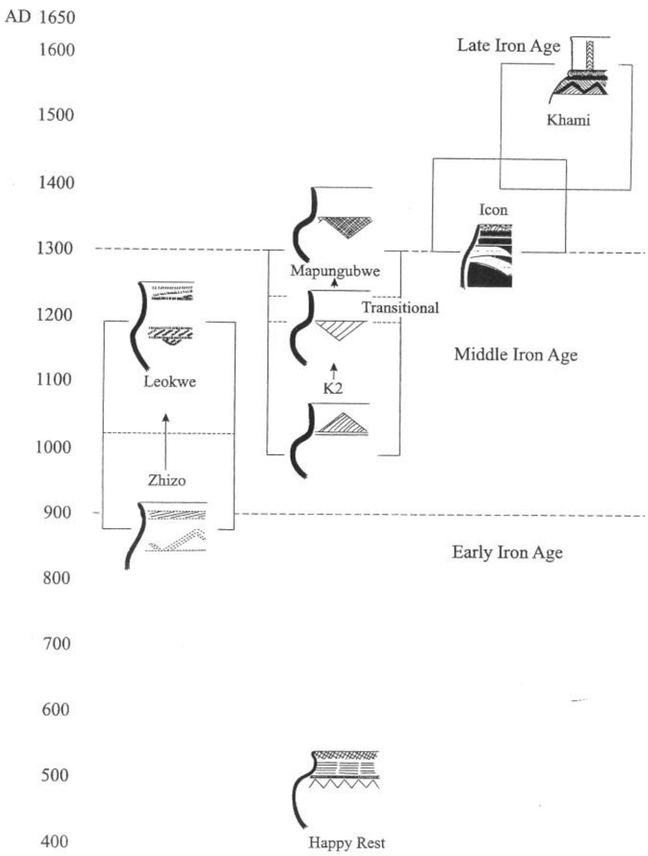

Figure 2.7: Iron Age ceramic sequence for the Mapungubwe region (Huffman 2009:41)

2.7.1. The K2 and Mapungubwe ceramic sequence

The K2 and Mapungubwe ceramic sequence has been developed by several researchers (Calabrese 2005; Eloff 1979; Fouché 1937; Gardner 1963; Huffman 2007; Meyer 1980, 1998, 2000; Schofield 1948). As mentioned previously, K2 and Mapungubwe are represented by the Leopard's Kopje culture (Huffman 1978), which represents the most successful period of occupation by Iron Age farming communities in the Shashe Limpopo Valley (Manyanga 2007:105). Typologically, Huffman (1974, 2007) places K2 ceramics into a southern variant branch of Leopard's Kopje A, which included a northern Mambo branch and places Mapungubwe ceramics into the southern variant branch of Leopard's Kopje B, which included a northern Woolandale branch (Meyer 1980:45-46). However, in southwestern Zimbabwe, they were termed Mambo and Woolandale (see Figure 2.8 for comparison of Zhizo and Mambo ceramic types) and the South African variants of Phases A and B were called K2 and Mapungubwe respectively (see Figure 2.9).

The ceramics from this study are therefore represented by the K2 and Mapungubwe phase periods, which generally accepts that the sequence consists of several phases or periods of occupation (see Table 2.2.)

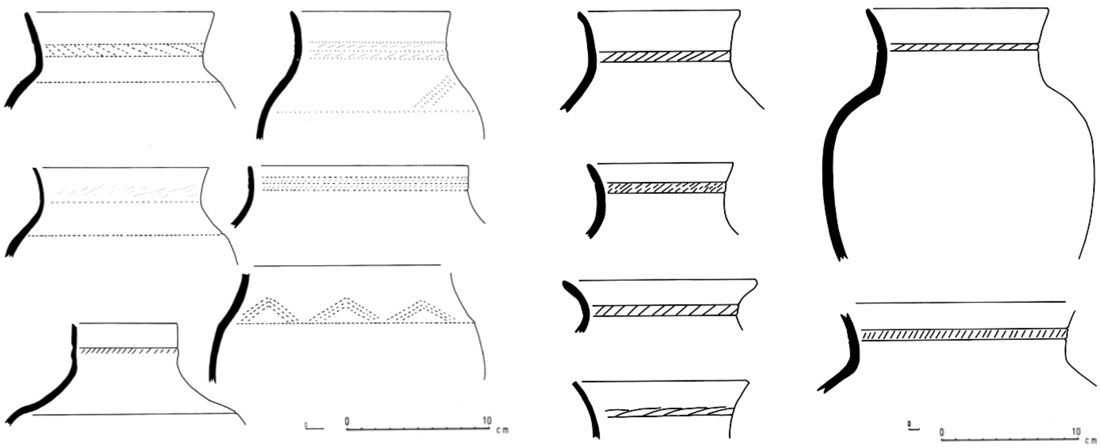

Figure 2.8: Examples of Mambo type ceramics (right) and Zhizo type ceramics (left) from southwestern Zimbabwe (Calabrese 2005:11)

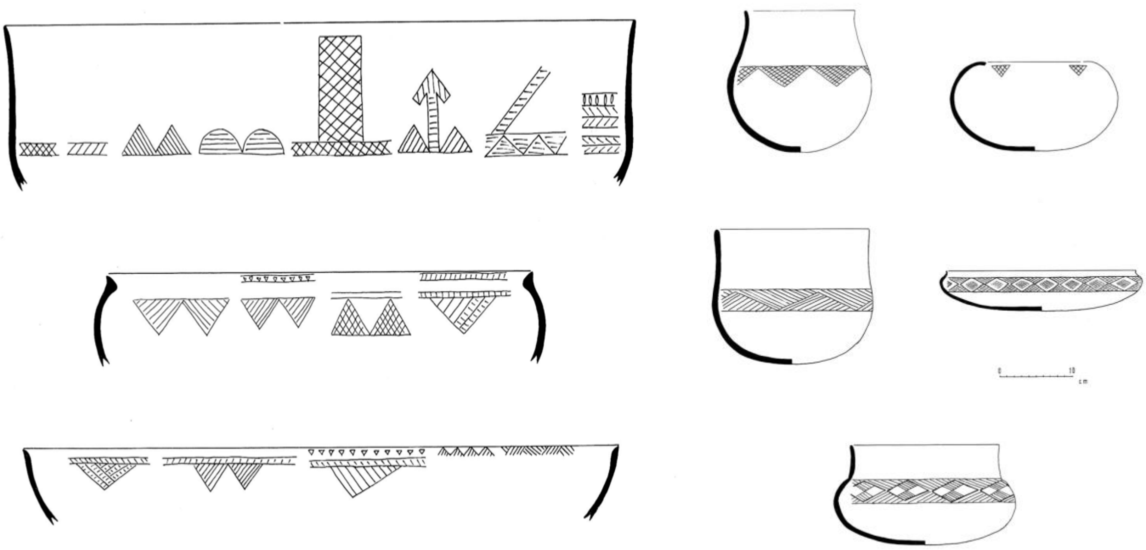

Figure 2.9: Examples of K2 type (left) and Mapungubwe type ceramics (right) (Calabrese 2005:28-29)

2.8. Previous ceramics research

These ceramic assemblages are some of the most well-known in southern African Iron Age archaeology, and many researchers largely depended on K2 and Mapungubwe ceramics to develop typologies and cultural sequences within the Shashe Limpopo Confluence Area. The study of these ceramics has also undoubtedly established a long research history (e.g. Calabrese 2000, 2005, 2007; Eloff 1979; 1980, 1981, 1982, 1983; Fagan 194, 1970; Fouché 1937; Gardner 1949, 1955, 1956, 1959, 1963; Huffman 1980, 2000, 2007, 2009; Lindahl and Pikirayi 2010; Meyer 1980, 1998, 2000; Pikirayi 2007; Schofield 1937, 1942, 1948; Sentker 1969).

2.8.1. Schofield

Schofield (1937, 1942[2], 1948) was the first to research and publish his findings on the K2 and Mapungubwe ceramic sequence, and was the first to also allude to aspects of ceramic manufacture, decorative and production techniques (Schofield 1948). Schofield (1937) was also the first to set up a classification system for the Mapungubwe and K2 ceramics, which was based on conventional typological aspects such as vessel shape and features such as rim shape, decoration, and finish. Schofield's (1937) original classification system broadly consisted of M_1 or Mapungubwe ceramics, M_2 ceramics were from K2 (now recognized as consistent with the modern K2 typology) and M_3 intrusive or imported ceramics (see Figure 2.10):

- M_1 Very fine burnished ware with well-drawn decoration incised on wet clay, of which the finest vessels were the shallow bowls (Mapungubwe ceramics).
- M_2 Rougher ware than M_1. Similar decoration but more roughly executed and minor differences in vessel form (K2 ceramics).
- M_3 A small class of intrusive vessels, with carinated forms and herringbone motifs; comparisons were made with ceramics from Zimbabwe, Botswana as well as Venda and Sotho ceramics (imported ceramics) (see Fouché 1937:94-95).

Schofield (1937) argued that ceramic vessels appeared homogenous throughout K2 and Mapungubwe and his two-fold typological division distinguished between rougher ceramics from K2 that were found in middens and under-floor fillings, with the finer ceramics from Mapungubwe that appeared in graves. Schofield also did not examine ceramic chronology and made little mention of the stratigraphy of Mapungubwe Hill, except for his ceramic frequency calculations (see Table 2.3.).

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[2] Schofield, J.F. March 1942. *The Pottery of the Mapungubwe District* Part II Original field report 1934-1942. Held in the Mapungubwe Archives, University of Pretoria UP/AGL/D/804

His comparisons were probably also based on Gardner's excavated ceramics. Schofield concluded that the rarer Mapungubwe (M_1) and K2 (M_2) ceramics were typologically distinct, and the closer one got to the surface, the more closely the two groups appeared typologically, arguing that just before the site was abandoned, the two ceramic traditions completely merged. Despite the fact that their site interpretations clearly contradicted one another, Schofield and Gardner reached similar conclusions that the ceramics in the upper deposits differed vastly from the ceramics in the lower layers (Meyer 1980).

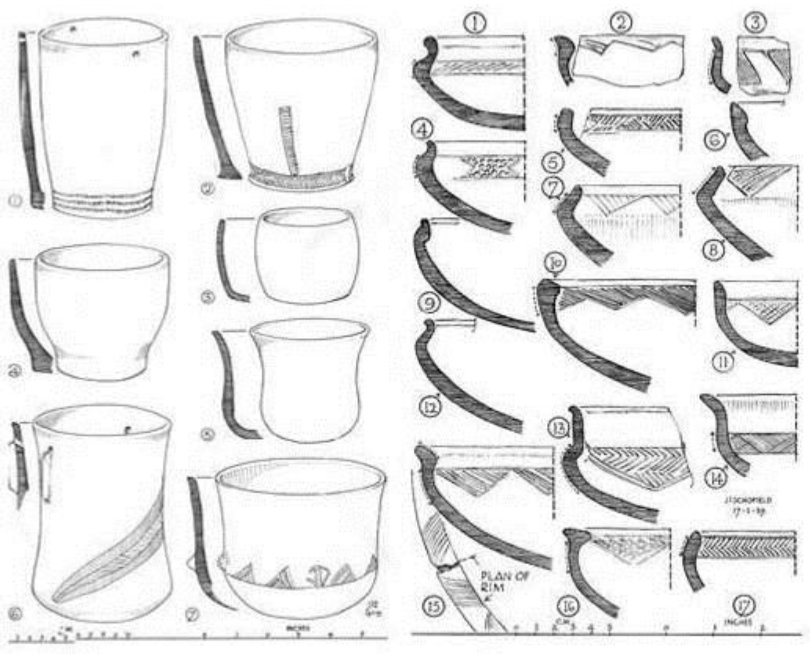


Figure 2.10: Example of Schofield's 1937 ceramic representations of known as M_2 from K2 (left) and ceramics known as M_1 from Mapungubwe Hill (right)

Depth			**Number of vessels**		**Percentage of total**		
	M1(Map)	M2(K2)	Indefinite	Total	M1	M2	Indefinite
1st foot	95	5	4	104	91.5%	4.8%	3.7%
2nd foot	119	13	9	141	84.5%	9.2%	6.3%
3rd foot	102	9	8	119	85.5%	7.5%	7.0%
4th foot	85	30	19	134	63.5%	22.4%	14.0%
5th foot	47	37	15	99	47.5%	37.5%	15.0%
9th foot	34	21	9	64	53.2%	32.7%	14.1%
7th foot	28	43	12	83	33.7%	51.7%	14.6%
8th foot	15	17	7	39	38.5%	43.5%	18.0%
9th foot	5	6	0	11	45.5%	54.5%	0.0%
10th foot	-	-	-	2	-	-	-
11th foot	4	11	2	17	23.5%	64.7%	11.8%

Table 2.3: Analytical table of estimate vessel distribution from Schofield's 1942 quantification

Schofield did manage, however, to determine the more recent Mapungubwe ceramics. (M_1) were different from the older, K2 ceramics (M_2). He noted that fine-lined incisions dominated the younger ceramics, while the coarser incisions and some comb-stamping prevailed in the older assemblages (Calabrese 2005:26). Both the ceramic sequences and typologies put forward by Schofield (1937) and Gardner (1963) were subsequently deemed inadequate, and so a re-examination of the cultural sequence, as well as new excavations were called for. This move was supported by other Iron Age archaeologists such as Inskeep (1969:34); Summers (1967:694) and Fagan (1970:197-198).

According to Fagan (1964:355), Schofield said little about the stratigraphy of the Mapungubwe Hill ceramics in 1937, but returned to the subject in 1948 and summarized the following: "For the first foot of the excavation, 91.5% of the pottery found belonged to Class M_1 (i.e. Mapungubwe), 4.8% belonged to this second type (provisionally called Class M_2 i.e. K2), and 3.7% was indefinite; but in the seventh foot the proportions were respectively 33.7%, 51.7% and 14.6% (Schofield 1948). The ceramic sequence of Schofield was later revisited, quantified and tabulated by Summers in 1966 (see Table 2.4).

Vessel type	**Depth of excavation in feet measured from surface**						**Quantity**					
	1	2	3	4	5	6	7	8	9	10	11	Total
Shallow bowls	33	42	23	21	17	8	6	2	-	-	-	152
M1 Map Bowls	11	22	30	23	18	17	15	6	4	-	3	
Pots	27	36	31	39	14	6	9	4	1	-	1	
M1 Total	38	58	61	62	32	23	24	10	5	-	4	317
M2 K2 Bowls		1	3	4	11	6	13	11	-	-	7	
beakers	1	1	-	1	1	-	7	1	1	-	1	
pots	-	4	1	12	14	6	21	14	3	-	3	
spouts	-	-	-	2	-	-	4	2	-	-	-	
'model pots'	-	3	-	2	2	2	1	-	-	-	2	
M2 Total	1	9	4	21	27	14	46	28	4	-	13	168
M3 (intrusive) indefinite	-	1	1	2	2	2	3	1	-	-	-	12
Total number of vessels	72	110	89	106	79	47	79	41	9	-	17	649

Table 2.4: Analytical table of estimated vessel distribution from Summers 1966 quantification

Both Inskeep (1969:34) and Fagan (1970:197) stressed the interrelationship of K2 and Mapungubwe ceramics as worth investigating, particularly the last phases of K2 and early phases of Mapungubwe. These recommendations were taken up by Eloff (1979), followed by Meyer (1980) who resumed Sentker's (1969) excavations on the Southern Terrace to investigate this particular phase, which is now referred to as Transitional K2 (Huffman 2007).

2.8.2. Eloff and Meyer

A major contribution to the ceramic sequence was the fieldwork of J F Eloff (1979, 180, 191, 1982, 1983) and A Meyer (1980, 1994, 1997, 1998, 2000). They both identified that the salient problem of the sequence was a major lack of stratigraphic contexts for the *Greefswald* ceramics. Meyer (1980:52) only focused on ceramics from both localities, largely using the material excavated in 1971 from proper stratigraphic contexts. Eloff and Meyer (1981) improved upon Schofield's initial ceramic classifications by refining the interpretation of the *Greefswald* ceramic sequence by employing vertical and lateral stratification frameworks to distinguish the two apparently different ceramic traditions. Their major aim was to conduct research along acceptable practices, using sound methodology, so they could come to accurate conclusions about the contexts of the ceramics, and determine the broad cultural relationships of the ceramics (Eloff 1972, 1979; Eloff and Meyer 1981; Meyer 1980). Meyer (1998:219) also built upon earlier ceramic frequencies for K2 and Mapungubwe, and provides a comparison of his K2, Mapungubwe and non-typical ceramic variations with that of Schofield (see Table 2.5).

Meyer's (1980) preferred approach to the ceramics was solely based on typological attributes and claims that technology cannot be utilized with the same success (Meyer 1980:52). His choice of approach is justified in his pivotal 1980 study for the following reasons. First, technology and function can only be adequately determined through ethnological research among living communities. Second, typology is determined by tradition, i.e. carried over from one pottery generation to the next, and it is this style that distinguishes one from the other. Meyer's typology was however extensively detailed, which was largely conducted on ceramics recovered between the 1971-1979 excavations and based on 3384 decorated sherds, including complete vessels from the 1930s excavations. The criteria he used to establish ceramic attributes included vessel shape, lip form, surface colour, quality of surface finish (polish and levelling of surface), decoration, quality and position of decoration, diverse additions such as spouts, lugs and their positions (Meyer 1980).

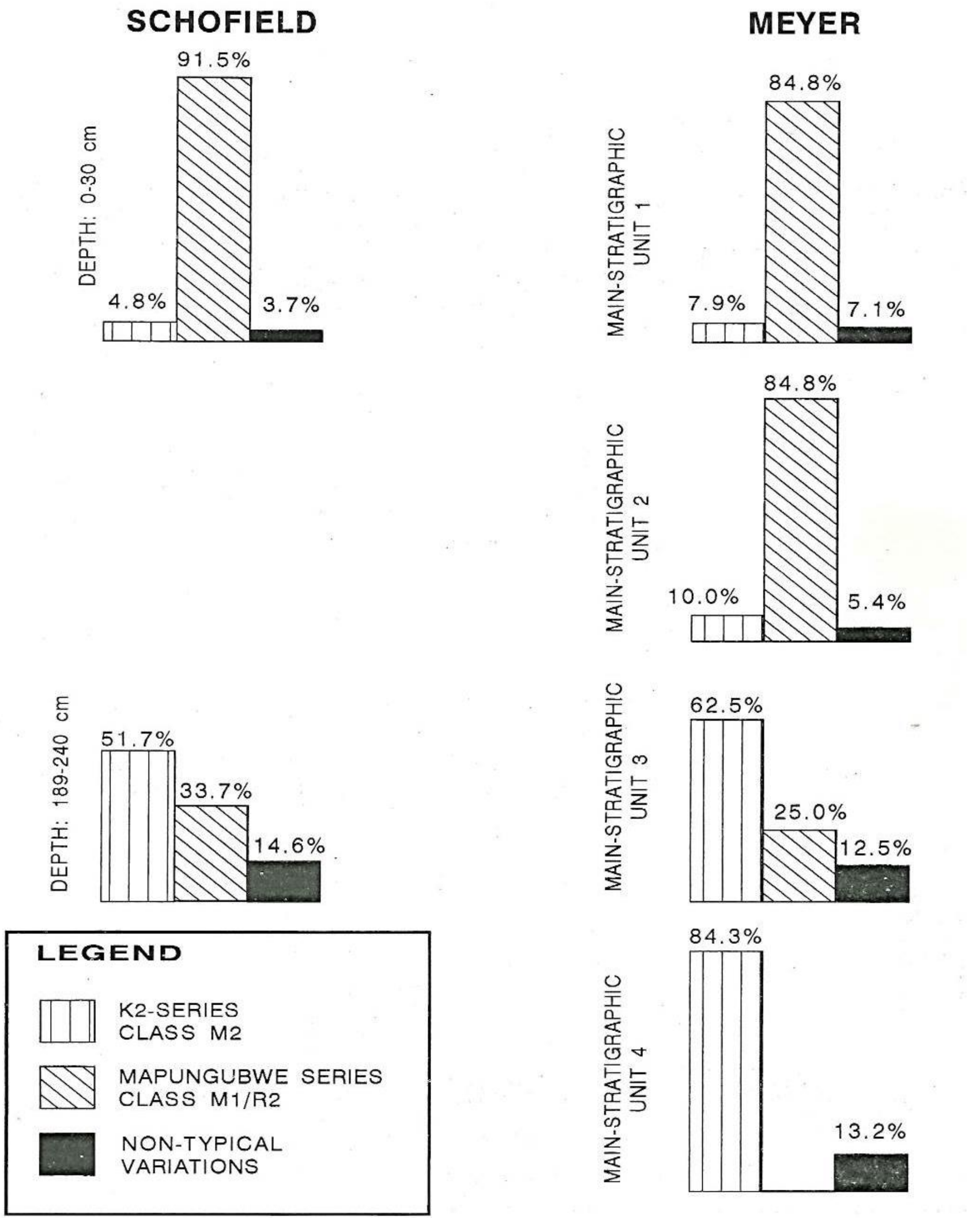


Table 2.5. Comparative ceramic frequency for K2, Mapungubwe and non-typical variations by Meyer and Schofield (Meyer 1998:219)

Meyer (1980) classified K2 vessels into six types and Mapungubwe vessels into ten types, according to shape, with over thirty attribute combinations or sub-forms. He further identified 41 decorative groups. Meyer's (1980) ceramic frequencies within each layer and locality are provided in Table 2.6 and Table 2.7. The typological classification according to Meyer (1980) concluded with two groups of vessels being distinguished, which he termed the K2 Vessel Series and the Mapungubwe Vessel Series. The K2 Vessel Series was found exclusively at K2 and in the bottom layers at Mapungubwe, but also in the more recent layers at Mapungubwe, the K2 Vessel Series was largely replaced by the Mapungubwe Vessel Series (see Meyer 1980, 2000).

In summary the K2 vessel series according to Meyer (2000:11) is characterized typologically as follows: spherical pots with short necks and mostly incised decorative motifs; hemispherical open bowls; spherical pots without necks but with small openings, often combined with spouts; deep beaker-shaped bowls, mostly with incised decoration; beakers, mostly with incised decoration; and a small number of spherical pots with necks and comb-stamp decoration. The Mapungubwe vessel series is characterized by round-bellied pots with necks and mostly incised decoration; wide-bellied pots with necks and incised decoration; shallow bowls with and without incised decoration and deep bowls with restricted orifices (Meyer 2000:11).

Meyer's (1980) conclusions for the Southern Terrace ceramics indicated heterogeneity, claiming that the ‘disappearance' of the K2 potters coincided with the arrival of Mapungubwe potters, confirming that the ceramics showed a definite similarity to those of K2, but acknowledged some differences as well. Of course it is now firmly established that the change in K2 style to Mapungubwe style did not signal the appearance of new people or a new population (e.g. Gardner 1959; Meyer 1980). Meyer's (1980) major contributions to the ceramic sequence, although often forgotten, laid the ceramics research foundation for some from the 1980s onwards. His typological approaches have always been accurate, detailed and methodical, but unfortunately are seldom used, perhaps because his major contribution (as well as that of Eloff 1979) was published in mainly Afrikaans, and as a direct result many have since chosen to rather follow Huffman's (1980, 2007) multi-dimensional stylistic approach, which is also much accessible and wider published (Huffman 1974, 1978, 1980, 1984, 1986, 1989, 1996, 2007, 2009).

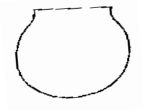
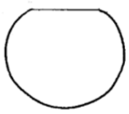
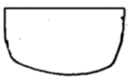
		K2	SOUTHERN TERRACE				MAPUNGUBWE HILL			
K2 Type vessels	**Layers**	**1- 4**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
TYPE 1 Form 0503 		259 29.3%	1 0.6%	8 7.0%	16 20.0%	5 20.0%	6 4.3%	6 3.5%	9 22.5%	20 44.4%
TYPE 2 Form 0203 		207 23.4%	14 8.1%	5 4.3%	17 21.3%	9 36.0%	5 3.6%	8 4.7%	9 22.5%	11 24.4%
TYPE 3 Form 0201 		111 12.5%	2 1.2%	0 -	4 5.0%	0 -	0 -	3 1.8%	2 5.0%	2 4.4%
TYPE 4 Form 0116 		76 8.6%	0 -	1 0.9%	7 8.8%	7 28.0%	0 -	0 -	3 7.5%	1 2.2%
TYPE 5 Form 0115 		13 1.5%	0 -	0 -	1 1.3%	1 4.0%	0 -	0 -	0 -	1 2.2%
TYPE 6 Form 0100 		88 9.9%	1 0.6%	1 0.9%	6 7.5%	0 -	0 -	0 -	2 5.0%	3 6.7%
Infrequent ceramic types/ Non-Typical		131 14.8%	11 6.4%	17 14.9%	6 7.6%	3 12.0%	10 7.1%	9 5.4%	5 12.5%	6 13.2%
	TOTAL %	**754** 85.2%	**18** 10.5%	**15** 13.1%	**51** 63.9%	**22** 88.0%	**11** 7.9%	**17** 10.0%	**25** 62.5%	**38** 84.3%

Table 2.6: Quantification of K2 type vessels within stratigraphic contexts
(Adapted from Meyer 1980 Table 39)

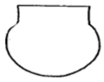
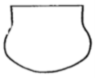
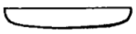
		Southern Terrace				**Mapungubwe**			
Mapungubwe Type vessels	**Layer**	**1**	**2**	**3**	**4**	**1**	**2**	**3**	**4**
TYPE 1 Form 0603 		17 9.9%	4 3.5%	-	-	25 18.1%	26 15.3%	2 5.0%	- -
TYPE 2 Form 0604 		15 8.7%	14 12.2%	1 1.3%	- -	19 13.8%	31 18.2%	- -	- -
TYPE 3 Form 0901 		21 12.2%	5 4.3%	- -	- -	16 11.6%	15 8.8%	- -	- -
TYPE 4 Form 0902 		4 2.3%	2 1.7%	- -	- -	3 2.2%	3 1.8%	1 2.5%	- -
TYPE 5 Form 0402 		22 12.8%	16 13.9%	3 3.8%	- -	16 11.6%	31 18.2%	1 2.5%	- -
TYPE 6 Form 0401 		15 8.7%	7 6.1%	- -	- -	10 7.2%	11 6.5%	- -	-
TYPE 7 Form 0403 		4 2.3%	- -	- -	- -	7 5.1%	1 0.6%	- -	- -
TYPE 8 Form 0303 		32 18.6%	19 16.5%	12 15.0%	- -	12 8.7%	20 11.8%	3 7.5%	1 2.2%
TYPE 9 Form 0302 		4 2.3%	10 8.7%	7 8.8%	- -	5 3.6%	2 1.2%	3 7.5%	- -
TYPE 10 Form 0301 		9 5.2%	6 5.2%	- -	- -	4 2.9%	4 2.4%	- -	- -
Infrequent ceramic types		11 6.4%	17 14.9%	6 7.6%	3 12.0%	10 7.1%	9 5.4%	5 12.5%	6 13.2%
	TOTAL **%**	**143** 83.0%	**83** 72.1%	**23** 28.9%	- -	**117** 84.8%	**144** 84.8%	**10** 25.0%	**1** 2.2%

Table 2.7: Quantification of Mapungubwe type vessels within stratigraphic contexts (Adapted from Meyer 1980 Table 39)

2.8.3. Huffman

The ceramic sequence for K2 and Mapungubwe, according to Meyer (1980:49) was largely determined by the previous works of Schofield (1948) and Robinson's (1966) identification of Leopard's Kopje. Yet, the earlier ceramics research by TN Huffman also made substantial contributions. In the early 1970s, Huffman based most of his ceramic analysis on shape, size, geometric style of decoration, position of decoration and also considered surface finishes to a small extent. He mainly developed ceramic types according to shape, which he then further divided into size and combinations of decoration (see Huffman 1974). Huffman focused on Leopard's Kopje chronologies and radiocarbon dating, advocating a clearer classification system of ceramics together with reliable radiocarbon dates. He developed ceramic sequences over time, based on as many attributes as possible for the identification of ceramic traditions (Meyer 1980:45).

Huffman (1974:45) determined fourteen classes of ceramic types which were defined by means of qualitative attributes and quantitative identification of attribute combinations within stratigraphic contexts. Huffman's (1980) multi-dimensional approach using ceramic types formed by the profile, decoration layout and motif (see Figure 2.11) is still mainly used as a standard means of analyses for most of K2 and Mapungubwe ceramic assemblages (Huffman 1974, 1978, 1980, 1984, 1986, 1989, 1996, 2000, 2007, 2009). Huffman usually employs the 'linking people with pots' approach (Hall 1984), using ceramic units or facies to represent linguistic entities; implying groups of people produce related ceramic facies.

Conventionally, Huffman (1974, 2007) classifies ceramics as part of a unit or facie, which belong within a broader ceramic tradition. In the case of the K2 and Mapungubwe 'facies' (see Huffman 2007: 279-288) he has further expanded these and has since defined Transitional K2 (see Figure 2.12 for examples)ceramics, which are then grouped under the Leopard's Kopje Cluster within the much broader Kalundu tradition (Huffman 2007:114). Of main relevance to this study is his Transitional K2 ceramics (AD 1220 -AD 1250), which can be summarized and characterized as follows:

- Spherical pots with short necks and mostly incised decorative motifs
- Hemispherical open bowls
- Spherical pots without necks but with restricted orifices (often combined with spouts)
- Deep beaker-shaped bowls, mostly with incised decoration
- Beakers, mostly with incised decoration
- Spherical pots with necks and comb-stamp decoration

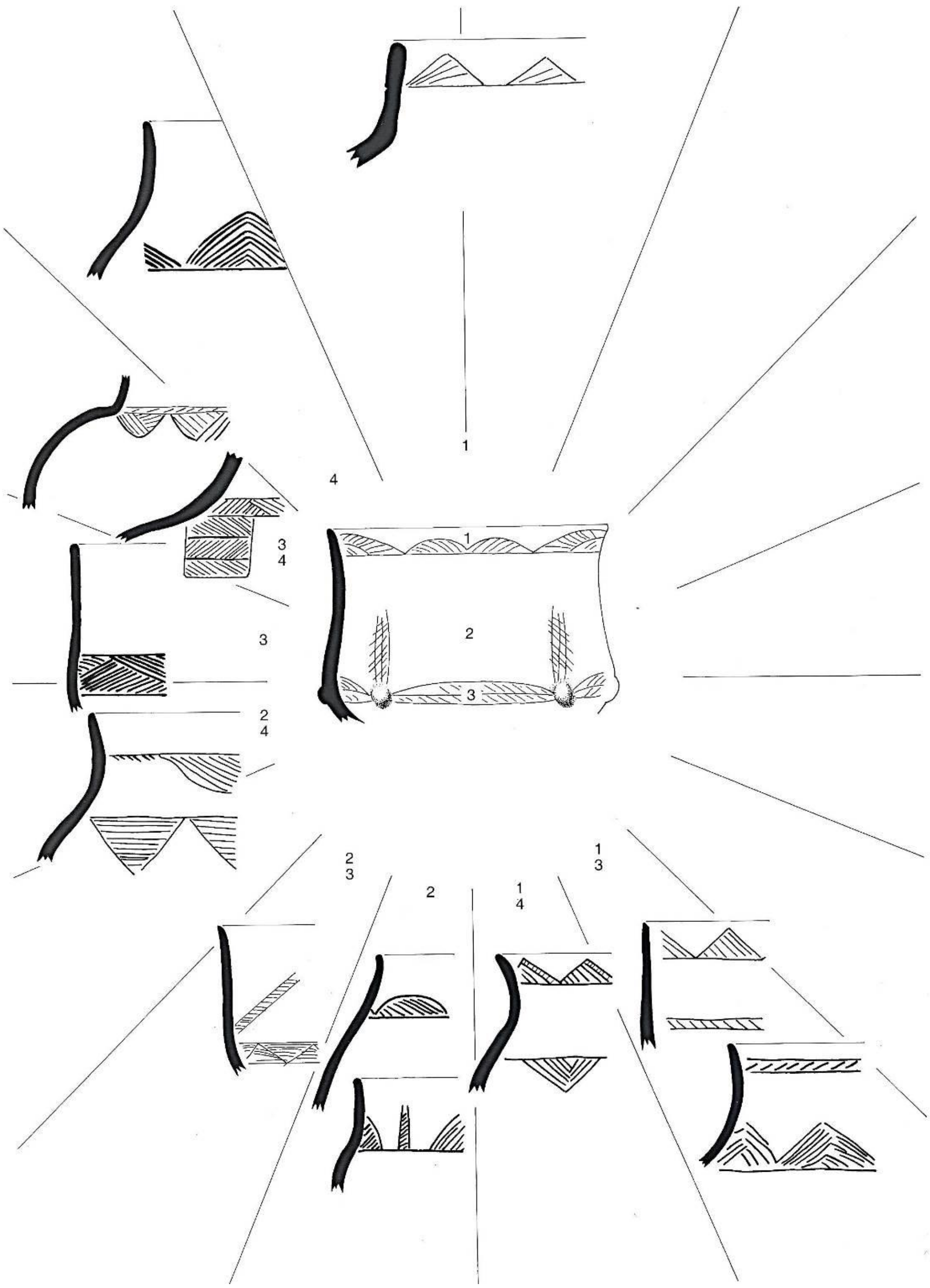


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Figure 2.11: Examples of Transitional K2 types as defined by Huffman (2007:282) and his stylistic typology using three dimensions: (1) profile; (2) design layout, and (3) motif (4) complex motif combination

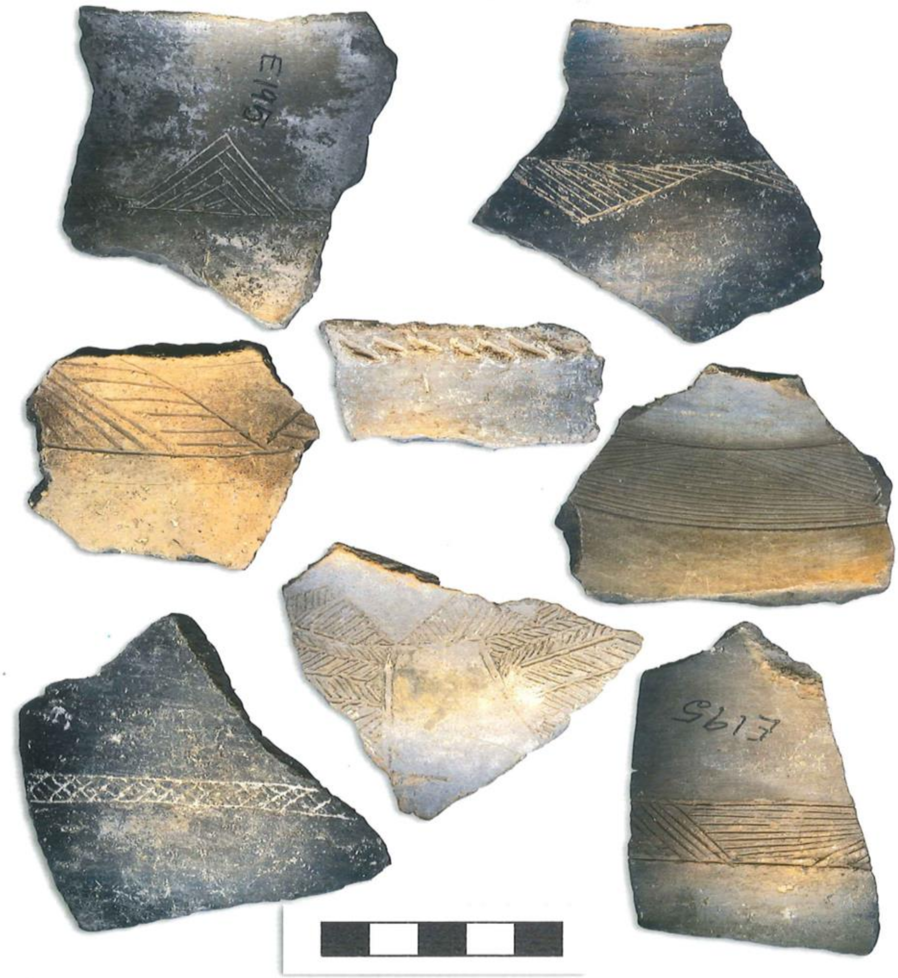


Figure 2.12: Examples of Transitional K2 type ceramic sherds (Huffman 2007:283)

2.8.4. Calabrese

Calabrese's (2005) study of the Mapungubwe ceramic assemblages focused on the two main spoil heaps (dump areas) formed by Gardner and Van Tonder's earlier excavations from the late 1930s. Using Huffman's standard approach of three central variables, i.e. form, decoration and placement, this model formed the core of his typological procedures. He also recorded other variables, including rim profile, lip form, lip shape, surface treatment, colour, lip thickness and wall thickness, but did not include any aspects of technology in particular. Stylistic typology was once again the main focus of Calabrese's research (2000, 2005). Calabrese (2005:270), admitted he did not use Meyer's (1980) data on the basis that, "it was not presentable in such a way as to be compatible with his research design".

Calabrese's four major vessel form categories were further divided into twelve distinct vessel forms for his ceramic analysis namely, jars, bowls, beakers and plates. Jars were divided into recurved/shouldered, short-necked, bag-shaped/constricted neck and bellied jars. Bowls were divided into simple deep bowls, simple shallow bowls, very shallow bowls, incurvate and necked bowls. Beakers and plates were not further grouped (Calabrese 2005:87-97). To an extent Calabrese's ceramic typology has also been used for comparative purposes for this study, alongside Meyer's (1980) and Huffman's (2007) ceramic typology.

2.9. Closing remarks

In conclusion, besides the necessity of refining and defining typological ceramic sequences (including efforts to produce more radiocarbon dates ceramic studies formed part of the focus, centred on models of development of complex social and political states in southern African (Huffman 2009), but not on ceramic technology As a consequence our knowledge of ceramic technology within the K2 and Mapungubwe ceramic assemblages remains inadequate and a largely unexplored area of research. This long ceramics research tradition as outlined in this chapter at the sites of K2 and Mapungubwe as has however never focused on ceramic technology as a potential research tool to understand these complex societies, modes of ceramic production, or as a means to investigate continuity and change within the Shashe Limpopo Confluence Area of southern Africa. Some of these issues will form the basis of discussion in the following theoretical chapter, to lay the foundation for a conceptual background to this study, now that K2 and Mapungubwe ceramics have been placed within archaeological perspective and typological framework.

CHAPTER 3

3.1. Introduction to theoretical framework

The purpose of this chapter serves as a wide theoretical review of the literature and introduces the concept of ceramic technology, but also provides a focus on the intended analytical approach to be used in this study. Literature pertaining to ceramic approaches, contributions of ceramic ethnoarchaeology, the dynamics of technology and style, the concepts of technological choices and the *chaîne opératoire* will be examined. In addition, an overview and critique of archaeological approaches to ceramics as well as current views of ceramic technology in southern African will also be reviewed. However, this study privileges no single approach, but rather considers the applicability of several approaches and other relevant broader theoretical aspects relating to archaeological ceramics. Methodological and theoretical approaches to ceramic technology and different combinations are primarily used depending, on which are the most useful to answer the questions posed in this study.

3.2. Ceramic approaches to technology

In the nineteenth century, archaeological ceramics were classically approached from a cultural or art historical perspective (see Orton *et al.* 1993). Both Henry Balfour (1863 -1939) and Augustus Pitt Rivers (1827- 1900), were well-acquainted with archaeological ceramics, as well as with the technology (see Orton *et al.* 1993). Yet, it was Pitt Rivers, who was inspired by Darwin's evolutionary theory to apply his one 'big idea' to material culture, stating that designs and technologies, like species of animals, evolved very slowly and gradually over time (Petch 1999). Pitt Rivers also resolved to overlook geographical, temporal and cultural dimensions, and arranged ceramics in a series of sequences composed of closely related forms (Petch 1999). Since then, this common approach to archaeological data was devised as a simple classification system for archaeological ceramics, whereby the object of classification is to create similarities of ceramics based on common features or attributes such as form, decoration and style that will form the basis of the analysis. This methodology is also referred to as ceramic typology, simply defined by Rice (1987:484) as "a theoretically oriented classification directed toward solving a problem and by ordering ceramics into groups based on their similarity". Because of the emphasis on describing and organizing archaeological data in this way, much of American archaeology for example, also used similar terms such as classificatory-descriptive and classificatory-historical periods (see Willey and Sabloff 1980:34-180). This description-based paradigm is expressed in ceramic studies as an emphasis on classification, whereby potsherds and, less frequently, entire vessels become basic units of study which are then divided into groups of attributes and reassembled as types.

Arnold (1985:3) states that, "such paradigms are only analytical, and are therefore invariably limited to arbitrary units, making ceramic analysis difficult to relate to other aspects of culture". The broader social, economic and technological meanings and relationship to the environment as a major factor is therefore not recognized. It is not that descriptive classifications are unimportant, but the fact that such theoretical approaches have greatly limited the kind of questions that archaeologists can ask about technology. Although ceramic typologies and classifications were important during the nineteenth and early twentieth centuries, elaborate ceramic classifications began to develop for descriptive and chronological purposes (see Rice 1987:274-288).

As the twentieth century progressed, "serious potsherd archaeology" (Fagan 1987:331) began with seriation or the sorting of ceramics into sequences. Such direct historical approaches were effective in linking cultural sequences, but were limited as a means of interpreting the past because it relied solely on artefacts and stratigraphic evidence, paying little attention to technology and other lines of evidence (Fagan 1987:67). This was just one of several methods used to determine the similarity of ceramic form or style, and ordered them into a series or group (type) by their morphology, this order being interpreted as relative age (Rice 1987:481).

Archaeology then began using ceramics as 'time markers' for establishing cultural sequences, using potsherds as stratigraphic and chronological indicators (Rice 1987; Shepard 1980). The recognition of ceramic types or groups, usually through style, is generally arbitrary and is based on a multiplicity of variables that could be classified according to shapes, sizes, rims, forms or decorations (see Huffman 1980, 2007). By selecting different kinds of variables or attributes in constructing classifications leads to different types, for example morphological, technological, functional or cultural types. Despite the fact that typological or type-variety approaches remained dominant worldwide, it is acknowledged, like all approaches that there are accepted limitations as such approaches tend to neglect aspects of technology and the social meanings of ceramics over time and space (e.g. Hegmon 1992, 1998; Pikirayi 1999, 2007; Rice 1976).

By the mid-20th century a nodal point in ceramic analysis can be attributed to the seminal work of Anna Shepard (1980), as she drew together ceramics as markers of trade and chronology and, to an extent, also addressed ceramic technology thus laying the foundation for most ceramic approaches from the 1950s onward into the 1980s. For example, other parallel ceramic approaches developed such as functional and characterization studies (e.g. Bishop *et al.* 1982; Henrickson and McDonald 1983; Rye 1981), as well as the emergence of ceramic quantification research (see Solheim 1960).

From about the 1950s, the 'radiocarbon revolution' (see Orton *et al.* 1993), also played a pivotal role in ceramic analysis, for example, "the terms 'fine-grained' and 'coarse-grained' dating have been firmly entrenched in the literature ever since" (Wintle 2008:276). Furthermore, thermoluminescence dating, as a means of obtaining the firing age of archaeological ceramics, was first developed by Aitken in the 1960s, and greatly furthered materials analysis and enhanced scientific techniques for archaeological ceramic studies (see Aitken 1985; Wintle 2008).

However, a detriment, to museum collections in particular has been the continued preference for destructive analysis for nearly four decades. Fortunately there have been valuable moves particularly in the field of conservation analysis, to employ non-destructive ceramic analysis as an alternative approach to invasive study. For example, the applications of portable x-ray florescence (pXRF) to archaeological ceramics (see Forster *et al.* 2011, and Spanish attempts at using ultrasound to find parameters related to physical characteristics of archaeological ceramics and fabric porosity (cf. Salazar *et al*. 2006) are positive efforts.

Historically another relevant development, was the contextual approach to analysis known as ceramic ecology, an elusive term devised by Matson (1965), which seeks to embed technical data into socio-economic frameworks, thereby relating technology to the environment and local resources available for ceramic production (see Matson 1965, 1981). This approach mostly received notable attention in American ceramic studies (e.g. Arnold 1985, Kolb 1988, Matson 1965), but the need for integrating ceramic studies with their environmental context has largely gone unrecognized on the African continent. Thereafter, diverse approaches rapidly accelerated from the 1960s onwards, as there were serious attempts to integrate ethnographic studies, and aspects of the environment and technology into mainstream ceramic approaches.

Orton *et al*. (1993:13) states that it was only after the research by Shepard in the 1980s, that ceramic studies "rode off in all directions". According to Willey and Sabloff (1980) the most widespread studies of ceramics by archaeologists still essentially lie in the formulation of typologies, which form the basis of chronology. This is generally reflected in cultural-historical frameworks using ceramics to create chronological sequences. While "typological studies have created a culture-historical framework of great use" (Hattingh and Hall 2009:301), calls for more social approaches (e.g. Pikirayi 1999, 2009) to Iron Age ceramics and technology is currently much needed. Traditionally, archaeologists have known that ceramics reflect culture and that changes in past societies are in turn mirrored by particular stylistic attributes such as shape, form, and decoration, but can such attributes be related to technology?

Many theoretical expectations at best, have considered the physical environment as only a neutral variable and not appreciably how it affected the similarities and differences in ceramics, their manufacture, production and the distribution patterns of vessels (Arnold 1985). Furthermore, few studies recognized that besides typology and style, the relationship of the environment and ceramics should be considered a key research component. It was only from the 1970s onwards that ceramic studies heightened research by relating ceramics to other aspects, such as social structures and wider aspects of archaeology as anthropology (see Longacre 1970; Longacre 1991a; Longacre *et al.* 1991b; Schiffer 2001a).

Social anthropology for example, has also greatly influenced archaeological ceramic paradigms (e.g. Dobres 2009), as archaeology witnessed a shift away from traditional cultural historical perspectives that express parallel directions, such as ceramic ecology (e.g. Matson 1965). The concept of ceramic ecology based on processual theory, addressed issues of human adaptation to the environment from an evolutionary perspective, thus viewing ceramic production and the use of ceramics within ecological and physical constraints (see Johnson 2009). However, the ceramic ecological approach also does not address explanations or answer questions relating to the social aspects and patterns of material culture. Efforts to assign social meanings to ceramic technology improved with approaches that were developed to identify social boundaries in material culture (e.g. Dietler and Herbich 1998; Gosselain 1998; Hegmon 1998; Pfaffenberger 1992; Stark 1998). Such fresh perspectives provided the ideal impetus for holistic conceptual frameworks needed to broaden and improve ceramic studies, as well as providing the theoretical base to infer social and technological aspects to ceramics, as active evidence of material culture (see Loney 2000).

In response to accepted limitations of stylistic typological approaches, a diversity of new social approaches (not necessarily alternative) developed to directly address the issue of ceramic technology among other related aspects. Thus, the result of this divergence has brought about a greater discourse on the subject of archaeological ceramic technology, but only several of these approaches are briefly listed here. For example, ethnoarchaeological studies (see David and Kramer 2001, Hegmon 2000; Longacre *et al.* 1991b; Roux 2003; Stark 2003), the social dynamics of technology and anthropology (see Gosselain 1998; Killick 2004; Pfaffenberger 1992; Schiffer and Skibbo *et al.* 2001b; Stark 1998, Stark *et al*. 2000), ceramic theory and ecology (e.g. Arnold 1985; Matson 1965) to the relevance of ceramic materials analysis to technology (see Berg 2008; Garcia-Heras *et al.* 1997; Matson 1981; Moody *et al.* 2003; Neff 1991, 1993, Reedy 1993, 1996), linking ceramic technology to manufacture techniques (e.g. Dobres 2010; Gosselain 1992; Rice 1987; Rye 1981; Stark *et al.* 2000; Van der Leeuw 1976), ceramic production and manufacture (see Croucher and Wynne-Jones 2006; Cumberpatch 2001; Gosselain 2009; Livingstone-Smith 2000; Neff *et al.* 1988; Rice 1996b; Sullivan 1988, Wallaert-Pêtre 2001, Van der Leeuw 1993), and the significant role of ceramic technology, style and function (e.g. Gosselain 1992; Hegmon 1992, 1998; Lechtman 1977; Rice 1996a).

According to Stark (1998) technology depends fundamentally on social relationships according to how people organize themselves to make and use material culture, this is essentially a people-and-practice centred approach:

> "At its most fundamental, technologies are embedded in the very matrix of culture and in cultural practices, as such they are inseparably material, social, personal, symbolic and political-even in the egalitarian of prehistoric societies and even when working with the most intractable of raw materials" (Dobres 2009:127).

Globally, current ceramic-making communities make use of traditions based on cognitive and behavioural rules about clay selection and sourcing (e.g. the decision-making process and potter's choice of materials), clay usage (e.g. process of transforming raw material) and vessel fabrication (e.g. completion of finished ceramic) that appear to have a common origin in the past (see Arnold *et al.* 1991). Such observed cultural practices enable ceramic studies to draw parallels, similarities and/or differences, to inform technological studies of archaeological ceramics.

In evaluating the current state of archaeological approaches to technology, Miller (2006:9) shows that "the integrative role of technological studies in archaeology makes it difficult to disentangle and label separate traditions or schools of research, since ceramic technology draws on multiple traditions of thought and method". Currently in ceramic studies, technology is largely considered a social phenomenon, which is generally informed by both, processual and post-processual (interpretative) theoretical frameworks (see Dobres and Hoffman 1994). Ceramic style is thus a communication tool that serves as a characteristic way of doing something while, at the same time, style mirrors social identity and can often carry information about social groups and boundaries (see Hegmon 1992; Wiessner 1989). Ceramic style is closely linked to technology because it is widely accepted as an active perspective that essentially resides in choices made by the potters and users of ceramics.

3.2.1. Technological choices

It is recognized that technological choices are not just restricted to ceramics, but can also be applied to other forms of technology such as metal production and lithic manufacture. In this study, the term 'choice' is related to the premise that ceramic manufacturers make certain choices, which are dictated by the technological tradition within their social groups (see Dobres 2009), in the same way that "the production of every pot requires the potter to make a series of 'choices' selecting from a range of possible raw materials, tools, energy sources, and techniques" (Sillar and Tite 2000:3). This holistic approach of technological choices in ceramic production owes much to the research on the 'anthropology of technology' proposed by Lemmonier (1993:27). This approach includes a range of significant and closely related technological aspects dealing with social choices (see Bédoucha 1993), such as the role of gender and technology (e.g. Bray 2007; Mahias 1993), socio-technical systems (e.g. Pfaffenberger 1992, 1993), and systems of technical skill (e.g. Lemonnier 1993).

Essentially, most social ceramic studies have in fact embedded complexities of technology and there is an immense variety of potter's choices in ceramic production (see Cumberpatch 2001:269-299). Sillar and Tite's (2000) approach allows archaeologists to consider patterns of behaviour or technical choices by the potters and the sequence of steps needed to produce the final vessel (see also Schiffer *et al.* 2001b). This perspective therefore, provides an explicit connection between the variations of ceramic attributes, the choices made by the makers and the behaviour of the manufacturers of ceramics. Within this broad context five main areas of such choices within ceramic technology are identified by Sillar and Tite (2000:4):

1. Raw materials from which the ceramic is made (clay, temper, water);
2. Tools used to shape the raw materials;
3. Energy sources used to transform the raw materials (i.e. fuels, fire, sun-baked);
4. Techniques used to organise the raw materials, tools and energy (to collect and process clay, to form a pot, surface treatment) and;
5. The sequences (or *chaîne opératoire*) in which these factor are linked together to transform raw materials (clay source) into an end product (vessel).

Stark and Bentley (1999:31) identify an operational sequence developed in an ethnographic setting with similar choices or steps:

1. Materials procurement
2. Materials preparation

3. Primary forming techniques
4. Secondary forming techniques
5. Decorative forming techniques
6. Drying and firing
7. Post-firing techniques

Van der Leeuw (1993) also discusses the theoretical relationship between technologies and techniques, and other conceptual aspects of potters' choices at length. This relationship ties these materials together and allows potters to borrow and transfer the techniques that they use, while the social network, between potters in this case, provides the conduit for the communication of technologies and techniques. In this way, ceramic technology then plays a central role in understanding the organizational principles of the society, which uses them (see Van der Leeuw 1993:240). His approach goes on to elucidate how technology works within a wider cultural context by reconstructing the production process, and by looking at each step in the operational sequence, while questioning the human choice of particular techniques and tools used in the ceramic production process. This notion of the 'human element'' is shared by Rice (1996b:169) in that "...human behaviour and cultural choices are encoded in pottery, along with geochemical information on its source or identity".

Technological choices are neither accidental nor simply constituted. They reflect decisions regarding material choices that relate back to the experience and understanding of clay and its properties; these in turn reflect group and individual interactions, movements of people, choices and notions of conformity or individual creativity (see Rice 1996*a*, 1996*b*). In general, such technological approaches to ceramics have been detailed (e.g. Dobres and Hoffman 1994; Stark 1998; Van der Leeuw 1976, 1993). Though much of this approach was first pioneered by anthropological thinkers, such as Cresswell (cf.1982, 1990, 1993); Leroi-Gourhan (cf. 1964); Lemmonier (cf. 1976, 1993) and Pfaffenberger (1992), it views material culture as a social relationship of ceramic production and technical processes. A critical factor is the investigation of technological choices, integrating the study of vessel functionality, as well as understanding the social and ideological context, in which these choices are made (Sillar and Tite 2000:17).

Lemmonier (1993), supported by Sillar and Tite (2000) proposes that another major factor to consider is the role of materials science in technological studies, an aspect, which should not be overlooked and can be twofold: firstly, it can provide the methodology for reconstructing past technologies, and secondly the extent, to which the physical and chemical characteristics can influence technological choices.

3.2.2. The concept of the *chaîne opératoire*

The methodological approach to ceramic technology and production processes or technical system from raw material to finished ceramic vessel was termed by Andre Leroi-Gourhan (1911-1986), as the c*haîne opératoire*. Other scholars have chartered this same concept and the chronological sequence of ceramic production is also termed as, operational sequence (e.g. Lemmonier 1976; 1993) or a work chain (e.g. Cresswell 1990). The definition of the c*haîne opératoire* was first authored and applied by Leroi-Gourhan (1964) who founded the basis of the term as a social phenomenon, considering that technology is constituted within a social and historical content. For example, by dividing the operational sequences of ceramic manufacture into separate stages, it allows archaeologists to consider the technical choices, or patterns of behaviour by the potters at each stage of the sequence (see Sillar and Tite 2000; Stark 1999). In this way, archaeological interpretation can be explicit about the connection between material culture and the potter's behaviour. The *chaîne opératoire* can therefore be used as a complimentary perspective for bridging the gap between stylistic ceramic attributes and technical choices.

According to Leroi-Gourhan (1964), the term also alludes to the sequence of actions involved in the production of an artefact or a series of technological operations, which transforms a raw material into a usable product. For example, clay texture, colour and composition of ceramics could all inform about the choices made in the selection of the raw material to produce a ceramic vessel. Martinón-Torres (2002) further proposes a dual meaning of the c*haîne opératoire,* to be not only defined as an object of study but also as an alternative technological approach. This concept, method and its applications has evolved progressively over the past few decades and is widely used in the study of ceramic technological processes (e.g. Dobres 2010; Dobres and Hoffman 1994; Gheorghiu 2007; Gosselain 2009; Martinón-Torres 2002; Schlanger 1994, 2005; Song-Yong 2010; Wallaert-Pêtre 2001). Archaeologists have also used the *chaîne opératoire* as a lithic analytical method (e.g. Bar-Yousef and Van Peer 2009; Bleed 2001; Shott 2003). In contrast however, there have been no direct archaeological applications of the concept c*haîne opératoire* on southern African ceramic approaches.

3.3. Southern African ceramic approaches

Ceramic research in southern Africa only really began in the late 1920s. Sadr (2008:104) asserts one reason being that "antiquarians in southern Africa at that time ignored ceramics because they resembled modern 'native' wares". Caton-Thompson (1931) was one of the first to evaluate ceramic evidence alongside other aspects of material culture, using a cultural historical framework.

Although her systematic fieldwork and research methods were considered ahead of her time, her theoretical observations were strongly influenced by Gordon Childes' idea of culture, accepting the equation between 'culture' and 'people' in the sociological sense (see Hall 1984). Caton-Thompson's research (1931) did however regard sherds as crucial evidence of continuous change, in turn developing the first typological approach for southern African archaeological ceramics (Sadr 2008:104). She divided ceramics into classes, tested associations between excavations and other sites, using decoration, techniques and colour as a basis. Her stylistic approach of viewing ceramics as the equivalent of groups of people was far from ideal, because she essentially equated people with static ceramic units.

Caton-Thompson's work influenced three well-known ceramic specialists; Percy Ward Laidler (1885-1945), John Schofield (1886-1956), and the Rhodesian archaeologist, Roger Summers (1907-2003). The studies by Laidler (1929, 1938); Schofield (1937, 1948) and Summers (1950, 1957, 1961) dominated ethnology-based approaches from the 1920s through to the 1950s, founding archaeological ceramic sequences for the southern African Iron Age. All three placed a strong emphasis on colonial ethnography for social models of change in ceramic interpretation and, at the same time, were the first to make references to technology and ceramic manufacture. He elaborated on manufacturing techniques by describing the preparation of the potter's clay, shaping, drying, and firing to the water-proofing of ceramics (see Schofield 1948:15-20). Likewise, Laidler's (1929) approach was also based on careful observations of aspects such as techniques of manufacture, admixture of temper, lip and rim forms, appendages, and how decoration was applied.

Laidler classified ceramics from an ethnological and archaeological perspective, using ceramics within population groups with colonial concepts such as 'Hottentot', 'Degenerate Hottentot' and 'Bantu', and later in 1938, related ceramics to evolutionary stages termed early, middle and late African wares (see Sadr 2008:104-105). Equally, Schofield's (1948) '*Primitive Pottery': An introduction to South African Ceramics, Prehistoric and Protohistoric* classified ceramics according to 'Late Stone Age', 'Bushman', 'Hottentot' and 'Iron Age'. At least Schofield's thorough descriptive analysis also stressed the significance of ceramic technology, alluding to methods of manufacture and production, from sourcing of clay, preparation of body, drying and firing techniques (see Schofield 1948:15-20). Historically regarded as a seminal work, in combination with his first classification of the Mapungubwe ceramics published in Fouché (1937:32-102) Schofield provided the first detailed and comprehensive classification system for southern African ceramics.

Soon thereafter Roger Summers (1957) wrote of both the dangers and advantages of using ethnography for ceramic interpretation. His groundwork on ceramic sequences in Rhodesia (Zimbabwe) was strongly influenced by Caton-Thompson, Laidler and Schofield to set yet another precedent for southern African Iron Age approaches from the 1950s onwards. Within these cultural-historical schools of thought, typological boxes were mapped out, with defined ceramics given generic labels such as M1, M2 and Leopard's Kopje 1 (see Fouché 1937; Huffman 1984; Schofield 1948).

However, it was only from the 1960s onwards that southern Africa Iron Age ceramic studies boomed and the focus continued on stylistic analysis (Evers 1981; Evers and Huffman 1988; Fagan 1964; Hanisch 1980; Maggs 1984; Mason 1952; Summers 1950, 1957, 1961). According to Hattingh and Hall (2009:301) it is "…the culture-historical sequences that Tom Huffman and Tim Maggs have, in large measure, constructed and formalised are fundamental in Iron Age studies and provide the structure within which to develop interpretation, and is one which we all work". Nevertheless, the greatest influence in southern African Iron Age ceramics is derived from what Hall (1984) views as the American contextual approach put forward and largely spearheaded, by Huffman (1970, 1974, 1978).

Huffman's qualitative and quantitative approach essentially focuses on three stylistic attributes, i.e. vessel shape (profile), decoration layout and motif to typologically classify Iron Age ceramics. Huffman states that the same three attributes will always provide the correct markers to distinguish group identity in southern African Iron Age ceramic assemblages, as long as the ceramic style is sufficiently complex (Huffman 2007:104). Calabrese (2000, 2005) has also expanded such approaches, using ceramic styles to understand regional interactions and group ethnicity.

Despite the obvious technological limitations of stylistic approaches, it must be acknowledged that ceramic assemblages have successfully been compared over time, both geographically and regionally, using such typological approaches. According to Hattingh and Hall (2009:301), typological studies remain crucial, "… despite debates over whether variability in ceramic style is continuous or discontinuous and what these units mean in terms of identity" (e.g. Evers 1988; Hall 1983; Huffman 1980, 1982, 2002). In essence, ceramic typological approaches remain deeply rooted in most southern African Iron Age studies and there is not much indication that this may change.

Despite the vast progress in southern African ceramics research over nine decades, the question of technological studies and functional studies remain largely neglected approaches (although see for example Fauvelle-Aymar and Sadr (2008), Fowler (2008), Jacobson (2005), Rosenstein (2002, 2008); Sadr and Sampson (2006); Wilmsen et al 2009). According to Pikirayi (1999:185) ,"Typology has dominated southern African ceramics studies to this day and will continue to be a necessity as long as many areas remain archaeologically unknown" One does acknowledge that while existing stylistic approaches are reliable evidence of group identity and ethnicity markers, hy is it that there is no integrated or complementary approach, other than stylistic analysis to archaeological ceramics in southern Africa? Pikirayi (1999) initiated this type of debate calling for more social approaches and widening the scope of ceramic studies on the basis that typology is limited and does not address more relevant archaeological issues (see Pikirayi 2009).

It is evident from the scarcity of literature that aspects of ceramic manufacturing technology, tools and techniques, locations of production, scale of production and ceramic specialization has been barely addressed by southern African Iron Age archaeologists. According to Pikirayi (1999) perhaps one of the reasons as to why ceramic technology studies have not been considered might be the adoption of American taxonomy for southern African ceramics (see Pikirayi 1999). Perhaps even the use of certain terminology and placing ceramics into distinct 'facies', 'traditions' or 'complexes' and even the term 'Iron Age' may have in fact disadvantaged or hampered ceramic technology studies, whether intentionally or unintentionally.

Whilst Hattingh and Hall (2009:301) agree that a new call for a social approach is welcome, "...it appears to be an alternative to ceramic typology and the construction of culture-historical sequences." In defence of the social approach Pikirayi (2007:297) is not "claiming a new methodology to measure social relations using archaeological pottery...instead, it is an extension of an existing 'scale of measurement' – ceramic style – in order to assemble more information about societies who used pottery in the past". Perhaps complementary or parallel methods should be considered, otherwise southern African Iron Age ceramics research will not develop without the application and elaboration on existing approaches (see Pikirayi 2007). Sadr (2008:115) proposes that "a way forward, at least in ceramic studies, may be to reduce emphasis on stylistic analyses and to turn more towards functional studies and comparison of ceramic technologies".

Fortunately, there are a handful of southern African ceramics studies such as those by Sampson (1972, 1974); Sampson and Sadr (1999); Sadr and Sampson (2006) Fowler's (2008) Zulu ceramic production studies, those undertaken in the North West Province on BaTswana ceramic manufacture (e.g. Rosenstein 2002, 2008), as well as Fauvelle-Aymar and Sadr (2008) have embraced ceramic technology. Hall's (2012) recent study on Tswana identity also supports the value of ceramic technological analysis in archaeology through the work of Gosselain (2000) where observations of technology of manufacture is embedded in both stylistic expression and in identity.

For example, Sadr and Sampson (2006:235-252) raise interesting views about the beginnings of ceramic technology in southern Africa and propose the presence of thin-walled plain ware among hunter-foragers, two or even four centuries before the arrival of Iron Age agropastoralists, which are uniformly associated with thick-walled ceramics. Implying that ceramic vessel technology did not diffuse southwards, but that the main stimulus for the local invention of pottery arose from the expanding exchange network, and associated needs to signal group identity through increasingly elaborate material markers (see Sadr and Sampson 2006:248).

Sadr and Sampson (2006:111) do however admit that the distinction between thick and thin wares goes beyond technology and style. According to Sadr (2008:105), some researchers involved in Late Stone Age ceramic technological studies have also applied this approach to Iron Age ceramics, specifically in an effort to link pots to clay sources (see Jacobson *et al.* 1991, Jacobson *et al.* 1994, Jacobson *et al.* 1995; Jacobson 2005). Jacobson's (2005) experimental results on some Mapungubwe sherds confirm on geochemical grounds at least the presence of non-local pottery as well as the local manufacture of non-local styles. He however he raises concerns that until local clay samples are collected and collated with sherds, including a thorough understanding of local geology much more work is needed in the Shashe Limpopo Valley. Clay sources within the Mapungubwe region would first need to be uniquely defined and compared with clays within the wider region until any observations on the production of pottery is made (see Jacobson 2005:133).

The ethnoarchaeological approach used by Lindahl and Pikirayi (2010) have examined pottery production techniques in northern South Africa and eastern Zimbabwe, and Fowler's (2008) ethnographic observations of Zulu ceramic production serve as as good examples to illustrate change and discuss ceramics in their broader social and technological context in the Iron Age of southern Africa.

Rosenstein's (2002, 2008) ceramic technology research is a valuable contribution, demonstrating that the BaTswana potters favoured temper as opposed to the BaTlokwa who maintained a technological style without distinctive temper and thus understanding change in ceramic technology as well as highlighting the value of luminescence for refining the dating of Late Iron Age sites.

Other researchers, not all mentioned here have also shed light on ceramic technology, by means of fabric studies, which have largely been based on chemical, isotopic and petrographic analysis used to identity tempers (Bollong *et al.* 1993; Sampson 1988; Sampson *et al.* 1989; Sampson and Sadr 1999, Wilmsen *et. al.* 2009). In this past decade alone, bolder social constructionist approaches to ceramic technology (see Killick 2004) have been addressed, particularly concerning issues of social identity and social boundaries (e.g. Pikirayi 1999, 2002, 2007).

The need to revisit approaches and broaden ceramic technological perspectives on social, economic and political interactions has been highlighted elsewhere in for examples see the West African studies of Gijanto and Ogundiran (2011) and the Ethiopian approaches (see Wayessa 2011). Future, southern African ceramic Iron Age studies can hopefully apply ceramic technology as a complementary approach to stylistic typology and borrowing leads from our Late Stone Age archaeology, as well as from research elsewhere on the continent. South Africa, like the rest of Africa has been slow to introduce the idea of ceramic technology into its approaches, however for now there is a gradual progress of moving into the right direction. This provides the ideal platform for the K2 and Mapungubwe ceramics to be used on an area of research that has not been considered before.

3.6. Closing remarks

Technological ceramic approaches are a growing and evolving research field on the African continent, whereas in southern Africa this approach is evidently still in its infancy. Previous studies on the Mapungubwe and K2 ceramics have paid little consideration to aspects of ceramic technology, because research has largely focused on typological approaches. However, as argued, technological analyses can complement and enhance existing typological understanding. This study will then use both stylistic typology as an organizational tool to present the data (see Chapter 5) and then draw upon a technological approach to trace evidence of the manufacturing sequence. Technological aspects of ceramic manufacture using non-destructive methods are used to characterize the composition of the ceramic fabric in combination with microstructural and other materials analytical data.

The results hopefully reveal more about the successive steps taken by the potter to produce a finished vessel and eventually interpret the data within a broader social context. This characterization of the ceramics is not based on comparative data in the assemblages, but rather on careful examination of any technological traces left by the potter on the ceramics. In turn, the value of this research will enhance our understanding of Iron Age ceramic technology, in an endeavour to answer further questions relating to ceramics and their social contexts. This study also hopes to foster a greater understanding of vessel manufacture, possible change and continuity in second millennium AD ceramics in southern Africa.

CHAPTER 4

4.1. Introduction

In this chapter an overview will be presented of the research methods, procedures and analytical techniques used in the technological study of twenty-six complete vessels from the 1930s excavations. Technological analysis, complemented by compositional materials analysis, will be conducted to investigate both the macro and micro characteristics of the ceramics. This analysis will be performed using three main methods: visual analysis, materials analysis and a technological analysis. The proposed analytical techniques and methods for this study will largely contribute valuable data to characterize the elemental and chemical composition of the ceramics and give an indication as to the technological individualities of the repertoire of K2 and Mapungubwe vessels. The approach which will be followed here is not exclusive, but rather an alternative complementary approach, which proposes that details of manufacture technology may be gleaned from a selective sample of complete K2 and Mapungubwe ceramics.

4.2. Aims and selection of methods

When choosing the most appropriate research methods for this study, three main factors are taken into consideration:

- The archaeological research question relating to ceramic technology.
- Limitations and potential of the individual research methods.
- Restrictions and potential of the complete ceramics under investigation.

It is with these factors in mind, that the main aim of the overall analyses is to observe as many physical traces left by the potter on the vessel or so-called 'pot reading' or any evidence resulting from the manufacturing process as possible (Gibson and Woods 1990). These technological traces are distinguished as primary traces, pointing to possible forming techniques such as coiling or hand pinching, and secondary traces such as surface finishing treatments such as scraping, wiping, smoothing or burnishing. The main purpose of using this strategy is to answer the research question of a) whether such technological traces are evident and visible on the ceramic vessels, and b) what they mean archaeologically.

In order to achieve this goal, a three-pronged approach is adopted:

(1) Contextual typological data and morphological (anatomical) information on the vessels which serve a descriptive and classificatory purpose.

(2) Technological characterization of the whole vessel and ceramic fabric to identify any evidence of manufacture or firing conditions.

(3) Compositional data (chemical and elemental) of the ceramic body to provide mineral data to support the technological analysis.

In order to conduct a thorough analysis, the twenty-six vessels which form part of this study were first identified and selected from the larger K2 and Mapungubwe ceramic museum assemblage. This process in itself is a limiting factor, as very little has been published on the complete vessels and no analytical data relating to complete vessels has been done, other than Meyer's (1980) typological analysis. The vessels were then further selected from different excavation contexts such as middens, burials and residential areas, and are also representative of specific site localities, as well as within ceramic type groups (Huffman 1980). Three main ceramic groups are then distinguished: K2 vessels (which include the Zhizo and Mambo ceramics), Transitional K2 vessels and Mapungubwe vessels. The vessels were then grouped chronologically and sub-divided into form/shape types on their basis of vessel groups, i.e. K2 beakers, Mapungubwe recurved jars, shallow bowls and so forth.

In order to perform an objective analysis within the same groups and to limit error and bias, each vessel is therefore considered as an individual unit of analysis. The data for each vessel is structured typologically and within site context, and then classified according to observable morphological traits. This approach allows for a simple and practical descriptive classification of the individual vessels, the focus of which is on overall similarity rather than according to styles or forms. Specific analytical variables are further used to identify specific research objectives that relate to vessel morphology, typology and technology (see Figure 4.1.)

Figure 4.1: Examples of analytical variables relating to vessel morphology, typology and technology

The technological analysis conducted uses both qualitative and quantitative analytical variables. The materials analysis employed in this study uses portable X-ray florescence (XRF) and X-ray diffraction (XRD) techniques as a direct approach to ceramic composition or characterization (cf. Peacock 1970). These two techniques have been selected on the basis of examining two significant ceramic components of the vessels: the characterization of the ceramic fabric, to identify chemical and elemental compositional signatures and the interior and exterior ceramic surfaces, as a means of determining the physical properties of the archaeological ceramics. Such physical evidence can indicate firing technology and the choice of raw materials used by the potters and clay preparation which govern the overall composition of the manufactured vessels (see Figure 4.2.).

Figure 4.2: Identified areas of ceramic fabric and surface in relation to firing technology

4.3. Range of technological analytical variables

This section provides the range of the analytical variables or parameters used to analyse ceramic technology. The choice of analytical variables (Table 4.1) used for this study has been adapted from the analytical guidelines proposed by the Prehistoric Ceramics Research Group (2010: 21-35). The ranges of variables presented are not necessarily recorded on every vessel, since each presents a different range of factors and because they are dependent on the nature of individual vessels, i.e. not all are decorated and some are not burnished, for example. The analytical variables used in this study are listed as follows:

Variable 1: Ceramic fabric type
Variable 2: Vessel form
Variable 3: Orifice diameter
Variable 4: Wall thickness and rim
Variable 5: Vessel colour
Variable 6: Primary forming
Variable 7: Firing conditions
Variable 8: Texture and secondary forming
Variable 9: Surface treatments and finishing
Variable 10: Decorative techniques
Variable 11: Form elements or additions
Variable 12: Use-wear evidence

Ceramic Variable	Technology Manufacture	Chronology	Nature of deposits	Production Distribution	Function Use	Settlement Organization	Social expression
Fabric type	√	√	√	√	√	√	√
Form type	√	√	√	√	√	√	√
Vessel type	√	√	-	√	√	√	√
Number of sherds	√	√	√	√	√	√	√
Wall thickness	√	√	√	-	√	√	-
Diameter of base	√	-	-	-	√	√	-
Diameter of rim	-	-	-	-	√	√	-
Height	√	-	-	-	√	√	-
Circumference	√	-	-	-	√	√	-
Surface treatment	√	√	√	√	√	√	√
Decoration	√	√	√	√	√	√	√
Manufacture tech.	√	√	-	√	-	√	√
Perforation type	√	-	-	√	√	√	-
Firing conditions	√	-	-	√	-	√	√

Table 4.1: Analytical variables used to identify specific research objectives
(Adapted from the Prehistoric Ceramics Research Group 2010:16)

4.3.1. Ceramic fabric type

The fabric analysis enables the characterization of the raw materials used in ceramic manufacture and provides information about the firing process. The ceramic fabric type usually consists of the clay matrix and inclusions found in the matrix, which are macroscopically visible with the naked eye, and those visible with the aid of a digital microscope. The matrix defines the fracture or body of the ceramic, which may contain grains that are smaller than 0.01 mm, these are not clearly distinguishable even under a microscope (Riederer 2004). The descriptions of the ceramic fabric based on the visual examination will include the surface colour according to the Munsell Soil Colour Chart (2000) and type of inclusions visible on existing fractures or breaks, and will be done according to standardized methods proposed by Peacock (1970) and those suggested by the Prehistoric Ceramics Research Group (2010).

All non-identifiable grains are classified by their colour. Visible inclusions include temper and voids. Voids are important evidence of the former presence of inclusions which may have burned or leached out during the firing process. Temper is defined as the coarser components of the ceramic, i.e. grains larger than 0.01mm that are either added intentionally or may be part of the natural clay. Voids are caused either by air bubbles within the clay or organic temper that has fallen out (Prehistoric Ceramics Research Group 2010:25).

When describing the individual inclusions/grains, they will be classified by their colour as it is not possible to correctly identify individual particles, without the aid of petrography or thin section analysis. Only a limited number of minerals can be recognized and thus the most common particles such as quartz, calcite or quartzite are noted and may occur in different colours. Among the other inclusions it is only possible to identify micaceous specks, and if identification is not certain, those inclusions particles are described as reddish or black inclusions as dull or shiny (e.g. Moody *et al.* 2003).

The description for each type of inclusion will be done according to guidelines detailed by the Prehistoric Ceramics Research Group (2010), this includes inclusion frequency (Table 4.2), size (Table 4.3.), sorting (Figure 4.3), the shape of the grain and rounding (see Appendix 4). The frequency of inclusions is an estimated percentage of grains visible in the overall fabric and is assessed with the aid of visual inclusion density and sediment sorting comparison charts (see Appendix 3). The measurements of the inclusions will be taken by means of the digital scale provided by the digital microscope and quoted in millimetres.

Rare	less than 3 %
Sparse	<3% to 9 %
Moderate	<11 to 25 %
Common	<26 to 40 %
Abundant	<40%

Table 4.2: Categories of frequency (estimated in %) describing density of inclusions (Prehistoric Ceramics Research Group 2010:25-26)

Fine	0.1mm to 0.25mm
Medium	0.25mm to 1.0mm
Coarse	1.0mm to 3.0mm

Table 4.3: Categories of fabric types according to inclusion size range (Prehistoric Ceramics Research Group 2010:26)

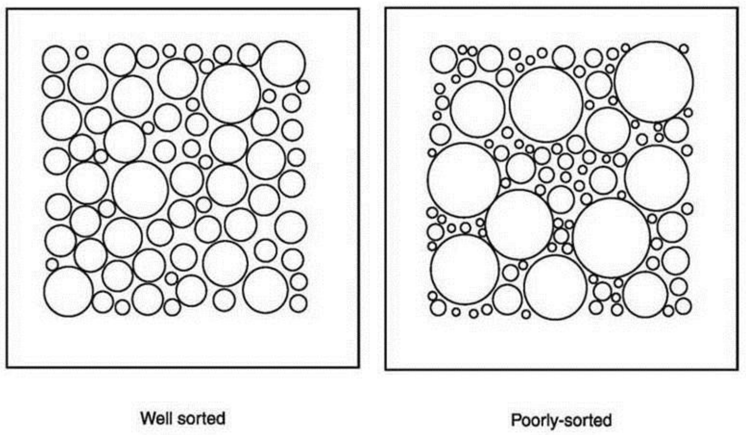


Figure 4.3: Sorting of inclusions as well-sorted or poorly-sorted (Prehistoric Ceramics Research Group 2010:50)

4.3.2. Vessel form

Vessel form generally refers to classification of the ceramic form according to its shape. For purposes of this study, combinations of existing ceramic classification systems are used to define the ceramic forms or types (e.g. Calabrese 2005; Huffman 1980; Meyer 1980; Schofield 1948). However, these individual researchers have used different terms for the same form, for example, shouldered or incurvate jars.

For the purpose of this study it is important not to be too rigid with type-variety systems (e.g. Willey and Sabloff 1980) or multi- dimensional approaches (e.g. Huffman 1989), since existing southern African ceramic typologies (Huffman 2007; Meyer 1980) ought not to be cast in stone as they are continually being developed and modified. Similarly, Sinopoli (1991:230) encourages researchers to "group ceramics into successively finer categories on the basis of some combination of variables".

The typological or classification approach, which will be used here draws upon the premise that since the morphology of all vessels vary, and none are identical or an exact replica of another, the ceramics in this study should not be grouped too rigidly into specific ceramic types. Therefore, the simplest definition of a vessel form as it relates to the shape of the overall vessel and sub-divisions are kept to an absolute minimum. The major vessel forms distinguished within this study can be link closely with Calabrese's (2005:88-97) and Meyer's (1980) definitions. Three major simple vessel forms are categorized into jars, bowls and beakers. Jars are further divided into recurved or shouldered jars, bellied jars and spherical (including sub-spherical) jars. Bowls are divided into shallow bowls, deep bowls, beaker bowls, and sub-spherical bowls (Table 4.4). Beakers are divided into two forms, vertical (also straight-sided) beakers and bell (also flared) beakers.

A combination of typologies will therefore be used with the most valuable information relevant to technological analysis added as a basis for vessel form descriptions and basic classifications. In order to meet the aims of this technological analysis, ceramic typology variations borrowed from Calabrese (2005); Huffman (2007); Meyer (1980) and Schofield (1948) will thus be broadly utilized, and for purposes of simplicity the vessels will be first divided as K2, Transitional K2 and Mapungubwe ceramics, and then further classified according to form or types. It is also not only form that determines the suitability of vessels for particular uses, as the size and final shape of a vessel also determines its stability. Stability in this sense refers to the vessel's resistance to tipping or imbalance, which is determined by shape and proportion (Rice 1987:225). For example, if the vessel is tall with a high shoulder, narrow neck and a restricted orifice, it would be more unstable as opposed to a shallow bowl with an unrestricted opening and a stable lower centre of gravity.

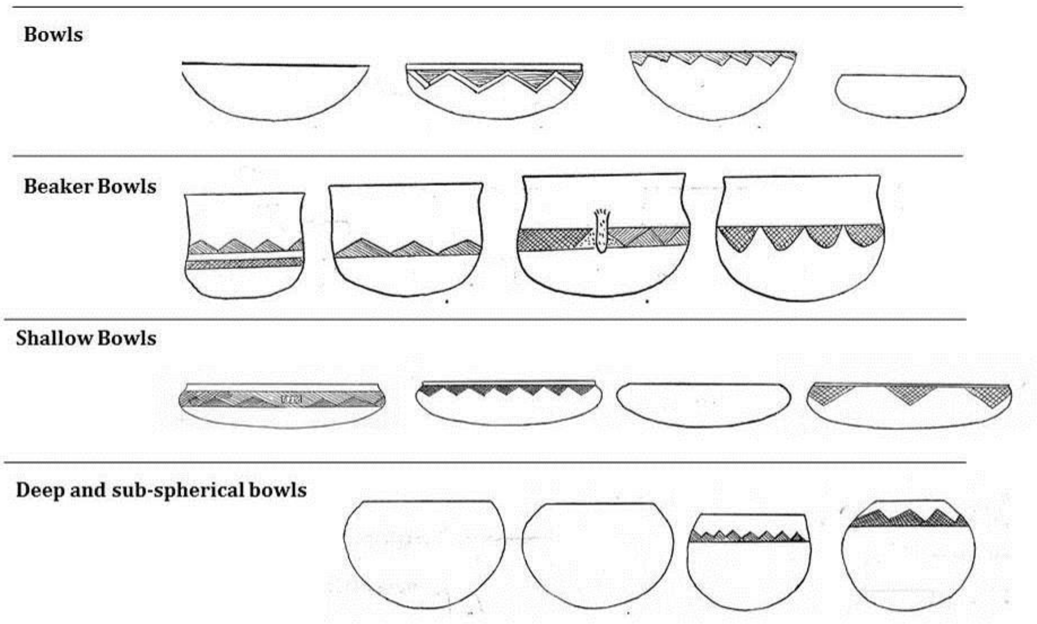


Table 4.4: Examples of variations of K2 and Mapungubwe bowl-type vessels
(Adapted from Gardner 1963)

4.3.3. Orifice diameter

The size of the orifice opening diameter at the top of the vessel is important as it determines the effectiveness of the vessel for function or use as a container. The opening is also the space through which materials must go that relate to its function (see Henrickson and McDonald 1983). For example a narrow restricted vessel may serve as a water container as its rim diameter is small to avoid spillage and restricts the flow of liquid, or a wide diameter opening for use as an open serving dish. Orifices can be described as restricted or unrestricted (Rice 1996a). Restricted refers to the opening which is less than the maximum diameter of the vessel and unrestricted if the opening is equal to or greater than the maximum diameter of the vessel. The unrestricted opening is made for easy accessibility to the vessel's contents and a restricted opening prohibits access since the angle is more difficult. Orifice measurements will also be recognized as rim diameters as it relates to utilization and function (Orton *et al.* 1993; Rice 1996*a*; Shepard 1980).

4.3.4. Wall thickness and rim

Wall thickness and rim measurements are a variable relating technology to use (Rice 1987:226-227), usually in association with orifice diameter, vessel form and size and can be used sometimes to assess vessel function. The thickness of the vessel wall is related to the size and shape of the ceramic since the walls serve as structural supports. In the case of this study, most wall measurements are not always possible to determine on complete vessels.

However, wall thickness will be provided by taking rim measurements and at points of fracture, where possible. Although it is noted that wall thickness can vary considerably within a single vessel, rim measurement and consistent wall thicknesses can be reasonably inferred. Wall measurements are important to record as vessels manufactured with thin walls conduct heat better and are therefore better suited for cooking whereas thicker walls increase strength, add weight and keep moisture in. During the shaping and drying process, the rim is also made thinner or thicker as a strengthener to the vessel body to avoid cracking and for stability (Rice 1987: 226-227).

4.3.5. Vessel Colour

Apart from the context of firing technology, the colour of the vessel surface and of the ceramic fabric is largely determined by the composition of raw materials (Shepard 1980:102-103). Despite the seemingly non-descript brown-grey, to red-blackish colour or discolorations typical of Iron Age vessels, ceramic colour is of great importance, particularly when using the Munsell system as stated by Shepard (1980:107), “the advantages are so great that it is hardly necessary to argue its superiority”.

Reference to vessel colour is applied using the standard Munsell Soil Colour Chart (2000), as opposed to generic colour observations, i.e. brown, grey, and black which are deemed insufficient (cf. Meyer 1980; Schofield 1937). The Munsell (see Figure 4.4) provides a means of measuring the similarity of different colours. It is accepted, however, that differences might exist in the way individuals’ record colour from the chart. Colour will be recorded, where possible, from both the interior and exterior surfaces and on exposed edges to provide an informative record of the colour range of the vessels and inference to elucidate firing technology. For this study, the purpose of colour is used to provide a scale of typical colour variances in hue, value and chroma for the K2 and Mapungubwe vessels The hue (i.e. YR) refers to the position of the colour in the spectrum, the value refers to how light or dark a colour is and chroma is the purity or saturation of the colour (Orton *et al.* 1993:68-69).

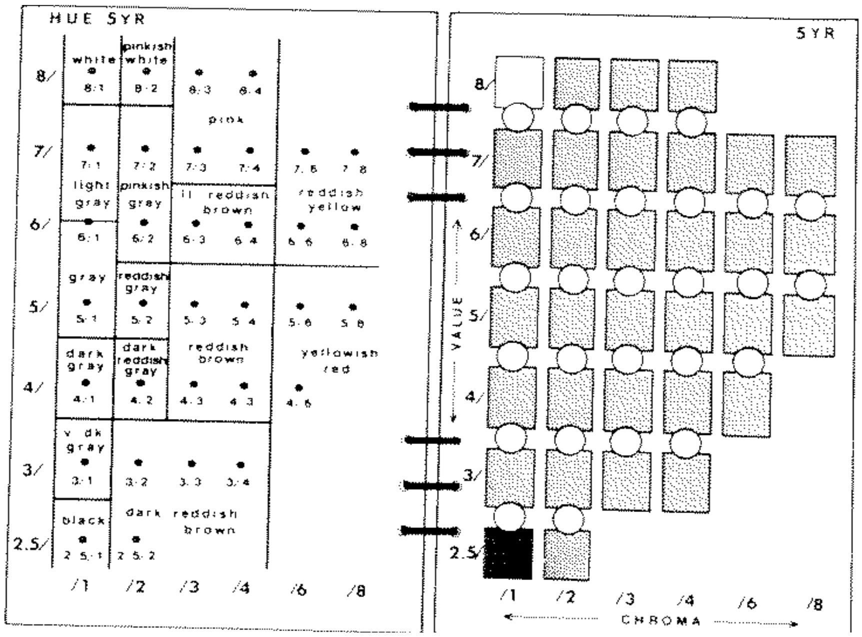


Figure 4.4: Example sheet of Munsell Soil Colour Chart (Rice 1987:82)

4.3.6. Primary forming

Primary forming techniques are not easily discernible on complete vessels unless there is evidence of horizontal cracks or fracture lines along the junctions between the coils of clay, or evidence of indentations in the vessel wall left by the pressure of the potter's fingers (Gibson and Woods 1990; Rye 1981). In the shaping and forming of ceramic vessels (Figure 4.5), clay is manipulated using the simplest tools and two basic known forming techniques will be identified, where possible:

1). A hand forming technique used by forming the clay into a ball or opening a lump and pulling vessel walls up between fingers and working the clay up, also referred to as the pinch method or modelling from a lump;

2). A hand forming technique by rolling the clay rings or long sausage-like cylinders that are used as successive coils to form the vessel. Joins are then pressed together by smoothing the internal and external surfaces of the coils.

3). Coiling by hand. This is most commonly referred to as the coiling method. Coiling is essentially a process of building up the vessel wall with superimposed rolls of clay (Shepard 1980:57).

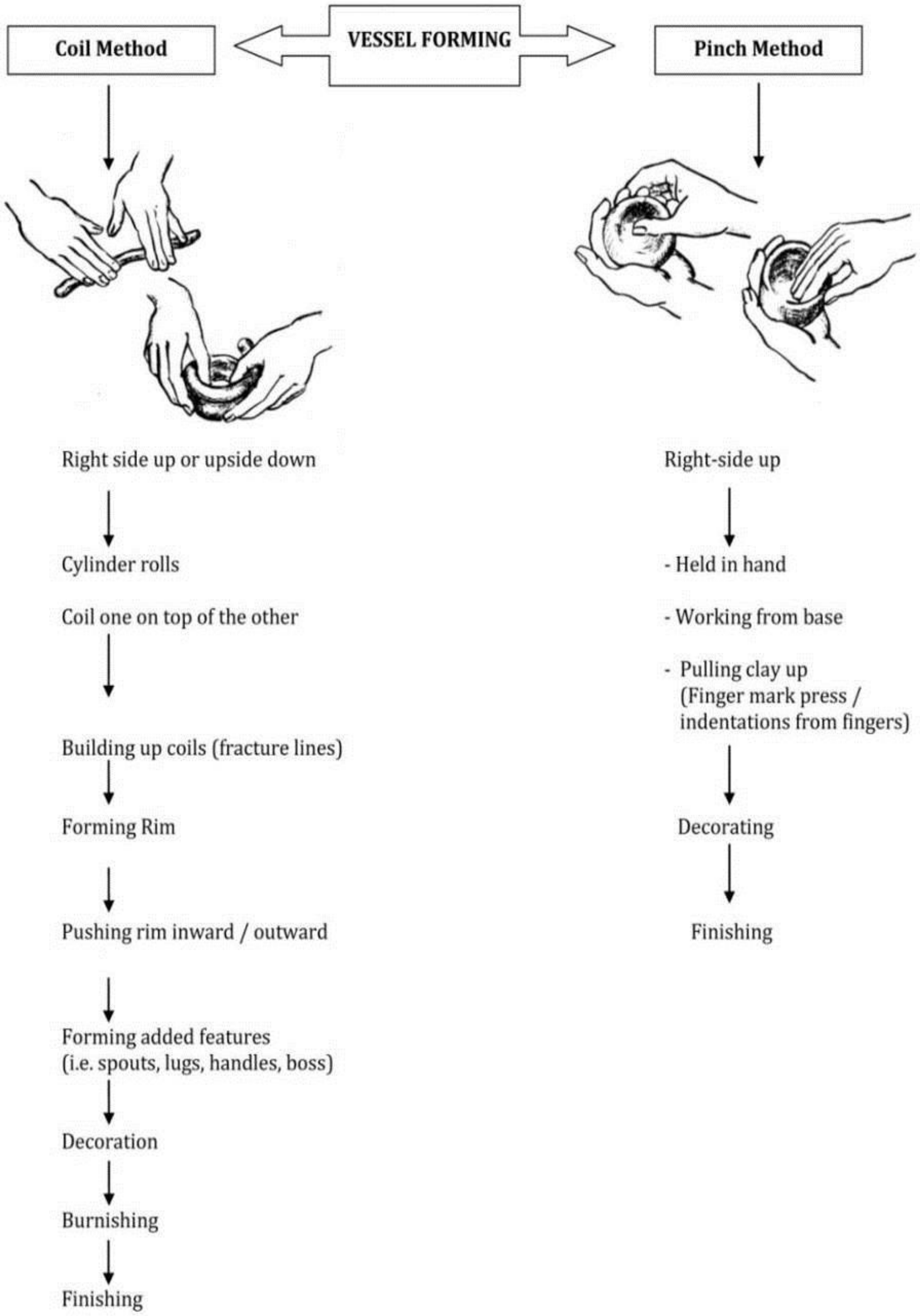


Figure 4.5: Illustration of vessel forming indicating coiling and pinch methods
(Adapted from Kenny 1949:10)

4.3.7. Firing conditions

Firing is considered the final stage of the manufacture process. Essentially the physical properties of the ceramics directly show the effectiveness of firing, but not necessarily the method itself because firing conditions produce varied results with different clays (Shepard 1980:214). This study therefore only makes inferences on the conditions and effects of firing which are based on the visual appearance of the vessel, or according to the physical properties of the ceramics. Where visible, for example on an exposed rim edge, colour variations between the interior, exterior and core of the ceramic fabric can also relate directly to general firing conditions (Prehistoric Ceramics Research Group 2010:54) and temperature (Rye 1981), and as such provide technological evidence of the firing process.

Furthermore, any visible surface evidence which may be useful in the description of the ceramic fabric can also provide evidence of firing techniques. For example, evidence of fire clouds or clouding results in black patches of colour on the surface of the vessels produced in open-pit firing (Gibson and Woods 1990). Such effects of firing are visible on the ceramics included in this study and are characteristic of this type of firing due to the deposition of carbon on the vessel. This also occurs when the ceramic has been in direct contact with the smoky part of the flame or with incompletely burnt fuel (Gibson and Woods 1990). According to the Prehistoric Ceramics Research Group (2010:54), there are several choices of firing categories, i.e. oxidized, unoxidized or incompletely oxidized or irregularly fired vessels (see Figure 4.6).

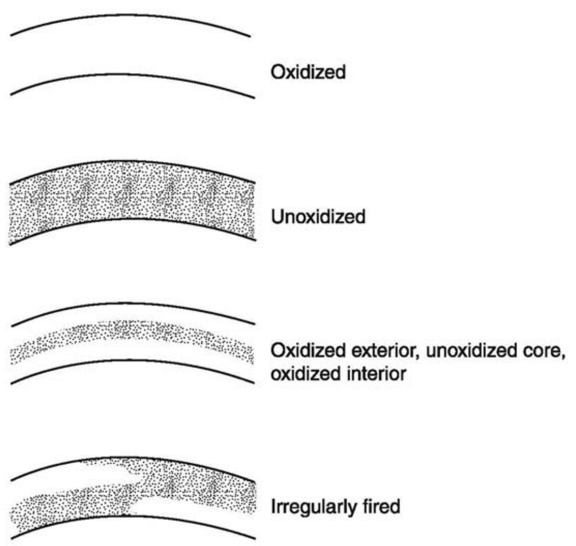


Figure 4.6: Visual representation of general firing conditions
(Prehistoric Ceramics Research Group 2010:54)

Rye (1981:115-117) summarises the results of the varying firing conditions as follows:

a) Uniform cross-section (other than black) – fully oxidising conditions, no organic matter in vessel. Surface colour variations result from differences in temperature;

b) Core grey or black, surfaces and sub-surfaces variously coloured, diffuse margins – incomplete oxidation, organic matter present;

c) Uniformly black – reduced or neutral atmosphere, but may indicate deliberate restriction of air; absence of organic matter and a fine matrix may prevent black cores while presence of organic matter leads to grey or black throughout.

According to Legodi and de Waal (2007:13), southern African archaeological ceramics are open or pit-fired, a common technique for manufacturing low-fired vessels. In this context therefore, the K2 and Mapungubwe ceramics are considered to be low-fired earthenware i.e. they are made from low-fired clay that is fired at relatively low temperatures thus rendering the clay body to be slightly porous (Figure 4.7).

Figure 4.7: Characteristic examples of low-fired ceramics from Mapungubwe, with an example of a black fire cloud on the base of a Mapungubwe vessel 21#N484 (bottom right)

4.3.8. Texture and secondary forming

Ceramic texture relates directly to fabric descriptions, which have been detailed and standardized by Orton *et al.* (1993) and Peacock (1970). In the context of this study, surface texture is determined by the method of finishing as evidenced by the texture of the clay matrix and ceramic fabric. According to Shepard (1980:190) the steps in the operational sequence can be reduced to the following factors that have an influence on ceramic texture:

a) Temper or non-plastic inclusions: texture of grains, shape and quantity as they affect the graininess and finishing technique of the vessel;
b) Quality of clay homogeneity;
c) Condition of clay at the time of finishing, whether plastic (flexible), leather-hard or dry;
d) Method of finishing

The overall appearance of the ceramic matrix texture can also be determined by tactile examination of the interior, exterior and any exposed ceramic fracture. General terms such as smooth, sandy or granular are borrowed textural terms that have been recommended by the Prehistoric Ceramics Research Group (2010:27). Texture is further determined by microscopic methods such as particle size, shape, grading and arrangement of particles. Other secondary forming traces or evidence of manufacture that can also be visually observed on the vessels interior and exterior surface are indications of scraping, smoothing, rubbing, finger imprints, drag marks, wiping and tool marks can also be identified (see Glossary for further definitions of these terms).

4.3.9. Surface treatments and finishing

After the initial forming and manufacture process, a vessel is set aside to dry until it reaches a relatively leather-hard state. Most of the water at this stage has mixed with the clay to make a workable surface, allowing for secondary finishing techniques such as surface treatment. Surface treatment is employed before decoration, forming that includes elements or burnishing. The methods of finishing the surface is intended primarily to improve the surface quality, remove surface irregularities and to improve general texture (Shepard 1980:65-66). This treatment involves smoothing, rubbing and wiping by hand or with implements that result in surface textural finishes that may be rough, smooth, matt or shiny (Gibson and Woods 1990; Shepard 1980, Sinopoli 1991).

Four main finishing techniques have been identified that are relevant to this study: scraping, wiping, smoothing and burnishing (see Glossary for further definitions of these terms). Scraping is a finishing technique which involves scraping a leather-hard vessel with an implement such as a shell, bone, stone or other types of tools held perpendicular to the vessel to thin or shape vessel. Wiping is a secondary finishing technique, which creates distinct linear ridges from wiping actions. Scraping and wiping are usually performed several times to thin the walls and eliminate any surface irregularities (Rice 1987:137).

Smoothing is generally performed after the scraping and wiping process, and is performed by lightly rubbing the vessel with hard tools such as a stone or potsherd to produce a smooth and relatively flat, matt surface in order to prepare it for surface treatment such as decoration or burnishing (see Figure 4.8).

Smooth, hard objects such as water-worn pebbles are common burnishing tools and several such 'polishing stones' have been found in context with the K2 and Mapungubwe ceramics (Gardner 1963). Burnishing marks are distinguishable because the back and forth rubbing process produces a facetted, uneven effect on the vessel's surface. This evidence serves both a functional and decorative purpose as the surface is compacted by the burnishing process, thereby slightly reducing permeability, and images are often given an attractive lustre-like surface and appearance (Gibson and Woods 1990).

Figure 4.8: Mapungubwe type shallow bowls with highly burnished surface treatments

4.3.10. Decorative techniques

Decoration on a vessel is considered a secondary manufacturing technique (Rye 1981; Shepard 1980), which takes place after the initial manufacture and forming process. Rice (1987:144) defines decoration as an embellishment of a vessel beyond procedures used in forming the clay mass into the final vessel shape and finishing its overall surface. Two types of ceramic decoration i.e. decorative techniques are distinguished by Rice (1987:144-152). One type penetrates the ceramic surface, and is known as plastic decoration, like incised or engraved motifs, and the other has additions or form elements, such as lugs and spouts which are added to the surface (see Figure 4.9 for examples).

Figure 4.9: Examples of surface treatments, form elements and decorative techniques

Such decoration on vessels is considered a secondary manufacturing technique (Rye 1981; Shepard 1980), which takes place after the initial manufacturing and forming process of the vessel. At this point, decorative motifs and designs or patterns are carried out and several types of techniques are executed such as incised, scratched, scored, impressed or stamped. Several techniques are identified relevant to this study and other decorative techniques are further defined in the glossary:

- Incised: This is a method employed by engraving or cutting lines into the surface of a vessel with a pointed implement. Incised linear (Figure 4.9) can be dragged shallowly or deeply and can leave traces such as displaced clay along the lines to indicate when the incision was made in the various stages of vessel manufacture, but is usually executed when the vessel is either in a wet or leather-hard stage (Shepard 1980:195-196).

- Impressed: This is a wide-ranging method consisting of single impressions, stamping and punctates. Specific impressed techniques identified in this study are comb stamping, where a comb, such as a die is used to produce a repeated pattern of identical motifs in either wet or leather-hard clay. Bead/bangle impressions use a string of beads fashioned from wood, bone, shell, metal or glass as a die to create a continuous pattern (Shepard 1980:193-194).
- Comb-stamped: This method employs the use of a comb as a die to produce a repeated pattern of identical motifs and this technique is distinguished by lack of continuity between successive impressions (Shepard 1980:194).

- Punctated: the use of an implement to punch depressions into wet clay. The implement used can vary widely in material and shape, ranging from reeds and sticks to carefully crafted tools. Punctated decoration can vary almost infinitely in shape; however, in the study area punctated decorations are typically round or triangular (Calabrese 2005:99)

The decorative technique referred to as appliqué or additions to the vessel surface is discussed below as a form element in the following variable. The standard approach developed by Huffman (1980) of using decoration layout and motif is widely used as an appropriate ceramic classificatory variable in southern African typological studies (Sadr 2008:105).

4.3.11. Form elements or additions

The addition or appliqué of form elements (also known as post-forming modifications) are decorative techniques that involve the addition of moulded clay to the vessel surface. This term according to Rice (1987:148) is the application of small, shaped pieces of clay to the surface of the vessel, may be complex and large, modelled additions. Form elements can include lugs, handles, bosses, flanges, spouts, perforations, pedestals (feet/cordons/bases), and lids onto the primary body of the vessel and are considered secondary forming techniques. Post forming modifications are projections of clay, which are either raised or applied, protruding from the body of vessel, and serve either decorative or functional purposes.

Perforations, for example, are common to K2 beaker vessels, which are holes made on either side of the vessel body after having been formed by pushing a round or sharp implement through the vessel wall from the interior or exterior. Lugs may be either vertically or horizontally pierced or perforated, and suggests that such perforations are to allow for the suspension of the vessel. Spouted vessels are relatively rare in both the K2 and Mapungubwe ceramic assemblages (Fouché 1937:39). Spouts are generally formed on the upper rim of spherical vessels and can vary in shape such as channel, tubular or bridge spouts (Figure 4.10).

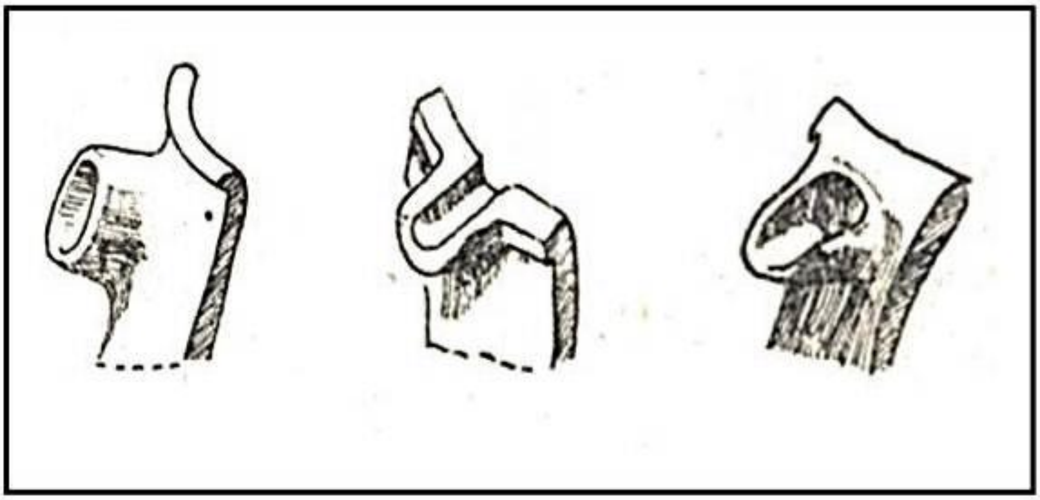


Figure 4.10: Spout forms, i.e. channel, bridge and tubular spouts (left to right.) (Schofield 1948:29)

4.3.12. Use-wear

Physical evidence on the vessel of use-wear, damage and deterioration can indicate the use and possible function of the ceramic (Rice 1987). For example, some of the ceramics exhibit major pitting on the base of the vessel may indicate that bottom of the vessel was probably placed over hearth stones during use. Many damage marks that were created prior to deposition can be seen on the interior of a complete vessel, and can serve as indication of scrape marks caused by wooden, bone or shell utensils for stirring, eating, grinding, scraping or cleaning. Visual differences in the appearance of a vessel can also be the result of numerous factors following burial conditions, environmental changes, previous interventions, i.e. plaster fills and even post-excavation damage.

4.4. Analytical procedures and methods of investigation

All laboratory procedures and physical examination of the K2 and Mapungubwe vessels took place in a secure research environment. Research was conducted within the Museum Objects Conservation Research Laboratory in the Old Arts Building at the University of Pretoria. Since the ceramics formed part of a permanent museum collection (see limitations discussion under sampling strategy), research was limited to this location for purposes of controlled research, easier access and to minimize handling. Furthermore, objects-based research had to be conducted within the ethical frameworks, policy and research protocols set out by the University of Pretoria Museum Collections Management Policy (March 2009).

Detailed photographic records were maintained, together with electronic data of all analyses, for the purposes of long term preservation of the ceramics and in keeping with museum research procedures and archival protocols. Archaeological provenance and museum accession data had to be collated, and all related information for each vessel, kept in compliance with regulations pertaining to the storage for access purposes of research data for 15 years at the University of Pretoria Archives (Promotion of Access to Information Act, No. 2 of 2000).

Analytical data procedures for this study can broadly be summarized as follows:

- Stage 1: Archival data was reviewed (both published and unpublished) for contextual, historical and archaeological data relating to all the ceramics (desktop study and literature reviewed).
- Stage 2: Technological analysis. Selection and identification of vessels followed by physical and visual examination, and investigation of traces of physically visible technology on the vessels, in combination with a range of other analytical methods such as digital photography, ceramic image analysis, visual analysis and stereoscope light microscopy (where possible);
- Stage 3: Sample selection and non-invasive analyses using non-destructive *in situ* (i.e. a handheld or portable instrument) energy dispersive X-ray spectrometry (XRF) and X-day diffraction (XRD)

4.4.1. Archival data

A preliminary investigation began with research in the Mapungubwe Ceramic Archives of the University of Pretoria. This archive preserves and curates the archaeological collection of the K2 and Mapungubwe ceramic assemblages and all related data. The Museum exhibits a majority of the complete ceramic vessels to the public, and also serves as a repository for all field and archival data relating to the archaeology of Mapungubwe. All the primary sources concerning the ceramics are lodged in the Mapungubwe Archives, which include qualitative data such as research reports (both published and unpublished), excavation and field reports, inventories, maps and research correspondence from the 1930s to the present, serving as a historical, literary as well as a form of archival analysis to this study. Such available data is an imperative contextual starting point, relating the vessels to locality, provenance and chronology, and provides a strong research background for each vessel.

4.4.2. Physical examination and visual data

Physical and visual analysis forms part of the very essence of any research on archaeological ceramics. Detailed macroscopic examination as part of basic laboratory procedures was used as a means of building up a general, comparative technological picture of the vessels manufacture. Comprehensive documentation and examination of the vessels that relate not only to the identification of technological evidence, but also to the condition and extent of damage on a vessel are also vital elements of research.

Physical and visual analyses provides the basic evidence for determining the anatomy of the vessels, including surface texture, colour, coil fractures and surface treatments that are indicators of ceramic technology. All macroscopic observations of the surfaces and fabrics were performed with the naked eye, a handheld magnification tool, a magnivisor, a desktop optivisor, a 40 X 40 binocular microscope, a Celestron digital microscope 10 X 150X and raking UV light, as well as a small torch, used for difficult and obscure areas such as under rims or inside restricted vessels.

The vessel fabric was also examined to include constituents such as tool marks, use-wear patterns and to determine measures of smooth or rough tactile texture or fabric type such as coarse fabrics or fine fabrics (matt or burnish). Similarly, differences in natural wear, damage, or deterioration products and any adhering material (especially previous attempts of reconstruction or post depositional causes) were also observed.

For example, cracks in the ceramic body may be caused by both the shrinking of the clay as the vessel dries during the manufacture process and could also be the result of shrinking of the plaster of Paris fills used to reconstruct the ceramics in the 1930s. It is important therefore, to differentiate the cause of shrinking and resultant cracks from either a technological point of view or as post excavation damage. Detailed observations will be further noted of the ceramic fabric both on the sherd edge, interior and exterior of the vessel, which could include constituents potter marks, forming or use-wear evidence and other technological details.

4.4.3. Compositional data

The techniques chosen for compositional analysis are non-invasive and will be conducted on all the research vessels however; the size of the complete vessel was a limiting factor for the micro stereoscope and for sample size restrictions, particularly with chemical analysis. From an ethical point of view (cf. ICOM Code of Ethics 1986), bulk composition and destructive sampling were not even considered on national heritage ceramics. With such restrictions beyond one's control and due to analytical limitations on intact vessels, one of the main objectives of materials analysis was to macroscopically characterize the ceramic fabric, where it was exposed on the rim, body, and base or with an existing fracture or loose fragment. This included both the interior and exterior surface areas (external characteristics) and to identify clay crystalline mineral traces or visible inclusions. In this context, fabric analysis refers to the spatial arrangement of inclusions, orientation of grains and grain-size distribution within the ceramic fabric (Peacock 1970).

In the absence of thin section analysis, the identification of individual inclusions and other petrologic observations are difficult to determine macroscopically. Therefore, existing minor samples of ceramic fabric or deposits flaked, as a result of deterioration from the exterior or interior surface of the vessels, will be retained (samples are preserved for future research) for micro analyses where possible to aid characterization of ceramic chemical composition. The elemental and chemical compositions of the ceramics will be determined by XRF and XRD. These non-invasive materials analyses provided preliminary qualitative data on the mineral composition of the vessels as a chemical signature. XRF was employed to determine relative major, minor or trace elements present in each ceramic vessel. These minor or trace elements may have little influence on the properties of the ceramic, but are often critical to distinguish ceramics from similar ceramics derived from different clay sources (Shepard 1980:144).

Fifteen major constituents will be presented in tabular format for each vessel as they usually occur in combinations and quantities that are more distinctive of individual clays or temper combinations (Rice 1987). The purpose of the preliminary analysis is to present a quantitative elemental signature for each vessel as this has never been done before. The chemical composition for all the ceramic vessels determined by XRF analysis will be in tabular form outlined in Appendix 5. Materials analysis was used as a means of building up a technological picture of the manufacture of the vessels and not only as statistical data analysis. Analytical non-destructive analyses was performed by using stereoscope light microscopy, a handheld or portable X-ray fluorescence (pXRF) instrument, and X-ray diffraction (XRD) used to characterize the ceramic body and the ceramic fabric at a micro level, as well as provide qualitative elemental compositional data.

4.5. Materials analysis

All materials analysis was conducted on the central campus of the University of Pretoria, utilizing the respective in-house analytical laboratories and the analytical equipment was made available by the Museum Conservation Research Laboratory, the XRF/XRD Facility at the Department of Geology and the Laboratory for Microscopy and Microanalysis at the University of Pretoria, with the exception of the handheld or portable XRF Analyser, kindly provided by *United Spectrometer Technologies cc.* in Johannesburg.

4.5.1. Stereoscope light microscopy

Stereomicroscopy was performed on six complete vessels, considered small in dimension, in order for the entire vessel to be simply inserted under the apparatus, without placing any risk to the ceramics. The Geiss Stereo Discovery.V20 features plan apochromatic (a microscopic objective of the highest correction, corrected for four colours chromatically and spherically, ideal for critical resolution and colour photomicrography), corrected microscope body with a zoom range of 20:1. Unlike laboratory grade 40X magnifications from conventional microscopes, the Stereo Discovery.V20 enabled higher magnifications with a smaller lens and a larger zoom range to allow for greater surface detail, precision recording data and pin sharp images. The vessels were examined in reflected light and transmitted light using a magnification range from 4.7X to 345X magnification in order to achieve fine surface detail, object field and a pin focus resolution of the ceramic fabric (see Appendix 6).

4.5.2. Digital microscopy

A handheld digital microscope using a magnification of 10X to 150X was used to examine the ceramic fabrics. Its lightweight features and rotatable focus lens enabled successful capture of inclusions on existing fractures and exposed areas on the complete vessels. A portable Delux Celestron LED digital microscope with white light illumination and a built-in camera recorded images in 1600 – 1200 pixels in a JPEG 24 bit depth format. This enabled 2MP snapshot image capture, as well as simple measurement functions (in millimetres) which are downloaded via as USB cable onto the Digital Microscope Software Suite 2.0 to process high resolution images of the ceramic fabrics as well as the ceramic surface (see Appendices 6 and 7).

4.5.3. X-ray fluorescence spectrometry (XRF)

The analytical technique of portable X-ray florescence (XRF) was employed to determine elemental signatures of each ceramic vessel. XRF is essentially based on the principal that individual atoms, when excited by an external energy source, emit x-ray photons of a characteristic energy or wavelength. By counting the number of photons (in this study counts are determined in parts per million or ppm) of each energy emitted from the sample, the elements present can then be identified and quantified (e.g. Jenkins 1999; Shackley 2011).

Elemental analyses was carried out following the standard method used in the XRF laboratory of the University of Pretoria, as adapted from Bennet and Oliver (1997). The laboratory grade instrument used for analysis was a portable Thermo Scientific Niton XL3t XRF Analyzer. This instrument has an Ag anode and measurement conditions were 50kV and 200µA in the x-ray tube with an acquisition time of 120 seconds. Depending on the density of each sample, the screening depth ranges from a few micros to 0.375 inches and small-spot sample 3mm capacity.

The integrated CCD camera for locating and storing ceramic data and images enabled electronic transfer of data onto the Niton Data Transfer PC software, ensuring that all results (expressed in ppm with relative error ± values) were easily downloaded in Excel format, where the data was then collated and tabulated (see Appendix 5 for summary of total data). A disadvantage of this particular unit is its inability to detect additional light elements such as Al, Si and P. It is also acknowledged "that there is a great deal of variability from one scan point to another…even a hundred point scan might not be fully representative and give an accurate estimation of the true average composition of the vessel". (Jacobson 2005:64). Conventional analysis of the same sample and comparison with other portable XRF readings is however not the focus of this study.

An advantage of the handheld, portable XRF analyser is that it does not come into direct contact with the ceramic vessel surface and was therefore selected for its *in situ* abilities, ideal for fragile museum objects such as ceramics, therefore avoiding all risks to the vessel during routine analyses. The standard analytical range of a total of twenty-five elements from sulphur (S) to uranium (U) was tested with the *in situ* handheld or portable XRF unit, on a smooth surface clear of dirt or accretions and where available, on a fresh break or fracture (permit parameters did not allow for any cleaning).

The data however, was not aimed to be fully comprehensive, but merely provided an individual elemental signature for each vessel. XRF analyses was thus formed for the following elements, being narrowed down to fifteen commonly used elements: potassium (K), calcium (Ca), titanium (Ti), iron (Fe), manganese (Mn), zinc (Zn), zirconium (Zr), strontium (Sr), rubidium (Rb), thorium (Th), copper (Cu), nickel (Ni), chromium (Cr), vanadium (V), and sulphur (S). Only constituents with high or relative concentrations or those which strongly correlate with each other (i.e. Rb and Sr) were presented for each vessel in tabular format (see Chapter 5). The semi-quantitative results hope to indicate at least low or high concentrations in parts per million (ppm) of major elements associated with the clay (e.g. Ti, Fe, Ca, K), minor elements (e.g. Zn, Zr, Mn) as well as trace constituents (e.g. Sr, Rb, Th, Cu, Ni, Cr and V). The issue of which elements to use can be debated, but ultimately it may be best to "use them all" according to Jacobson (2005:193), particularly elements which are strongly correlated to one another i.e. Sr and Rb, and often Ca and Sr

This is particularly necessary as clays are multi-mineral mixtures in which differences in mineral and chemical composition that may provide technological clues to the vessel composition (Garcia-Heras *et al*. 1997:1006). The effects of burial and contamination resulting from use and post depositional information also play a significant role in affecting the composition of ceramics (cf. Copley *et al*. 2004; Cronyn 1990; Freestone *et al*. 1985; Jacobson 2005). The elements of lead, arsenic; platinum, cobalt, and scandium are omitted from the table with each vessel as variability is so low due to extremely low concentrations or undetermined intensities. Sulphur (S) results were also excluded as it is considered a possible contaminant from the storage environment (Cronyn 1990:37). The total analyses which brings together all major, minor and trace elemental data is numerically summarized and presented in Appendix 5. Although the sample size is limited for this study, this analysis of the complete vessels should only be considered preliminary work with the handheld XRF and that further statistical ceramic sampling and conventional analysis of the same sample will be needed in future research.

4.5.4 X-ray diffraction (XRD)

Energy dispersive x-ray diffraction (XRD) analysis was employed as a method of ceramic characterization based on identifying minerals by their crystalline structure within the ceramic fabric. The XRD technique operates on the principal that different minerals feature in distinctive crystalline structures by bouncing x-rays off the powdered clay matrix and recognising crystalline phases or patterns (Rice 1987). These mineral phases i.e. quartz, albite, microcline feldspars, diopside are then interpreted in terms of the atomic arrangements of the crystals and produces a diffraction pattern of sharp lines or a crystal spectrum. This spectrum of any pure chemical element or compound is therefore characteristic of the clay mineral present in the vessel (Shepard 1980:146-147).

From a technological viewpoint, the presence of mineral patterns relate to the physical properties of the ceramics enabling thermal strength, elasticity and moisture absorption (see Wallace 1989:33-39). The XRD analysis provides the mineral fingerprint of the clay, as well as preliminary information on the composition of the raw materials used to manufacture the vessels and results can also be associated to geological formations.

Seven samples (two samples from K2, three from Transitional K2 and two from Mapungubwe) were analysed using energy dispersive XRD, due to the small sample size of holders using the X'Celerator detector. Existing minor samples of ceramic fabric or deposits that had flaked, as a result of deterioration, from the exterior or interior surface of the vessels were retained and the samples preserved for reuse. Existing ceramic fragments or loose samples from the exterior and interior of the vessel walls were hand-milled and top loaded onto a zero-background holder. Sample size was a major limitation but smaller samples could simply be fitted into sample holders specially designed for such sample pieces. They were analysed using a PANalytical X'Pert Pro powder diffractometer with X'Celerator detector and variable divergence- and receiving slits with Fe filtered Co-Kα radiation.

The XRD mineral phases were identified using X'Pert High score plus software and were then converted to electronic Excel data. Diffractograms of each of the samples were illustrated as JPEG image files and the mineral compositions are easily provided with an accompanying legend.

4.5.5. Digital photography and illustration

Digital photography and electronic methods of recording archaeological ceramics is advantageous as such techniques visualize the shape and colour of vessels in a more accurate way than traditional black and white line drawings (cf. Dorrell 1994; Glock 1987). Vessel profiles have been adapted from Schofield (1937, 1942) and Meyer (1980) and converted to digital 2D profiles, allowing for imperfections to be corrected by hand from visual observations of the ceramic profile, hence the entire shape of the vessel is not illustrated, only a portion. Furthermore, ceramic classifications using computer graphics and photogrammetry have been investigated by Kampel *et al.* (2001) as well as by Shirvalkar *et al.* (2010), proposing digital photography as an alternative technique for Indian archaeological ceramic analysis, thereby opening new research avenues for archaeological ceramics research.

For this study, detailed digital recordings with a Nikon D 700 digital camera utilizing lenses Nikkor PC 45mm and a Nikkor AF 60mm Micro are used to avoid distortion, which is common with ordinary lenses. A medical Nikkor lens used for the interior of restricted vessels was suitable at x 3 magnification to document difficult angles. All images will be photographed in raw format 12Mb at the exposure of 1/125 at f45 to f22 using two Elinchrom studio flashes plus umbrellas for lighting to avoid unnecessary ceramic shadows. All the vessels were photographed in a white tent on a white background, which maintained the original colour of the vessel, with no visual distortion of the electronic images with shadows or any manipulated colour.

All raw images were processed in Adobe CS5 Photoshop and saved in a psd format and jpeg format for easy research access and data storage purposes. For detailed illustration purposes, the rubbing method was used on the decoration of the vessels (See Appendix 7). This is a recommended practical rubbing approach for complete vessels, as well as for sherds. The rubbing is produced using with conservation grade tissue paper (not damaging carbon paper as this leaves carbon residues) and a soft HB pencil to avoid abrading the vessel surface, thereby reproducing an accurate representation of the decorative technique. The decision to use this technique is for better accuracy with reference to depth and dimension of decorative technique as opposed to artistically rendered or the hand-drawn monochrome illustrations.

For this study, the profile drawings of the ceramics produced in Adobe Illustrator, using the trace tool to draw outlines of the ceramics, within scale, used in combination with the physical assessments of determining actual vessel profiles.

The horizontal image, flipped, is then cut in half at midpoint, and the edges aligned to analyse a virtual ceramic image (cf. Shirvalkar *et al.* 2010). Scales and measurements maintain a separate layer according to physical measurements of the ceramics. Examples of utilizing illustrations together with digital recording data further demonstrates and highlights the importance of accurate illustrations for ceramic technology in particular (Glock 1987).

For this study, detailed digital photography (e.g. Dorrel 1994) was particularly utilized in combination with illustration and the method of rubbing decoration to systematically communicate visual data and technical information, in order to interpret data independently and judge the validity and accuracy of traces of technological evidence on the K2 and Mapungubwe ceramics.

4.6. Selection strategy and limitations

The K2 and Mapungubwe ceramics used for the purposes of this study consist of 26 complete or partially complete vessels (See Chapter 1), which are characteristic of the core archaeological localities of mainly K2 and Mapungubwe Hill. As outlined in the archaeological background in Chapter 2, the vessels are accounted for within their stratigraphic contexts, as well as some from feature and non-feature related contexts. It is known that the occupation of settlements contain household (residential or living areas), midden deposits, storage pits, granaries, human burials, cattle burials and other types of features, in which ceramic vessels are expected to be found.

Diagnostic types of vessels were also chosen for analysis such as shallow bowls, beakers, beaker bowls, shouldered pots, spherical pots and bellied pots, ranging from large, medium and small to very miniature vessels. It is also essential to use both decorated and undecorated vessel forms as they exhibit a wide variety of contexts; variables differ in terms of both morphological and technological traits in terms of their size, shape and they serve as typical illustrative samples within the wider K2 and Mapungubwe ceramic repertoires.

The rationale for utilizing 26 complete vessels is based on several criteria, which best relate to the archaeological question of whether physical manufacturing evidence is discernible on whole vessels as such evidence is usually limited on sherds. Second, the vessels should also characterize the period, quality of context, quality of preservation, range of size, as well as the form and ceramic types represented within a scope of two core localities mainly K2 and Mapungubwe Hill (See Table 4.5.).

In addition, the greatest limiting factor for selecting a larger sample size was mainly based on certain sampling restrictions posed by sections 32 and 35 (4) of the National Heritage Resources Act, Act No 25. of 1999, which prohibits any destructive analysis of declared national heritage objects. In the case of this study, research had to be in line with legislative parameters since twenty-one of the ceramics are specifically declared heritage objects (i.e. a national heritage collection indicated by the accession nos. N) and therefore no destructive sampling can take place and, according to permit conditions the ceramics, "should in no way be damaged" (SAHRA Permit No: 80/11/001/71).

# Acc. nos.	ID	Site Context	Excavation Context	Estimated date range
*N/248	1	K2, Block 4 Section 7 3' 10' 3' (no 30/37)	Occupation area (midden)	AD 900 – AD 1030
*N/252	2	K2, KS 38 (Skel.). Block 3 Section 5 10' 2' 2"	Human burial (juvenile)	AD 1000 – AD 1220
*N/283	3	K2, KS 48 (Skel.). Block 3 Section 7 15' 21' 2"	Human burial (juvenile)	AD 1030 – AD 1220
*N/280	4	K2, Block 3 Section 9 depth 3' 22' 3'	Occupation area (midden)	AD 1030 – AD 1220
*N/273	5	K2, Beast burial 6 Block 4 Section 6	Cattle burial	AD 1030 – AD 1220
*N/433	6	K2, Block 2.2. Section 12 12' 6' 2' (No.4)	Occupation area (midden)	AD 1030 – AD 1220
*N/259	7	K2, Beast burial 6, Block 4 Section 6 4' 7' 56"	Cattle burial	AD 1030 – AD 1220
*N/264	8	K2 surface	Surface area	AD 1030 – AD 1220
C/421	9	K2, Test Pit 8 no.4	Occupational area	AD 1030 – AD 1220
C/2198	10	K2, Block 2 Section 2	Occupation area (midden)	AD 1030 – AD 1220
*N/275	11	Map Hill, Block 5 Section 1 14' 42' 3'	Occupation Area	AD 1200 - AD 1250
*N/397	12	Mapungubwe Hill Block 7 Section 6	Occupation area	AD 1200 - AD 1250
*N/398	13	Mapungubwe Hill Original grave area 33.161	Grave area burial	AD 1200 - AD 1250
*N/390	14	Map Hill, Eastern excavation erosion area	Palace area	AD 1200 - AD 1250
*N/404	15	Mapungubwe Hill, Trench JS4 120' 2' 6"	Occupation area	AD 1220 - AD 1290
*N/403	16	Mapungubwe grave area west ext. no 1A	Human burial	AD 1220 - AD 1290
*N/219	17	Mapungubwe Hill Skel. 14 Grave Area Exc. Nos. 00	Grave area/burial	AD 1220 - AD 1290
*N/220	18	Map Hill, Grave Area Burial, skel.11	Human burial	AD 1250 - AD 1290
*N/221	19	Mapungubwe Hill Grave Area Exc. Nos.00	Grave Area/burial	AD 1250 - AD 1290
*N/266	20	Map Hill, Block 1 Section 4, 10' 41' 4'	Occupation Area	AD 1220 - AD 1290
*N/484	21	Map Hill, Block 5 Section 4 15' 4' 8'	Occupation Area	AD 1220 - AD 1290
*N/224	22	Southern Terrace Trench JS 2b	Court area	AD 1200 – AD 1250
C/428	23	Mapungubwe Hill grave area	Grave area/ burial	AD 1250 - AD 1290
C/427	24	Mapungubwe Hill surface/ trench JS5	Palace area	AD 1220 - AD 1290
*N/376	25	Map Hill, Block 5 Section 5 ,60' 1' 9'	Occupation Area	AD 1220 - AD 1290
C/2196	26	Map Hill, Block 5 Section 2 25' 5' 5'	Occupation Area	AD 1220 - AD 1290

(Vessel samples listed with * N= National Heritage Collection)

Table 4.5: Summary of inventory of all sample vessels, chronology and contextual data

4.7. Closing remarks

Since the technological aspects of manufacture Iron Age ceramics is at present poorly understood in a southern African context, it is hoped that this preliminary analyses of 26 complete vessels from K2 and Mapungubwe Hill will be a meaningful contribution to ceramic research technology. Taking into account all considerations, the restrictions, and limitations on sampling from a nationally significant archaeological collection, the primary unit of technological analysis is essentially the complete vessel. The broader value of this study will be to relate the preliminary technological data to wider future quantitative ceramic sherd studies, particularly with the focus on determining clay sources, production sites and, on a larger regional scale, for comparative purposes with other related ceramic research assemblages from the Shashe Limpopo Confluence Area. The results of the analysis will be presented in the following chapter.

CHAPTER 5

This chapter provides the data analysis of the ceramics according to the range of analytical variables related to ceramic technology previously outlined in Chapter 4. In order to obtain a detailed analysis and to ensure some degree of consistency, the twenty-six vessels are broadly grouped into three ceramic traditions: K2, Transitional K2 and Mapungubwe ceramics respectively, broadly covering the period AD c.1000 – AD 1300. Due to the expected limitations of materials analysis on complete vessels and overall sample size, each ceramic has been considered as a single unit of analyses, therefore this chapter presents the ceramics individually, yet are organised according to stylistic units. Each vessel is further placed within a basic descriptive, chronological and contextual framework. Excavation context and typology are presented first, followed by the technological analysis, then by XRF elemental and XRF mineralogical analysis, where possible. The final results of the total analysis of all the vessels will then be discussed in the following Chapter 6.

5.1. ANALYSIS OF K2 CERAMICS

5.1.1. Vessel 1

Excavation context, typology and morphology

Vessel 1 (#N248[1]) is a decorated Zhizo (possibly even Leokwe) globular recurved jar (334mm x 277mm) excavated in 1937 from K2 block 4, section 7, 3' inches (7.6cm) from the extreme left of the section, 10' inches (25,4cm) across the section from left to right and at a depth of 3' inches (7.6cm) from the surface. This reconstructed vessel is considered typically Zhizo (Alexander Antonites, pers. comm. 2012), characterized by the restricted narrow aperture and the predominant zoned diagonal band of decorative comb-stamping on the central neck. According to Huffman (1997:145), the distinguishing feature commonly associated to Zhizo vessels is the recurved jar with stamped and incised decorative bands on the lower rim, neck and shoulder. This vessel is associated to the K2 midden occupation area within the Leopard's Kopje Phase I (c. AD 1000 – AD 1025). Similar Zhizo vessels have previously been described (see Schofield 1937:8-12 Plate XXVII) and are found sparsely in K2 deposits (Meyer 1980:278-279). Similar jars have also been excavated from Leokwe Hill (Calabrese 2005:196). According to Meyer (1980), this vessel is also classified as a variation of the K2 series form no. 05.01 of globular/ovaloid vessels with necks of his Group 5.

[1] #N248 is an example of the permanent museum accession number allocated to each vessel and serves as the identification number within the larger K2 and Mapungubwe ceramics assemblages.

The vessel shape is distinguished as an ovoid form, with a globular body, long neck (70mm), a straight rim profile, restricted orifice (103mm) and very round base (see Figure 5.1.1). The vessel was excavated from the occupational area of K2, which included several *in situ* fire hearths and hammer stones, together with several sherds and was proposed as a possible cooking area, where vessels were placed directly onto a series of upright stones (Gardner 1963:12). It was also found in association with a beaker, a pottery garden roller (GR)-type bead, half a fragment of a GR clay mould with globules of glass, a bone awl and ivory fragments (Gardner 1963:120).

Figure 5.1.1: Globular Zhizo vessel with a narrow aperture and distinct fire cloud on body

Technological analysis

The vessel is composed of a medium type fabric (as defined in Chapter 4, see Table 4.3.) with predominant clusters of clear glassy white inclusions with a size range of 0.25mm to 1.0mm. The frequency of inclusions is about <30% (common) of the total fabric, within a dense, non-porous, relatively smooth texture (Prehistoric Ceramics Research Group 2010). Reflective micaceous specks are also present on the ceramic surface. This vessel shows clear signs of use-wear on the exterior from the base upward to the centre of the body, which has a pitted and spalled surface, exposing an area of visible red/brown (<1.0mm) mineral inclusions, most probably red oxide or iron (see Figure 5.1.2). The latter element is identified and consistent with the XRF results (see Table 5.1). An existing fracture on the rim has exposed an unoxidized black fabric core with thin oxidized interior, and exterior margins indicating the effects of incomplete oxidation conditions during the firing process (Prehistoric Ceramics Research Group 2010:54).

The overall surface colour is varied, with patchy black areas, but the exterior surface is mostly brown (10YR 4/3). A fire cloud (see Figure 5.1.1.) is clearly visible as a black area on the body; this discolouration could be the result of the deposition of soot on the surface where the vessels come into contact with the smoke or local reduction during the firing process (Gibson and Woods 1990:121; Shepard 1980:76). The forming technique of this vessel is not very clear as there are no primary traces indicating evidence of shaping. However, a fracture around the shoulder is evident, indicating that the base and neck were possibly shaped separately in sections. The vessel has been finished and scraped smoothed with a low burnish (i.e. not lustrous) and therefore the surface texture appears relatively smooth. A single band of zoned diagonal comb-stamping decorates the neck, and the whole rim and lip is broken away. This stamping technique is distinguished by a lack of continuity between successive impressions (Shepard 1980:194; see technique detail Figure 5.1.2b.)

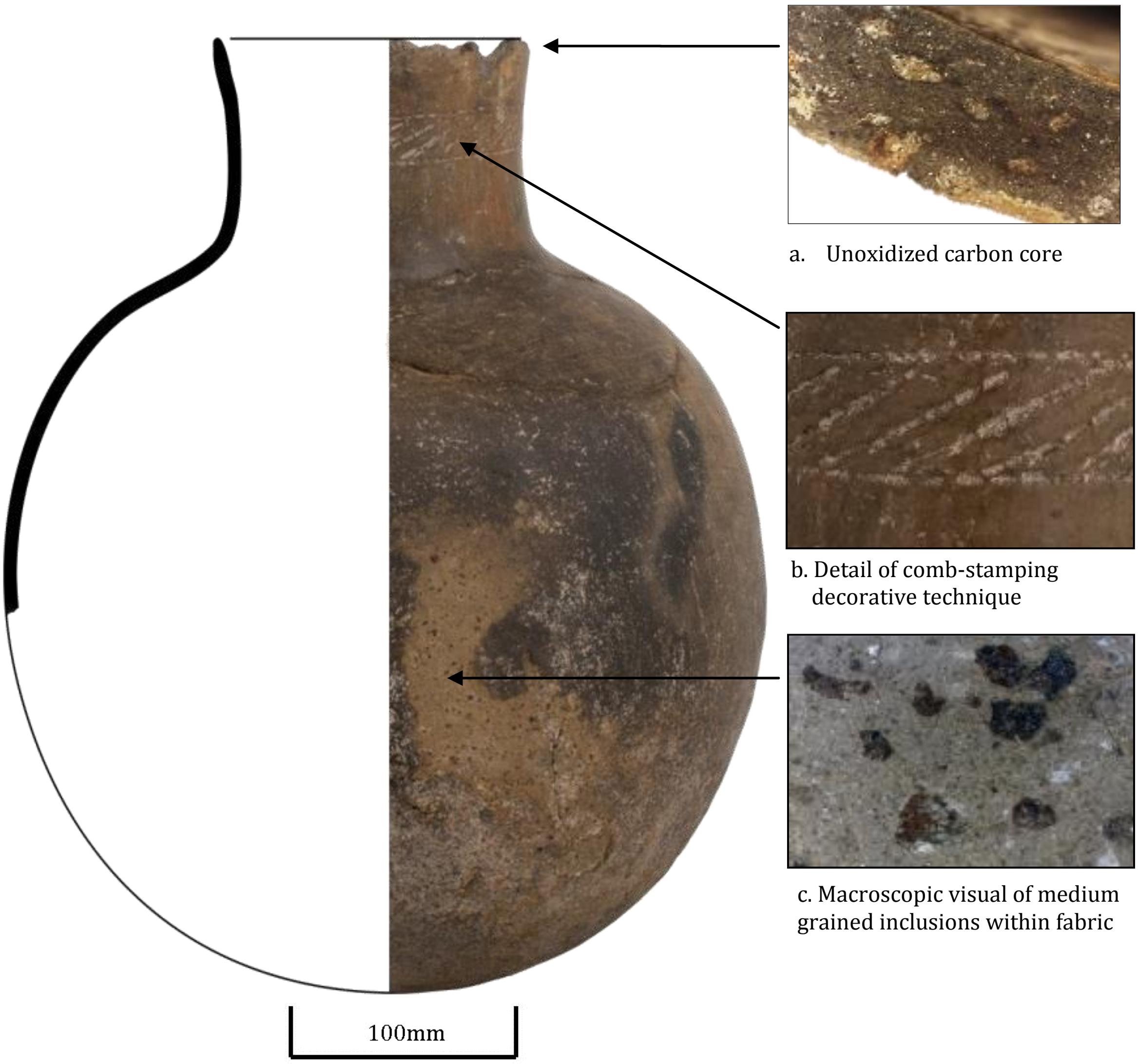


Figure 5.1.2: Comb-stamped Zhizo vessel from K2 with evidence of firing core (a), decorative motif technique (b) and dark red/brown mineral inclusions (c) in the fabric

Chemical (XRF) analysis

XRF analysis for vessel 1 was performed for the presence of the following elements: K, Ca, Ti, Mn, Fe, Zn, Zr, Sr, Rb, Th, Cu, Cr, Ni and V. (see Table 5.1). The XRF analysis presents the elemental quantification signature for the ceramic. The vessel shows major concentrations of iron (Fe), potassium (K) and calcium (Ca) and the remainder of the minor elements indicate low concentrations.

The trace element intensities are expressed in ppm and includes the relative error ± values (see Table 5.1) as outlined in the methodology (see Chapter 4). The total summary of all the XRF results for each vessel are tabulated and compared in Appendix 5. The semi-quantitative results, although preliminary are further discussed in Chapter 6

Element	ppm	*Error ±
K	34940.84	±333.69
Ca	27052.16	209.68
Ti	6588.35	89.83
Mn	657.47	47.57
Fe	39146.63	234.82
Zn	174.21	10.24
Zr	396.14	07.37
Sr	518.17	06.36
Rb	95.01	3.51
Th	7.35	3.81
Cu	67.23	10.96
Ni	112.78	20.83
Cr	98.81	21.87
V	81.13	27.2

* Trace element intensities (expressed in ppm) with relative error ± value
Table 5.1: XRF elemental quantification signature of vessel 1

5.1.2. Vessel 2

Excavation context, typology and morphology

Vessel 2 (#N252) is a decorated Mambo (possibly early K2) recurved jar (145mm x 152mm) excavated in 1937 from K2, K.S Burial No 38, block 3, section 5, 10' inches (25.4cm) from the extreme left of the section, 2' inches (5.1cm) across the section from left to right and at a depth of 2" inches (5.1cm).

Typologically this vessel is characterized as Mambo (Alexander Antonites, pers. comm. 2012) with incised arcades on the short upper neck, and a globular body (Calabrese 2005:12), but is also similar to form no. 05.03 (Meyer 1980:69) and very similar to the arcade attributes common to other Mambo/ Leopard's Kopje ceramics from southwestern Zimbabwe (Huffman 2007:363). This vessel form (see Figure 5.2.1.) is spherical, with a restricted orifice (99mm), a globular body, rounded base and slightly everted rim.

The vessel, consisting of two large sherds, was previously reconstructed and is associated to a juvenile burial (Figure 5.2.2.) lying on the left side and facing north-east. Associated material includes a bowl, a large number of trade glass beads, shell beads and two *Natica* seashells (see Gardner 1963:46 Plates XXX, XVI No. 3). The vessel is not characteristic of the K2 type series and is a variation of the Mambo tradition (Huffman 1974) associated to the Leopard's Kopje Phase II (± AD 1000– AD 1200).

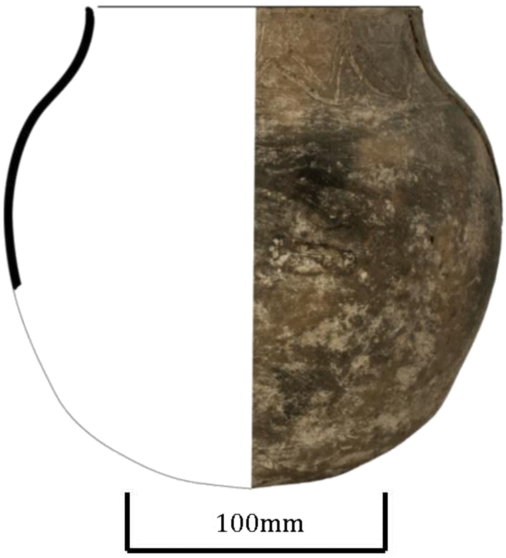


Figure 5.2.1: Mambo spherical vessel from K2 with characteristic incised arcade motifs

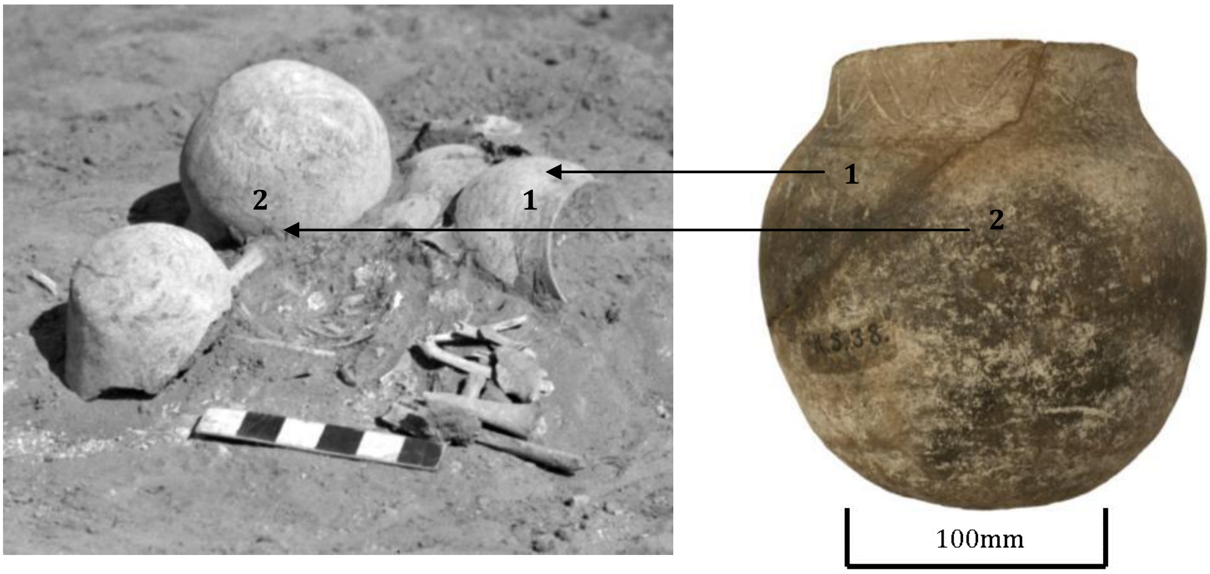


Figure 5.2.2: Reconstructed recurved K2 jar from K.S. No. 38, block 3, section 5
Vessel *in situ* (left) excavated by Gardner 1937 (Gardner 1963:188)

Technological analysis

The vessel is composed of a medium type fabric with a <11-25% frequency of inclusions (with a size range 0.25mm to 1.0mm) of the total fabric with moderate amounts of glassy white and dark black shiny (rare 1%), inclusions, reflective specks and clusters of red earthy inclusions. These mineral grain, possibly iron oxide (red) and quartz (white) particles can be clearly observed on the partially exposed fabric on the rim of the vessel (Figure 5.2.3). According to Riederer (2004:45) these comparatively large grains can be considered possible temper, since they are larger than 0.01mm, and are clearly visible with the naked eye. The overall fabric has a distinctive sand-papery nature, resulting in a sandy feel with an irregular appearance and larger, more widely spaced porosity. The surface colour is varied, brown to black (7.5YR 3/2).

The vessel is not fully oxidized, with a dark grey core which is partially visible, indicating the effects of incomplete oxidation conditions during the firing process (Prehistoric Ceramics Research Group 2010:54). Subsequent smoothing of the surface on both the exterior and interior has obliterated traces of primary forming. Nonetheless, there are clear traces of scraping on the interior neck close to the upper rim (Figure 5.2.4), a method used to thin the walls and remove surface imperfections.

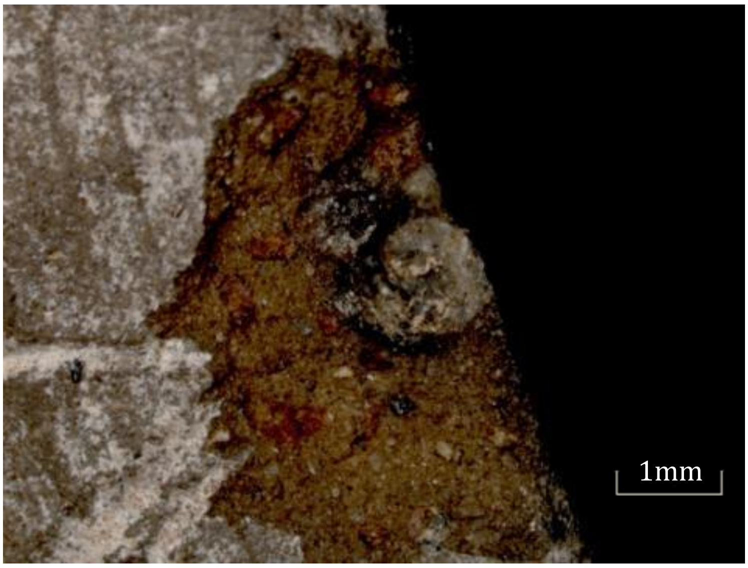


Figure 5.2.3: Stereoscopic X25 view of medium-grained inclusions in fabric of Mambo vessel

Figure 5.2.4: Macroscopic view of scrape mark traces on the inner rim of a Mambo vessel

The surface colour of this vessel varies from light brown to a dark grey, with patchy black areas visible on the surface as a result of the firing conditions. A soft white calcareous-type deposit from burial conditions also covers the exterior and interior surface sporadically. The surface treatment is lightly burnished to smooth over the surface of clay particles. The surface was then decorated while the clay was still relatively wet and then smoothed again as horizontal scrape marks are visible over the decorative motifs. The vessel is decorated on the upper neck with a double triangular arcade motif using an incised technique. This technique appears almost rudimentary in comparison to other K2 geometric motifs and is perhaps tooled (Gibson and Woods 1990:259) with a wooden stick, only lightly scoring the outer surface of the vessel by dragging the implement through the clay (Figure 5.2.5).

Figure 5.2.5: Close-up view of arcade motifs on neck of Mambo vessel, employing rough incised technique of a tooled surface onto relatively wet clay

Chemical analysis (XRF)

The XRF analysis for vessel 2 was performed for the following elements: K, Ca, Ti, Mn, Fe, Zn, Zr, Sr, Rb, Th, Cu, Cr, Ni and V (see Table 5.2). The elemental signature for this vessel provides a major concentration of calcium (Ca) and two other major elements, iron (Fe) and potassium (K) are also identified. Minor concentrations of Mn, Zn, Zr, Sr, Rb, Th, Cu, Cr, Ni and V also occur (see Table 5.2). While calcium is one of the main natural chemical constituents of most clay, the elevated calcium content could also be attributed to post-depositional conditions, if the vessel is saturated with groundwater or its association within a human burial, which could result in the deposition of calcium in the pores of the ceramic (Bishop *et al.* 1982:294).

Element	**ppm**	**Error±**
K	28672.08	±309.67
Ca	99937.74	385.98
Ti	4485.43	78.92
Mn	1391.05	61.87
Fe	30741.55	210.91
Zn	61.67	7.38
Zr	389.2	7.3
Sr	448.5	5.99
Rb	90.92	3.45
Th	9.63	3.74
Cu	66.41	11.05
Ni	81.71	20.55
Cr	63.77	19.9
V	57.14	24.29

Table 5.2: XRF elemental quantification signature of vessel 2

5.1.3. Vessel 3

Excavation context, typology and morphology

Vessel 3 (#N283) is a decorated K2 beaker (108mm x 91mm) that was excavated in 1937 from K.S Burial No. 48, block 3, section 7, 15' inches (38.1cm) from the extreme left of the section, 21' inches (53.3cm) across the section from left to right and at a depth of 2" inches (5.1cm). Typologically this beaker is classified by Meyer (1980:59) as a typical cylindrical beaker Type 5 form no. 01.02, and corresponds with Calabrese's (2005:93) small beaker forms with nearly vertical sides.

The beaker is found in association to four other ceramic vessels (Figure 5.3.1.) in a juvenile burial, with the body laying partly flexed to the right side and facing south-west. A large stone was placed near the skull and several other ceramics were deliberately broken around the juvenile skeleton (see Figure 5.3.2). Other materials related to this burial include trade glass beads, *Achatina* shell beads, a few fragments of corroded iron and a quartz flake (Gardner 1963:48). This vessel is associated to the domestic residential area, central to K2, dating to the main occupation period of AD 1030 – AD 1220. This vessel form is distinguished as a cylindrical-shaped beaker with an unrestricted orifice of 80mm, with very thin vertical walls (±5mm) and a pronounced round base. The rim is rounded with a straight profile. The beaker has two circular perforations on opposite ends of the rim.

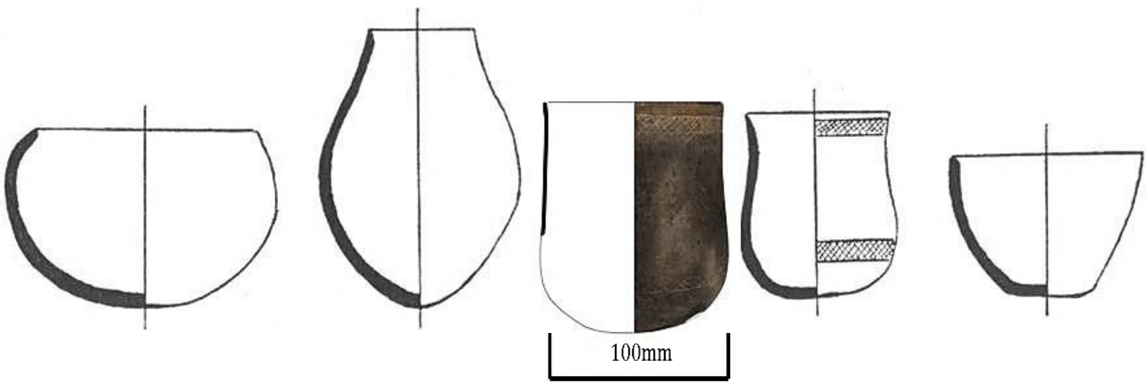


Figure 5.3.1: Vessel 3 associated to other ceramics from Burial KS. 48 block 3, section 7 (Adapted from Gardner 1963:48)

Figure 5.3.2: Five vessels in situ associated to K2 Burial KS. 48, beaker vessel 3 marked X (Gardner 1963:189 Plate XV00 No.3)

Technological analysis

The vessel is composed of a fine type fabric with very small fragments of mostly opaque and clear white inclusions with a size range of 0.1mm to 0.25mm. Irregular voids are visible, as well as reflective micaceous specks resulting in a smooth-textured fabric with moderate amounts of inclusions (<11-25%). An existing fracture reveals a dense appearance of the fabric with irregular, small closely spaced gaps and little porosity, and white aggregates or inclusions are clearly visible on the exterior surface fabric (Figure 3.4.). The surface colour is a varied brown, to dark greyish brown (10YR 4/2). An exposed fracture on the rim reveals an oxidized exterior and interior margin with a very dark grey central core indicating partially oxidized firing conditions (Figure 5.3.3).

There are also severe use-wear marks on the interior base where scraping actions have scarred the interior surface walls (Shepard 1980). Based on the pronounced horizontal scrape marks on the interior (see Figure 5.3.4.) and secondary smoothing on the exterior used to obliterate any visible joins, it can be inferred that the coiling method was used to manufacture the beaker's shape. The incised technique has been used to decorate the beaker with two thin cross-hatched band motifs in the position of the upper rim and on the lower body near the base. The incisions are made with a well-pointed implement, perhaps a sharp bone tool, to execute clear thin shallow lines just scoring the surface. Two single, perforations, ±5mm (Figure 5.3.5) on either side of the vessel body have been formed by pushing a round sharp implement through the vessel wall from the outside.

The perforations show clear signs of use-wear on either side of the holes (interior and exterior) which indicates that the beaker may have been suspended or used for daily activities prior to its deposition.

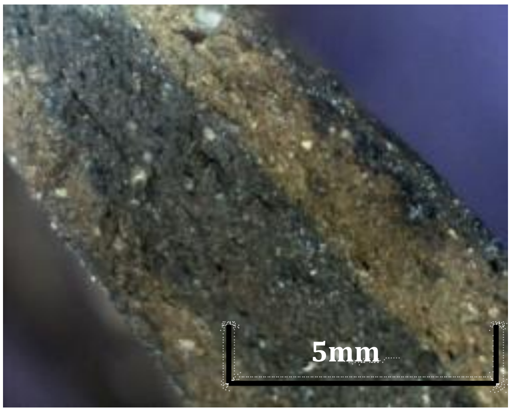


Figure 5.3.3: Fine fabric of K2 beaker with oxidized exterior and interior margin and central black core indicating partially oxidized firing conditions

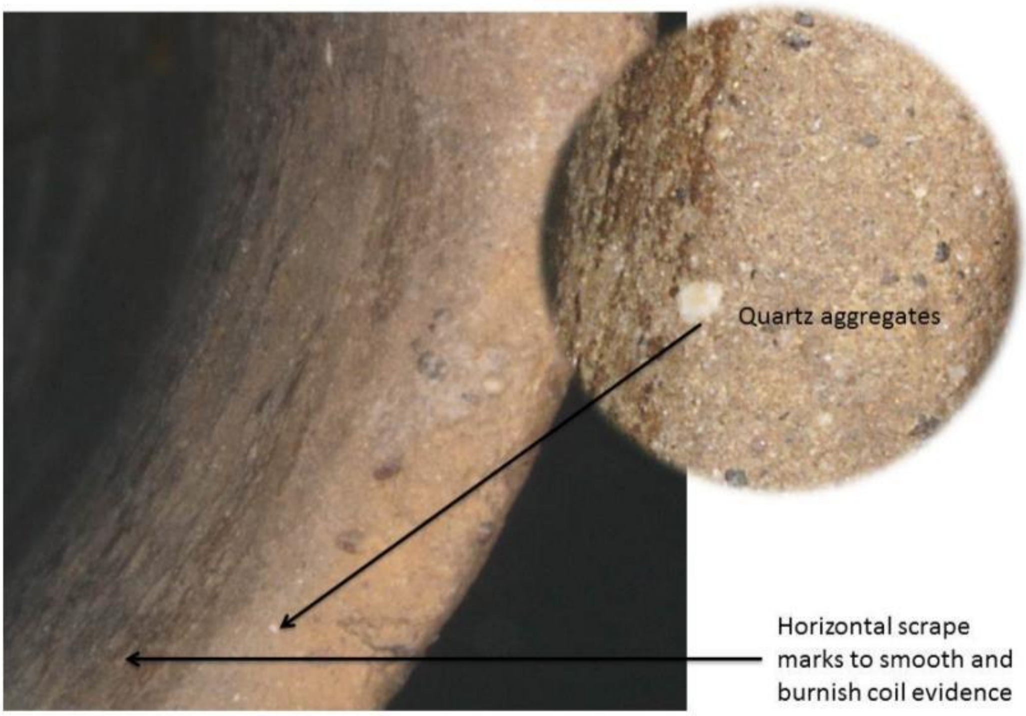


Figure 5.3.4: Macroscopic view of inclusions on clay surface and inner rim scrape marks on K2 beaker

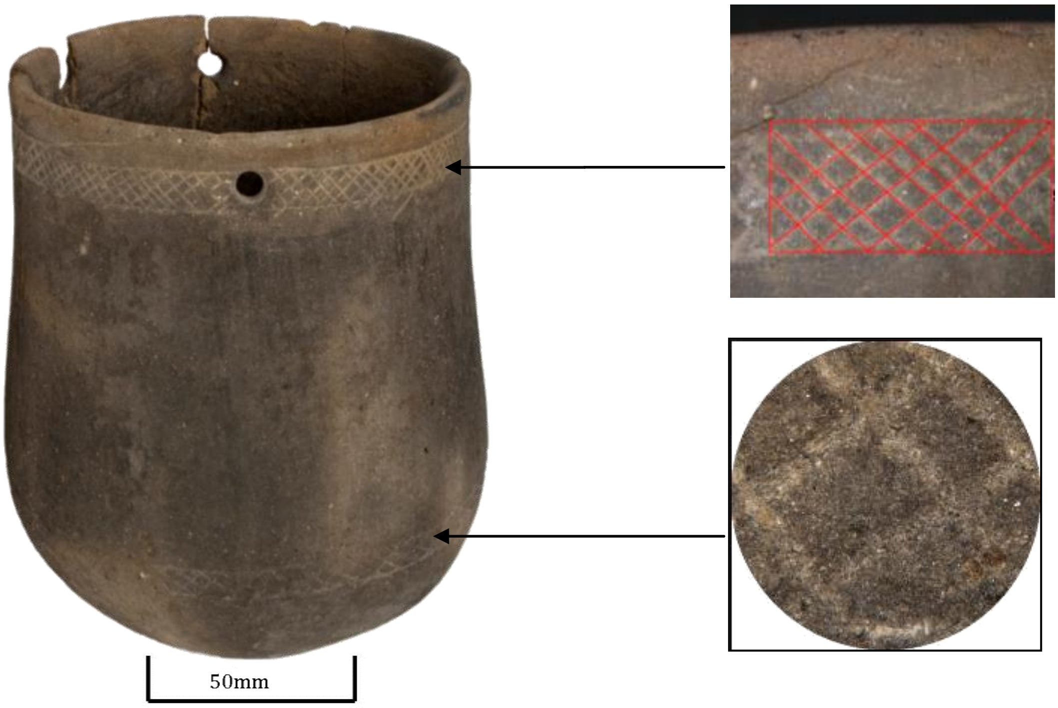


Figure 5.3.5: Detail of K2 beaker with perforations and cross-hatch incised technique with thin shallow lines scoring the clay surface

Chemical analysis (XRF)

XRF analysis for vessel 4 identified the following elements: K, Ca, Ti, Mn, Fe, Zn, Zr, Sr, Rb, Th, Cu, Cr, Ni and V (Table 5.3). The results provide major concentrations of Fe, K, Ti and Ca and minor concentrations for the remainder of the elements, which is a normal indication of the composite nature of natural clay elements.

Element	**ppm**	**Error±**
K	21736.3	256.33
Ca	17658.68	163.14
Ti	6428.45	82.95
Mn	528.07	44.68
Fe	35164.09	225.25
Zn	59.82	7.32
Zr	390.22	7.27
Sr	424.76	5.84
Rb	89.03	3.42
Th	9.30	3.75
Cu	42.88	10.39
Ni	79.16	20.29
Cr	99.39	20.15
V	70.96	24.75

Table 5.3: XRF elemental quantification signature of vessel 3

5.1.4. Vessel 4

Excavation context, typology and morphology

Vessel 4 (#N280) is a decorated beaker from K2, recovered from Gardner's 1937 excavation from the main midden area of block 3, section 9, 3 inches (7.6cm) from the extreme left of the section, 22' inches (55.9cm) across the section from left to right, located at a depth of 3" inches (7.6cm) from the surface. This beaker (122mm x 119mm) is typologically grouped as cylindrical, Type 5, form no. 01.04 (Meyer 1980:59) with an unrestricted orifice (112mm), a rounded rim with a relatively straight profile and a flat base with a very slight curvature (see Figure 5.4.1).

The vessel form also corresponds with Calabrese's (2005:93) category of small beakers with nearly vertical sides and height equal to, or greater than, the orifice diameter. According to Gardner (1963) beakers could be classified either as cylindrical or straight-sided (Figure 5.4.2). This vessel falls within the latter group and is associated to Phase 2 of the main occupation period of K2 (AD 1030 – AD 1220). This ceramic is also found within the context of block 3, an area mainly linked to juvenile burials, which is central to the main midden area. Excavations yielded abundant quantities of ceramics in this block, particularly "lavishly decorated beakers, many with pierced lugs and bowls of all description" (Gardner 1963:12).

Figure 5.4.1: Vessel 4, cylindrical K2 beaker form and secondary decorative finishing

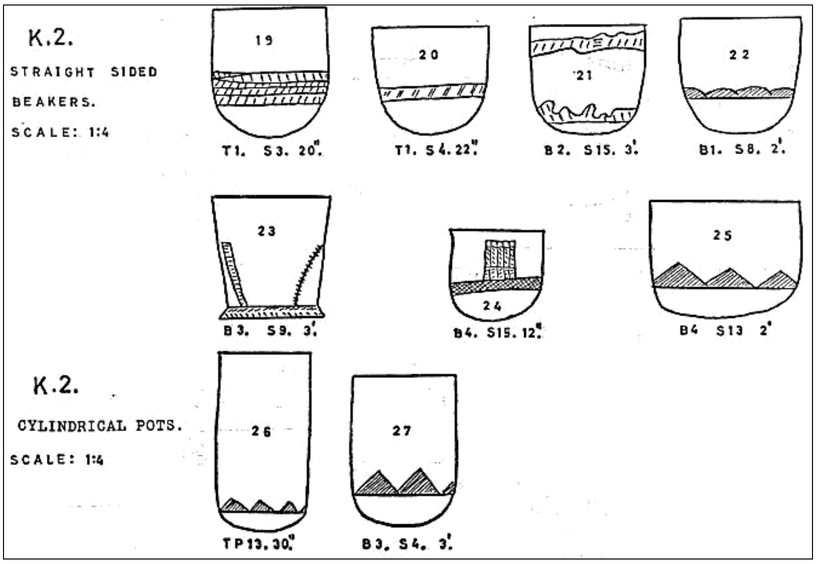


Figure 5.4.2: Example of Gardner's (1963) K2 cylindrical type jars and straight-sided beakers, and an illustration of vessel 4 #N280 (No.23 middle row, left)

Technological analysis

This vessel is composed of a medium type fabric with few visible fragments of light and dark inclusions, with a sparse <3-10% frequency of inclusions within the overall fabric and a size range of 0.1mm to 0.25mm. Opaque white (quartz) inclusions are dominant with <1% dull black inclusions, as well as visible reflective micaceous specks. Based on an existing rim fracture, there are no visible surface irregularities, with a dense, non-porous appearance of the fabric. The interior and exterior surface has a low burnished, smooth surface finish. The surface colour is a varied red to red-brown colour (2.5YR 4/6). An exposed fracture reveals firing in partially oxidized firing conditions based on the unoxidized grey core and oxidized inner and outer margins (Figure 5.4.3.).

The walls are relatively thin (4.92mm) and the body is incised with decoration as well as around the circumference of the base. Two types of decorative treatments are visible: surface penetration, i.e. decorative incisions into the clay, and the addition of clay onto the ceramic surface of a single boss or flange on the base. The manufacturing method of the beaker cannot be determined as there is no direct evidence of forming. Three freehand decorative motifs using incised techniques (Figure 5.4.4) are distinguished on the vessel's body.

This cutting technique using incisions was done with a sharp-pointed implement to create lines that are narrow, generally deep and have a v-shaped cross-section. The incised decoration on this beaker is not particularly well executed. It was done with rough end-strokes whilst the clay is still relatively wet as there is displacement of clay along the rough lines.

Figure 5.4.3: Incomplete oxidized grey core with diffused inner and outer margins of fabric indicating partial oxidized firing conditions of vessel 4

Figure 5.4.4: Three decorative motifs on vessel 4 depicting variations in depth, width, and profile with deep strokes partially incised into wet clay

Chemical analysis (XRF)

XRF analysis of vessel 4 identified high concentrations of three major elements: iron (Fe), potassium (K) and calcium (Ca) with minor concentrations of Ti, Mn, Fe, Zn, Zr, Sr, Rb, Th, Cu, Cr, Ni and V. (See Table 5.4). The iron-rich content in this vessel is also noted as the possible chief colorant of the fired clay (Shepard 1980:18) and is clearly visible as a terracotta-red or red-brown (2.5YR 4/6) surface colour on the exterior body on one side of the beaker.

Element	ppm	Error±
K	26564.51	280.18
Ca	28531.95	203.68
Ti	5375.42	75.33
Mn	541.64	44.25
Fe	31086.32	212.38
Zn	75.36	7.78
Zr	451.91	7.48
Sr	287.95	4.95
Rb	90.77	3.44
Th	11.89	3.78
Cu	50.56	10.66
Ni	47.77	19.63
Cr	77.15	19.03
V	64.80	22.53

Table 5.4: XRF elemental quantification signature for vessel 4

5.1.5. Vessel 5

Excavation context, typology and morphology

Vessel 5 (#N273) is a beaker bowl excavated in 1938 from K2 Beast Burial No 6, block 4, section 6, 7' inches (17.8cm) from the extreme left of the section, 5' inches (12.7cm) across the section from left to right and at a depth of 6" inches (15.2cm). This is a ritual cattle burial associated to Phase 2 of the early K2 period and was found with thirteen ceramic vessels and other funerary ware (see Gardner 1963:56 Plate XXXIII). According to Meyer (1980:59-64) this K2 beaker bowl is typologically classified as Type 5, form no. 01.11. Calabrese (2005:93) does not distinguish beaker bowls as a separate classification, and rather restricts them to just beaker forms or simple deep bowl forms.

This vessel is formed (114mm x 197mm) in a cylindrical shape (also a bell-beaker shape), unrestricted orifice (188mm) with a convex base, slightly everted rim with incised triangle motifs in a band on the lower body (Figure 5.5.1). Beaker bowls are similar to the smaller-sized typical straight-sided K2 beakers, but are considered much larger in size (Schofield 1937:38).

Beaker bowls first appear within early contexts at K2 (Schofield 1937), but also later on Mapungubwe Hill, with most types characterized by a decorative band on the lower body just above a rounded base.

Figure 5.5.1: Typical example of a K2 beaker bowl form, vessel 5, with a scraped, smoothed and low burnished secondary finish

Technological analysis

The vessel is composed of a fine type fabric characterized by both light and dark inclusions which are considered small, with a size range of 0.1mm to 0.25mm. The frequency of inclusions is about <26-40% of the total fabric with dominant clear glassy white (possibly quartz) inclusions and about <3% dull black inclusions. Very small voids are visible within the fabric as well as reflective micaceous specks. The presence of voids suggests evidence of previous inclusions which may have been burned or leached out during the firing process (Prehistoric Ceramics Research Group 2010:25-26). The fabric reveals an oxidized exterior and interior margin with a very dark unoxidized grey central core indicating partial oxidized firing conditions. A black area or fire cloud below the rim can be indicative of open-pit firing conditions (Figure 5.5.2) or can also be caused by the reduction of iron oxides within the vessel walls (Gibson and Woods 1990:188). The overall surface colour on the interior and exterior is a varied brown (7.5YR 4/3). The vessel is cracked around the base, which may indicate a fracture line between two coils, as many ceramics display such common patterns of breakage along coil fractures (Gibson and Woods 1990). However, there is no direct evidence of junctions of coiling visible, as subsequent smoothing of all surfaces have eliminated traces of primary shaping. Scraping and smoothing finishing marks are also present. The decorative technique employed is incisions into the clay of a single band of upright alternating triangles with vertical incised lines on the lower body; the decorative motifs have been smoothed over during the light burnishing process of the exterior surface.

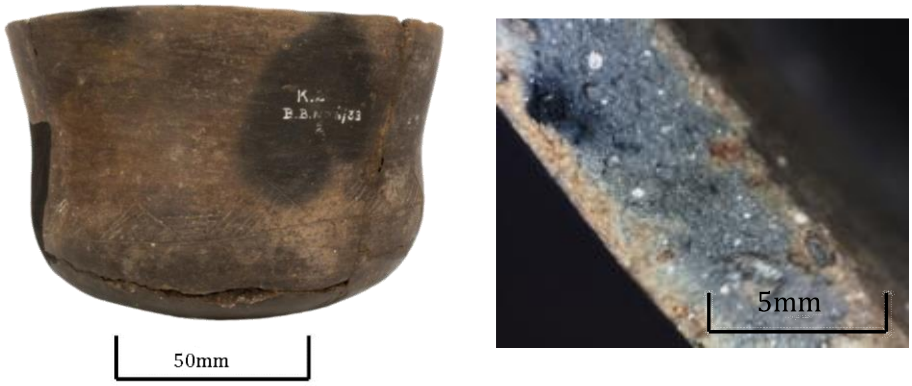


Figure 5.5.2: Vessel 5 with evidence of a fire cloud which is indicated by a black area spreading from the rim to the vessel body, and an oxidized exterior and inner margin with a central grey core

Chemical analysis (XRF)

XRF analysis of vessel 5 identifies major elements of iron (Fe) and calcium (Ca) respectively, with low concentrations of titanium (Ti). The manganese (Mn) signature on this ceramic is the highest concentration in comparison to all the other vessels, which may be significant as the minor traces of zinc and nickel (see Table 5.5) may be attributed to common Mn impurities. However, their presence might sometimes assist to identify the manganese from a particular source (Shepard 1980:41). The increased concentration of iron oxide is the main colorant of the fired clay (Rice 1987:335; Shepard 1980:18) and is visible as red spots on the surface area, particularly near the rim. These results indicate natural clay components and are also expected to result from firing in an oxidizing atmosphere, common for the manufacturing low-fired or open-pit fired ceramics (Legodi and de Waal 2007:137).

Element	ppm	Error±
K	51898.61	411.97
Ca	22717.31	202.67
Ti	6476.78	87.49
Mn	2085.41	74.98
Fe	42152.65	249.21
Zn	96.81	8.63
Zr	414.37	7.39
Sr	352.77	5.38
Rb	84.34	3.4
Th	14.59	4.07
Cu	69.38	11.37
Ni	145.09	22.15
Cr	137.80	23.15
V	131.07	26.5

Table 5.5: XRF elemental quantification signature for vessel 5

5.1.6. Vessel 6

Excavation context, typology and morphology

Vessel 7 (#N433) is a spherical jar excavated in 1936 from K2 block 2, section 12, 12' inches (30.5cm) from the extreme left of the section, 6' inches (15.2cm) across the section from left to right and at a depth of 2" inches (5.1cm) from the surface. Meyer (1980:64-65) typologically classifies this as a spherical pot, Type 3, form no. 02.01. The vessel has a spherical shape (125mm x 167mm), with a restricted narrow orifice of 98mm, rounded rim (5.53mm) and a round base (Figure 5.6.1). The vessel is associated to a clay female torso figurine and faunal remains (Gardner 1963:106), and found within the K2 occupation area of the main midden (AD 1030 – AD 1220).

Figure 5.6.1: Vessel 6, example of K2 restricted spherical form

Technological analysis

The vessel is composed of a fine type fabric with an inclusion size range of 0.1mm to 0.25mm, which is characterized by very small opaque and translucent glassy white inclusions in abundant frequency from <20-40%. Both shiny and dull black inclusions, as well as reflective micaceous specks are also present in a relatively grainy fabric with a sandy irregular texture (Figure 5.6.2). A partially exposed fracture on the rim reveals an oxidized exterior and interior margin with a black central core indicating incomplete or partially oxidized firing conditions. The overall surface colour is a uniform very dark greyish-brown, almost black (10YR 3/2). There is no direct evidence of determining the forming technique of this vessel. There are vertical incised triangle motifs on the upper rim shoulder near the rim. This incised technique has been used for decoration probably while the clay was still relatively wet, since there is displacement of the clay along some of the lines.

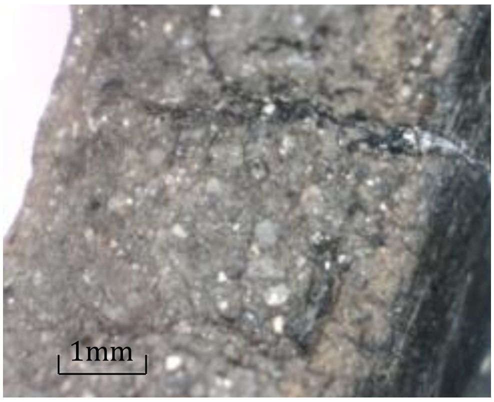


Figure 5.6.2: Vessel 6 with fine-type grainy fabric with a sandy irregular texture

There is a spalled area (see Figure 5.6.3a below) on the exterior body, which probably is the result of the expansion of clay particles during the firing process. Spalling is a physical defect in the manufacturing process probably caused by oxidation during firing or a fairly rapid drying process, and is characterized by a fine network of whitish cracks formed within the minute pores visible on the ceramic fabric (Buys and Oakley 1993:20). Spalling is also usually evident when the surface is flaking or 'popping' as the clay is pushed from the porous surface of the vessel (Shepard 1980:91), leaving an exposed shallow area or lacuna. In addition, the entire surface of this vessel is covered with a thin network of fine cracks also known as crazing (see Figure 5.6.3b).

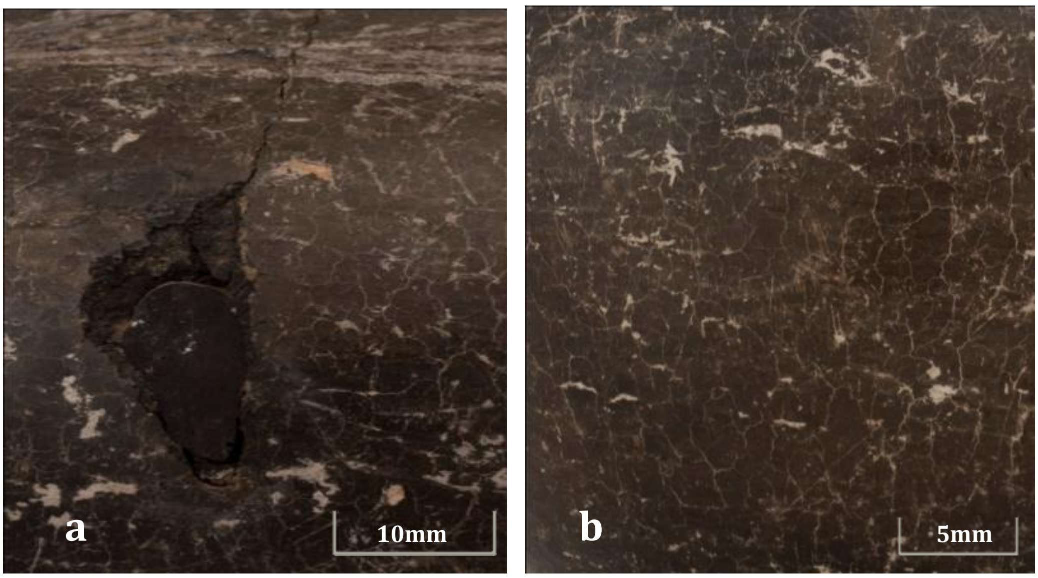


Figure 5.6.3: Manufacturing defects visible on K2 spherical vessel 6, with evidence of (a) spalling and (b) crazing, which is indicated by a fine network of cracks on the ceramic surface

Chemical analysis (XRF)

XRF analysis of vessel 6 (see Table 5.6.) indicates major intensities of potassium (K), titanium (Ti), calcium (Ca) and iron (Fe), but particularly the highest concentration of zirconium (Zr) recorded for all the vessels. Whilst Padilla *et al.* (2006:285) states that zirconium and thorium concentrations vary for different crystallization stages, even low zirconium intensities in the ceramic fabric can be well-correlated within most geological environments. Such elemental signatures can therefore characterize the natural raw clays, which probably contain a variable quantity of other minerals such as quartz, feldspars, calcite and other compounds (Cronyn 1990:142).

Element	ppm	Error±
K	23089.12	280.34
Ca	38294.4	246.64
Ti	6707.2	93.26
Mn	503.59	45.29
Fe	43917.79	252.01
Zn	58.07	7.51
Zr	666.55	8.97
Sr	454.45	6.05
Rb	68.09	3.12
Th	10.35	3.84
Cu	58.59	10.88
Ni	62.0	20.37
Cr	99.52	22.6
V	94.39	28.44

Table 5.6: XRF elemental quantification signature for vessel 6

5.1.7. Vessel 7

Excavation context, typology and morphology

Vessel 7 (#N259) is a K2 spouted jar that was recovered in 1938 from Beast Burial No 6, block 4, section 6, 7' inches (17.8cm) from the extreme left of the section, 5' inches (12.7cm) across the section from left to right and at a depth of 6" inches (15.2cm). Spouted vessels forms are not generally included in most typological analyses because they were not decorated and according to Calabrese (2005:96) are thus not classified. According to Meyer (1980) this vessel may be classed as Type 3, form no. 02.02. The vessel shape is distinguished as a spherical, tubular spouted (196mm x 270mm) with a round base, a restricted orifice (202mm) and a 5mm squared rim shape; the surface is undecorated (Figure 5.7.1.).

Burial 6 is considered the most elaborate of a total of six Beast Burials (BB) found at K2, due to the extensive amount of funerary wares and ornaments associated to a ritual cattle burial. According to Gardner (1963:54), Burial 6 is connected with Phase 2 (±AD 1030 – AD 1220) of the K2 period and glass beads within the burial partially support this interpretation (Wood 2005:118). Ritual cattle burials appear constrained to this period, as no beast burials contained any Mapungubwe type ceramics. Copper ornaments, *Achatina* (land snail) and cowry shells, trade glass beads, a quartz crystal, four fragments of mica, the tusk of a wild pig, 58 ceramic fragments, 47 fragments of a large beaker and 14 other ceramic vessels were also associated to this burial (Figure 5.7.2). This burial is radiocarbon dated to AD± 1050 by an associated charcoal sample (Figure 5.7.3 - see Summers 1966).

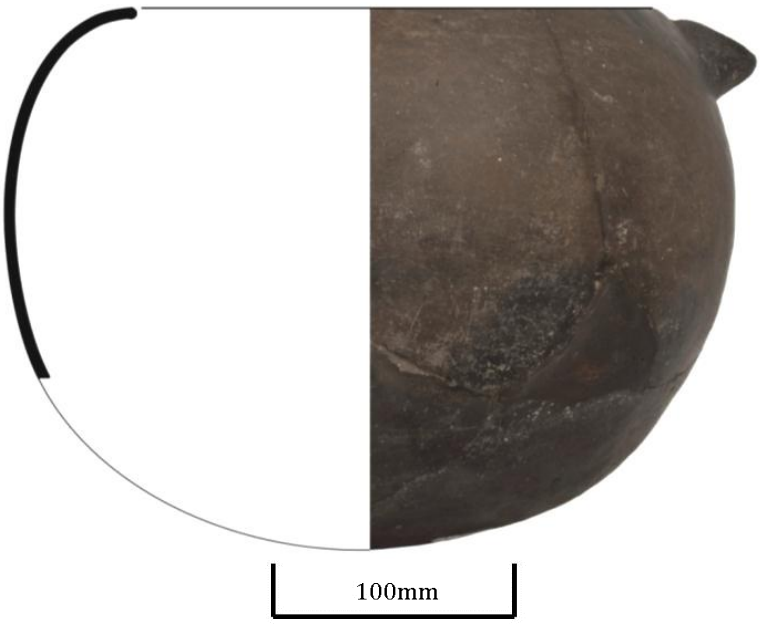


Figure 5.7.1: Vessel 7 K2 spherical tubular-spouted jar from Beast Burial No. 6

Spouted vessels are relatively uncommon in the Shashe-Limpopo ceramic sequence and in the K2 and Mapungubwe ceramic assemblages. Fouché (1937:39) noted only fourteen have been found at Mapungubwe, eleven with channel spouts and three with tubular spouts, whereas Gardner (1963:63) noted only six spouted vessels from K2 and only two from Mapungubwe Hill. Their presence in burials and rarity within the ceramic sequence may indicate distinctive significance, yet spouted vessels remain under-studied, largely because they are mostly undecorated and ignored in stylistic ceramics research.

Figure 5.7.2: K2 spouted vessel (centre) with twelve other ceramics associated to K2 Beast Burial 6 (Gardner 1963:194 Plate XXII)

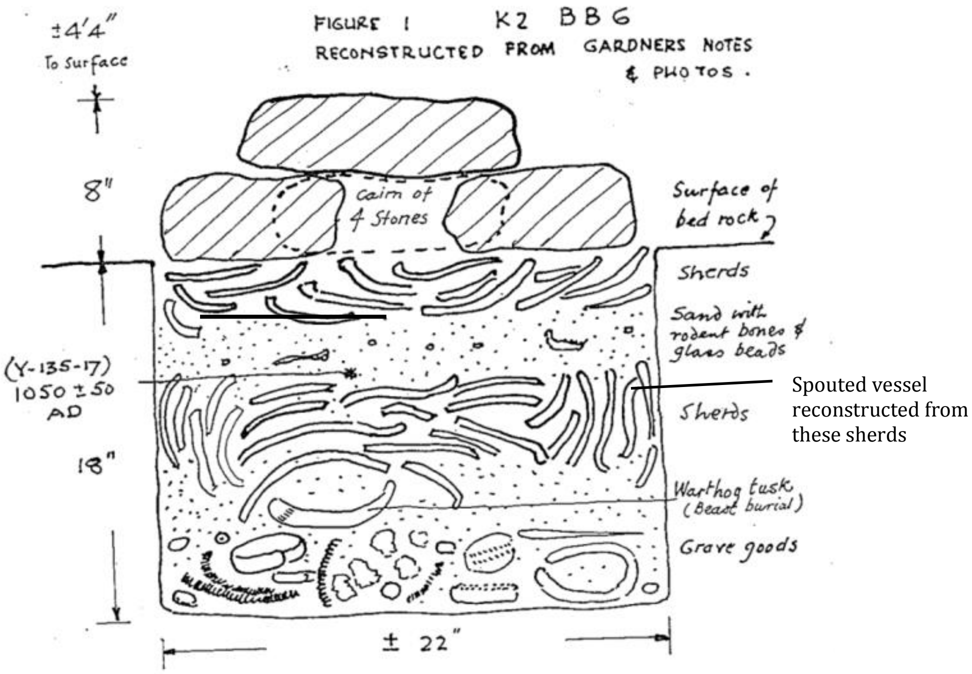


Figure 5.7.3: Roger Summer's 1966 reconstruction of K2 Beast Burial 6 according to Gardner's 1963 description, indicating dated layer and direct context of spouted vessel (UP/AGL/D/2054)

Technological analysis

The vessel is composed of a medium type fabric with an inclusion size range of 0.25mm to 1.0mm. The fabric is characterized by very small sandy light-brown and black shiny inclusions (in rare frequency) with dominant clusters of clear white and opaque white inclusions in common quantities (<26-40%). The overall fabric has a sandy textural feel with a distinct sand-papery appearance, and with spaces created between the clay matrix and inclusions (Figure 5.7.4.).

A fresh break on the rim reveals very faint, thin oxidized exterior and interior margins with a black central core indicating incomplete oxidized firing conditions. The surface colour on the exterior and interior is predominantly a dark brown (7.5YR 3/1).

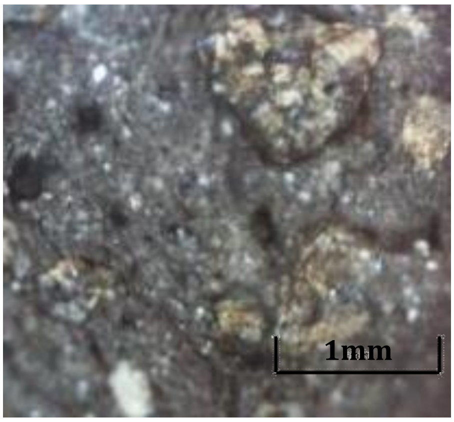


Figure 5.7.4: Medium type fabric of vessel 7 comprising a sandy textural appearance with spaces and voids between clay matrix and inclusions.

The rim is slightly squared and edged. The rim shape is formed by inward folding, where the upper portion of the wall is made slightly thinner than the body and the top is rounded neatly, after which the rim portion of the clay is folded to the inside. The tubular spout (see Figure 5.7.5a) is pushed outward and formed from the inside of the vessel, possibly with a finger, and is considered to be a secondary forming technique serving a functional purpose, e.g. pouring liquid. Spouts are secondary form variations, which not only aid in serving liquids but also prevent spillage (Rice 1987:240) because the rim of the spout is formed at a slight angle and has been thickened substantially with added clay to form an integral part of the vessel body (see Figure 5.7.5b).

The finishing of this vessel is completed with a low burnish and the application of a functional spout. Such secondary forming techniques have significant effects on the final surface finish of the vessel. Compacting and re-orientation of the clay particles give the surface a slight gloss as well as smoothing out the clay and thereby enlarge the contours of the vessel (Rice 1987:138). There is no direct evidence of how the vessel is formed since the scraping, wiping and smoothing process has obliterated any evidence of primary forming, and there are also no visible marks on the interior. The vessel has been previously reconstructed from several sherds and gaps have been filled with plaster of Paris, most probably by Schofield.

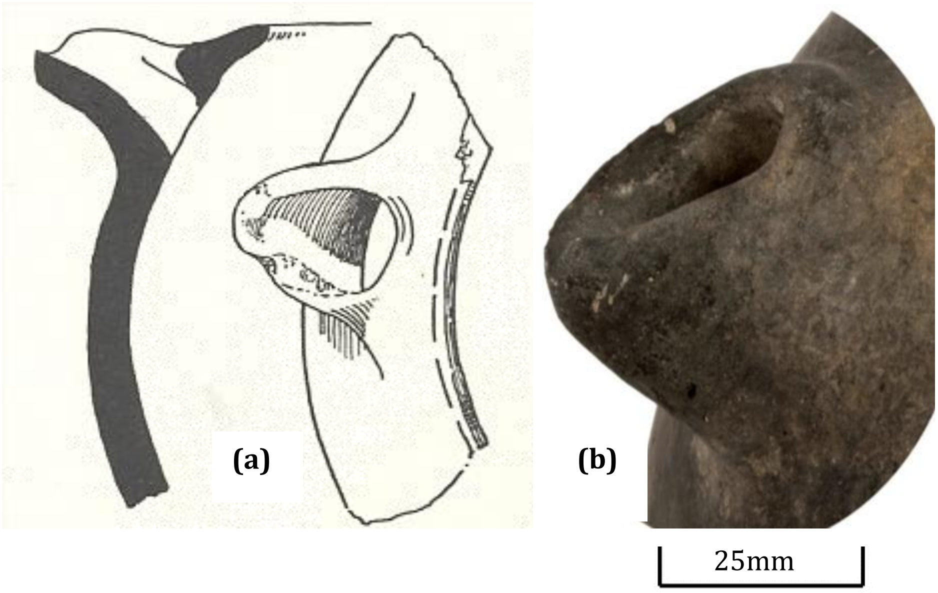


Figure 5.7.5: Tubular spout formed by (a) pushing clay outward from interior wall with a finger profile and (b) detail of thickend spout (Adapted from Schofield 1948:29)

Chemical analysis (XRF)

XRF analysis of vessel 7 shows concentrations of major elements such as potassium (K), iron (Fe), calcium (Ca) and titanium (Ti). Determinations of minor trace elements of Zn, Zr, Sr, Rb, Th, Ni, Cr, Cu and V are present as well (Table 5.7). Whilst the elements commonly associated with the temper fraction in the vessel are mainly rubidium, calcium, strontium and titanium (Table 5.7), the present portions of calcium and potassium can also be correlated with plagioclase (albite and anorthite) and feldspar minerals (Padilla *et al.* 2006:286).

Element	ppm	Error±
K	31143.38	316.66
Ca	24140.69	198.36
Ti	6910.93	87.81
Mn	679.71	49.39
Fe	40140.72	243.68
Zn	95.66	8.62
Zr	503.48	7.94
Sr	321.04	5.17
Rb	90.39	3.49
Th	9.33	3.87
Cu	56.70	11.01
Ni	75.57	20.85
Cr	117.94	21.87
V	98.76	26.11

Table 5.7: XRF elemental quantification signature for vessel 7

5.1.8. Vessel 8

Excavation context, typology and morphology

Vessel 8 (#N264) is an undecorated deep bowl (137mm x 350mm) presumably a surface find from K2. Although no direct provenance is available, this vessel provides valuable data regarding vessel technology from the main K2 occupation period as it serves as an example of a large complete vessel from the repertoire of deep undecorated K2 bowl forms. Since this vessel is undecorated, it is not directly classified. However it does correspond with wider variations of simple shallow bowl forms (Calabrese 2005:93). According to Meyer (1980:66-67) this vessel shape falls within his classification of Type 2, form no.02.03. This vessel form is considered an ellipsoid form with an unrestricted orifice (335mm), a broad squared rim and a partially flattened base (Figure 5.8.1). The bowl was probably recovered during 1935-1939 from Gardner's excavations, as Schofield's 1930s reconstruction of the sherds with plaster of Paris is evident on the vessel fills.

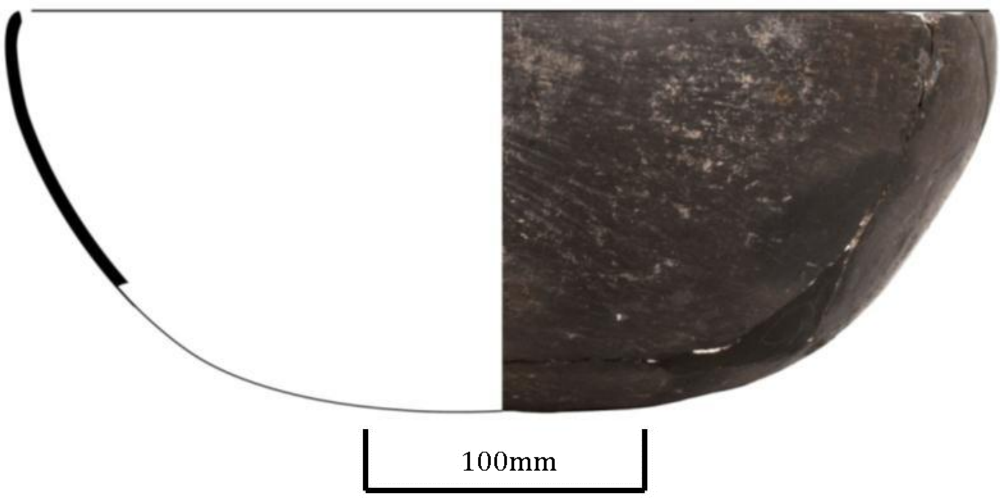


Figure 5.8.1: Vessel 8 unrestricted deep K2 bowl form exhibiting a low burnished finish

Technological analysis

This vessel is composed of a medium type fabric with few visible fragments of light and dark inclusions, occurring in sparse <3-10% frequencies and an inclusion size range of 0.25mm to 1.0mm. Dominant white (quartz) and dull black inclusions appear within a sandy fabric (see Figure 5.8.2.), which is texturally irregular and friable with a more porous appearance, perhaps as a result of under-firing. A fracture and exposed surface also exhibits distinct voids, which form ovals or spheres creating a rough surface with spaces created between the clay matrix and the inclusions.

A fresh break reveals manufacture in partially oxidized firing conditions based on an unoxidized dark grey core with very fine oxidized inner and outer margins. The overall surface colour is very dark greyish brown (10YR 3/1). This particular dark colour of the vessel may be attributed to the manganese compound (confirmed by XRF, see Table 5.8), which is an intense black pigment (Shepard 1980:41).

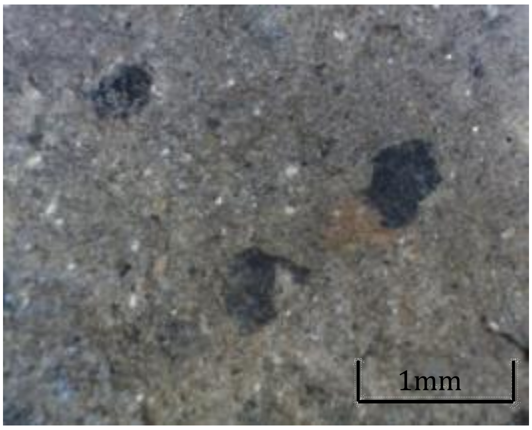


Figure 5.8.2: Structure of medium type sandy fabric of vessel 8 with dull black inclusions

This vessel was probably manufactured using the coil method, as evidence of horizontal cracks along the junctions between the coils of clay is visible on the base. The deep bowl also possesses a relatively thick wall (± 9mm). The secondary surface finishing includes scraping, wiping, smoothing and low burnishing of the exterior and interior surface. Clear traces of horizontal burnishing tool marks appear both on the inside and outside of the bowl (see Figure 5.8.3a). The rim is formed by smoothing on an added thicker coil of clay to make a squared rim with edges. The rim gradually thickens to the top as the clay was pushed to the inside and downwards, creating a partially squared bevelled rim that slopes inward at an angle (Figure 5.8.3b). The outside of the rim edge has been given a finishing treatment so that the thick rim (8mm) from the exterior forms an integral part with the vessel wall.

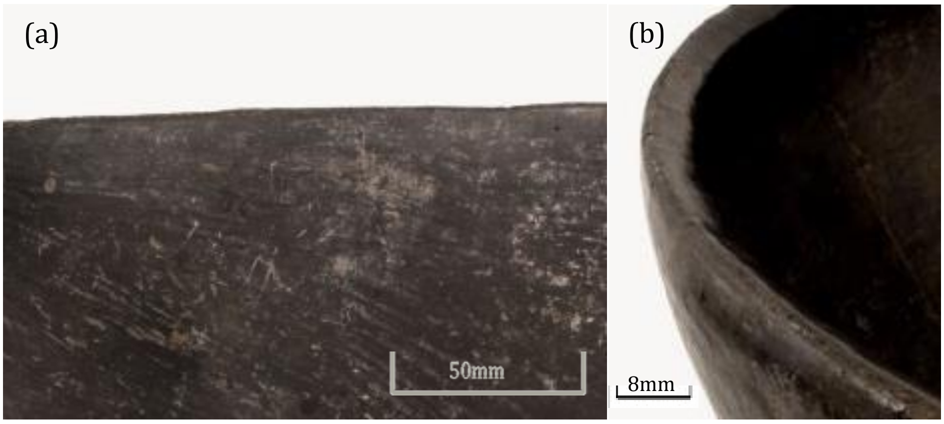


Figure 5.8.3: (a) K2 deep bowl exhibiting burnishing facets on surface (b)bevelled rim with burnished surface area

Chemical analysis (XRF)

XRF analysis of vessel 8 identifies major elements of potassium (K), calcium (Ca), iron (Fe) and titanium (Ti) as well as a high intensity of manganese (Mn) (Table 5.8). The major traces of potassium and calcium can also possibly be geologically linked (Riederer 2004:147) to potassium feldspar (microcline and orthoclase), which can occur in magmatic and the high grade metamorphic rocks of the Limpopo Mobile Belt, typical to the Mapungubwe geological landscape (Chinoda *et al.* 2009:24).

Element	ppm	Error±
K	34901.44	333.50
Ca	21738.43	190.21
Ti	6655.16	91.70
Mn	1555.85	62.2
Fe	33243.46	209.61
Zn	58.97	6.93
Zr	408.22	6.92
Sr	333.56	4.96
Rb	94.36	3.35
Th	8.15	3.53
Cu	61.0	10.21
Ni	85.32	19.0
Cr	136.79	22.84
V	102.48	28.12

Table 5.8: XRF elemental quantification signature for vessel 8

5.1.9. Vessel 9

Excavation context, typology and morphology

Vessel 9 (#C421) is an undecorated bowl common to K2, which was recovered intact (Figure 5.9.1) in 1935 and excavated from Trial Pit No. 8 at a depth of 30" inches (72.6cm) on the outer perimeter of K2. Trial Pit No. 8 is near the eastern slopes of Bambandyanalo and the southern talus slope of the central K2 midden. As a vessel with no decorative motif, Calabrese (2005) does not classify this form. However, its shape does correspond with Meyer's (1980:67-68) neckless shallow bowl variation, form no. 04.01. The vessel is distinguished as an open bowl (76mm x 166mm) with an unrestricted orifice (diameter of 156mm), and has a hemispherical form with a round base. The rim is round, slightly folded inwards and is uneven. The vessel is associated to Phase 2 (AD 1030 – AD 1220) of the K2 occupation deposits, along with a portion of a spouted bowl, a clay handle, ostrich eggshell beads and a corroded iron arrowhead (Gardner 1963:224).

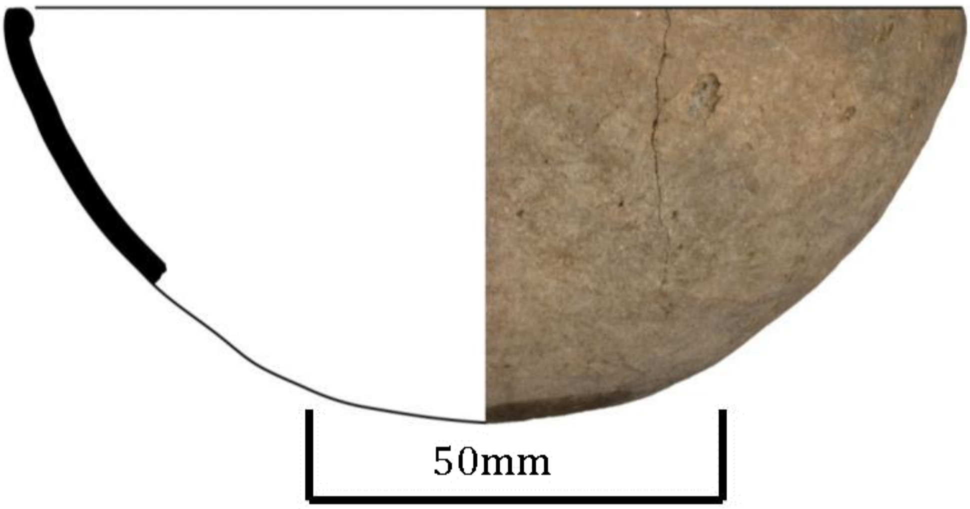


Figure 5.9.1: Vessel 9 typical unrestricted undecorated hemispherical K2 type vessel

Technological analysis

The vessel is composed of a medium type fabric with several types of multi-coloured inclusions which range in size from 0.25 to 1.0mm occurring in common <26-40% frequencies. A clean fracture reveals predominantly opaque white inclusions (0.98mm) with common amounts of dull black clusters of glassy white, as well as small red-earthy inclusions. According to the Prehistoric Ceramics Research Group (2010:25-26), voids that are visible in the fabric and on the surface of the vessel are important evidence of the former presence of inclusions, which may have burned or leached out during the firing process (see Figure 5.9.2).

There is no distinct fracture or break area on this vessel and the fabric core is not visible, thus firing conditions cannot be determined. The fabric is however, soft and can be scratched with a fingernail; it has a distinct sandy texture.

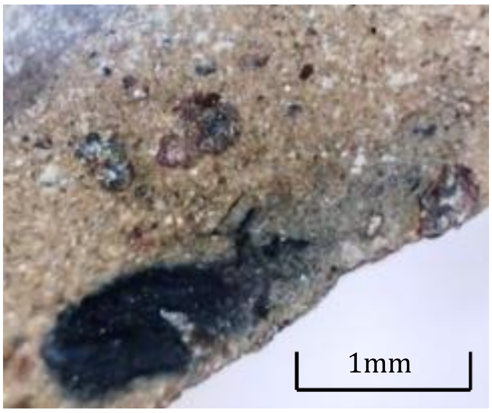


Figure 5.9.2: Vessel 9 medium fabric type with several coloured inclusions, the presence of a visible black void suggest the former presence of inclusions or organics which may have burned out during the firing process

The overall surface is very uneven, resulting in a matt but rough surface finish that has been wiped and partially smoothed. The surface colour is largely light grey (2.5YR 7/2) as a result of a thin post-burial deposit covering most of the exterior and interior surfaces. Beneath this post depositional covering, reddish surface areas are also visible. The forming technique of this vessel could not be determined. Scrape marks are clearly visible near the rim on the inside and outside (see Figure 5.9.3.), which has been partially smoothed, but remains uneven. The rim is folded inward, and formed between the finger tips by pulling the clay to form a lip. To finish the rim shape, it is further thickened by pushing the clay downwards, running the finger along the circumference of the vessel thereby creating a straight and uneven rim which is also slightly rounded in some places. Further rim profiling of the vessel was done by pressure of the fingers as indentation marks are visible in these areas. The exterior surface shows expected minor post-depositional damage as a result of natural weathering with minor surface accretions on the interior, and pitting due to damage and possible use-wear.

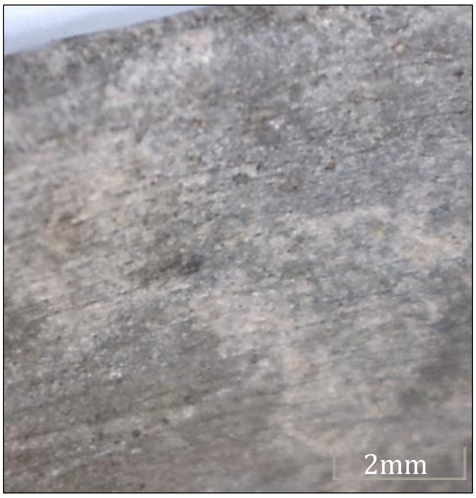


Figure 5.9.3: Narrow uni-linear grooves closely spaced showing fine scrape marks from smearing and smoothing of the interior surface of vessel 9

Chemical analysis (XRF)

XRF analysis of vessel 9 identifies major concentrations of potassium (K) and iron (Fe). The high potassium content can be attributed to its alkali feldspar (albite and microcline) content (Rice 1987:96), and the presence of this compound is confirmed by XRD (see Figure 5.9.4.). The high iron (Fe) content is possibly a contributing 'colouring' element to give the vessel a slight reddish colour, but it is also considered that the many variable conditions during the firing process would also have affected the vessel's colour (Shepard 1980:24). Trace constituents of rubidium (Rb), thorium (Th), copper (Cu), nickel (Ni), and vanadium (V) also occur at extremely low concentrations. No chromium (Cr) traces were determined.

Element	**ppm**	**Error±**
K	22208.39	333.20
Ca	92108.22	512.01
Ti	3978.87	63.27
Mn	560.96	70.32
Fe	32100.43	246.24
Zn	113.3	10.14
Zr	229.16	4.76
Sr	336.61	5.60
Rb	47.96	1.83
Th	17.27	3.99
Cu	103.73	14.24
Ni	52.67	28.86
Cr	0	0
V	389.7	32.85

Table 5.9: XRF elemental quantification signature for vessel 9

Mineralogical analysis (XRD)

The analysis of this vessel was determined by X-ray diffraction (XRD). XRD provided the mineral fingerprint of the clay and also preliminary information on the composition of the raw materials used to manufacture this complete vessel. The main minerals identified are quartz, albite and microcline feldspars, diopside and muscovite (Figure 5.9.4). The presence of albite and microcline, which are both alkali feldspars typically occur in dolerite rock. Diopside occurs in ultramafic (volcanic) rocks which are characteristic of the local geology of the Mapungubwe area (see Bumby 2003).

Although minerals such as quartz and feldspars are abundant in most archaeological ceramics, they are obvious constituents of a silica-rich raw clay material, and the presence of quartz may be an indigenous mineral of natural clay or it may also be an intentionally added temper (Shepard 1980:28). There are a few isolated large-grained quartz inclusions (estimated size range ±1.0mm), which are clearly visible with the naked eye on the surface walls of the vessel. It is accepted by Shepard (1980:28) that quartz is a major constituent of common tempers as it does not appear to change during low firing, and is therefore not assumed to form part of the primary clay. In this vessel the quartz may be deliberately added to facilitate the shaping and firing process (Cronyn 1990:142).

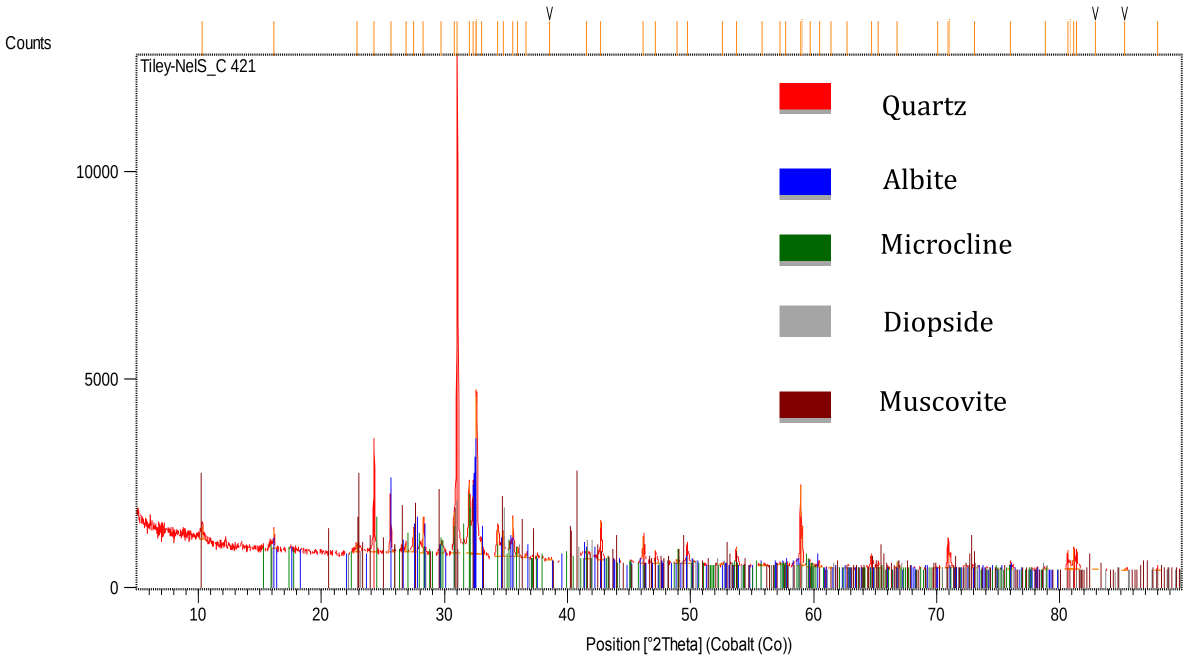


Figure 5.9.4: XRD diffractogram of vessel 9. Each peak is related to one or more minerals, for example the longest peak shown here is indicative of quartz

5.1.10. Vessel 10

Excavation context, typology and morphology

Vessel 10 (#C2198) is an undecorated bowl (Figure 5.10.1) from K2, block 2, section 2, from the occupational area of the main midden. No further contextual data is available other than Gardner excavated block 2 over two seasons, in 1936, and then down to bedrock in 1937 (Gardner 1963:11). This vessel is typologically grouped as a variation of shallow bowls (form no. 04.01) or deep dishware (Meyer 1980:67-68), and also corresponds with Calabrese's (2005:93) simple shallow bowl forms. The vessel is associated to the main occupation period of Phase 2 (AD 1030- AD 1220). The vessel form is distinguished as a shallow bowl (43mm x 98mm) with an unrestricted orifice (88mm), with a hemispherical form and a round unbalanced base. The rim is round, slightly folded inwards and is uneven. The vessel wall is relatively thick, thus adding strength to the vessel's overall form.

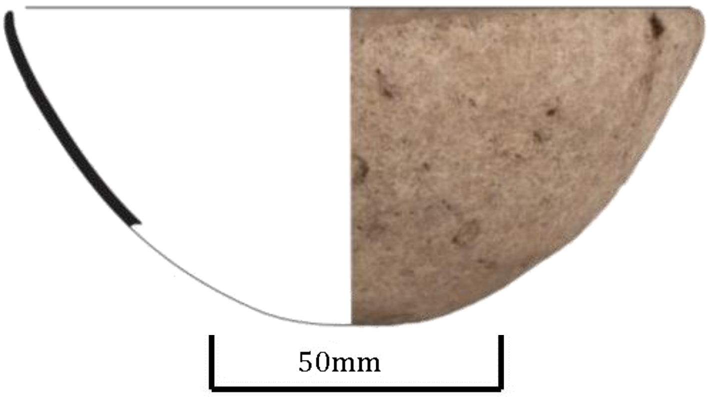


Figure 5.10.1 Vessel 10 pinch-formed unrestricted K2 hemispherical bowl

Technological analysis

This vessel is composed of a fine type fabric with sandy coloured (0.17mm) grains and very small fragments of white and black inclusions ranging from 0.1mm to 0.25mm in size and occurring in less than 3% quantities. These inclusions are very small opaque white, and slightly larger clear glassy grains are visible within the fabric. These inclusions are identified by XRD (see Figure 5.10.3) as quartz, albite, muscovite (reflective specks of mica) and rutile (red mineral). A fracture exposes a few inclusions within a sandy textured fabric, which appears non-porous and dense with no visible voids (Figure 5.10.2). The surface is undecorated with a rough, matt finish and a relatively thickly formed vessel wall. Scraping, wiping and smoothing marks are also visible on the interior surface wall. The ceramic exterior surface colour is light grey (2.5Y 7/2) with an exposed reddish-brown interior fabric (5YR 4/4). A white post-burial deposit or a calcareous-like deposit has formed a discrete layer covering the interior and exterior of the vessel.

A partial fracture though reveals a rich red ceramic fabric with possible quartz and calcite temper inclusions, suggesting an incomplete or partial oxidation firing process although a carbon core is not visible. This unrestricted vessel is manufactured by the pinch or hand mould technique, which entails the opening out and expansion of a ball of clay by forming the vessel between the fingers, while the bowl is supported and turned by the potter's hands. This technique is recognized by the distinct indentations visible on the vessel walls left by the potter and often results in small, round-based unrestricted shapes with uneven and undulated surfaces (Gibson and Woods 1990:220).

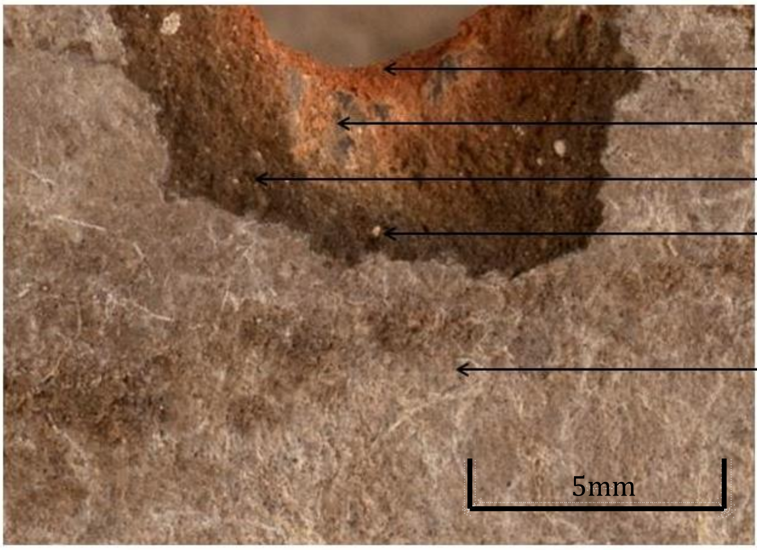


Figure 5.10.2 Microscopic view of vessel 10 indicating fine type sandy fabric and exposed rim fracture revealing visible inclusions and partial firing conditions

Chemical analysis (XRF)

XRF analysis of vessel 10 identifies major elements of potassium (K), iron (Fe), calcium (Ca) and titanium (Ti), and trace constituents of Zn, Zr, Sr, Rb, Th, Cu, Ni, Cr and V are present in very low concentration (Table 5.10). Thorium traces were not determined. The data indicates a proportionately high concentration of calcium (Table 5.10). Shepard (1980:19) cautions on placing too much emphasis on the element calcium due to the multitude of its potential sources since its marked concentration can most likely be the result of the original calcareous clay, or a calcium-rich temper such as limestone, shell or fragments of calcite, among many other reasons.

According to Legodi and de Waal (2007:141) clays with high calcium carbonate content can also form compact ceramic structures at low firing temperatures, as in the case of this vessel, which has a compact white layer over its entire surface. A third explanation of this result might be that, since the deposit forms a discrete layer on the entire surface, it may be calcareous and therefore can also be attributed to post-depositional formation.

Element	**ppm**	**Error±**
K	20666.65	258.88
Ca	123504.6	407.54
Ti	2416.55	55.36
Mn	639.13	46.98
Fe	28101.24	205.27
Zn	72.96	7.76
Zr	399.23	7.27
Sr	308.18	5.09
Rb	88.13	3.44
Th	0	0
Cu	43.99	10.68
Ni	66.75	20.57
Cr	40.16	15.93
V	33.86	16.78

Table 5.10: XRF elemental quantification signature for vessel 10

Mineralogical Analysis (XRD)

The analysis of this vessel was determined by X-ray diffraction (XRD). The main identified minerals are quartz, calcite, albite (alkali feldspar), muscovite (mica) and rutile (see Figure 5.10.3). The presence of rutile in this vessel is significant, as it is an independent mineral generally associated to the element titanium (which also supports the XRF result above) and is a common mineral in intrusive igneous rocks as well as natural clays. Titanium is also frequently associated to other inclusions such as quartz and calcite (Riederer 2004:147).

The red colour imparted by the clay in this vessel can also be attributed to the oxide mineral rutile, from the Latin *rutilus*, for *red*, a common colour of the mineral (Anthony *et al.* 2001), or to the presence of a high iron content supported by the XRF analysis (see Table 5.10). The presence of this specific mineral may indicate a source of different raw material in comparison to the other vessels, as only vessels 13 and 16 contain rutile.

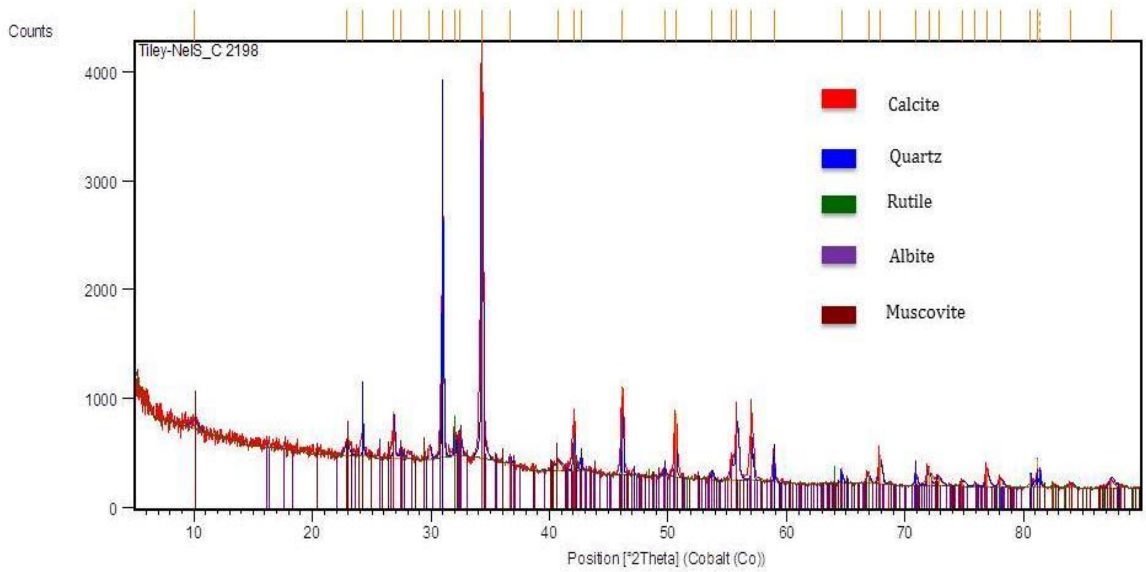


Figure 5.10.3: XRD diffractogram of vessel 10 indicating calcite and quartz as tallest peaks with rutile, albite and muscovite minerals also present

5.2. ANALYSIS OF TRANSITIONAL K2 CERAMICS

5.2.1. Vessel 11

Excavation context, typology and morphology

Vessel 11 (#N275) is a possible Transitional K2 (TK2) beaker bowl excavated in 1939 from Mapungubwe Hill, block 5, section 1, 14' inches (35.56cm) from the extreme left of the section, 42' inches (106.68cm) across the section from left to right and at a depth of 8" inches (20.32cm) from the surface. The reason for classification as a possible Transitional K2 or TK2 (van der Walt 2012:21) is not based on the placement of the decorative motif (usually triangles on the lower neck and upper shoulder (see Huffman 2007:282), but rather the classical K2 beaker form style found in the lower occupation layers of the Hill. The beaker bowl classified by Schofield (1948:30) is a bowl with vertical sides, and also corresponds with Meyer's (1980:59-64) Type 4, form no. 01.09 within his broader Group 0.16 of beaker bowl forms. According to Calabrese (2005:93), this vessel can therefore be grouped as either a beaker or a simple deep bowl form. The vessel (144mm x 170mm) is defined as cylindrical in shape with an unrestricted orifice and a straight rim that has been slightly squared (see Figure 5.11.1). It was found associated to other ceramics, iron and copper bangles and a garden roller bead (Gardner 1963:151).

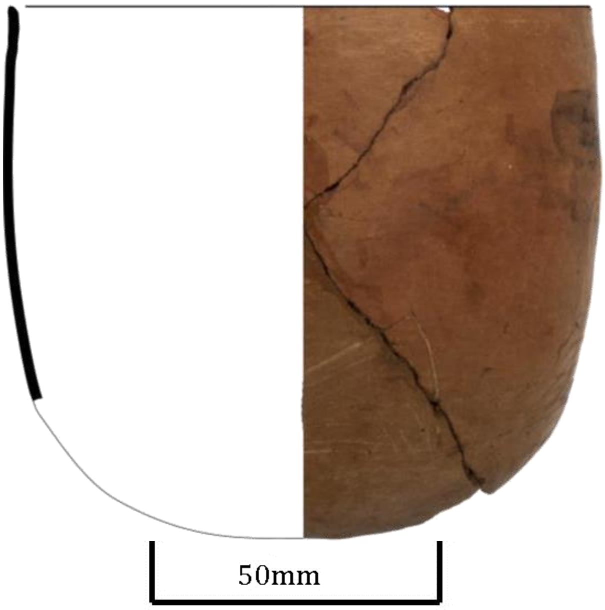


Figure 5.11.1: Example of Transitional K2 beaker bowl vessel 11 from Mapungubwe Hill

Technological analysis

The vessel is composed of a medium type fabric with moderate amounts (>11-25%) of light opaque and glassy white (±0.14mm) and sparse quantities (<3-5%) of black inclusions (ranging from <0.25mm-1.0mm in size). The fabric has a sandy appearance of an irregular nature with larger, more porous and widely-spaced gaps visible, as well as numerous voids. The entire vessel is well-burnished with an exterior and interior surface finish and a distinct reddish-brown surface colour (5YR 5/4). A partially exposed rim fracture reveals a thin unoxidized dark grey core with broad red oxidized inner and outer margins, indicating incomplete or partially oxidized firing conditions (see Figure 5.11.2). Two small isolated holes, one on the interior and one on the exterior, are visible. Such localized holes, or pitting, (see Figure 5.11.3) in the fired clay surface are usually formed by volatile particles (generally calcium carbonate) breaking through and removing some of the clay surface during the firing process (Rice 1987:98).

The rim shape is slightly flared and the thickness of the vertical wall remains constant. The interior wall has faint, long horizontal linear ridges from the scraping and wiping process (Rice 1987:137) because the vessel has been scraped, smoothed and wiped several times to thin the walls and eliminate evidence of possible coiling. It appears that the vessel was manufactured using the coiling technique as undulated parallel planes are visible on the interior (Rice 1987:124-127).

The vessel base has been scored on the lower body; this surface treatment consists of rough, random shallowly incised decoration. This technique is executed with a sharp implement just scoring the surface, often with slightly raised edges, indicating it was executed when the clay was relatively wet (Gibson and Woods 1990:237-238). The rim is worn and abraded also revealing visible black grain inclusions, but it is difficult to distinguish whether these grains have been added to the clay intentionally as a temper, or whether they form part of the raw clay material (Riederer 2004:145).

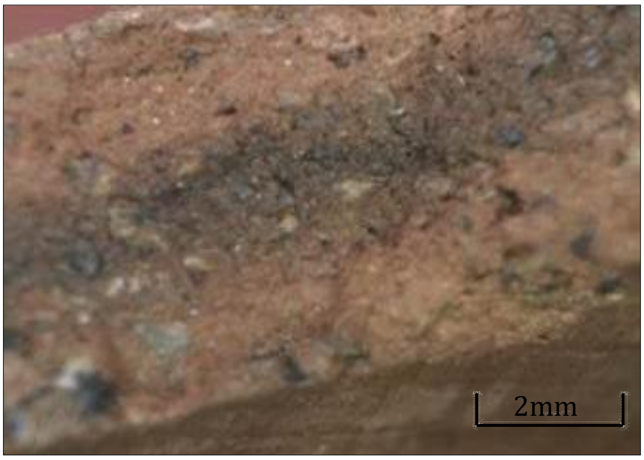


Figure 5.11.2: Thin unoxidized dark grey core of vessel 11 with broad red oxidized margins

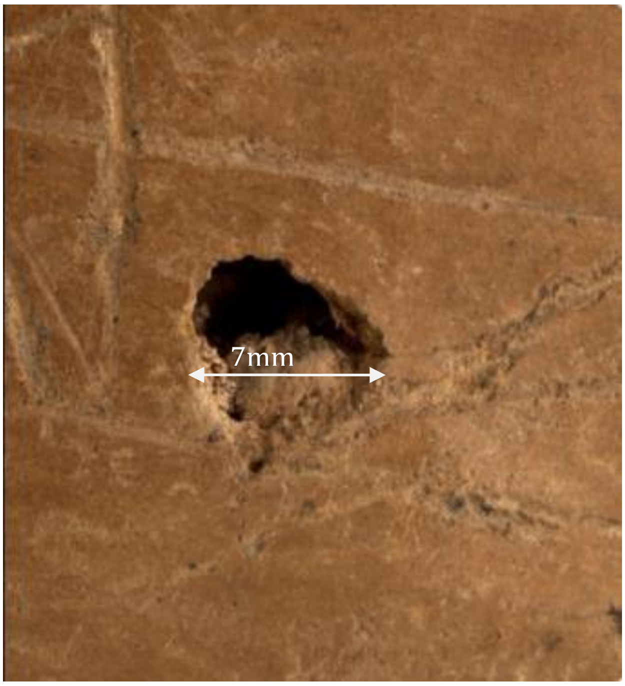


Figure 5.11.3: A small isolated hole or pitting in the clay surface is a visible manufacturing defect

Chemical analysis (XRF)

XRF analysis of vessel 11 identified major concentrations of three major elements: iron (Fe), potassium (K), and calcium (Ca). The presence of the iron-rich content may be attributed to the vessel's typical red surface colour (Shepard 1980:18). The high calcium content identified is significant. According to Rice (1987:98), problems may develop during the firing process with vessels composed of calcareous clays that may cause manufacturing defects such as pitted holes or 'popping' of the fired clay surface, as in the case of this vessel. Such surface defects are formed by volatile inclusions breaking through and removing some of the clay surface during firing. Inclusions of calcium carbonate limestone, shell or calcite, when fired to higher temperatures, decompose and after cooling rehydrate quickly with an accompanying expansion of the clay surface (Rice 1987:478). Minor elements identified are also Ti, Mn, Zn, Zr Sr, and trace constituents of Rb, Th, Cu, Cr and V are also identified (see Table 5.11).

Element	**ppm**	**Error±**
K	32672.03	324.95
Ca	22062.99	191.66
Ti	7394. 20	92.98
Mn	583.38	45.68
Fe	39236.14	233.9
Zn	66.34	7.49
Zr	532.11	7.93
Sr	357.18	5.28
Rb	103.83	3.63
Th	11.1	3.92
Cu	65.77	10.77
Ni	70.33	19.51
Cr	143.53	22.75
V	73.14	27.66

Table 5.11: XRF elemental quantification signature for vessel 11

5.2.2. Vessel 12

Excavation context, typology and morphology

Vessel 12 (#N397) is a Transitional K2 (TK2) recurved or shouldered jar excavated from block 7, section 6 in 1939 within the western occupation area on Mapungubwe Hill. Gardner (1963:63-64) only recovered seven vessels of this large size (417mm x 420mm), and states that they were found grouped together on the summit, perhaps as containers for water or grain storage (see Gardner 1963:229 Plate LVII).

Typologically this vessel form can be grouped with Meyer's (1980:74) globular shouldered vessels with necks, form no. 10.02, although the shoulder junction is not very distinctive. This form also corresponds with Calabrese's (2005:88) recurved jars with a globular body, with a height greater than mouth diameter, and sometimes with a distinct shoulder. The vessel form is distinguished as ovaloid or globular with a restricted orifice (300mm), a slightly everted round rim (±8mm) and round base (Figure 5.12.1). The vessel is decorated on the upper shoulder with alternating upright triangles which is a stylistic characteristic of Transitional K2 ceramics (Huffman 2007:282). The vessel is associated to the residential area on the summit and falls within the Transitional K2 period AD 1220 –AD 1250.

Figure 5.12.1 Example of Transitional K2 recurved or shouldered jar form

Technological analysis

The vessel is composed of a medium type fabric with sparse frequencies (<3-10%) of white inclusions of glassy quartz and opaque calcite, as well as dull black (possibly magnetite) inclusions which range in size from about 0.25mm to 1.0mm. The inclusions are minerals present in the fabric and are identified as quartz, calcite, magnetite, albite, orthoclase, gypsum, muscovite and enstatite (see Figure 5.12.4). The dark grey matrix appears unoxidized (see Figure 5.12.2.) with a sandy texture, voids are irregular and are indicative of the former presence of inclusions which may have burned or leached out during the firing process (Prehistoric Ceramics Research Group 2010:25). The overall surface colour of the vessel on the interior and exterior is very dark grey (2.5YR 3/1).

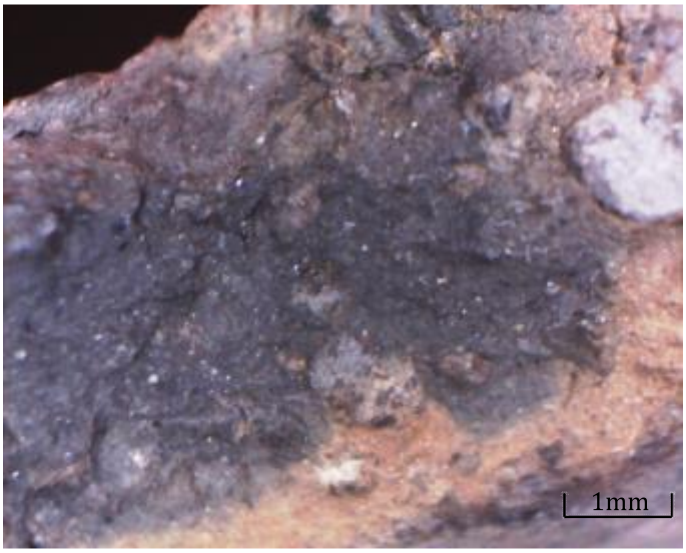


Figure 5.12.2 Dark grey core of medium type fabric of TK2 vessel indicating incomplete firing

The primary forming technique on this large and proportionally heavy vessel (approximately 25kg) is discernible from a physical examination of the many interior and exterior surface markings. This vessel form was probably built from the base up, beginning with the preparation of the round and pronounced thickened base. The vessel wall was probably gradually raised by flattening the clay coil between both hands and the neck constructed separately with a larger coil. A fracture line and join line is visible where the body attaches to the neck. Indications of coiling can be seen clearly from two types of surface markings on both the exterior and interior surfaces. Firstly, the fracture line at the coiling point where the body attaches to the base (see Figure 5.12.3) and secondly, by bends on the interior of the wall and the variations of wall thickness.

It is also possible that the rim was formed to increase a moderate thickness by manipulating the edge of the wall (Shepard 1980:248), or adding another single coil. The rounded rim has visible indentations and is undulated, as if finished between the fingers. The rim is also proportionally thick, which suggests a strengthening of the orifice for functional purposes and also for supporting a relatively thick-walled vessel. Visible surface deposits or residues are also preserved as encrustations adhering to the interior surface of the vessel. Evidence of scraping, wiping and smoothing marks are also clearly visible on the interior upper rim. The decorative motif of alternating triangles on the shoulder was executed using the incised technique.

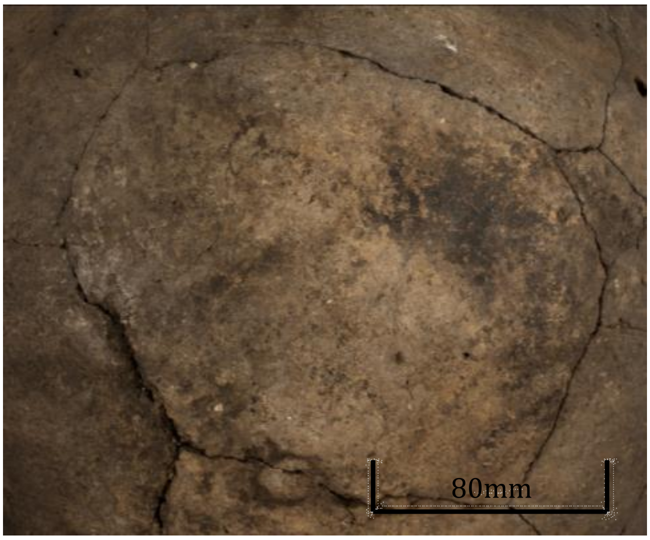


Figure 5.12.3: Evidence of distinct coil fracture on base of Transitional K2 vessel

Chemical analysis (XRF)

XRF analysis of vessel 12 shows concentrations of major elements such as potassium (K), calcium (Ca) and iron (Fe) with low concentrations of Ti, Mn, Zn, Zr, and Sr. These elements either reflect the major clay constituents within the vessel or could represent impurities in the clay . Trace constituents of Rb, Th, Cu, Cr and V were identified in very low concentrations, and nickel was not determined.

The XRF results (see Table 5.12) support the XRD results (Figure 5.12.4) and indicate that the vessel is composed primarily of quartz and calcite clay minerals with other organic compounds such as titanium and phosphates as well as iron oxides (muscovite and magnetite), and may be geologically associated to the typical mafic and ultramafic complexes and the quartz-feldspar gneisses common to the Limpopo Mobile Belt (Chinoda *et al.* 2009:24-25).

Element	ppm	Error±
K	30535.97	362.87
Ca	64105.33	391.34
Ti	3247.2	57.44
Mn	524.71	71.03
Fe	29065.3	244.78
Zn	156.37	11.91
Zr	218.11	4.83
Sr	289.4	5.38
Rb	47.36	1.91
Th	21.57	4.28
Cu	114.03	15.48
Ni	0	0
Cr	26.88	17.58
V	74.74	29.97

Table 5.12: XRF elemental quantification signature for vessel 12

Mineralogical analysis (XRD)

X-ray diffraction (XRD) analysis was carried out on two samples taken from this vessel: #N397a an existing minor broken body fragment from the exterior of the vessel, and #N397b an interior sample fragment. The main identified minerals from both samples indicate the presence of quartz, magnetite, albite, orthoclase, muscovite and enstatite. Magnetite and enstatite are only observed in sample a (Figure 5.12.4a), whereas calcite and gypsum are only identified in sample b (see Figure 5.12.4b).

The most intense peak is the mineral quartz, probably a natural source from the typical Mapungubwe Karoo sandstones (Chinoda *et al.* 2009), while the presence of feldspar clay minerals such as orthoclase and albite confirms that the vessel was fired at low temperatures. The calcite and gypsum either could occur as impurities in the clay minerals or were formed during the firing process (Legodi and de Waal 2007:140-142).

Orthoclase generally occurs in magmatic and metamorphic rocks and gypsum. It is also a common mineral widely distributed in sedimentary rocks and frequently occurs interstratified with limestone and shales (Legodi and de Waal 2007:141), suggesting an association to Mapungubwe's regional geology. The different XRD phases (see Figure 5.12.4) within the same vessel confirm that the natural clay minerals occur as mixtures and that these mineral and silicates within the ceramic fabric are significant since they can probably reflect the properties of the local geology of the vessel's place of manufacture (Riederer 2004:157).

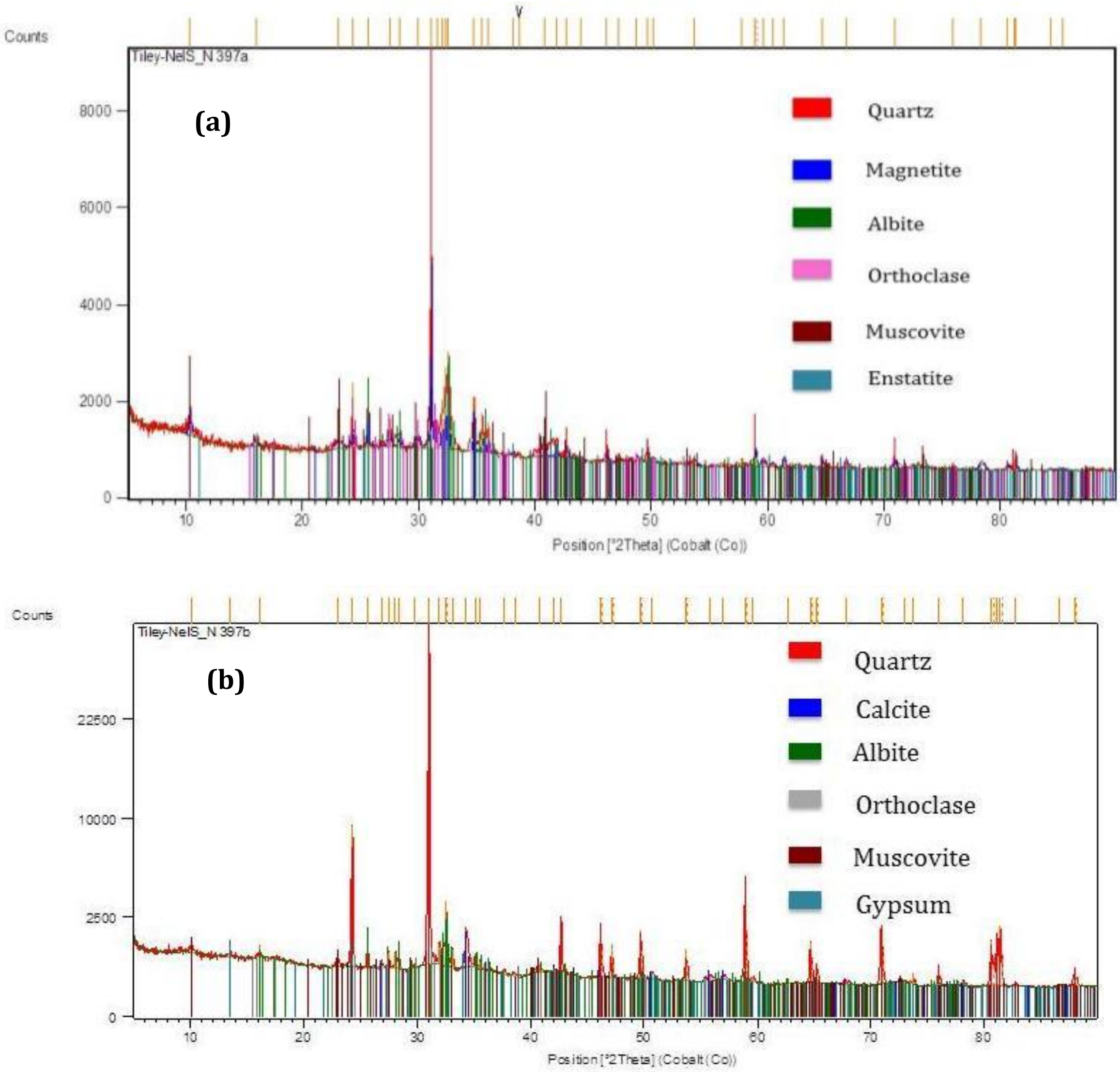


Figure 5.12.4: XRD diffractograms of vessel 12 with two samples (a) and (b)which have an intense peak for quartz and the presence of common feldspar clay minerals such as albite and orthoclase. Only sample (b) is characterized by calcite

5.2.3. Vessel 13

Excavation context, typology and morphology

Vessel 13 (#N398) is a decorated recurved Transitional K2 (TK2) jar, recovered by Jones during the first preliminary excavation season in July 1933/1934 from an excavation referred to as No.00 of the original Grave Area on Mapungubwe Hill (Fouché 1937:9). This vessel can be classified into both Huffman's (2007:282) and van der Walt's (2012:42) TK2 stylistic class of recurved jars with incised triangles on the shoulder. Typologically this vessel corresponds with Meyer's (1980:69) Group 5 of globular vessels with necks and also corresponds with Calabrese's (2005:88) classification of recurved jars.

This vessel is proportionally heavy, weighing approximately 10kg (350mm x 458mm) and is defined as a spherical form with a restricted orifice (262mm). The vessel has a globular body with a short neck, with downward triangular decorative motifs on the upper shoulder, a straight rim and a round base (see Figure 5.13.1 below) and is associated to the main occupation period of Mapungubwe Hill Phase 3 or Transitional K2 AD 1220 – AD 1250.

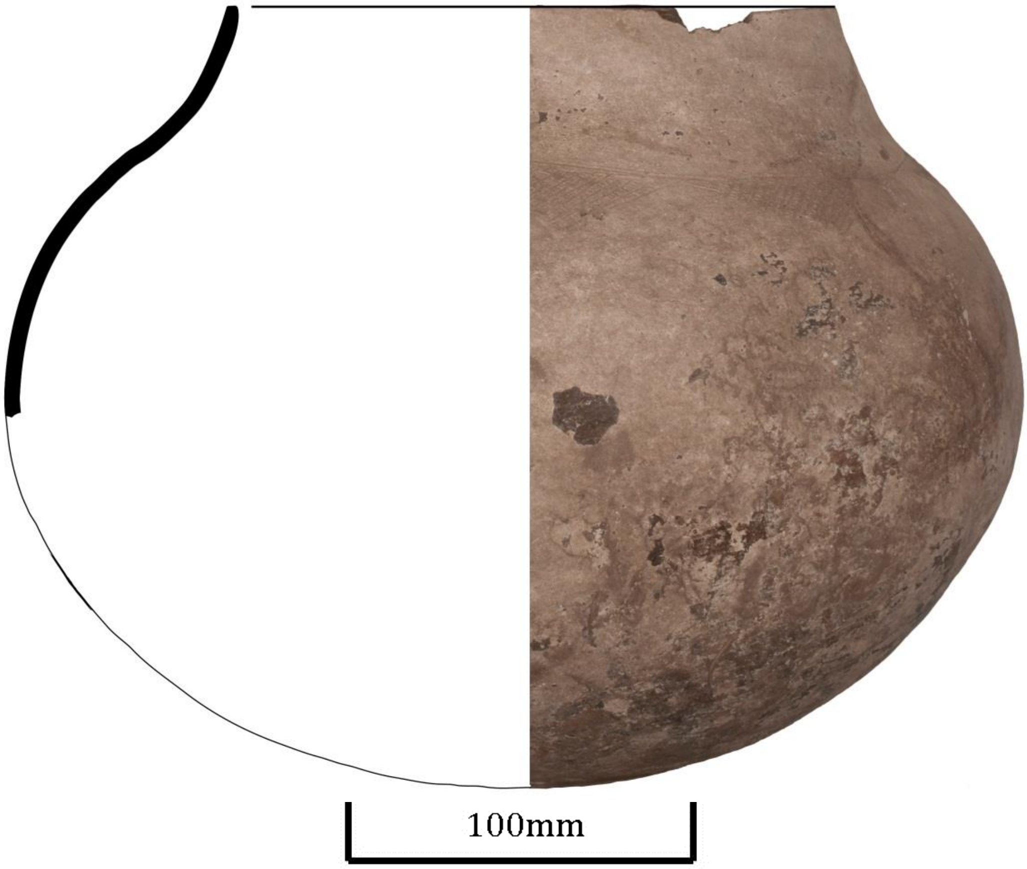
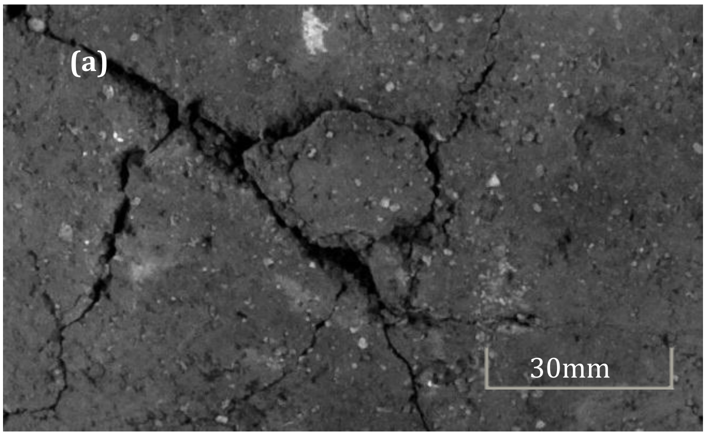


Figure 5.13.1: Example of a typical Transitional K2 recurved jar from Mapungubwe Hill

Technological analysis

The vessel is composed of a medium-type fabric with common amounts (<26% - 40%) of glassy and opaque white inclusions, ranging in size from <0.25mm to 1.0mm (Prehistoric Ceramics Research Group: 2010). The fabric is sandy-textured with spaces created between the clay matrix and inclusions giving a more granular and porous appearance. The inclusions are also clearly visible on an existing rim fracture (Figure 5.13.2.) and are either predominantly quartz or very small fragments of white opaque calcite grains as identified by XRD (see Figure 5.13.3 below).

A fractured area on the base exhibits use-wear and exposes a granular type of sandy fabric (see Figure 5.13.2a), which is often tempered and used to reinforce clay for structural support for thicker walled and heavy vessels (Rice 1987:227). The exterior and interior surfaces have been smoothed to a matt finish. The shoulder has been incised with cross-hatched triangle decoration below a single incised line. Although the vessel surface is covered in a thin white layer obscuring patches of the exterior surface, exposed areas reveal a brown (7.5YR 4/3) surface colour. A rim fracture reveals a black unoxidized core with oxidized interior and exterior margins, suggesting incomplete or partially oxidized firing conditions (see Figure 5.13.2b). The vessel also exhibits extensive use-wear, particularly visible on the rounded base and worn rim, as well as a hole in the vessel wall, probably post-excavation tool damage. There is no evidence to suggest a particular forming technique for this vessel.



(b)

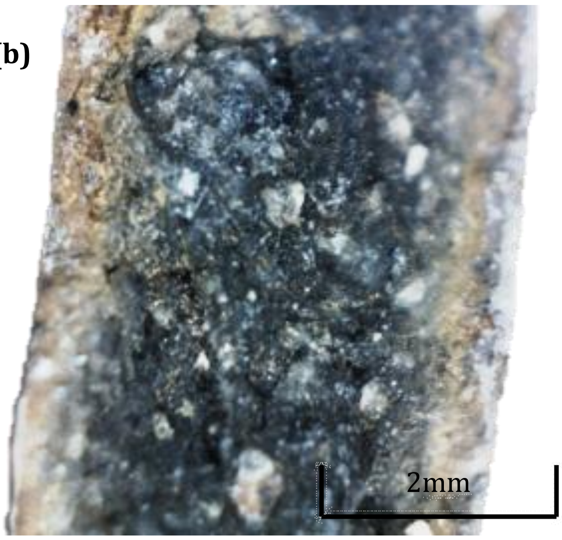


Figure 5.13.2: Evidence of sandy texture of vessel 13 with fracture exposing (a) distinct white mineral based fabric and (b) exhibiting a dark grey unoxidized central core

Chemical analysis (XRF)

XRF analysis of vessel 13 identifies major trace elements such as potassium (K), calcium (Ca), iron (Fe) and titanium (Ti) (see Table 5.13). Minor elements identified are Zn and Sr which occur in low concentrations, and Rb, Th and Cu reflect trace constituents (Ni, Cr and V are not determined). The above elements indicate that most rocks are composed of silicates such as magnesium, iron, calcium, sodium and potassium. Rock-forming clay minerals such as quartz and calcite (Rice 1987:33) are also identified, which is confirmed by the XRD data below (see Figure 5.13.3).

Element	ppm	Error±
K	16335.82	216.86
Ca	34000.88	211.44
Ti	3330.95	60.24
Mn	400.31	41.74
Fe	31197.36	219.98
Zn	58.6	7.46
Zr	369.66	7.12
Sr	263.70	4.81
Rb	97.4	3.66
Th	6.88	3.74
Cu	44.44	10.99
Ni	0	0
Cr	0	0
V	0	0

Table 5.13: XRF elemental quantification signature for vessel 13

Mineralogical (XRD) analysis

The mineralogical analysis of this vessel was determined by X-ray diffraction (XRD) on two samples (see Figure 5.13.3). The main identified mineral phases are quartz, calcite, albite, microcline, rutile, montmorillonite (Figure 5.13.3a), gypsum, cristobalite and anorthite (Figure 5.13.3b). The mineral composition of this vessel, supported by the presence of common silicates of potassium, iron, calcium and manganese (confirmed by the XRF analysis above), suggests dominant rock forming minerals mainly composed of quartz, calcite as well as both alkali feldspars, e.g. microcline and plagioclases such as albite and anorthite (Rice 1987:33-35). The presence of titanium, identified as a major trace element in the XRF analysis (see Table 5.13), forms part of the above clay minerals as it can occur naturally in the clay as the mineral rutile. The traces of gypsum possibly relates to the discrete hard calcareous layer formed on the exterior of the vessel. This deposit does not appear to be part of the original ceramic surface and is therefore considered post-depositional.

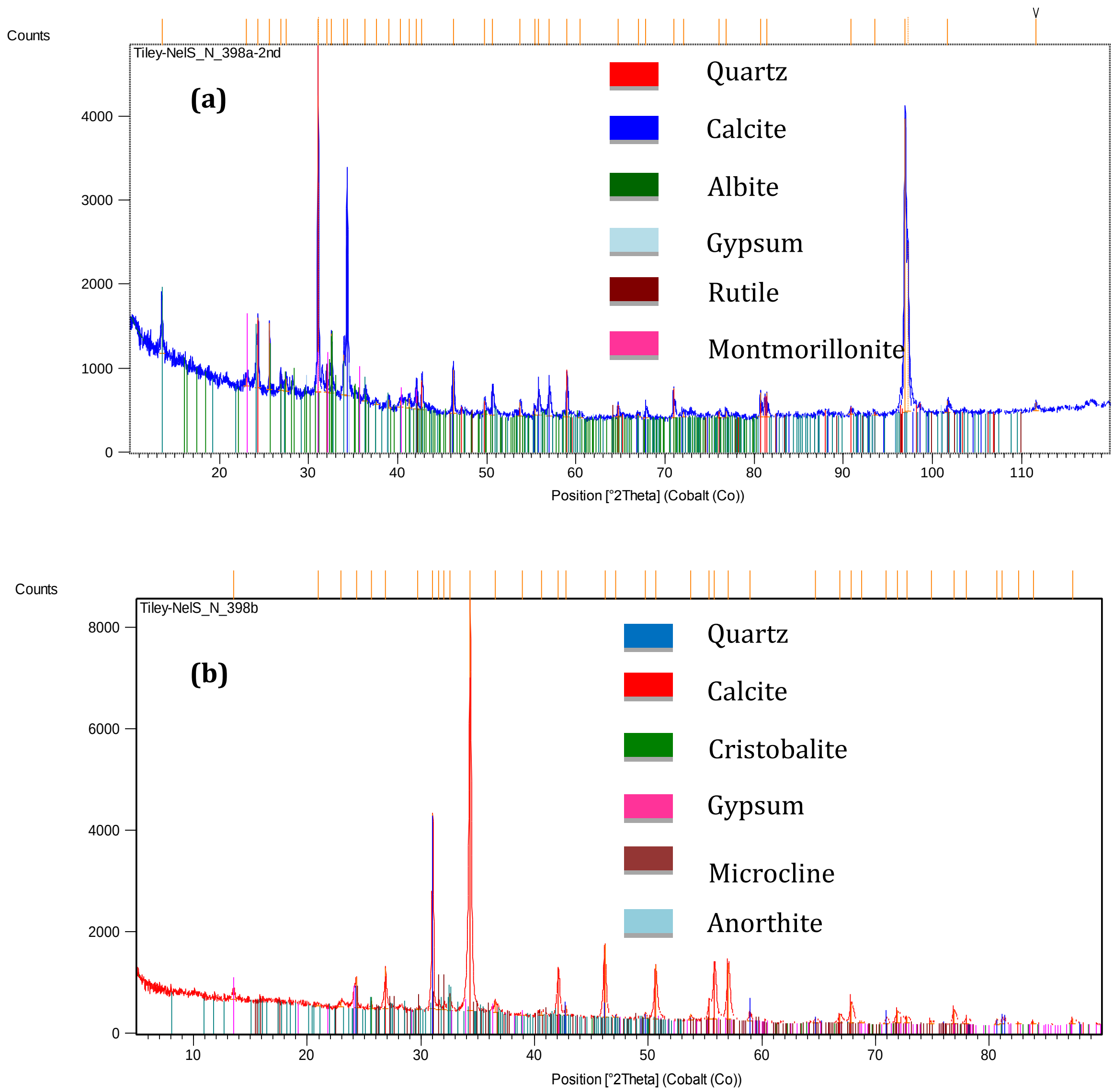


Figure 5.13.3: XRD diffractograms of vessel 13 samples (a) and (b) with calcite and quartz indicated with high peaks intensities

5.2.4. Vessel 14

Excavation context, typology and morphology

Vessel 14 (#N390) is a possible Transitional K2 (TK2) recurved jar (215mm x 277mm) recovered in 1940, west from an erosion area near 'Peg C' which is located near the eastern ascent on Mapungubwe Hill. The vessel is decorated on the upper shoulder with alternating downward incised triangle motifs, a stylistic marker according to Huffman (2007:282) of Transitional K2 ceramics (AD 1220 – AD 1250). This vessel is also associated to the palace area (or near the rainmaking area), which has also been linked with TK2 ceramics (Huffman 2000:21). The vessel form is defined as spherical with a restricted orifice (163mm), a round shape, slightly everted rim and a round base (Figure 5.14.1).

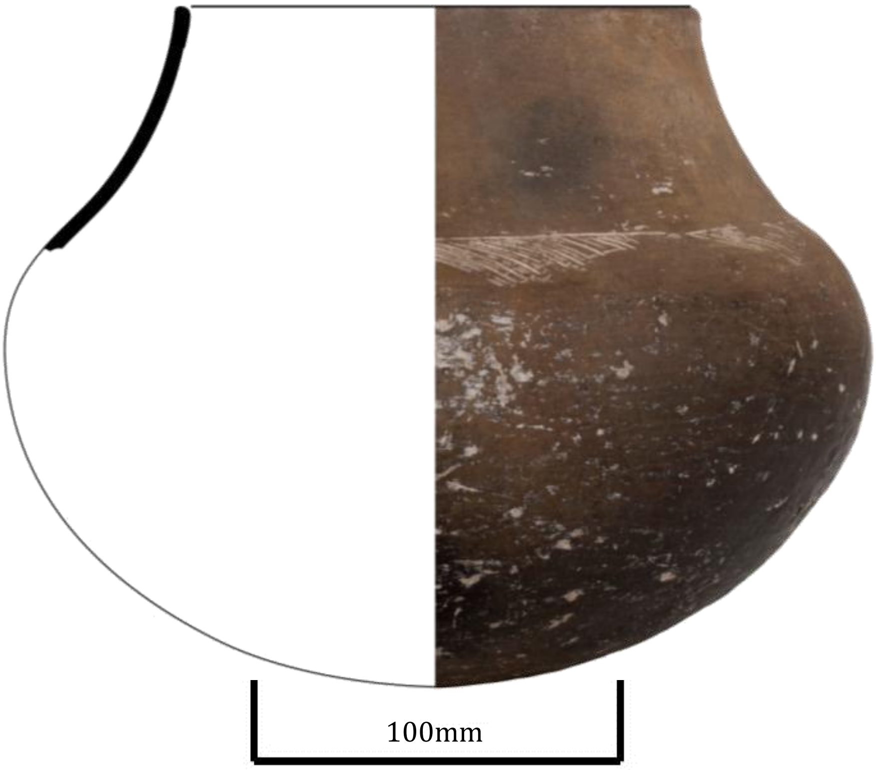


Figure 5.14.1 Common type of recurved jar form, possibly Transitional K2

Technological analysis

The vessel is composed of a medium type fabric with inclusions which range in size from 0.25mm to 1.0mm (Prehistoric Ceramics Research Group 2010). The fabric is clearly composed of several types of coloured inclusions, that consist of glassy and opaque white, dull and shiny black, red and grey grains, as well as reflective micaceous specks found in abundant (>40-50%) frequencies. There are also spaces between the ceramic matrix with a smooth fine, non-porous appearance. The rim exhibits extensive use-wear marks and is abraded, clearly exposing visible red grain inclusions within the ceramic fabric (see Figure 5.14.2). The exterior surface colour is brown overall (7.5YR 5/4) with large black patchy areas, probably resulting from incomplete firing conditions or from open-pit firing. No carbon core is visible however to confirm this.

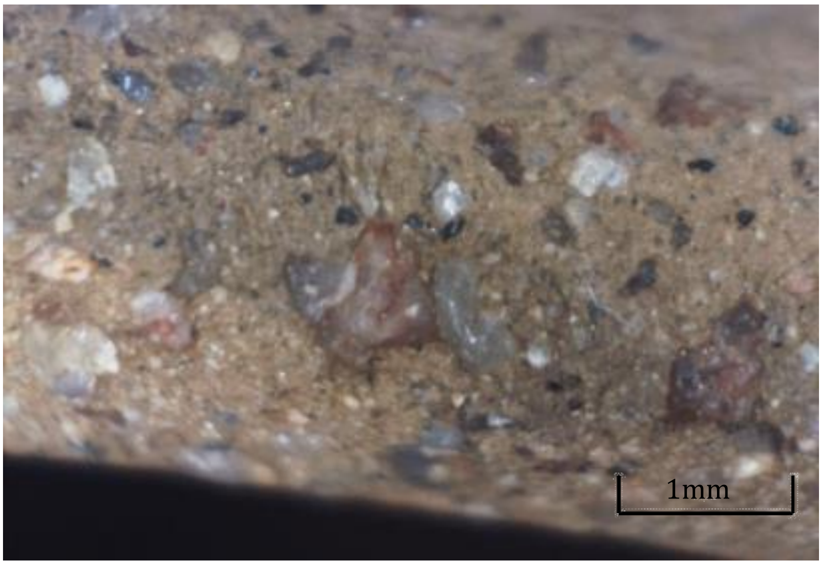


Figure 5.14.2 Multi-coloured grained inclusions visible on rim fracture of Transitional K2 jar

Linear horizontal strokes from the burnishing process are visible, running around the circumference of the vessel, as well as repeated scratches on the interior, which appear to be the result of stirring or of the scraping process. Narrow burnishing marks are visible as horizontal striations to obliterate any evidence of primary forming. The slightly everted rim is thickened, as the clay on top of the wall was pushed downwards and outwards. To finish the rim, the transition from the top wall and rim is smoothed from the inside, creating a thickened overhang and distinct horizontal, raised drag marks are evident around the diameter of the rim for smoothing the surface.

Chemical analysis (XRF)

XRF analysis of vessel 14 identifies major elements of iron (Fe), potassium (K), and calcium (Ca) with the intensity of iron, possibly associated to the exterior reddish surface colour. The elevated calcium content may suggest calcium-rich clay or a calcareous temper within the fabric (Shepard 1980:24). The sample also indicates low concentrations for other elements such as Cu, Ni, Cr and V as trace constituents only, with the exception of thorium (Th) (see Table 5.14).

Element	ppm	Error±
K	15329.81	232.7
Ca	51767.92	280.21
Ti	5689.28	83.75
Mn	522.67	45.75
Fe	38660.95	240.77
Zn	58.81	7.55
Zr	341.2	6.81
Sr	271.68	4.80
Rb	67.71	3.11
Th	0	0
Cu	55.25	110.1
Ni	53.45	20.29
Cr	100.34	21.31
V	50.79	25.0

Table 5.14: XRF elemental quantification signature for vessel 14

5.3. ANALYSIS OF MAPUNGUBWE CERAMICS

5.3.1. Vessel 15

Excavation context, typology and morphology

Vessel 15 (#N404) is a Mapungubwe undecorated recurved jar (356mm x 440mm) from a trench area known as JS4 on Mapungubwe Hill, at 120' inches (304.8cm) from the extreme left of the section, 2' inches (5.08cm) across the section from left to right and at a depth of 6" inches (15.2cm). Typologically this vessel is an example of a common Mapungubwe ceramic type, restricted and undecorated, with a globular body and a distinct shoulder junction. This vessel corresponds to Calabrese's (2005:88) recurved necked globular jars and directly links to the shouldered form no. 06.02 of Meyer's (1980:70-72) classification. The vessel form is defined as spherical with a restricted orifice (214mm), a straight, rounded rim and a round base. The vessel is supported by a heavy globular body with a pronounced broad shoulder and short 50mm-long neck (see Figure 5.15.1). Supposedly a 'large beer pot' (Fouché 1937:14), this vessel was located within the upper levels of a residential hut floor (the occupation period AD 1250 – AD 1290). Associated materials include two ceramic vessels, an upper grindstone, three clay animal figurines, a bone needle, a burnishing stone, clay spindle whorls, iron implements and fragments of tuyère (Fouché 1937:14).

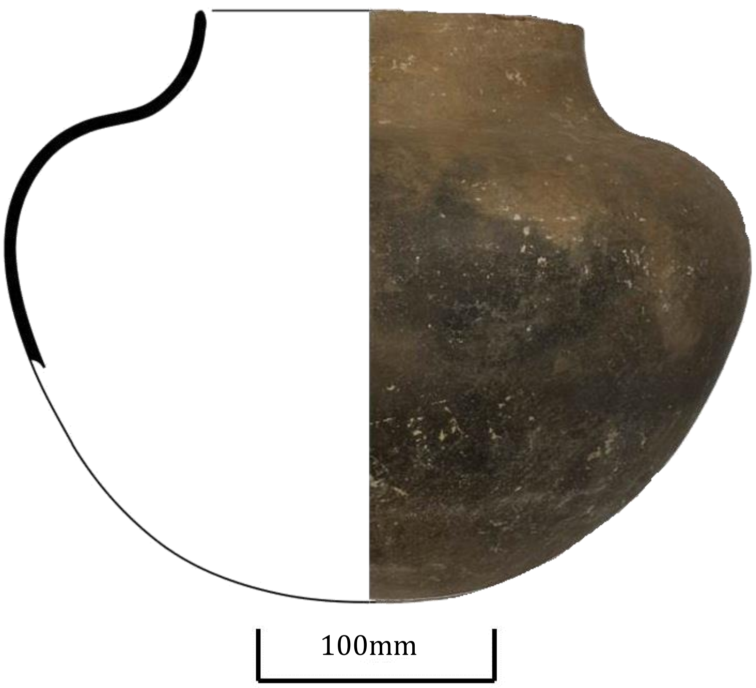


Figure 5.15.1 Example of typical Mapungubwe type with a globular belly and recurved jar form

Technological analysis

The vessel is characterized by a coarse fabric type with an inclusion size range of <1.0mm to 3.0mm. Granular fragments of dull black and shiny black inclusions occur in abundant frequencies (>40-50%), as well as some very small white inclusions, which occur in rare quantities (<1%). The overall fabric therefore has a very sandy texture with friable inclusions of a gravelly nature with large voids present, and the surface is easily scratched. These minerals identified by XRD (See Figure 5.15.4) are quartz, microcline, enstatite, albite and muscovite. The surface colour is reddish brown (5YR 4/4) to dark reddish brown (5YR 3/2), with black patchy areas produced by firing conditions. The carbon core is not discernible since there is no existing fracture, so therefore firing conditions cannot be determined.

The undecorated surface has been smoothed and burnished, as low burnish facets running horizontally along the circumference are long, indicating that the vessel was rotated during the burnishing process (Gibson and Woods 1990:109). The forming technique on this vessel is not evident as the forming process and low burnishing has obliterated any shaping marks and also compacted a smoother surface (Rice 1987:137-138). Horizontal scrape marks (see Figure 5.15.3) are also visible on the interior of the rim, possibly used to thin the upper shoulder portion by hand and finish the rim with the fingers.

Figure 5.15.2: Coarse type fabric of Mapungubwe vessel with large dark tempered minerals

The walls of this vessel are thick and serve as structural support to a heavy clay body, possibly with coarse grained temper to reinforce the clay (Rice 1987:227). Evidence to support this, is the abundant quantity of large dark inclusions that are visible within the ceramic fabric (see Figure 5.15.2 above), particularly exposed on the rim. The compaction of the coarse inclusions are clearly visible, as drag marks are created on the surface during turning, when the smoothing process picks up inclusions within the clay and drags them along the surface thereby leaving scratches (Gibson and Woods 1990:141).

Thick loose encrustations or evidence of residues still adhere to the interior of the vessel walls; these can be post-depositional material or original deposits, and may indicate the use and function of the vessel. Samples of this deposit have been retained for future analysis. Evidence of extensive use-wear and visible stains resulting from damaging soluble salts are visible on the inner surface. This may suggest that this vessel was possibly used for storing liquids i.e. water or beer, as the thick walls and thick base increase stability and keep moisture in or out, thus ensuring that the container is able to retain liquids. Use-wear on the vessel, caused by attrition of the surface, is further visible on the outside and left striations and pitting that has exposed the underlying fabric (Rice 1996*a*:147).

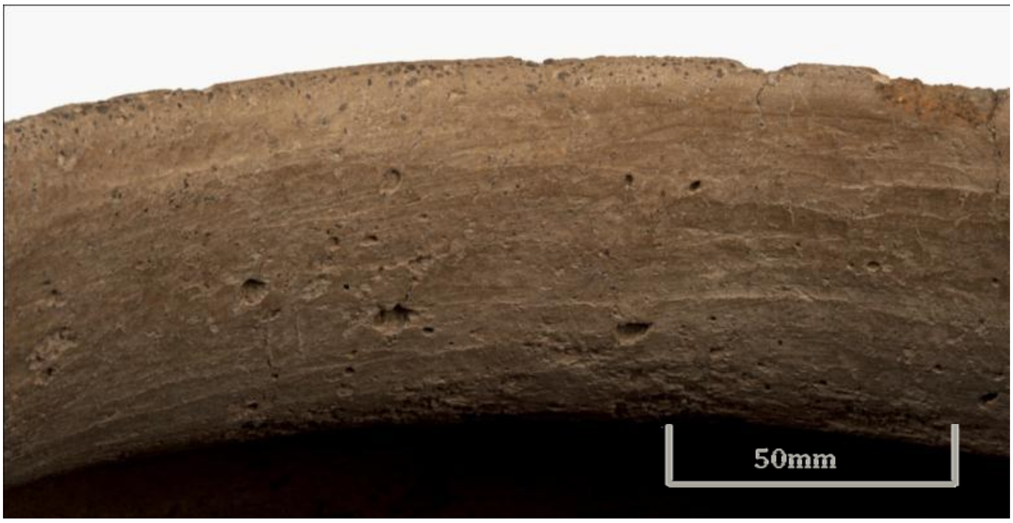


Figure 5.15.3 Wiping interior drag marks and horizontal facets from scraping and burnishing

Chemical analysis (XRF)

The XRF elemental signature for vessel 15 identifies major concentrations of calcium (Ca), iron (Fe) and potassium (K) with minor concentrations of Mn, Zn, Zr, Sr, Rb, Th, Cu, Cr, Ni and V (Table 5.15.). This data supports the XRD analysis below (See Figure 5.15.4), indicating that elements such as potassium and titanium are possible clay impurities and the presence of iron as a major concentration may be a contributing factor to the reddish brown colour of the vessel (Shepard 1980:24).

Element	ppm	Error±
K	22823.59	264.34
Ca	39270.09	237.33
Ti	5982.03	85.81
Mn	524.19	47.48
Fe	36200.54	240.59
Zn	56.8	56.8
Zr	477.54	8.44
Sr	555.75	7.01
Rb	73.03	3.36
Th	8.1	3.93
Cu	60.26	11.82
Ni	134.56	23.31
Cr	181.55	21.0
V	67.73	28.29

Table 5.15: XRF elemental quantification signature for vessel 15

Mineralogical analysis (XRD)

XRD analysis identified that the principal mineral phases identified are quartz, microcline, enstatite, albite and muscovite (see Figure 5.15.4). The data indicates that the vessel is primarily composed of quartz, presumably originating from regional sandstones as well as common silicate minerals such as muscovite (which contains potassium) and enstatite (a stable form of magnesium silicate). In addition, typical feldspar minerals such as microcline and albite (Riederer 2004:157), may be directly associated to the mafic and ultramafic geology of the Limpopo region (Bumby 2003; Chinoda *et al.* 2009). The presence of these clay minerals further supports the XRF data (Table 5.15 above).

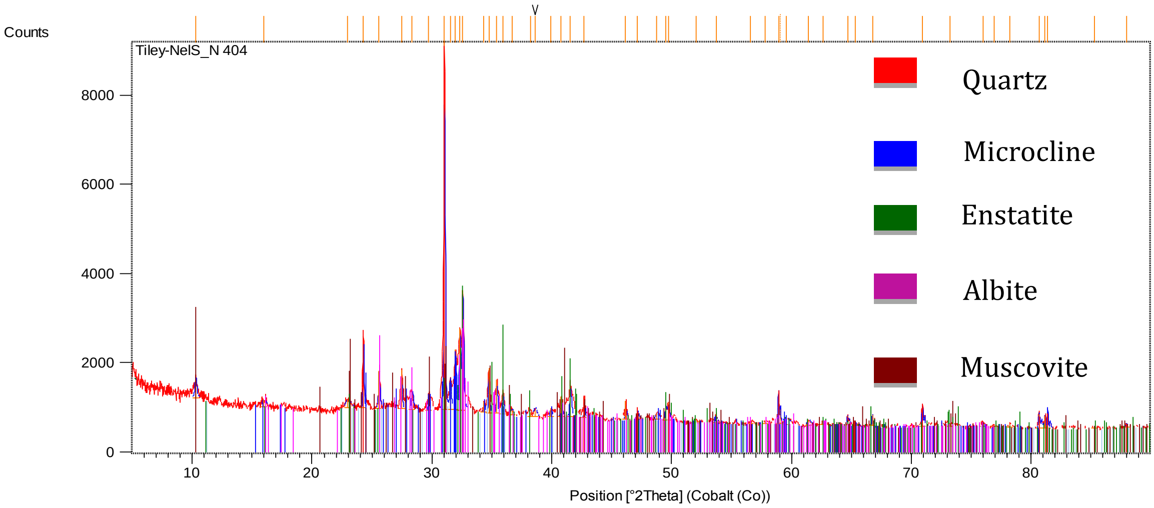


Figure 5.15.4: XRD diffractogram of vessel 15 indicating an intense peak for quartz and the presence of common feldspar clay minerals such as albite and microcline

5.3.2. Vessel 16

Excavation context, typology and morphology

Vessel 16 (#N403) is a typical Mapungubwe undecorated recurved jar excavated in 1934 (Figure 5.16.1) from the main Grave Area (west of ext. no 1A) on Mapungubwe Hill (Gardner 1963:177). Typologically the vessel corresponds with Meyer's (1980:70-72) Group 6 of shouldered ellipsoid-shaped vessels, form no. 0.6.02. It also corresponds with Calabrese's (2005:88) category of bellied jars, of a globular form with height greater than mouth diameter. This vessel (295mm x 362mm) is defined as ellipsoid in shape or described geometrically as a cylindrical neck sitting atop an ellipsoid body with a restricted orifice of 204mm (Calabrese 2005:88). The vessel has a globular body with a long neck projecting from a sharp-angled shoulder (or, according to Rice 1987:218, is known as a simple inflection point), a slightly everted round rim and a round base (see Figure 5.16.2). The vessel is associated to the main occupation period of Mapungubwe Hill AD 1250 – AD 1290.

Figure 5.16.1 Recurved vessel 16 *in situ* in 1934 on Mapungubwe Hill
(Gardner 1963:177 Plate V No.2)

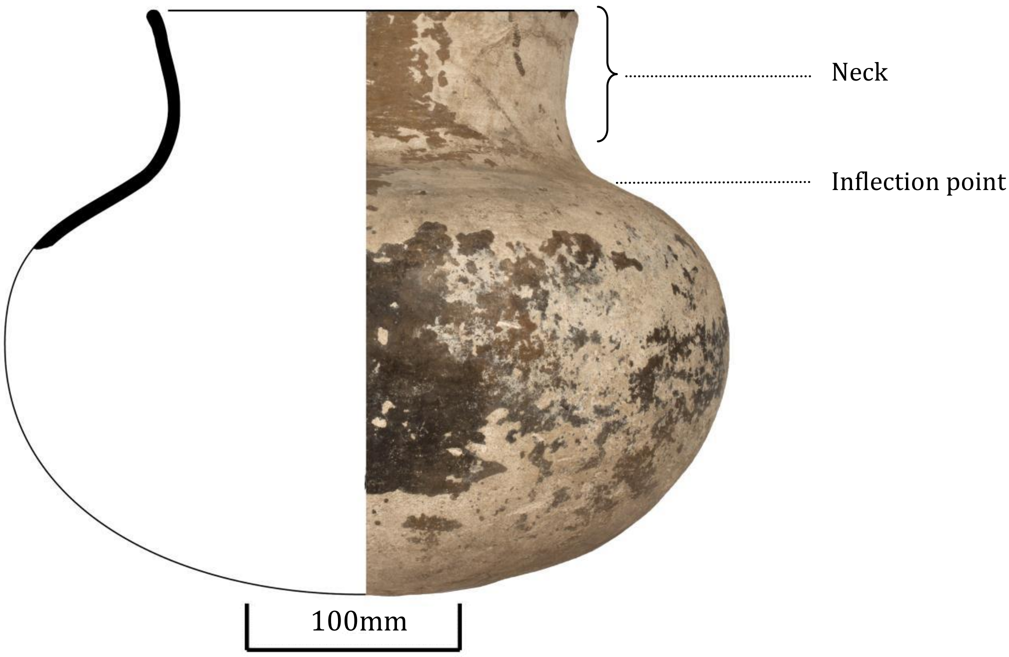


Figure 5.16.2: Vessel 16 restricted Mapungubwe recurved jar with a simple inflection point

Technological analysis

The vessel is composed of a fine type fabric with an inclusion size ranging from 0.1mm to 0.25mm, consisting of very small fragments of mostly white glassy and opaque inclusions that occur in sparse amounts (<3-10%). The fabric exhibits few visible voids and limited inclusions, rendering a smooth texture with a dense appearance of the clay matrix, where the size range of inclusions is generally small, which is suggestive of a fine grain (Prehistoric Ceramics Research Group 2010:25-26). Exposed external areas between post-depositional calcareous accretions reveal an overall reddish brown (5YR 4/4) to dark reddish brown (5YR 3/2) surface colour. A fracture exposes a black central unoxidized core with oxidized margins indicating incomplete firing conditions (see Figure 5.16.3). Several fire clouds are visible as black patchy areas on the exterior body, due to the deposition of carbon on the vessel during the firing process where the surface came into contact with the smoke (Gibson and Woods 1990:121).

The undecorated surface has been relatively smoothed as burnish facets running horizontally along the circumference are long, indicating that the vessel was rotated during the burnishing process (Gibson and Woods 1990:109). In relation to its size, the vessel is rather heavy (±5 kg) as the walls are fairly thick, thereby providing structural support and stability to carry its heavy structure. According to Rice (1987:241), a restricted neck can also serve as a special adaption in that it is principally useful for storage purposes, such as water or dry food. It is presumed that the vessel was manufactured by the coiling method since several rough join voids (Gibson and Woods 1990:189) are visible on the inside. The vessel is also cracked horizontally on the rim along this plane of weakness, which is a characteristic of coiled vessels (Rice 1987:474).

Figure 5.16.3: Fine fabric type of vessel 16 with unoxidized core and sparse amounts of various white inclusions

Chemical analysis (XRF)

The elemental signature for vessel 16 identifies major traces of iron (Fe), calcium (Ca) and potassium (K), with minor trace elements such as Ti, Mn, Zn, Zr and Sr (Table 5.16). Calcium is an element also commonly associated to the temper fraction in the ceramic fabric (Padilla *et al.* 2006:285).

Element	ppm	Error±
K	30248.46	319.86
Ca	44204.15	267.62
Ti	6746.65	93.0
Mn	513.99	42.35
Fe	35844.16	217.69
Zn	51.59	6.76
Zr	406.99	6.92
Sr	324.75	4.91
Rb	106.22	3.55
Th	9.73	3.67
Cu	58.42	10.22
Ni	105.47	19.65
Cr	96.96	22.25
V	45.11	27.84

Table 5.16: XRF elemental quantification signature for vessel 16

Mineralogical analysis (XRD)

The analysis of this vessel was determined by X-ray diffraction (XRD) from two samples (see Figure 5.16.4a and 5.16.4.b). The main identified minerals phases are quartz, calcite, albite, microcline, diopside, rutile, gypsum, hydrophilite (Figure 5.16.4a) and tremolite (Figure 5.16.4b). The mineral composition of the vessel is dominated by rock forming minerals such as quartz and calcite, as well as microcline and albite which are both known as alkali feldspars, which are generally rich in potassium (Rice 1987:96).

Tremolite, identified in sample b, is a member of the amphibole group of silicate minerals, which form in metamorphic sediments rich in dolomite and quartz, and in low-grade ultramafic rocks (Anthony *et al.* 2001). This is consistent with the local geology of the Mapungubwe area (Bumby 2003). The presence of hydrophilite, which is essentially calcium-carbonate based, is often found in association with gypsum, both of which may be considered damaging salts and could be the principal cause of ceramic deterioration (Cronyn 1990:103-105). The post-depositional accretion that has formed a discrete layer on the surface of this vessel is probably the source of the calcium carbonate.

In addition, the source of the gypsum in combination with the calcium-rich content from the XRF (see Table 5.16) may also be a result of contamination from the plaster of Paris (essentially gypsum plaster) used to reconstruct the vessel in the 1930s. Gypsum and calcium carbonate could therefore be the main cause of damaging salts to the porous ceramic fabric (Cronyn 1990:103-105). On the other hand, gypsum is also a common mineral widely distributed in sedimentary rocks and frequently occurs interstratified with limestone and shale (Legodi and de Waal 2007:141), which can be geologically associated to the sandstone, limestone and shale formations found within Mapungubwe's geology (Chinoda *et al.* 2009:26)

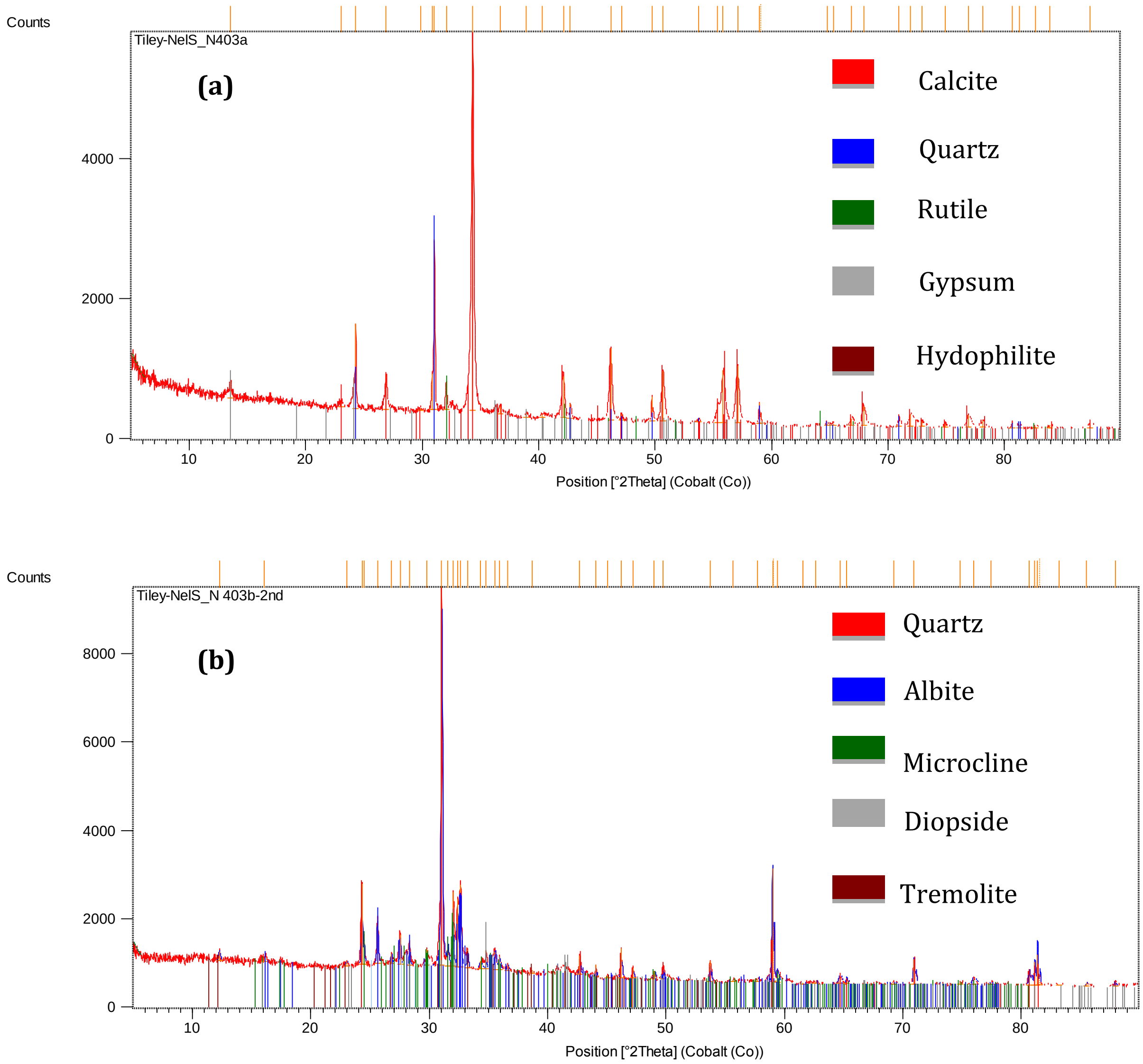


Figure 5.16.4: XRD diffractograms of Mapungubwe vessel 16, indicating the presence of hydophilite (a) and tremolite (b) are unusual peaks not found in other ceramic samples

5.3.3. Vessel 17

Excavation context, typology and morphology

Vessel 17 (#N219) is a Mapungubwe bellied jar (265mm x 360mm) reconstructed in 1934 from sherds excavated from the Grave Area, Excavation No.00 on Mapungubwe Hill (Fouché 1937:37 Plate XX No. 4). According to Meyer (1980:70-72) this form is shouldered (Group 6), bellied with a neck and corresponds with his form no. 06.01 and typologically also fits in with the bellied jars category of Calabrese (2005:88). The vessel form is defined as ellipsoid due to a cylindrical neck atop an ellipsoid body (see Calabrese 2005:88, Figure 4.4), with a narrow restricted orifice (114mm) and a concave base. The vertical narrow neck is long (±95mm) with a broad flat shoulder curving over a wide globular belly (Figure 5.17.1).

The rim diameter is much narrower than the maximum diameter, resulting in a closed or restricted vessel (Gibson and Woods 1990:168). The rim shape cannot be determined because the entire rim and upper portions of the neck are missing and have been 'reconstructed' by Schofield from plaster of Paris. This vessel was located within the main Mapungubwe Grave Area, which has an estimated date range from AD 1250 to AD 1290 (see Vogel 2000:53; Woodborne *et al.* 2009:103).

Figure 5.17.1: Characteristic Mapungubwe ellipsoid closed vessel with a restricted orifice

Technological analysis

This vessel is composed of a medium type fabric with inclusions which range in size from 0.25mm to 1.0mm (Prehistoric Ceramics Research Group 2010). The fabric is composed of very dominant clear glassy white (quartz) inclusions and opaque (calcite/quartzite) white inclusions occurring in >40% abundant frequencies (Figure 5.17.2). Sparse amounts of very small shiny black rounded inclusions (<3%) are also visible in the sandy, dense texture fabric. A dark grey unoxidized core is partially visible with a tan oxidized exterior margin, suggesting incomplete firing conditions. The overall surface colour is 7.5YR 4/3 brown and the exterior surface is a smooth fine texture resulting from burnishing and the application of a secondary finishing on the shoulder. This surface treatment is executed after shaping and smoothing, as decorative motifs are applied after the burnishing process. The shoulder is stylistically executed with four cross-hatch downward triangles and a single diamond motif using the incised technique.

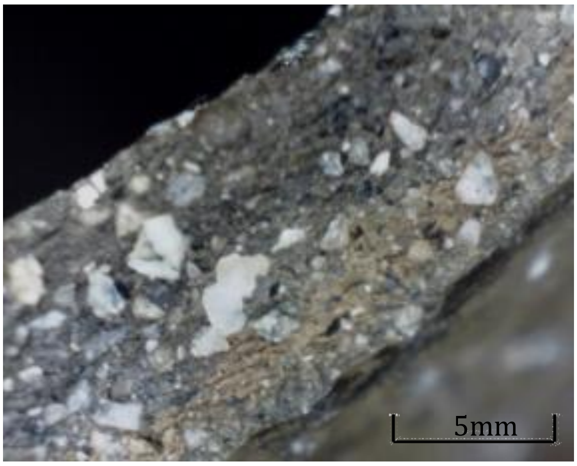


Figure 5.17.2: Abundant frequencies of dominant white inclusions in medium grained fabric of Mapungubwe burial vessel 17

The primary forming method on this complex-shaped vessel is not easily discernible, as the narrow restricted opening limits visible evidence within the interior. The vessel wall is relatively thick therefore, adding strength and distributing its weight. This restriction of the vessel wall aids in retaining the contents and renders the vessel more useful for possible liquid storage (Shepard 1980:228). There is also evidence for extensive use-wear, as pitted surface marks are visible on the concave base. The wide belly and narrow neck appear to be manufactured in two separate sections, since there is a junction at the formation of the body and neck. The concave base also exhibits a possible coil fracture, providing some clues to the vessel's forming and shaping, but this is not conclusive.

Chemical analysis (XRF)

XRF analysis for vessel 17 identifies major elements of potassium (K) and calcium (Ca), with a high concentration of iron (Fe) in particular. The presence of iron intensities can impart the colour of the vessel after oxidation of all the organic matter, and in this case the ceramic's dark colour further confirms firing in partial or incomplete oxidizing conditions (Rice 1987:333-334). Low concentrations of Ti, Mn, Zn, Zr and Sr were also identified, except for Th. (see Table 5.17).

Element	ppm	Error±
K	20498	259.59
Ca	30861.2	218
Ti	5264.35	87.45
Mn	497.56	42.88
Fe	37612.6	227.06
Zn	114.08	8.66
Zr	174.47	5.1
Sr	228.46	4.22
Rb	35.24	2.32
Th	0	0
Cu	42.99	9.98
Ni	71.05	19.24
Cr	112.54	22.22
V	74.74	27.41

Table 5.17: XRF elemental quantification signature for vessel 17

5.3.4. Vessel 18

Excavation context, typology and morphology

Vessel 21 (#N220) is a shallow bowl (47mm x 250mm) excavated in 1934 from Grave 11 (A627) skeleton no. M_6 found within the Mapungubwe Hill Grave Area. Typologically this vessel corresponds with both Meyer's (1980:75) type no. 12.01 and Calabrese's (2005:93) category of shallow bowl forms. The bowl is elaborately decorated and its shape is defined as ellipsoid with an unrestricted orifice (214mm), a flat base, and an outward sloping rim (Figure 5.18.1). According to Schofield (1937:37), shallow bowl forms probably served as both dishes and bowl covers, as most examples are decorated on the base and are further associated to Mapungubwe Hill burials in particular (Gardner 1963:65). This particular shallow bowl form is characteristic of Mapungubwe type vessels as they are exclusively found in the upper layer deposits (Phase 4, AD 1250 – AD 1290) of Mapungubwe Hill. The vessel is associated to fragments of a wooden vessel, iron ornaments, as well as fragmentary 'charred' human remains found at bedrock (Fouché 1937:149).

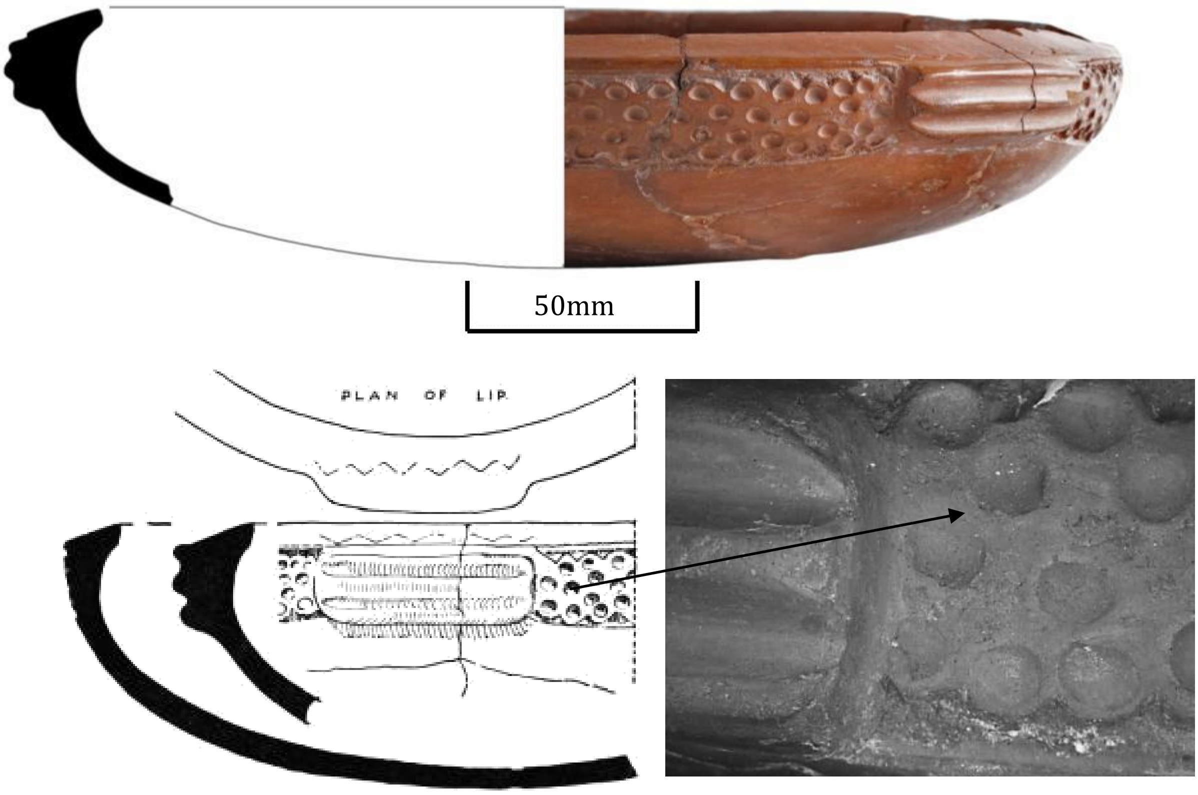


Figure 5.18.1: Vessel 18 shallow bowl from Grave 11 (M_6) with red fabric and red surface colour with decorative motif detail (Fouché 1937:74 Plate XXII)

Technological analysis

This shallow vessel is characterized by a fine type fabric (Figure 5.18.2) where the size of inclusions is generally small, ranging from 0.1mm to 0.25mm (Prehistoric Ceramics Research Group 2010). Both light and dark inclusions occur in abundant quantities (<40%). Very small fragments of dull black grains as well as grey, opaque white and clusters of glassy white grains and reflective micaceous specks are visible. The surface colour is a red or terracotta colour (2.5YR 5/6) and an exposed fracture reveals the same fabric colour with a uniform red, cross-section of a fully oxidized core indicative of firing conditions (see Figure 5.18.2). This distinct red colour imparted by the clay can also be attributed to the concentrations of iron/hematite, which has fully oxidized (Rice 1987:335). According to Legodi and de Waal (2007:139), hematite is also considered one of the most intense colouring materials and only 1% to 1.5% of hematite is required to impart a red fabric colour. The presence of the compound hematite is confirmed by the XRD results (see Figure 5.18.3).

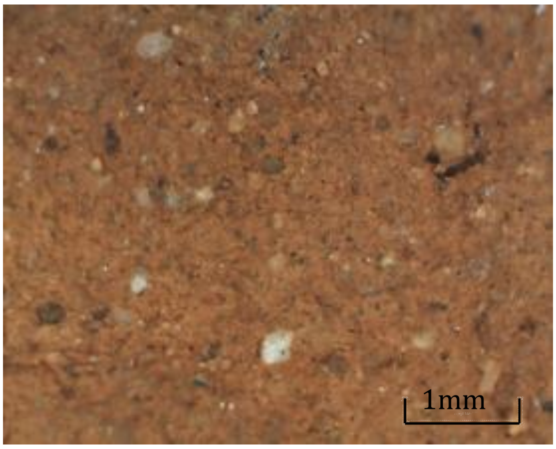


Figure 5.18.2: Vessel 18 Mapungubwe shallow bowl with light and dark coloured inclusions of a small size range between 0.1mm to 0.25mm to define a fine type fabric

This shallow bowl was finished with several secondary form variations, a fine surface finish and elaborate decorative techniques with ridged flanges, punctates and incisions. Three types of decorative treatment are visible: surface penetration, i.e. fine zigzag incisions into the clay on the lip, the appliqué of clay (either decorative or functional) onto the ceramic surface on the body, i.e. broad horizontal flanges, as well as circular stylus impressions within a decorative band on the upper body near the rim (see Figure 5.18.1.).

The base and walls are relatively thin, ±6mm and the clay walls thicken (±12mm) towards the bevelled and squared rim. The flat sloping area inside the rim of the vessel has been used as a decoration platform for a single line zigzag incision (see Figure 5.18.1 above for plan of lip). The burnishing process has compacted the surface, smooth and short horizontal burnishing facets are visible on the exterior. The entire vessel has been thoroughly burnished to such an extent that the forming technique of the shallow bowl is not discernible, and other surface detail may have been obliterated from the scraping, wiping and smoothing process.

Chemical analysis (XRF)

XRF analysis for vessel 18 identifies major elements of potassium (K), calcium (Ca) and iron (Fe) in the clay (Table 5.18). The presence of titanium as a major element can also be a common impurity that occasionally influences the colour of the clay (Shepard 1980:19), and it is also a commonly recognized temper (Padilla *et al.* 2006:285). In addition, conditions leading to titanium absorption onto the clay particles are also rather specific and can be linked to low-grade metamorphic rocks (Bishop *et al.* 1982:294). The iron-rich content in this vessel is also noted as the possible chief colorant of the fired clay (Shepard 1980:18) and is clearly visible as a terracotta-red or red of both the vessels surface and uniform red fabric (2.5YR 5/6).

Major traces identified (see Table 5.18) include potassium and calcium which can be geologically linked to potassium feldspar (Riederer 2004:147) that occurs in the high-grade metamorphic rocks typical of the Limpopo Belt (Chinoda *et al.* 2009:24).

Element	ppm	Error±
K	34269.17	330.35
Ca	19824.32	182.36
Ti	7292.67	91.76
Mn	674.05	45.78
Fe	34395.46	212.86
Zn	94.49	7.95
Zr	409.53	6.86
Sr	286.40	4.61
Rb	97.33	3.39
Th	12.12	3.69
Cu	59.19	10.13
Ni	58.51	18.45
Cr	136.82	22.57
V	82.97	27.39

Table 5.18: XRF elemental quantification signature for vessel 18

Mineralogical analysis (XRD)

The analysis of this vessel was determined by X-ray diffraction (XRD). The main identified minerals phases are quartz, hematite, albite, kaolinite and microcline (see Figure 5.18.3). This is the only ceramic in this study in which kaolinite was identified. Kaolinite is a common clay mineral with a usually high alumina content, but low iron content, and is also resistant to the absorption of impurities. Kaolinite is also considered relatively refractory and can attain a natural high lustre without the need of burnishing (Rice 1987:47).

The presence of kaolin clay mineral in this vessel also suggests that the firing temperature was not high enough (i.e. <800°C) to effect complete dissolution of this clay mineral (Legodi and de Waal 2007:139). The presence of microcline and albite are both known as alkali feldspar which is rich in potassium (Rice 1987:96). The presence of this element is also confirmed by the XRF results (see Table 5.18)

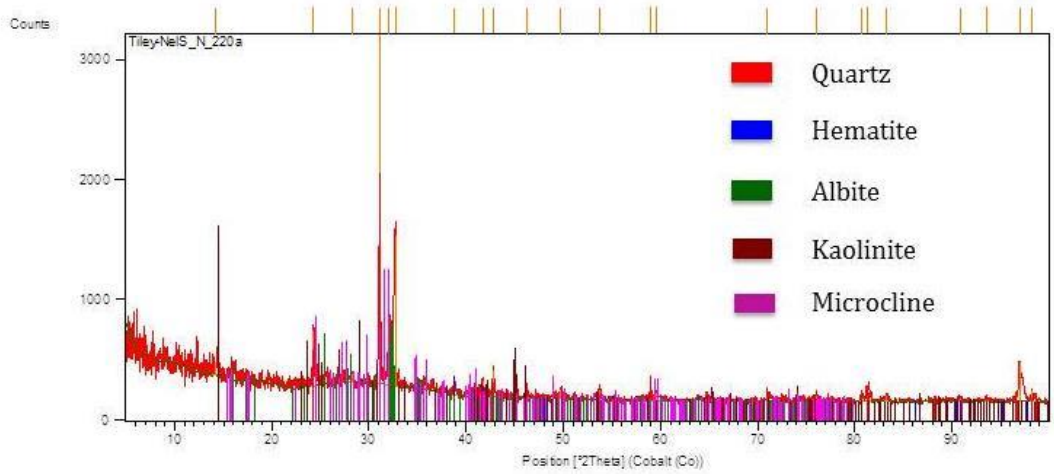


Figure 5.18.3: XRD diffractogram of vessel 18 of red shallow Mapungubwe bowl with kaolinite associated to granitic rocks high in feldspar and quartz

5.3.5. Vessel 19

Excavation context, typology and morphology

Vessel 19 (#N221) is a Mapungubwe shallow bowl recovered in 1933 from excavation No.00 of the main Grave Area on Mapungubwe Hill (Fouché 1937:74). Typologically similar to vessel 18, this form corresponds with Meyer's (1980:67-68) shallow bowl variations form no. 09.01 and also links to Calabrese's (2005:93) very shallow bowl or plate category. The vessel (66mm x 225mm) is defined as ellipsoid in shape with an unrestricted orifice (184mm), with a slightly everted round rim (5mm) and a convex base. The vessel is characterized by elaborate stylistic decorative motifs on a black clay body and a glossy burnish (see Figure 5.19.1.). According to Gardner (1959:35) shallow bowl forms (some highly decorated and burnished black, others undecorated) only appear in the upper later deposits (Phase 4, AD 1250 –AD 1290). Such distinct forms of shallow bowls and ones of high quality finish were not found at K2 (Fagan 1964:354) and they can also be associated to two distinct types of trade glass beads; black oblates and red oblates (Gardner 1959).

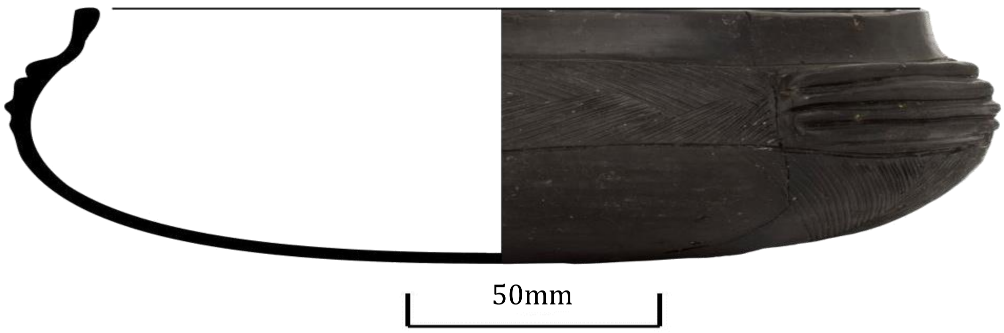


Figure 5.19.1: Vessel 19, Mapungubwe type black shallow bowl with distinct black burnish

Technological analysis

This shallow vessel is characterized by a fine type fabric with very few visible inclusions, ranging in size from 0.1mm to 0.25mm, and very small fragments of glassy white inclusions, which occur in rare quantities (<3%). Micaceous reflective specks are also present as glistening flakes within the ceramic fabric. The fabric appears dense, smooth and non-porous with a fine texture, and there are few visible voids. The overall surface colour on the interior and exterior is black 10YR 2/1) and an exposed fracture reveals an unoxidized black cross-section fabric core suggesting reduced firing conditions (Figure 5.19.2). The uniformly black core may indicate deliberate restriction of air or an absence of organics, while the presence of organics also leads to black throughout (Rice 1987:115). Whilst the organic compounds within the clay can impart a black colour, the major concentration of iron could suggest the presence of other oxides such as magnetite, which could also contribute to the black colour of the vessel (Shepard 1980:37).

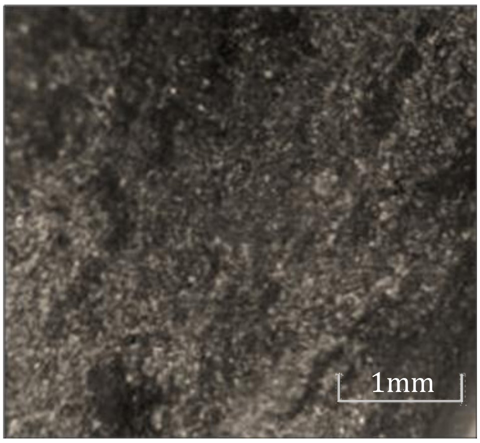


Figure 5.19.2: Vessel 19 shallow bowl with fine fabric and uniformly unoxidized black core

The surface on the interior as well as the exterior is extremely smooth, with a matt surface finish from extensive burnishing. This process has compacted and aligned the surface particles to produce a glossy lustre as short horizontal burnishing facets are visible all over the vessel's surface (Rice 1987:473). The surface has been overall well-finished, not only by the burnishing technique but also with added secondary form variations, almost modifying the shape, with elaborate decorative techniques and appliqué that have been executed for decorative purposes (Rice 1987:144). Three ridged-shaped flanges (68.07mm in length) have been moulded from separate pieces of clay and added to the sides of the vessel's upper body. These may have served ornamental or functional purposes as handles. Below, the appliqué flanges are three large incised triangles that decorate the base as well as, an incised chevron motif band near the upper rim (see Figure 5.19.3). The incised technique is grooved with an instrument that has a broad, round or pointed tip, creating generally broad shallow lines (Shepard 1980:199).

Scraping was probably performed to obtain its shape and relatively thin walls, followed by the wiping, smoothing and final burnishing process. The forming method of this vessel is not evident as all traces of shaping have been obliterated by secondary processes.

Figure 5.19.3: Black burnished shallow bowl form with elaborate decorative motifs (left to right): decorated base with incised triangles, ridged flanges and deep incisions

Chemical analysis (XRF)

Elemental analysis of vessel 18 identifies major elements of potassium (K) and calcium (Ca) with high concentrations of iron (Fe) and manganese (Mn) in particular. Minor trace elements identified include Ti, Zr and Sr, and trace constituents of Zn, Rb, Th, Cu, Ni, Cr and V, which occurred in very low concentrations (see Table 5.19). Whilst the organic compounds, depending on amount and oxidizing conditions, generally present within the clay can impart its black colour, the major concentration of iron could also suggest the presence of other oxides, such as hematite or magnetite that may also contribute to the black colour (Shepard 1980:37). This vessel has the highest proportion of magnesium in comparison to all vessels within this study (see Appendix 5 for summary data of total XRF).

Element	ppm	Error±
K	20150.31	245.53
Ca	15240.48	150.76
Ti	6030.13	80.5
Mn	965.02	56.6
Fe	35745.84	235.78
Zn	80.75	8.29
Zr	427.97	7.74
Sr	382.42	5.76
Rb	83.52	3.51
Th	11.83	4.01
Cu	65.55	11.56
Ni	35.07	20.26
Cr	110.29	19.87
V	76.35	24.19

Table 5.19: XRF elemental quantification signature for vessel 19

5.3.6. Vessel 20

Excavation context, typology and morphology

Vessel 20 (#N266) is a pedestal, undecorated shallow bowl (reconstructed from twelve sherds) excavated in 1937 from Mapungubwe Hill, block 1, section 4, 10' inches (25.4cm) from the extreme left of the section, 41' inches (104.14cm) across the section from left to right and at a depth of 4' inches (10.16cm) from the surface. Typologically, this vessel is a variation of Mapungubwe's characteristic classical shallow bowl forms. The shape corresponds to Calabrese's (2005:93) category of plates and Meyer's (1980:67-68) shallow bowl or dishware Group 4. The vessel form is distinguished as an ellipsoid shape with an unrestricted orifice of 295mm, and is larger in size (86mm x 323mm) than the average Mapungubwe shallow bowl. On the other hand, according to Calabrese (2005:93), such dishware in comparison to other shallow bowls is usually substantially smaller with a diameter of around 20cm. The vessel wall is relatively thick, ±12mm, with a squared broad rim shape that is bevelled, and a round base, which rests on two elongated, horizontally raised pedestal feet or cordons[2] (80mm x 3.5mm) (see Figure 5.20.1). This rather unusual vessel, or a 'large flat dish' according to Gardner (1963:137), is associated to two other ceramic vessels, ostrich eggshell beads and a copper ring.

[2] A cordon is a lump of clay either raised from or applied to the body of the vessel. In the case of this vessel the appropriate archaeological term would be a 'horizontal cordon' or raised pedestal feet (Gibson and Woods 1990:129).

The vessel is associated to the later occupation period, Phase 4 of Mapungubwe Hill (AD 1250 – AD 1290) as such shallow bowl types are only linked to the upper layer deposits on the summit (Gardner 1959:35-37).

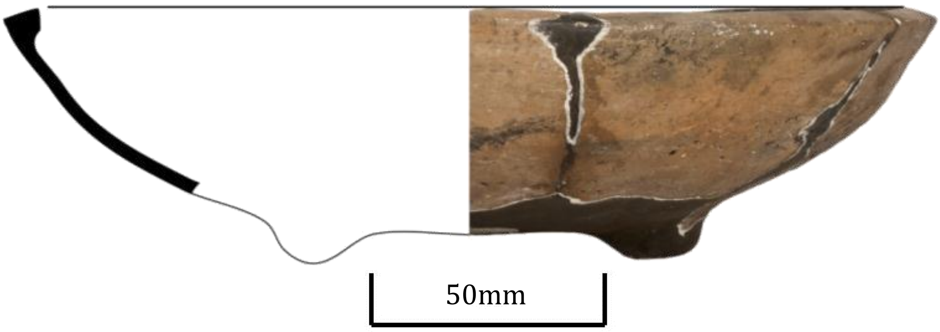


Figure 5.20.1: Vessel 20 uncommon shallow bowl-type from Mapungubwe with raised cordons

Technological analysis

The vessel is characterized by a coarse fabric type with shiny and dull black (possibly black iron ore) inclusions ranging in size from >1.00mm to 3.00mm and occurring in abundant quantities (>40%). The fabric is also composed of smaller grey and brown inclusions with sparse amounts of clear glassy and opaque white inclusions. There are also very small reflective white inclusions which look like shell fragments and reflective specks are visible on an exposed abraded surface area on the base. Large dominant >2mm black inclusions are clearly visible (see Figure 5.20.2) within the fabric and project from the clay surface, particularly on the base, causing cracks and exfoliated surface areas. The inclusions are clearly composed of several types of minerals and various colour sediments and rock grains which are visible, but difficult to identify. The granular surface appearance is very porous and irregular with common voids. The exterior surface colour is reddish brown (5YR 4/3) with a patchy blackened central interior as a result of the firing process, but there is no existing fracture, so a carbon core is not visible. The vessel has a matt surface finish, the interior has been smoothed down but the exterior remains very coarse with bumps, and also shows traces of sand and impressions of dry clay and dust. The bowl appears to be formed from a lump of clay, not coiled, as there are indications of hand forming and finger impressions resulting in a rough, undulated surface. The bevelled rim is uneven, indentations cover the surface and finger marks are visible on the base as a result of the smoothing and scraping the clay with fingers to form and shape the vessel. The horizontal pedestal feet, or cordons (Gibson and Woods 1990:129), are modelled in low relief from two separate lumps of clay and were applied to the base after the initial forming of the bowl. Cracks have developed around the pedestal and base, resulting in a vessel which tips from side to side, uneven and with no stability.

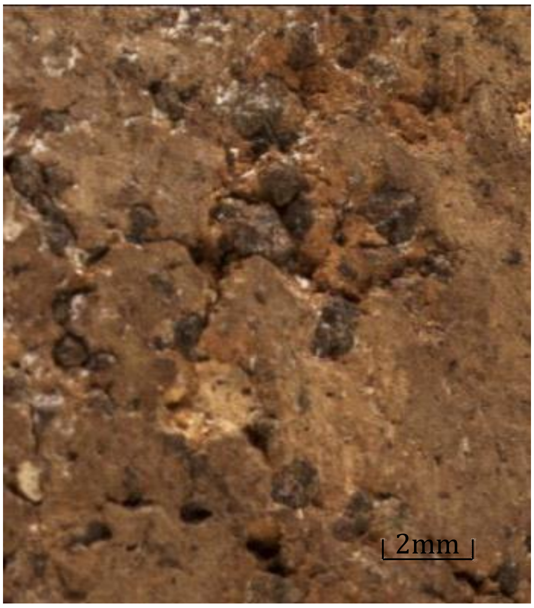


Figure 5.20.2: Large black grained >2mm inclusions visible within ceramic fabric of vessel 20

Chemical analysis (XRF)

XRF analysis of vessel 20 identifies three major elements: potassium (K), iron (Fe) and calcium (Ca). Minor trace elements of titanium (Ti) and manganese (Mn) are also identified and determinations of trace elements of Zn, Zr, Sr, Rb, Ni, Cr and V are present in very low concentrations with the exception of no traces of thorium (Th) (see Table 5.20).

Element	**ppm**	**Error±**
K	37325.55	359.12
Ca	61546.57	318.59
Ti	6005.93	86.01
Mn	837.06	53.57
Fe	44144.08	254.88
Zn	83.61	8.37
Zr	367.6	7.06
Sr	345.34	5.34
Rb	75.09	3.25
Th	0	0
Cu	104.38	12.3
Ni	148.65	22.4
Cr	164.42	23.15
V	76.53	25.62

Table 5.20: XRF elemental quantification signature for vessel 20

5.3.7. Vessel 21

Excavation context, typology and morphology

Vessel 21 (#N484) is a Mapungubwe deep bowl (117mm x 197mm) excavated in 1939 from Mapungubwe Hill, block 5, section 4, 15 inches (38.1cm) from the extreme left of the section, 4 inches (10.16cm) across the section from left to right and at a depth of 8 inches (20.32cm) from the surface. According to Meyer (1980:64) this vessel, Type 10, form no. 02.04, falls within his Group 2 of spherical neckless vessels. Typologically it also corresponds with Calabrese's (2005:93) category of simple deep bowl forms, and can possibly even be considered hemispherical. The vessel shape is defined as spherical with a restricted orifice (153mm), round rim and a round base (see Figure 5.21.1). A large rim and body sherd portion is also missing from this partially reconstructed vessel. The vessel is associated to the later occupation period Phase 4 of Mapungubwe Hill (AD 1250 –AD 1290).

Figure 5.21.1: Mapungubwe deep bowl type with profile, black fire cloud and smoothed interior

Technological analysis

The vessel is characterized by a medium type fabric (size range of 0.25mm to 1.0mm) with small fragments of light and dark coloured inclusions in sparse (<3-10%) quantities with clear glassy grains and white glass grains (see Figure 5.21.2). There are also rare amounts (<3%) of very small black shiny inclusions, as well as reflective micaceous specks that are also visible. The ceramic fabric has a smooth texture with a dense non-porous appearance resulting in a matt surface with a very smooth burnished finish on the exterior and interior. The overall surface colour is a rich reddish brown (5YR 4/3) with a faint unoxidized grey core and oxidized inner and outer margins indicating incomplete firing conditions (Figure 5.21.2). The base shows minimal signs of wear and has a distinct black (10YR 2/1) fire cloud (see Figure 5.21.1) on the exterior due to the deposition of carbon base during the firing process or when the base was in direct contact with the smoky part of the flame (Gibson and Woods 1990:151).

Finishing of this vessel includes a smoothing surface treatment, thereby compacting the surface considerably, with some horizontal burnishing marks visible. The incised technique has been employed with fine-line precision, using a sharp implement to decorate a single incised band on the upper body near the rim. The rim of the vessel also shows use-wear. It is abraded and pitted, suggesting the vessel might have been inverted or stored upside down. The forming method cannot be determined as all traces of forming have been obliterated from the scraping, wiping, smoothing and burnishing process.

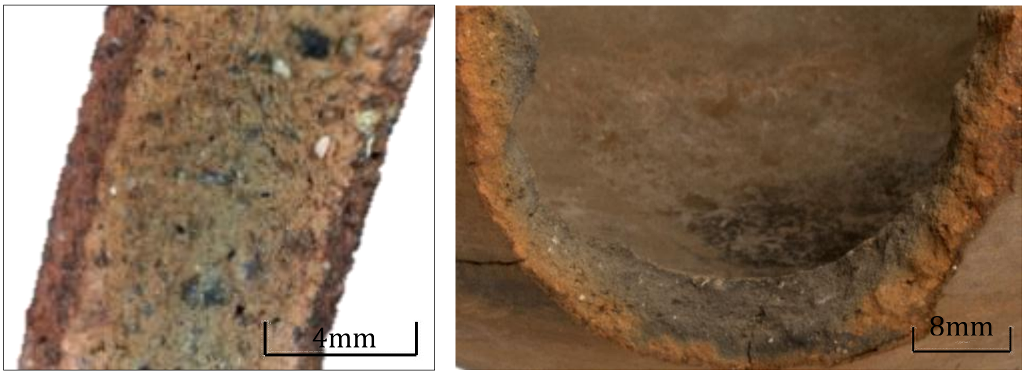


Figure 5.21.2 Characteristic black core of the fabric indicates a brief firing time to allow for burning of carbonaceous matter in the clay, inferring incomplete firing conditions

Chemical analysis (XRF)

XRF analysis of vessel 21 indicates a low content of titanium (Ti), manganese (Mn), zinc (Zn), zirconium (Zr) and strontium (SR), and identifies major concentrations of elements centred on iron (Fe), potassium (K) and calcium (Ca) (see Table 5.21). Trace constituents of Zn, Zr, Sr, Rb, Th, Cu, Cr and V are also identified (with the exception of Ni). The presence of the compound iron oxide probably imparts the red exterior surface colour characteristic of this vessel (Shepard 1980:24), and the elevated levels of calcium could suggest calcium-rich clay or a calcareous temper.

Element	ppm	Error±
K	16118.04	213.54
Ca	49954.37	249.83
Ti	3009.74	54.17
Mn	472.42	47.96
Fe	28491.41	232.06
Zn	52.66	8.15
Zr	373.18	7.94
Sr	282.35	5.48
Rb	84.29	3.81
Th	14.69	4.38
Cu	63.04	13.18
Ni	0	0
Cr	47.09	15.1
V	54.67	16.41

Table 5.21: XRF elemental quantification signature for vessel 21

5.3.8. Vessel 22

Excavation context, typology and morphology

Vessel 22 (#N224) is a Mapungubwe incurvate bowl (97mm x 202mm) excavated in 1934 from trench JS2 (b) from the occupation area at the base of the western ascent of Mapungubwe Hill (Fouché 1937:15-16). The base or Southern Terrace is marked by both residential deposits of commoners as well as the elite who lived on terraces around the hill and JS2 (b) in particular, which is considered by Huffman (2009:44) to be the official court area. Typologically this is a variation of the shallow bowl forms, Type 3 form no. 07.01 (Meyer 1980) but has no direct association with Calabrese's (2005) categories. This ellipsoid form is restricted with a short neck, projecting out from a globular body at an angle with a pronounced shoulder, rounded rim and a round base. The opening diameter is 105mm and is restricted (see Figure 5.22.1). Unfortunately, the vessel has been badly reconstructed from six sherds by Schofield in the 1930s, where excessive plaster of Paris was poured into the base, thus severely damaging the vessel and obscuring many surface attributes.

The bowl is also associated to hut foundations and walling features and dates within either Meyer's (1980) main occupation period Phase 3 or even the later occupation period of Phase 4 (AD 1250 –AD 1250). According to Van der Walt's study (2012:50) the area JS 2(b) contains ceramics from five ceramic facies, of which Transitional K2 ceramics dominate the sequence.

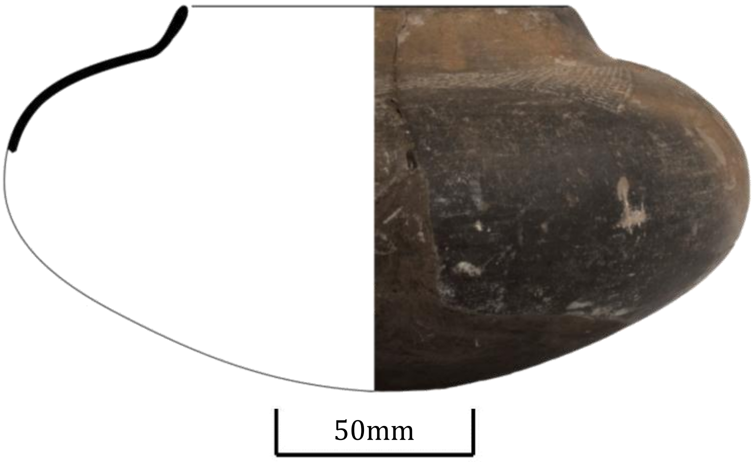


Figure 5.22.1: Vessel 22 characteristic Mapungubwe type hemispherical or incurvate bowl

Technological analysis

The vessel is characterized by a medium type fabric (size range of 0.25mm to 1.0mm) with abundant >50% clear glassy and translucent light-grey inclusions, probably quartz grains (see Figure 5.22.2). There are also very small fragments of black, round inclusions in moderate amounts (10-15%) with reflective micaceous specks also present. Some of the snowy white flecks within the fabric are ingrained remnants of plaster which has migrated into the vessel pores. The ceramic fabric is composed of a sandy texture with a dense non-porous appearance and a matt exterior surface which exhibits minor black patches and is overall a dark-brown colour (7.5YR 3/2). Since the surface colour varies from brown to black on the exterior, this is possibly an indication of use for cooking or a result of the firing conditions. The central core is a sandy colour indicating partial oxidation or irregular firing conditions. The exterior and interior surface show extensive damage and deterioration, yet is smooth from low burnishing as horizontal marks are visible on the surface. There is also localized use-wear on the rim, indicating that the vessel could have been inverted during use, but could also be the post depositional result of a badly eroded surface. There is no indication of the forming method on this ceramic because of the severe level of deterioration. The vessel is finely decorated on the angled upper shoulder with nine inverted cross-hatch triangle motifs. The incised lines are clean, cut partially into wet clay as there is a raised margin from some minor displacement of clay along the lines (Rice 1987:146).

Figure 5.22.2: Distinct quartz grain (±0.84mm) within medium fabric type of vessel 22

Chemical analysis (XRF)

XRF analysis for vessel 22 identifies the major element concentrations identified as potassium (K), iron (Fe) titanium (Ti) manganese (Mn) and zirconium (Zr) with low levels of Zr, Sr, Rb, Th, Cu, Ni, Cr and V (Table 5.22), indicating the composite nature of raw clay components. The major concentrations of calcium (Ca) may be attributed to contamination of the ceramic fabric by the plaster of Paris (calcium sulphate) which is widely used as a filling material for archaeological ceramics, and is generally considered a common source of ceramic contamination (Buys and Oakley 1993: 67).

Element	ppm	Error±
K	40916.45	352.24
Ca	71310.62	322.64
Ti	3596.11	74.17
Mn	458.59	37.5
Fe	23134.34	168.77
Zn	95.4	7.49
Zr	284.23	5.66
Sr	214.7	3.88
Rb	69.03	2.8
Th	5.95	3.08
Cu	44.84	9.24
Ni	48.11	17.34
Cr	125.05	20.15
V	35.99	23.44

Table 5.22: XRF elemental quantification signature for vessel 22

5.3.9. Vessel 23

Excavation context, typology and morphology

Vessel 23 (#C428) is a undecorated incurvate bowl (67mm x 124mm) recovered in 1934 from a pot burial (KS no. 5 or KS no. 24) from the Grave Area on the summit of Mapungubwe Hill (see Fouché 1937:17 Plate IX No.1). The vessel's direct context cannot be confirmed as an identical vessel can also be distinguished within the same grave area (see Figure 5.23.1). According to Meyer (1980:74-75) this is sub-spherical bowl Type 10, form no.03.01 and links with Calabrese's (2005:96) category of incurvate bowls, which are simple, spherical vessels with constricted orifice. This shape is distinguished as more ellipsoid than spherical with a partially flat base, narrow restricted orifice 63mm. The rim is round, with a highly incurvate profile (see Figure 5.23.2).

Figure 5.23.1: Incurvate bowls *in situ* associated to Mapungubwe Hill burial (Fouché 1937:17)

Figure 5.23.2: Vessel 23, common example of Mapungubwe incurvate ellipsoid-shaped vessel

Technological analysis

This undecorated vessel is composed of a medium type fabric based on visible surface inclusions partially exposed on an abraded rim area (see Figure 15.23.3.). The inclusions occur in common frequencies (<26-40%), and are predominantly shiny black and white glassy inclusions, with a medium size range of 0.25mm to 1.0mm (Prehistoric Ceramics Research Group 2010). Based on tactile examination, the exposed fabric has a granular texture, but the amount or size range of inclusions is considered to be small as the exterior surface appears smooth to the touch.

The surface is also matt with a very dark greyish-brown colour (10YR 3/2) on the exterior and minor black patches probably the results of the effects of firing conditions. A carbon core is not visible as there is no existing body fracture and therefore the forming technique cannot be determined. In addition, most surface evidence has been obliterated from the smoothing and wiping process. There is also a single finger impression on the surface from the wiping process. This method is further characterized by the roughening of the exterior surface by wiping the clay with a course material (Gibson and Woods 1990:275), which has also caused pitting and an abraded surface.

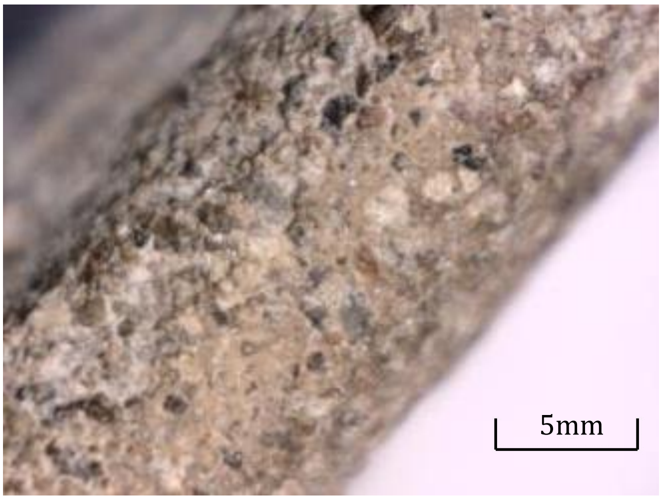


Figure 5.23.3: Example of medium fabric type with grained texture and common inclusions visible on the rim surface

Chemical analysis (XRF)

XRF analysis of vessel 23 identified major concentrations of calcium (Ca), iron (Fe), and potassium (K) with minor elements present of Ti, Mn, Zn, Zr and Sr, including trace constituents of Rb, Th, Cu, Ni, Cr and V (Table 5.23). This data identifies principal chemical components (i.e. major elements in high concentrations of calcium and iron) typical of the composite nature of natural clay and temper (Rice 1987:390) providing the chemical signature for this vessel.

Element	ppm	Error±
K	18221.75	230.9
Ca	48025.29	252.01
Ti	2758.45	60.92
Mn	195.94	31.29
Fe	21460.02	170.31
Zn	25.22.	5.58
Zr	277.6	5.95
Sr	246.44	4.34
Rb	42.73	2.43
Th	7.07	3.21
Cu	41.24	9.75
Ni	32.71	17.99
Cr	36.3	17.05
V	38.09	19.29

Table 5.23: XRF elemental quantification signature for vessel 23

5.3.10. Vessel 24

Excavation context, typology and morphology

Vessel 24 (#C427) is an undecorated Mapungubwe incurvate bowl (69mm x 120mm) recovered in 1934 from Mapungubwe Hill or possibly from trench JS 5 (see Fouché 1937:91 Plate XXX No. 7). Although its direct context cannot be ascertained, this vessel provides valuable data on undecorated, simple contour Mapungubwe vessels of a closed form (Shepard 1980:234). The restricted orifice (75mm) has a rounded rim, which is folded and curved inwards (see Figure 5.24.1). The wall is relatively thick thereby adding some strength to the vessel's overall form. Whilst such spherical forms are considered common (Schofield 1937:39), they are also typologically grouped as incurvate bowls by Calabrese (2005:96-97) and as sub-spherical bowls by Meyer (1980:275-276) Type 10, form nos. 03.01/03.05.

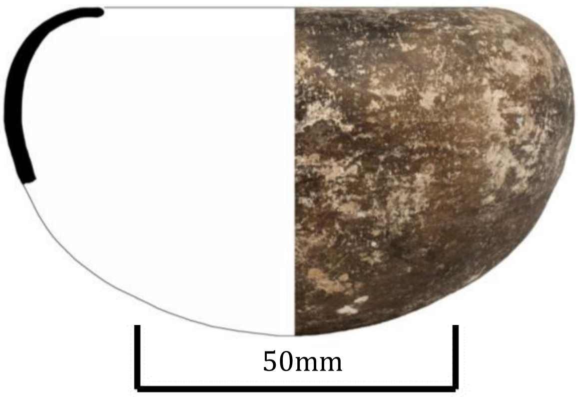


Figure 5.24.1: Vessel 24 Mapungubwe incurvate bowl with simple contours and closed form

Technological analysis

This vessel is characterized by a medium type fabric with both light and dark coloured inclusions occurring in moderate quantities (>11-25%), ranging in size from 0.25m to 1.0mm (Figure 5.24.2.). The inclusions are predominantly clear white glassy and opaque white inclusions with sparse grey as well as shiny black and dull black angular inclusions. Clear or whitish grains, possibly quartz (or natural inclusions) within the clay fabric are clearly visible on an exposed area of the rim suggesting a granular texture of the ceramic fabric (Shepard 1980:117-118). The overall surface colour is very dark greyish-brown (10YR 3/2) to very dark grey/black, but there is no direct evidence to suggest firing conditions.

The vessel appears to be formed with a hand pinching technique, resulting in a round-based, unrestricted shape as indentations left by the potter's hands are visible on the exterior body surface and interior walls (Gibson and Woods 1990:220). As a result, the surface is uneven with a matt finish, and horizontal wiping marks are evident on the exterior body. There are also traces of smoothing the interior walls by scraping with a sharp implement, as drag marks are noticeable just below the overlap of the rim.

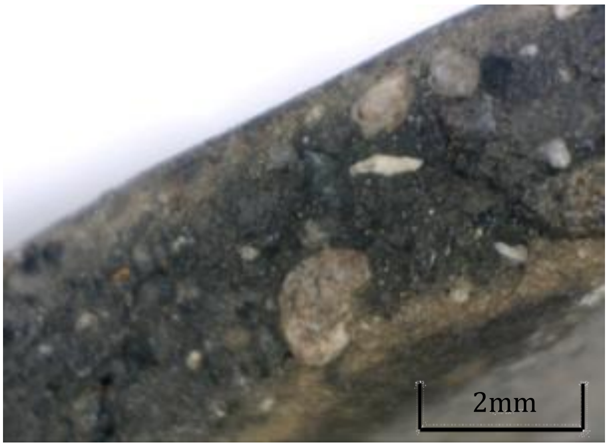


Figure 5.24.2 Quartz inclusions clearly visible within the medium type fabric of vessel 24

Chemical analysis (XRF)

XRF analysis on vessel 24 identifies major trace elements such as calcium (Ca) and iron (Fe). Other mineral data identified include potassium (K) and minor traces elements of Ti, Mn, Zn, Zr, and Sr respectively, as well as trace constituents of Rb, Cu, Ni and V but Th was not determined (see Table 5.24). The presence of iron as an impurity component of various silicates is common as well as the iron oxide as a reactive colouring agent of fired clay (Shepard 1980:18).

Element	ppm	Error±
K	18652.45	259.7
Ca	52850.01	290.46
Ti	6041.71	87.41
Mn	837.24	50.83
Fe	40931.79	236.17
Zn	50.97	6.96
Zr	352.19	6.62
Sr	308.54	4.86
Rb	68.02	2.99
Th	0	0
Cu	76.08	10.84
Ni	72.4	19.45
Cr	105.78	22.64
V	65.96	26.19

Table 5.24: XRF elemental quantification signature for vessel 24

5.3.11. Vessel 25

Excavation context, typology and morphology

Vessel 25 (#N376) is a Mapungubwe undecorated incurvate bowl excavated in 1939 from block 5, section 5, 60' inches (63.5cm) from the extreme left of the section, 1' inch (1.70cm) across the section from left to right and at a depth of 9" inches (12.70cm) from the surface. This vessel corresponds with Calabrese's (2005:96) category of incurvate bowls, "simple, spheroidal with constricted mouths", as well as with Meyer's (1980:64-65) Type 10, form no. 02.01. The vessel is associated to the Phase 4 occupation period of Mapungubwe Hill (AD 1250 –AD 1290). The vessel shape is incurvate (115mm x 137mm) with a restricted orifice (88mm) and an inverted round rim. The vessel has relatively thick walls (±9mm) with two single horizontal perforations (5mm) on either side of the body near the rim (Figure 5.25.1).

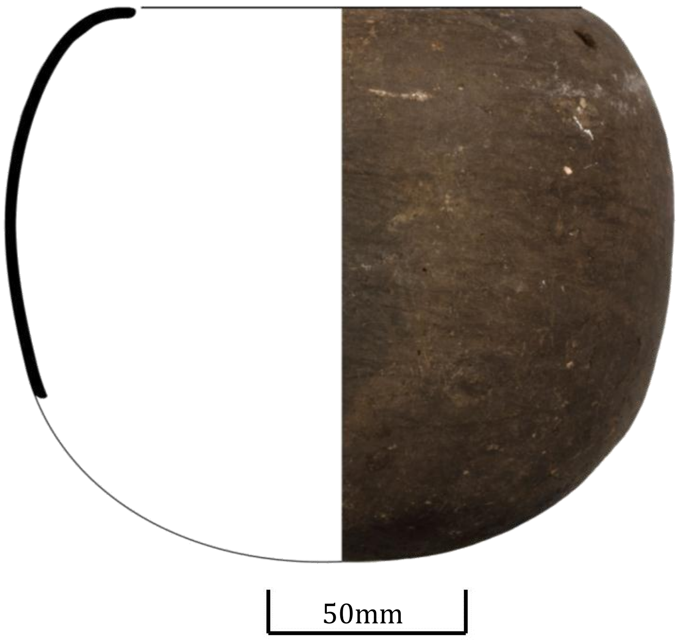


Figure 5.25.1: Example of undecorated incurvate burnished bowl with side rim perforations

Technological analysis

This vessel is characterized by medium type fabric that contains both moderate amounts (>11-25%) of clear glassy (possibly quartz) inclusions and opaque (possibly quartzite) white inclusions ranging in size from <0.25mm to 1.0mm. Dull black and brown/red inclusions are rare (<1%). The fabric has a sandy texture with spaces between the matrix and inclusions. The rim is abraded, exposing the ceramic fabric which exhibits white inclusions (non-diagnostic) on the vessel wall that are clearly visible with the naked eye (see Figure 5.25.2). According to Shoval and Beck (2005:615) the presence of such visible grains or inclusions can relate to ceramic strength and thermal shock resistance that require low firing temperatures and high temper concentrations. The overall exterior surface colour is a very dark brown (7.5YR 3/2) and a faint black margin is visible indicating partial oxidized firing conditions.

Short, linear burnishing streaks are visible around the body and a distinct abrasion mark from use-wear is evident on the bottom part of the vessel. Pronounced scrape marks, secondary smoothing and burnishing on the exterior have obliterated any evidence from primary forming, therefore it cannot be determined what method was used to form the spherical shape. The two single perforations, ±5.25mm (on either side of the vessel body) have been formed by pushing a round sharp implement through the vessel wall from the outside. The interior of the perforations show signs of use-wear, which may indicate that the vessel could have been suspended. The vessel surface is undecorated.

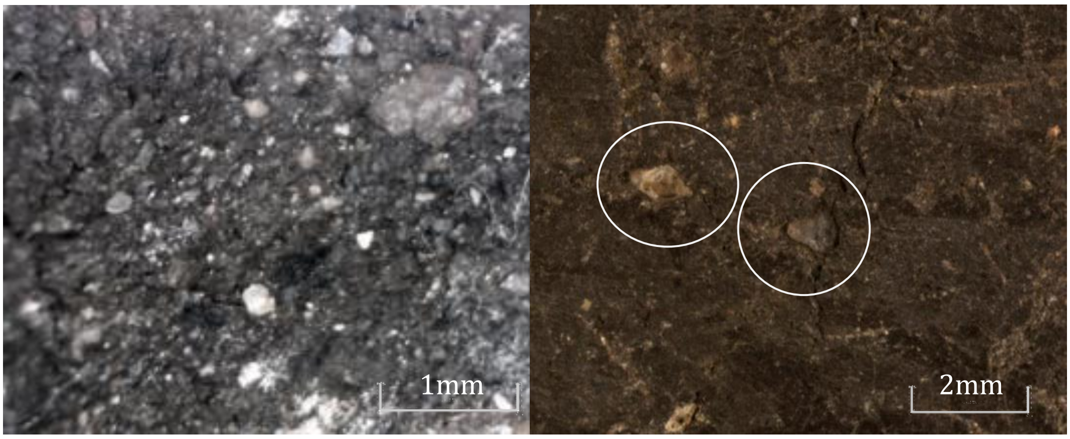


Figure 5.25.2: Vessel 25 with non-diagnostic grain inclusions exposed in fabric

Chemical analysis (XRF)

XRF analysis for vessel 25 identifies, major concentrations of potassium (K), calcium (Ca), and particularly iron (Fe), and also identifies a low range of minor traces of titanium (Ti), manganese (Mn), zirconium (Zr) and strontium (Sr) (Table 5.25). This vessel consists of clay content high in potassium, calcium and iron with the presence of visible particles or inclusions (non-diagnostic) which may have been deliberately or naturally present in the clay source as impurity elements.

Element	ppm	Error±
K	31529.8	321.66
Ca	18528.72	177.57
Ti	7334.46	92.22
Mn	736.59	51.23
Fe	47439.47	262.05
Zn	48.36	7.26
Zr	396.01	7.1
Sr	282.96	4.81
Rb	54.7	2.84
Th	10.16	3.89
Cu	99.91	11.96
Ni	81.82	20.76
Cr	84.66	22.34
V	110.05	27.58

Table 5.25: XRF elemental quantification signature for vessel 25

5.3.12. Vessel 26

Excavation context, typology and morphology

Vessel 26 (#C2196) is an undecorated miniature pinch pot excavated in 1939 from Mapungubwe Hill block 5, section 2, 25' inches (63.5cm) from the extreme left of the section, 5' inches (12.70cm) across the section from left to right and at a depth of 5" inches (12.70cm) from the surface. Typologically this vessel corresponds with Meyer's (1980:75-76) form no.13.00. The vessel shape is distinguished as ovaloid, with an unrestricted orifice measuring 35mm. The rim is straight and rounded with a flat base. In comparison to common-sized vessels, this is defined as a miniature or a model pot with a diminutive size of 49mm x 47mm (see Figure 5.26.1).

The walls are relatively thick, adding considerable weight and strength to the vessel's small form. The vessel is associated to the later occupation period of Mapungubwe Hill (AD 1250 – AD 1290). However, according to Calabrese (2005:96), these miniature vessels present typological problems as few are decorated, but must be significant as they are found in large numbers and have been interpreted as medicine bowls, or as practice or toy vessels made by children. Similar vessels in the assemblage have adult fingerprints in the clay and confirm that interpretations about these miniature vessels were made by children are therefore incorrect.

Figure 5.26.1: Vessel 26 hand-modelled or miniature pot formed by using the pinch technique

Technological analysis

This small vessel appears to be composed of a fine type fabric however, there are no existing fractures so identification is based on the very few inclusions visible on the exposed surface. Overall the fabric appears very dense, with very small white glassy inclusions ranging in size from 0.1mm to 0.25mm (Figure 5.26.2.). There are reflective micaceous specks also visible with small closely-spaced irregularities and few sporadic voids. The vessel is undecorated and has a matt surface finish with a very dark grey colour (7.5YR 3/1) on the exterior and interior surface.

This vessel has been modelled by direct shaping (Shepard 1980:55), i.e. by forming a depression into a small ball of clay. This method is then followed by a drawing technique using the fingers to raise the walls of the clay. The walls are then made thinner by kneading and spreading the clay between the thumb and the fingers, and then pinching the walls to reduce thickness but increasing the size of the vessel. This is considered a simple pinching technique (see Figure 5.26.3) by manipulating the clay and gradually pinching out the walls to an even thickness into a small, round-based open shape (Gibson and Woods 1990:220). The base is flat which indicates it was modelled between the thumb and middle finger or placed on a flat surface area. The outer surface is uneven and is roughly shaped, showing traces of the clay being spread with finger impressions visible on the base. Post-depositional accretions are thickly encrusted on the interior and sporadically cover and disfigure the exterior surface.

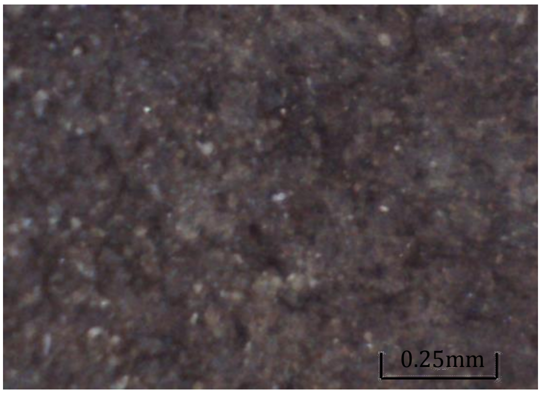


Figure 5.26.2: Dense, non-porous fine type fabric of hand modelled pinch pot

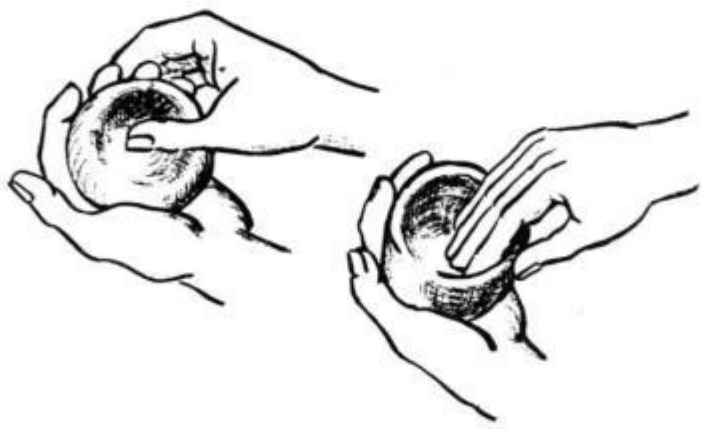


Figure 5.26.3 Illustration to depict the pinch technique by drawing the clay walls into shape (Kenny 1949:1)

Chemical analysis (XRF)

XRF analysis of vessel 26 identifies major concentrations of potassium (K), calcium (Ca) and iron (Fe) with a low content range for titanium (Ti), manganese (Mn), zinc (Zn), zirconium (Zr) and strontium (SR) with trace constituents of Rb, Th, Cu, Cr and V, except Ni (see Table 5.26). A sample of the post-depositional white deposit on the surface of the vessel was also analysed and XRF confirms high intensities of calcium and supports the analysis by Ensio (2009) who identified and characterized calcareous surface deposits on Mapungubwe ceramics.

Element	ppm	Error±
K	27814.09	380.28
Ca	26460.25	313.78
Ti	5112.64	71.05
Mn	544.23	69.83
Fe	34260.85	252.24
Zn	84.52	9.08
Zr	213.36	4.55
Sr	271.14	4.96
Rb	51.87	1.89
Th	17.55	3.93
Cu	65.47	12.78
Ni	0	0
Cr	64.53	24.33
V	394.01	34.03

Table 5.26: XRF elemental quantification signature for vessel 26

CHAPTER 6

The purpose of this chapter is threefold: to summarise the results, discuss the implications and interpret the findings of the technological and compositional analysis provided in Chapter 5. The discussion for this chapter focuses on the *chaîne opératoire* to elucidate ceramic technology since the findings of this study relate to four stages, i.e. fabric, forming, finishing and firing as evidence of the manufacturing sequence of K2, TK2 and Mapungubwe vessels. Lastly, interpretations are provided highlighting the implications of these findings within their wider archaeological context,

6.1. Ceramic fabric results

Three main ceramic fabric types[1] or groups (see Figure 6.1.) have been identified and are based on macroscopic descriptions of clay inclusions and the textural analyses of the clay matrix. The fabric results for each vessel are further summarized below in Table 6.1. The characterizations and descriptions of the fabric types provided below are consistent with the accepted methods and standards of the Prehistoric Ceramics Research Group (2010) as outlined in Chapter 4.

6.1.1. Fine Fabric Type I

The fine fabrics are overall characterized by inclusions that range from 0.01mm to 0.25mm in size (see Chapter 4 for category size range and types, Table 4.3). There are a few visible irregularities, with a dense, non-porous appearance to the clay matrix, and sediments which mostly appear well-sorted. The most dominant visible inclusions are opaque or clear (translucent) glassy white, possibly quartz, quartzite or calcite, a majority of which appear in varying frequencies. These white inclusions are generally well-sorted, round as well as sub-rounded. Generally, the frequency of dark inclusions, which are mostly black, occur in rare quantities of less than 3% and there are few visible voids. Also present in the fine fabric and distinctly noticeable, is the abundance of reflective micaceous specks. The fine fabric group comprises nine samples representing beakers, bowls and jars from K2 and Mapungubwe, but none from Transitional K2. The fine fabrics are predominantly associated with burial contexts (vessels 16, 18, 19 and 23) and K2 beaker forms (vessels 3, 4 and 5), with the exception of two samples (vessels 10 and 26) that come from occupational or residential contexts.

[1] The ceramic fabric types should be considered as only umbrella qualitative groups as they are not internally homogenous in terms of their fabric (e.g. provenance and raw material).

6.1.2. Medium Fabric Type II

The medium fabrics are characterized by inclusions that range from >0.25mm to 1.00mm in size. The result is a sandy clay matrix, a generally common textural type having a distinctive sand-papery feel with larger or widely-spaced gaps and more porosity in appearance than the fine fabrics. This less dense fabric exhibits voids which form ovals or spheres that suggest evidence of previous inclusions or organic matter that may have been leached or burned out during the firing process (Prehistoric Ceramics Research Group 2010:25). The frequency of inclusions in the total fabric is moderate (10%-19%) to common (20%-29%), with the exception of some sparse amounts (3%-9%) generally with poorly sorted sediments that are usually rounded, sub-rounded as well as angular in shape. Overall, the inclusions are slightly larger in size than the fine fabric group, with both light and dark coloured minerals. Predominant clusters of clear glassy and opaque white inclusions (possibly quartz/quartzite or calcite) as well as shiny black and dull black minerals occur, but in lesser densities. In some instances, red-earthy inclusions occur in rare quantities (<3%) and reflective micaceous specks are also present. This fabric is the dominant group, comprising fifteen samples represented by a range of vessel forms from all three sites such as recurved, spherical, incurvate and spouted jars to bowl shapes. The medium fabric vessels are associated with diverse contexts including occupational areas (vessels 1, 9, 11, 12, 21 and 25), two from the court and palace area (vessels 14, 22 and 24), five from burials (vessels 2,7,13,17, 23 and 25) and all four Transitional K2 ceramics fit within this group. There appears to be no clear distinct association between fabric type, vessel form or related contexts for this common fabric group.

6.1.3. Coarse Fabric Type III

The coarse fabrics are characterized by inclusions that range in size from >1.0mm to 3.00mm. The result is a granular, more porous surface of the clay matrix that appears rough, with much more irregular and uneven spaces created between the clay matrix and inclusions. Large voids and pores are common in this fabric. Sediments are usually rounded, as well as angular, and are poorly sorted. They are also composed of several types of colours of minerals and rock grains, of which some are difficult to identify conclusively. Moderate (<11-25%) to abundant (>40%) amounts of predominantly black inclusions (possible iron ore, magnetite or hematite) are visible with rare and sparse (<3%) amounts of white inclusions. Only two samples (vessels 15 and 20) are represented in the coarse fabric group and both are associated with residential areas from Mapungubwe.

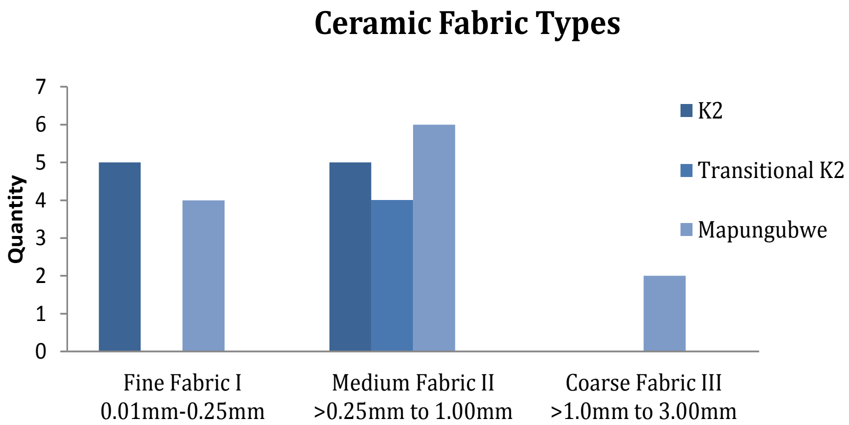


Figure 6.1: Distribution and groupings of ceramic fabrics and estimated size range of inclusions

ID	Fabric	Frequency	Inclusion shape	Sorting	Context	Vessel Shape
	Zhizo					
1	Medium	<26-40% Common	Rounded	Poorly sorted	Occupation area	Ovaloid
	Mambo					
2	Medium	<11-25% Moderate	Sub-rounded and angular	Poorly sorted	Human burial	Spherical
	K2					
3	Fine	<11-25% Moderate	Rounded and sub-rounded	Well sorted	Human burial	Cylindrical
4	Fine	<3- 10% Sparse	Angular, rounded and sub-rounded	Well sorted	Occupation area	Cylindrical
5	Fine	<26-40% Common	Rounded	Well sorted	Cattle burial	Cylindrical
6	Fine	<40% Abundant	Rounded, sub-rounded and sub-angular	Poorly sorted	Occupation area	Spherical
7	Medium	<26-40% Common	Rounded and angular	Poorly sorted	Cattle burial	Spherical
8	Medium	<3- 10% Sparse	Sub-rounded and angular	Poorly sorted	Surface area	Ellipsoid
9	Medium	<26-40% Common	Round, angular, sub-angular	Poorly sorted	Occupational area	Hemispherical
10	Fine	<3% Rare	Rounded	Well sorted	Occupation area	Hemispherical
	TK2					
11	Medium	<11-25% Moderate	Rounded and sub-rounded	Poorly sorted	Occupation Area	Cylindrical
12	Medium	<3-10% Sparse	Sub-rounded and sub-angular	Poorly sorted	Occupation area	Ovaloid
13	Medium	<26-40% Common	Rounded and sub-rounded	Poorly sorted	Grave area burial	Spherical
14	Medium	>40- 50% Abundant	Rounded and sub-rounded	Well sorted	Palace area	Spherical
	Map					
15	Coarse	>11-25% Moderate	Rounded, sub-rounded and angular	Poorly sorted	Occupation area	Spherical
16	Fine	<3-10% Sparse	Rounded and sub-rounded	Well sorted	Human burial	Ellipsoid
17	Medium	>40% Abundant	Rounded, sub-rounded, sub-angular	Well sorted	Grave area/burial	Ellipsoid
18	Fine	>40% Abundant	Angular, rounded and sub-rounded	Well sorted	Human burial	Ellipsoid
19	Fine	<3% Rare	Rounded	Well sorted	Grave Area/burial	Ellipsoid
20	Coarse	>40% Abundant	Rounded and sub-angular	Poorly sorted	Occupation Area	Ellipsoid
21	Medium	<3- 10% Sparse	Sub-angular and angular	Poorly sorted	Occupation Area	Spherical
22	Medium	>40% Abundant	Rounded and angular	Poorly sorted	Court area	Ellipsoid
23	Medium	<26-40% Common	Rounded, sub-rounded and sub-angular	Poorly sorted	Grave area/ burial	Ellipsoid
24	Medium	>11-25% Moderate	Round, angular	Poorly sorted	Palace area	Ellipsoid
25	Medium	>11-25% Moderate	Sub-rounded, rounded and angular	Poorly sorted	Occupation Area	Sub-spherical
26	Fine	<3% Rare	Rounded	Well sorted	Occupation Area	Ovaloid

Table 6.1: Summary data of ceramic fabric analyses within sample range

Although the preliminary fabric analysis does not make the data immediately meaningful due to the small sample size, there is a substantial range of signature fabric compositions or recipes with noticeable compositional variations. The ceramic fabric data summarized above (see Table 6.1) does however provide some insight into technological processes and practices exercised at K2 and Mapungubwe, in relation to the choice of inclusions, clay selection and preparation of particular fabrics.

For example, the fine fabrics appear to exhibit predominantly white inclusions as opposed to the coarse fabrics, which are mainly characterized by dark inclusions. It is possible that this may suggest specific tempering choices and a mixing of clays for specific vessel types. Most clay contains naturally occurring minerals and inclusions. In some cases however, naturally occurring clay needs to be altered in order to make suitable ceramics since different clays have different properties (Rice 1987:118-119). Alternatively, they might also represent two different clay sources. The data presented on the diversity of inclusions within the ceramic fabrics can therefore also be used to interpret information about the nature and choice of the raw materials used in ceramic manufacture at K2 and Mapungubwe. Such evidence can be used to support the the view that the potters understood the physical properties of clay fabrics as an important aspect in the manufacture of vessels that could withstand handling, heating, cooling, expansion and contraction. Since the arrangement of the ceramic fabric is rarely uniform and each vessel is uniquely manufactured, choice of raw material for the ceramic fabric also has an impact on the mechanical and thermal strength of the vessels (Rye 1981).

In summary, the inherent nature of the fabrics can therefore raise questions relating to the identification of raw materials, fabric recipes, preparation of clay and tempering materials and predictions of clay sources. Ceramic fabrics depend on the natural variability in the raw materials, which is greatly affected by the local geology (Bishop 1992). The geology, number of clay sources, and their distribution offer different choices in terms of clay types and inclusions, which significantly affect fabric variability. However, in wide and complex geological regions such as the Shashe Limpopo Confluence Area, it is therefore likely that the ceramic fabric groups indicate locally manufactured vessels on the basis of consistency with the geology of the immediate environment since they contain commonly found inclusions of sedimentary, igneous and metamorphic origins (Chinoda *et al.* 2009:24-26). This suggestion is further complemented by the compositional results of all the vessels summarized below.

6.2. Ceramic compositional results

Elemental and chemical characterization was conducted on a total of twenty-six vessels using X-ray florescence (see Appendix 5 for details of total XRF results) and X-ray diffraction (see Table 6.2) as outlined in Chapter 4 and individually presented in Chapter 5. These results can be used to complement the macroscopic fabric analysis and reveal the basic compositional recipe of the raw materials used to manufacture the ceramics.

6.2.1. Summary of XRF results

The XRF data can be characterized by a wide, overall elemental variability (see Figure 6.2) and indicates that all 26 XRF readings from the individual vessels do not provide the exact same compositional signature. The results suggest both low and high concentrations (ppm) of major and minor elements, as well as trace constituents associated with the clay. The major elements determined in all the samples were iron, titanium calcium and potassium, with minor elements of zinc, zirconium and manganese, and trace constituents of sodium, rubidium and strontium. These elements occur in combinations and in varying amounts that are distinctive of individual clays or possible temper combinations. Thorium was not determined on samples 10, 14, 20 and 24 and nickel traces were also not determined on samples 12, 13 and 21. Chromium was another element not found in samples 9 and 13, whilst sample 13 showed no traces of vanadium.

The XRF analysis linked together with the XRD analysis indicates that the potters most likely used similar clay types and locally available raw materials. The XRD results also identified some of the clay mineral composition of sediments, which indicate what elements are commonly associated to the inclusions in the ceramic fabrics or temper fractions in the clay. However, according to Jacobson (2005) and Rice (1987) only constituents with relative concentrations or those which strongly correlate with each other (i.e. Rb and Sr and often Ca and Sr) can suggest more distinctive individual clays or temper combinations.

The analysis further showed similarities between the ceramics in terms of major trace elements, most notably high iron and calcium concentration. All 26 vessels presented particularly high iron-rich clay components. Other than an iron-rich clay, what iron may further suggest is not yet known. In addition, all vessels reflected particularly high calcium concentrations and therefore its presence is a major component to be considered. There is a proportionately rich concentration of calcium in a majority of the vessels, with the exception of vessels 6, 8, 19 and 17 (with slightly lower concentrations), which are notably well-burnished and black to very dark brown in colour. Marked concentrations of calcium can most likely be the result of either the original calcareous clay, or a calcium-rich temper such as limestone, shell or fragments of calcite (Shepard 1980:19). Nonetheless, only a few elemental patterns can be drawn from the existing data and are presented below.

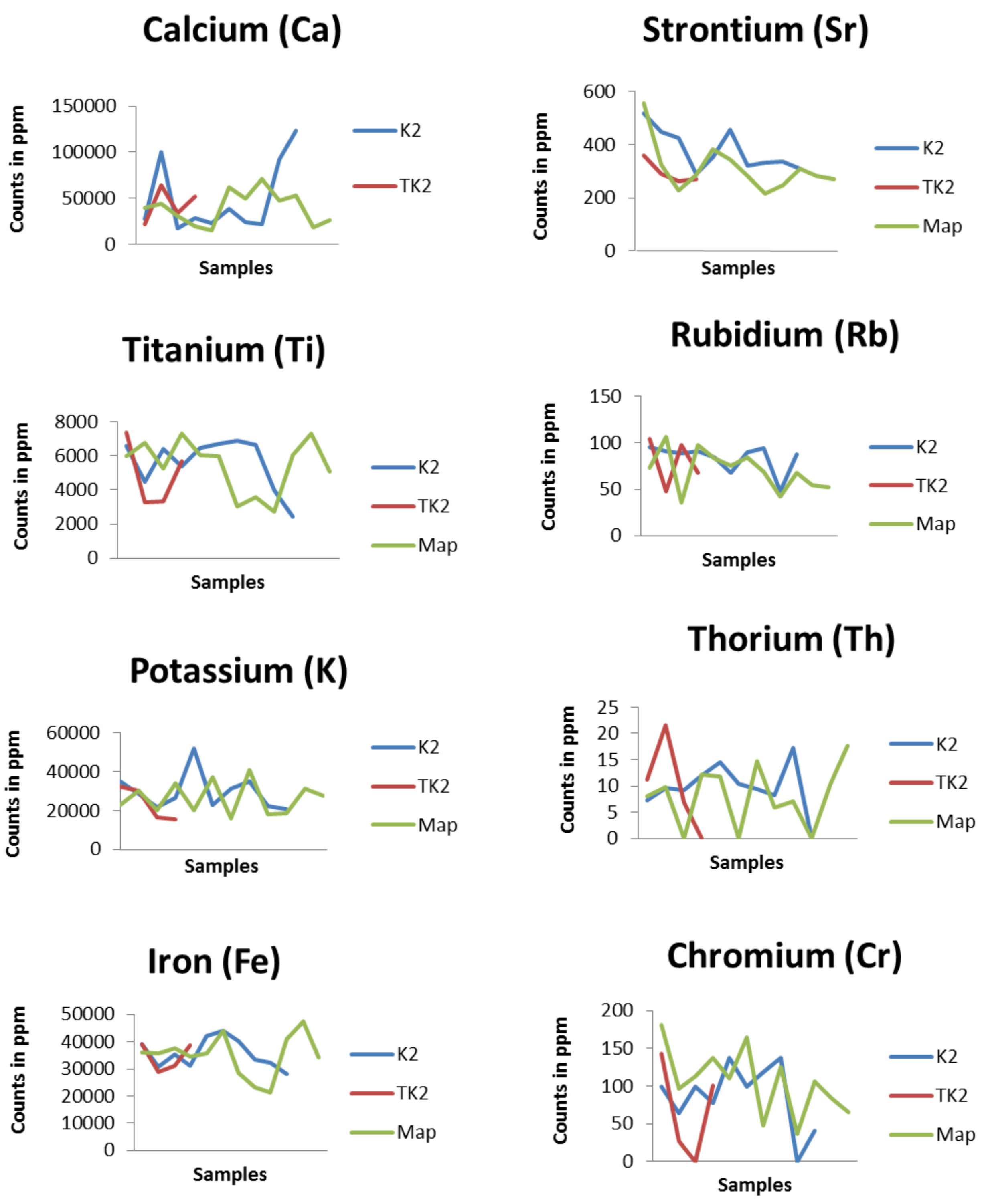


Figure 6.2: XRF line chart for selected elements showing chemical variability between K2 ceramics (Blue Line), Transitional K2 ceramics (Red Line) and Mapungubwe ceramics (Green line). Elemental counts are expressed in parts per million (ppm). *All vessels are represented as samples on the x-axis.

Although Shepard (1980) stresses that calcium may be a major constituent of the clay minerals or impurities in the clay, too much emphasis can also be placed on this element due to the multitude of its potential sources. According to Legodi and de Waal (2007:141), clays with high calcium carbonate content can also form compact ceramic structures at low firing temperatures as in the case of the K2 vessels (samples 9 and 10), which both have a compact white layer covering the ceramic surface. Another explanation of the presence of calcium may be attributed to post-depositional formation (for example sample 26) since the deposit, which is calcareous in nature, forms a discrete layer on the surface of the vessel. Calcium is also one of the main natural chemical constituents of most clay, and the calcium-rich content can also be the result of burial conditions, where the vessel can become being saturated with ground water, resulting in the deposition of calcium in the pores of the ceramic (Bishop *et al.* 1982:294).

Another consideration of the high concentrations or abnormal calcium intensities can also be attributed to contamination of the ceramic fabric by the plaster of Paris (calcium sulphate), which was used as a filling material or for reconstruction for the ceramics (for example samples 20 and 22), and is regarded widely as a known common source of ceramic contamination (Buys and Oakley 1993:67). Therefore, as a result of the complexity of calcium as an element and its varying sources, only once elemental data is studied in the light of the geological nature of the ceramics, complementary and supplementary analysis will become apparent to determine whether its presence is significant or not (Shepard 1980). Nevertheless, calcium may be a significant technological indicator of calcareous clay or an added calcareous temper for the K2 and Mapungubwe ceramics. For this reason, calcium as a major element should not be overlooked.

The overall XRF findings do however indicate chemical variability. This is a relatively predictable result, as compositionally these elements are a natural indication of the complex nature of the clay from which the ceramics are manufactured. These results do however give indications of the compositional variability of raw materials and together with the fabric results suggest a mixing of clays (or tempering), which is technologically vital. Tempering practices also represent a more stable aspect of ceramic manufacture (Gosselain 2000) and variation depends on the natural variability of the raw materials (Arnold 1985). How such findings are interpreted and how they impact on technological choices and the manufacturing processes of the K2 and Mapungubwe vessels will be expanded upon later in this chapter.

6.2.2 Summary of XRD results

Due to vessel size restrictions and sample preparation limitations, chemical characterization using X-Ray Diffraction (XRD) provided the following results (see Table 6.2) for seven samples. The results confirm low firing temperatures indicated by the presence of kaolin, montmorillonite and illite clay minerals (Legodi and de Waal 2007:141). All seven vessels are characterized by common chemical signatures of quartz, albite (with the exception of no albite in sample 13) and calcite (with the exception of samples 9, 16 and 18). Only two vessels, 16 and 9, contained diopside and vessels 12 and 15 are characterized by enstatite. Only vessel 16 contained hydrophilite. The presence of at least two dominant clay minerals is observed; quartz and calcite. These two chemical signatures may eventually prove to be regionally significant, which possibly suggest the exploitation of two different clay sources, one more calcite-rich and the other more quartz-rich, or as either quartz tempered or calcite tempered. Nevertheless the sample size is very small and as such observations are only tentative at this stage.

ID	Quartz	Calcite	Albite	Microcline	Muscovite	Rutile	Gypsum	Other
Vessel 12 TK2 Fabric II	√	√	√	-	√	-	√	Orthoclase, Enstatite, Magnetite
Vessel 16 MAP Fabric I	√	-	√	√	-	√	-	Hydrophilite, Sodian, Diopside, Tremolite
Vessel 13 TK2 Fabric II	√	√	-	√	-	√	√	Cristobalite, Anorthite, Montmorillonite
Vessel 18 MAP Fabric I	√	-	√	√	-	-	-	Hematite, kaolinite
Vessel 15 MAP Fabric III	√	√	√	√	√	-	-	Enstatite
Vessel 10 K2 Fabric I	√	√	√		√	√	-	
Vessel 9 K2 Fabric II	√	-	√	√	√	-	-	Diopside

Table 6.2: Summary results of the XRD analysis

Based on the overall compositional results, both the XRF results (Appendix 5) and XRD results (see Table 6.2.) support one another. The results indicate that a majority of vessels are composed primarily of quartz and calcite clay, possibly temper minerals with other inorganic compounds such as titanium and phosphates as well as iron oxides (muscovite and magnetite), and can be geologically associated to the typical mafic and ultramafic complexes and the quartz-feldspar gneisses common to the Limpopo Mobile Belt (Chinoda *et al.* 2009:24-25).

For example, trace elements such as Mn, Zr, Ti and Ni, although found in relatively low concentrations, could further be used as ceramic fingerprints attributed to the geochemical affinity of these elements with the lithography of the surrounding Limpopo Bushveld Complex (Chinoda *et al.* 2009). Furthermore, the common sandstone of the K2 and Mapungubwe geological landscape could most probably be the natural source of quartz, which is a predominant element. According to Padilla *et al.* (2006:286) certain elements may be linked to geological associations for compositional profiling of the ceramics (see Table 6.3. for elements associated to geological compositions). These elements indicate that most rocks are composed of silicates such as magnesium, iron, calcium, sodium and potassium as well as, rock-forming clay minerals such as quartz and calcite (Rice 1987:33), which presence is confirmed by both the XRF and the XRD analysis. The kaolinite (identified in vessel 18) is not commonly associated with the immediate geology and therefore may serve as an indicator of a 'foreign' or 'non-local' ceramic. This aspect of movement of pots across the wider landscape (see Wilmsen et al 2009) would need to be further investigated and is an idea also supported by Jacobson (2005:198) who suggests that it may not necessarily be the movement of pots, but rather a selection of clay sources further away.

Element	Associated to
Na	Plagioclase
K	Potassium feldspar
Rb	Granites, potassium containing minerals
Mg	Simple and complex compounds (pyroxene, amphibole, mica, magnetite, calcite, dolomite, clays,
Ca	Plagioclase, mica, calcite, dolomite, gypsum, evaporated and precipitated origin sediments
Sr	Correlated with calcium or substituting potassium in minerals
Ba	Highly adsorbed in clays. The ratio Sr: Ba changes between different igneous rocks
Sc	Ultrabasic and basic rocks, as well as in pyroxene, amphibole, mica minerals
Y	Variability due differences in crystallization of igneous rocks
Ti	Independent minerals (e.g. rutile), complex oxides in the initial crystallized minerals.
Zr	Varies for different crystallization stages
Hf	Lower contents in ultrabasic rocks, largest in granite
Cr	Chromite, picotite, Concentration varies for different crystallization stages
Fe	Sulfides (pyrite, chalcopyrite,pirrotyne) and oxides (ilmenite, chromite, magnetite, hematite)

Table 6.3: Relevant elements and geological associations for compositional profiling of ceramics (Padilla *et al.* 2006:286)

The results presented here suggest that all the vessels appeared to be composites of quartz and other raw clay types such as variable quantities of feldspars (albite and microcline), calcite (white inclusions) and iron ore (black inclusions) compounds, which are all evidently associated to in the Limpopo region (Chinoda *et al.* 2009:24).

The compositional data and fabric data also include substantial amounts of other inclusions, which are difficult to identify but are clearly composed of several other types of colours of minerals, rock grains and sand. Patterns at the same time also indicate variability in the clay samples since the natural clay used to manufacture the vessels often occur as mixtures consisting of minerals, carbonates, quartz, feldspars and calcite-rich clays, quartz-rich or iron-rich clays (Legodi and de Waal 2007:139).

What is also interesting is that the fine fabrics are dominated by white inclusions (quartz and calcite identified by XRD) and coarse fabrics are dominated by black inclusions (e.g. magnetite, hematite), whether this is a significant finding or not, is not yet known, until much more fabric analysis is done. Yet, there is no clear cut boundary or marked compositional differences between the K2 and Mapungubwe vessels. Both vessels show rich inclusions of quartz and calcite, possibly as deliberately added tempers.

Nonetheless, by characterizing the fabrics and composition of the ceramics and how those materials combined, one may deduce how the physical qualities of the raw materials might affect and constrain the types of forming and firing technologies and finishing treatments that were used to manufacture complete vessels. In summary, the fabric and compositional results are three-fold: a) a range of raw materials were used in ceramic manufacture; b) these materials appear to be, according to their mineral content, associated with the regional geology; c) different choices were employed in the preparation of the fabrics as three main groups have been identified.

6.3. Primary forming results

Gosselain (2000:193) states that fashioning or shaping, also called primary forming (Rye 1981), usually constitutes a very stable element of the manufacturing process as it is less likely to change and is expected to reflect enduring aspects of a potter's social identity. Evidence presented in this study supports this assertion, as no apparent change was observed in primary forming methods between the K2, TK2 and Mapungubwe ceramics. Nevertheless, inferences can be made here about the primary forming process itself since evidence on vessels within all three ceramic traditions is minimal (see Table 6.4 for summary data of forming). The only direct evidence for forming suggested on some vessels is the identification of junction points from the coiling process and, in other cases, finger impressions resulting from forming in the hand and pinching the clay to form a vessel as the data shows in Chapter 5. Only eight vessels in total exhibit evidence of possibly forming by the coiling technique, while four vessels suggest shaping by the pinching method.

For the remainder of the samples forming indications are undetermined because secondary forming processes have obliterated any physical marks or potter traces that could be construed as evidence. In the view of the detailed data provided in Chapter 5, preliminary results suggest that the coiling technique was possibly more commonly used for globular shapes, particularly for larger vessels with thicker and heavier walls. Vessel 12 for example, which is proportionally large, and might have been intended to be used for storage, has a thick wall and a thick base, which is more functionally advantageous as thicker walls increase stability and impermeability (Rice 1987:227).

Rounded shapes are also generally stronger than angular ones, due to the fact that angles accommodate stress, and breakage resistance is improved by an increased wall thickness (Rice 1987:226). The vessels particularly from the Transitional K2 period appear to be strengthened in this way, notably on the rims. As is the case of vessel 12, which is a very large type vessel, coils, were added to thicken the rim and strengthen the upper wall. Similarly, smaller vessels with thinner walls that could be cupped into a hand were modelled from a lump of clay and pressed into shape using the pinched technique. On the other hand, the coiling technique may not have been necessarily needed for the smaller, thinner walled vessels such as the characteristic unrestricted bowl forms commonly found at both K2 and Mapungubwe.

Although this study identifies only two types of forming techniques, namely the pinch method and coil method, it does not exclude the fact that other forming techniques such as the pulling technique or the paddle and anvil techniques may also have been used in the manufacture of the K2 and Mapungubwe ceramics. For example, Lindahl and Pikirayi (2010) have proven the technological advantages of the pulling technique over coiling, but admit that it is often difficult to deduce the forming technique since evidence is not always easily distinguishable. The primary forming results therefore suggest that the forming methods for vessels at K2 and Mapungubwe demonstrate continuity in the choice of shaping methods. The purpose of this technical choice lies perhaps in the durability of the vessel for its functional strength, while smaller vessels that were modelled by hand might have been stronger and survived longer than larger coiled vessels were nevertheless more easily prone to cracking and breaking. However, since the primary forming methods only serve as a framework to the making and shaping of a vessel, it is the secondary finishing techniques that actually provide the eventual vessel form, as scraping is used to give the vessel wall thickness and its final shape. It is evident that the K2 and Mapungubwe potters had knowledge of the properties of refining raw clay, which demanded considerable skill from the potters to recognise the advantages of particular clay and its preparation for the forming and shaping process.

6.4. Secondary forming and finishing results

In contrast to forming evidence, secondary traces such as scraping, wiping, smoothing or burnishing are common finishing techniques observed on a majority of the vessels (see Table 6.4 for summary data). Such techniques have technological advantages but may have been performed in some cases solely to enhance the vessel's surface. Scrape marks were clearly evident on 17 of the vessels and wipe marks visible on 16 vessels. Such traces, mostly visible on the interior of the ceramic walls, have fortunately been preserved, as it is the next step in the smoothing process that usually obliterates such technological evidence.

The smoothing process is visible on all the interior and exterior surfaces of the vessels, with the exception of vessels 7 and 23, which show no smoothing marks. Technically smoothing, which is essentially a simple finish of evening the final surface, appears to be more common than burnishing. Such secondary forming processes also prepare the ceramic surface for final finishing, such as the application of decoration or burnishing. As opposed to primary forming evidence, secondary traces are particularly visible and technically flexible in the manufacturing process and are more likely to reflect wider changes throughout the K2 and Mapungubwe assemblages, particularly in the case of stylistic changes in decoration. It is further evident that by only shaping the vessel, the required surface cannot be obtained at once, and that scraping of the surface is then followed by smoothing before burnishing, which are important additional steps in the potter's *chaîne opératoire*. This finishing is usually done at the leather-hard stage to improve the smoothness and density of the vessel's final surface.

Since there is a high degree of vessel variation within the broader K2 and Mapungubwe ceramic assemblages, it can be deduced that there is an increase, particularly in the selection and specialization, of secondary forming techniques. For example, quality care in the scraping, wiping and smoothing process properly prepares the surface for better execution of the finishing techniques, such as decorating and burnishing. Mapungubwe ceramics are more highly decorated than those found at K2 but, in contrast, secondary additions such as lugs, spouts, perforations and bosses are more evident on K2 vessels. Finishing and applying decoration are apparently more sensitive to innovation, and are most likely to change since they do not affect the success of the complete manufacturing sequence because such techniques are easily adopted or modified in the *chaîne opératoire* (Gosselain 1992:582).

The most obvious pattern observed within the ceramics is the increase in exterior and interior burnishing of the vessel walls, which is intended to make the surface regular and smoother in order to eliminate surface irregularities and is a very intensive labour process.

The burnishing process may serve a functional purpose as well for reducing permeability (Rice 1987:23). Worked river pebbles or burnishing stones have been found in both K2 and Mapungubwe Hill contexts and serve as direct evidence for burnishing tools (Fouché 1937:26). In view of the entire *chaîne opératoire* sequence, Mapungubwe potters appear to have invested a significant amount of time and effort in the manufacture of their ceramics, which can possibly indicate a high level of craftsmanship, even specialised production as an indicator consistent with increasing social and political complexity. This is suggested by the production of highly burnished and elaborately decorated vessels at Mapungubwe in comparison to the K2 ceramics, which largely exhibit only low burnished surfaces with less decorative features.

Mapungubwe Hill ceramics further exhibit a wider variety of finishing techniques, particularly relating to secondary processes such as well-burnished, high-gloss and smoother textural surfaces, which may indicate a select technical choice by Mapungubwe potters. It is also possible that the Mapungubwe high-gloss, burnished ceramics may be linked to black burial vessels in particular (and characterized by fine fabrics), but this observation would require further investigation.

In summary, the overall forming data points to more physical evidence and marked changes in secondary forming techniques visible on all the K2, TK2 and Mapungubwe ceramics, than in primary forming techniques. It would also seem that the K2 potters appear to rely more heavily on the scraping and wiping method to produce a surface finish, perhaps in an attempt to make thinner walls or to prepare the surface for secondary additions. Evidence suggests that more K2 vessels were formed with additions of spouts, lugs, bosses and perforations, perhaps serving only a functional purpose, but not technologically common to Mapungubwe vessels. By comparison, Mapungubwe potters also appear to mask secondary forming marks from the scraping and wiping process by employing a thorough smoothing process to prepare a better quality surface for finishing, particularly for burnishing and intricate decoration.

ID	Fabric Type	Vessel shape	Forming	Scraped	Wiped	Smoothed	Burnished	Decorated
	Zhizo							
1	Medium	Ovaloid	Undetermined	✓	-	✓	✓	✓
	Mambo							
2	Medium	Spherical	Undetermined	✓	-	✓	-	✓
	K2							
3	Fine	Cylindrical	Possibly coiled	-	-	✓	-	✓
4	Fine	Cylindrical	Undetermined	-	-	✓	✓	✓
5	Fine	Cylindrical	Undetermined	✓	-	✓	✓	✓
6	Fine	Spherical	Undetermined	-	-	✓	✓	✓
7	Medium	Spherical	Undetermined	-	-	-	✓	-
8	Medium	Ellipsoid	Probably coiled	✓	✓	✓	✓	-
9	Medium	Hemispherical	Undetermined	-	✓	✓	-	-
10	Fine	Hemispherical	Possibly pinched	✓	✓	✓	-	-
	TK2							
11	Medium	Cylindrical	Possibly coiled	✓	✓	✓	✓	✓
12	Medium	Ovaloid	Possibly coiled	✓	✓	✓	-	✓
13	Medium	Spherical	Undetermined	✓	✓	✓	-	✓
14	Medium	Spherical	Undetermined	✓	✓	✓	✓	✓
	Map							
15	Coarse	Spherical	Undetermined	✓	✓	✓	✓	-
16	Fine	Ellipsoid	Possibly coiled	✓	✓	✓	✓	-
17	Medium	Ellipsoid	Probably coiled	-	-	✓	✓	✓
18	Fine	Ellipsoid	Undetermined	✓	✓	✓	✓	✓
19	Fine	Ellipsoid	Undetermined	✓	✓	✓	✓	✓
20	Coarse	Ellipsoid	Possibly pinched	✓	✓	✓	-	-
21	Medium	Spherical	Undetermined	✓	✓	✓	✓	✓
22	Medium	Ellipsoid	Undetermined	-	-	✓	✓	✓
23	Medium	Ellipsoid	Undetermined	-	✓	-	✓	-
24	Medium	Ellipsoid	Possibly pinched	✓	✓	✓	-	-
25	Medium	Spherical	Unknown	✓	-	✓	✓	-
26	Fine	Ovaloid	Pinch formed	-	✓	✓	-	-

Table 6.4: Summary data of primary forming and finishing evidence

6.5. Firing results

The firing conditions of the K2 and Mapungubwe vessels has been inferred from evidence that was observed macroscopically within the ceramic fabric analyses (see Table 6.5). The variation of colour within the ceramic matrix relates to firing techniques, and as such provides valuable technological indicators of the firing conditions for the vessels (Gibson and Woods 1990; Rye 1981). Based on the fabric analysis, carbon cores were observed on eighteen vessels but no carbon cores were observable on vessels 9, 10, 14, 15, 20, 23, 24 and 26 due to poor visible fractures or incomplete cross-sections of the vessel fabric.

The firing process for both K2 and Mapungubwe is characterized by low temperatures in an incomplete oxidation firing atmosphere, which was possibly not regulated very well, imparting the colour variability evident within the vessels. Therefore a majority of the vessels exhibit either a narrow or broad unoxidized grey core with lighter or feint oxidized interior and exterior margins that reflect incomplete or partial oxidation in the presence of organic material.

Only vessel 18 exhibits a uniform cross-section, which implies a fully oxidized firing atmosphere indicating no organic matter in the vessel as surface colour variations result from differences in temperature (Rye 1981:115-117). According to Legodi and de Waal (2007:139) the presence of the mineral kaolin in this particular vessel may imply that the processing temperature was not high enough to affect complete dissolution of this clay mineral. In contrast, vessel 19, a black shallow bowl, is the only ceramic characterized by the presence of a uniformly dark black carbon core, suggesting controlled and regulated reduced firing conditions. The control of temperature, duration of firing and reduced firing are significant indicators of pyrotechnic skill by the Mapungubwe potters.

As shown in Appendix 7, the surface colour of all the vessels is relatively variable due to the firing conditions or their clay mineral content. The predominant colour spectrum of nearly all the vessels is dark brown to black, very dark grey to black, brown and reddish-brown (Munsell Colour 2000). This colour range is considered to be a normal indication of the composite nature of the raw clay (Legodi and de Waal 2007:137). The accumulative firing results only provide some preliminary evidence of firing conditions and based on observations made of carbon cores, whereby the nature of the clay fabric can also provide some information about the firing process. For example, the presence of calcite, and its progressive alteration during the firing process is well-known as it also serves as a clear indicator of low firing temperatures (Rice 1987; Shepard 1980).

The fabric analysis has also enabled characterization of the raw materials in the ceramics, which allows inferences to be made about deliberate and mindful choices of specific clay components and their reaction to a low firing process, in order to produce vessels of a variable colour. The colour of archaeological ceramics and their fabrics are therefore, technologically telling features that can be attributed to firing temperatures and conditions (Orton *et al.* 1993). Other than the above, no further firing patterns can be deduced from the preliminary results.

ID	Fabric	Forming	Firing conditions	Carbon Core	Vessel Colour
	Zhizo				
1	Medium	Unknown	Partially oxidized	Black	10YR 4/3 Brown
	Mambo				
2	Medium	Unknown	Partially oxidized	Dark grey	7.5YR 3/2 Dark Brown
	K2				
3	Fine	Unknown	Partially oxidized	Dark grey/ black	10YR 4/2 Dark grayish brown
4	Fine	Coil	Partially oxidized	Grey	2.5YR 4/6 Red
5	Fine	Probably coil	Partially oxidized	Dark grey	7.5YR 4/3Brown
6	Fine	Unknown	Partially oxidized	Black	10YR 3/2 Very dark grayish brown
7	Medium	Unknown	Partially oxidized	Black	7.5YR 3/3 Very brown
8	Medium	Probably coil	Partially oxidized	Dark grey	10YR 3/2 Very dark grayish brown
9	Medium	Unknown	Not determined	Not visible	10YR 6/2 Light brownish grey
10	Fine	Possibly pinch	Not determined	Not visible	10YR 6/2 Light brownish grey
	TK2				
11	Medium	Possibly coil	Partially oxidized	Dark grey	5YR 5/4 Reddish brown
12	Medium	Probably coiled	Partially oxidized	Dark grey	10YR 3/1 Very dark gray
13	Medium	Unknown	Partially oxidized	Black	7.5yr 4/3 Brown
14	Medium	Unknown	Not determined	Not visible	7.5YR 5/4 brown
	Map				
15	Coarse	Unknown	Not determined	Not visible	5YR 4/4 Reddish brown
16	Fine	Possibly coiled	Partially oxidized	Black	5YR 4/4 Reddish brown
17	Medium	Probably coiled	Not determined	Dark grey	7.5YR 4/3 Brown
18	Fine	Unknown	Fully oxidized	Red	2.5 YR 5/6 Red
19	Fine	Unknown	Unoxidized/Reduced	Black	10YR 2/1 Black
20	Coarse	Possibly pinch	Not determined	Not visible	7.5YR 4/6 Strong brown
21	Medium	Unknown	Partially oxidized	Grey	5YR 4/3 Reddish brown
22	Medium	Unknown	Partially oxidized	Sandy	7.5 YR 3/2 Dark brown
23	Medium	Unknown	Not determined	Not visible	10YR 3/2 Very dark grayish brown
24	Medium	Possibly pinch	Not determined	Not visible	10YR 3/2 Very dark grayish brown
25	Medium	Unknown	Partially oxidized	Black	7.5YR 3/2 Dark brown
26	Fine	Pinch formed	Not determined	Not visible	7.5YR 3/1 Very dark gray

Table: 6.5: Summary of results of firing effects and firing conditions

6.6. Discussion of raw materials

6.6.1. Mixing of clays and sourcing

The current compositional and fabric data in this study shows patterns of considerable variation in the raw clay used, and supports Jacobson's (2005:37) views that "clay mixing also presupposes that there are compositionally variable clays near a settlement". The evidence of variation within this study may reflect a multitude of patterns relating to clay sources, variations in a single clay source or could indicate different ceramic production workshops. It may also merely suggest different treatments of the same raw materials. Likewise, it is also expected that technological variability does not always translate into consistent compositional differences between ceramics produced within the K2 and Mapungubwe assemblages, as no vessel is exactly identical in form or fabric. On the other hand, nor do the overall results simply imply that locally produced ceramics were standardized or homogenous. Technological variability is inherently complex.

All the vessels displayed variability in their clay fabrics, with differences in the potter's choices for finer or coarser inclusions, and thereby demonstrating a mixing of clays. While non-plastic inclusions or temper type is not clearly established in this study, it was determined that the raw materials obtained, probably from various clay sources, were selected for manufacturing different types of vessels. It is assumed that although there is no evidence for clay sources, the Limpopo River, its tributaries and river valleys with their seasonal water sources would provide suitable clay in close proximity to both these sites (Jacobson 2005).

Clay types and primary clay sources within the Shashe Limpopo Confluence Area still need to be identified and comparative clay samples from sherds need to be matched to regional geological sources. For example, the dominant clay inclusions consistent in the vessels included mainly white minerals, quartz, quartzite or calcite, which is commonly found within the sandstone typography consistent with Mapungubwe's geological landscape. While natural clay was apparently abundant and possibly quarried from the nearby rivers and tributary sources, not all clay is suitable for ceramic making, or suitable for use with local technologies (Arnold 1985:21).

6.6.2. The selection of specific inclusions

Non-plastic inclusions or temper are usually indicative of the natural environment, in which the potters lived and therefore indicate the nature of the available raw material (Arnold 1985). The introduction of quartz or calcite as possible crushed temper in all the vessels might suggest that these inclusions were tempered deliberately into the clay for a particular reason. In this case, temper refers to the inclusions added by the potter, but it is difficult to deduce whether the quartz or calcite were added material or is a result from naturally present inclusions. At the most simple level, the presence of temper and characterization of the ceramic fabric mainly allows the grouping of the vessels into two meaningful compositional types.

The combined evidence indicates two fundamental technological choices: the fine and medium fabrics exhibit dominant white inclusions and the coarse fabrics exhibit dominant black inclusions. This does not mean that the fabrics are identical, but implies that potters chose similarly fine clays and tempered their raw materials with dominant amounts of quartz or calcite, whilst coarse clays were preferentially tempered with black inclusions. Although, these inclusions have not been conclusively identified and the direct source of the quartz and calcite is not determined, the ceramics are still characterized by clay signature sediments and minerals. Quartz is one of the most often observed types of inclusions in all the analysed samples, and generally high concentrations of quartz temper result in lower fracture strength and significant crack propagation (Rye 1981).

Therefore, the three fabric groups could suggest that the vessels were manufactured from different clay sources and distinct choices were made with regard to clay selections and preparations, preferences for black (iron ore, magnetite or hematite) or white (probably quartz, quartzite or calcite) inclusions. Only detailed petrographic or thin section analysis would however confirm their identification. This further illustrates the continued exploitation of the natural environment and provides clues of the raw materials used for clay selection, mixing and tempering information, which is technologically, central to ceramic manufacture. For this reason, the selection of different inclusions may be better viewed as a cultural rather than a functional choice. Jacobson (2005) does however warn of the complications of temper, which is known to mask original clay signatures.

> "The addition of a temper can change a clay's composition and as the addition of different types of temper to the same clay by different potters could result in several different compositions, it is important to understand its exact influence on chemical composition. Otherwise, there is the danger that the "temper effect" could result in vessels being attributed to more clay sources than is the case and in an extreme situation, to a source far removed from the actual locality of the site with the resulting, erroneous, implication that the vessel was imported"
>
> (Jacobson 2005:22)

6.6.3. The choice of calcite

Likewise, the seemingly apparent use of calcite as a raw material is also worth mentioning as it is just as abundant as quartz as a temper in clay (Rye 1981:116). A majority of the vessel fabrics are characterized by the presence of calcite; this is also supported conclusively by the XRD analysis. This common mineral may have been deliberately tempered into the vessels or may have naturally occurred within calcite-based clays. Furthermore it may also indicate that in quarrying the clay the K2 and Mapungubwe potters operated more selectively. Keough *et al. (*2006) have previously proposed that calcite was gathered in the form of crystals or aggregates and brought to Mapungubwe for calcite bead manufacturing purposes since unworked and refined fragments of calcite crystals have been found at Mapungubwe Hill. Calcite has also been associated with the copper mines in the Musina area near to Mapungubwe (Cairncross and Dixon 1995:192). Likewise, the choice of calcite may have also been used for a similar purpose for vessel manufacture, but much more comparative and petrographic analysis would be needed to confirm this hypothesis.

6.6.4. The choice of mica

Another interesting pattern that re-occurs within the raw material found commonly in nearly all the K2, Transitional K2 and Mapungubwe ceramics is the presence or use of muscovite or common mica. Muscovite is a potassium aluminium silicate that is rich in aluminium and is therefore refractory. From a technological point of view, the presence of muscovite or common mica has several advantages since the properties of muscovite give thermal strength, elasticity and moisture absorption to the clay, thereby minimizing cracks and strengthening the vessels to be more impact resistant (Wallace 1989:33-39). Both quartz and mica have similar densities and both have poor thermal conductivity, which also implies high heat resistance (Rice 1987:364) and it could thus be argued that the consistent choice of mica in all the clay vessels is evidenced by the reflective specks. Rosenstein's preliminary work (2005:29) on the Moloko ceramic fabrics of the Tswana sites in the North West Province also demonstrates that muscovite mica was crushed and added as temper to the clay material. She also noted the distinct sparkly effect the mica inclusions have on the exterior of the ceramics. This choice may have been a desired characteristic to impart a favourite effect to the vessel surface or that the physical advantages of the properties of muscovite were known by the potters. Fragments of raw mica were excavated by Gardner (1963:57) from K2 and have been found in Bambandyanalo 'Beast Burials' contexts, which may be more significant than initially thought, as this common mineral may have held some form of social meaning for the potters. Archaeologically, mineral usage, its collection, exploitation, use as a suitable temper and even cultural meaning at K2 and Mapungubwe have yet to be investigated.

6.6.5. Closing remarks on overall results

Based on the overall results and analysis, certain threads of technological continuity and variability can be found to support existing contextual, typological and chronological signatures of the K2 and Mapungubwe ceramic sequence (Huffman 2007; Meyer 1980). The key findings therefore indicate no major changes in the forming processes, but certainly some incremental changes or individual choices were made in secondary forming techniques. Furthermore, there is compositional variability in the ceramic fabrics, yet in terms of the manufacturing sequence indications point to technological assimilation or continuity. This is a significant finding, as ''technology is not typology'' (Bar-Yousef and van Peer 2009:105), because it takes into account the entire ceramic vessel without preferentially isolating arbitrary attributes such as style. Instead it examines the manufacturing sequence within the ceramic *chaîne opératoire* from raw material to the complete vessel.

These preliminary findings further indicate the complexity of ceramic technology, with regard to raw material and technical choice, which are not necessarily always environmentally constrained, but can largely also be determined by social or cultural choices too. This technological complexity is consistent with the archaeology of the region, as mirrored by other technologies. However, there are no suggestions at this point in the research to differentiate between a distinct separate K2 and a Mapungubwe ceramic technology. It is within this context that ceramic technology is interpreted.

6.7. Interpretations

The above results and discussion of raw materials elucidates the ceramic technology of the K2 and Mapungubwe ceramics through the analysis of four steps in the *chaîne opératoire*: fabric, forming, firing and finishing. As with any technical activity, ceramic manufacture consists of a sequence of steps, during which technological knowledge is put into practice in a specific social and environmental setting (see Gosselain 2008:77). Therefore, any social changes in the K2 and Mapungubwe society may possibly affect the roles and positions of potters, as well as the ceramic manufacturing process. It is within this framework and the broader archaeological Iron Age setting, that ceramic technology is interpreted.

However, because of the paucity of ceramic manufacture research at either K2 or Mapungubwe, making technological interpretations and comparisons is challenging. Without excavated material associated with ceramic technology, it is also problematic to deduce ceramic manufacture patterns, particularly when there is no compelling evidence of ceramic production sites, tools used for processing or firing pits, despite indications of complete vessels and ubiquitous potsherds. Ceramic technology is undoubtedly a significant area of research, which has not been investigated as a means to understand the K2 and Mapungubwe society. But since there is also a generally lack of ceramic technology research within southern African archaeology, this is not unexpected.

6.7.1. Ceramic technology at K2 and Mapungubwe

Ceramics research in the Shashe Limpopo Confluence Area has thus far, consistently been concerned with regional classification and cultural sequences based primarily on ceramic style (e.g. Calabrese 2005; Hall 1987; Huffman; 2007; Meyer 1980, 1998). Although such typological approaches tend to categorise and differentiate continuity or discontinuity in the K2 and Mapungubwe assemblages, technological approaches can also contribute to other ceramic patterns alongside this differentiation.

This study also shows that, together with stylistic attributes i.e. form, decoration or layout, other technological variables can also be used to further our knowledge of these ceramics. Evidence reveals the potential of utilizing whole K2 and Mapungubwe vessels to provide information that stylistic typology cannot and how ceramic technology can be further used as means of exploring broader social developments in the Shashe Limpopo Confluence Area. But how can technology further aid our interpretations of K2 and Mapungubwe?

In general, other technologies at K2 and Mapungubwe over this period are fairly well understood, as demonstrated by other types of technological studies, for example the specialist iron production (see Chirikure 2007) and Mapungubwe's gold fabrication technology (see Miller 2001). Such technological research, however, has been largely limited to metal fabrication studies (e.g. Chirikure 2007; Miller and Desai 2002, Miller 2001, 2002). Other researchers though have also confirmed the existence of more technological traditions, for instance glass bead manufacture (e.g. Wood 2011) and a specialised ivory and bone tool technology (e.g. Voigt 1983). Still, Miller (2001:99) asserts that assemblages could be far more valuable sources of social as well as technological information if appropriate excavation and analytical techniques are employed. It is within this context that any technological study should therefore also consider both the technical and social factors in their interpretations.

This study has proposed a pattern of continuous technological variability over time, reflected in the variations of the raw materials and continuity in certain technical choices made during the forming, firing and finishing processes of the ceramic *chaîne opératoire.* The results enhance our archaeological perspective of K2 and Mapungubwe potters, who in an ever-changing socio-political and developing state recognised the persistence of their local ceramic manufacture. Overall the results do not reflect two distinct separate ceramic technologies or technological styles, despite stylistic differences. There is therefore no clear-cut boundary between a distinct K2 ceramic technology when compared to a Mapungubwe ceramic technology. Explanations for this may lie in the social structures (individual or group) of both communities that govern the continuity of ceramic technology and choices made within the *chaîne opératoire* sequence.

The data presented in this study provides evidence that ceramic manufacture took place locally and specific tempers where chosen for specific vessel types. Moreover, the technological evidence also suggests that ceramic making activities were possibly widely practised throughout all levels of society. But what characterizes the ceramic technology employed at K2 and Mapungubwe? Where was the clay sourced from, how were the ceramics made and why?

Can the physical traces on the vessels serve as conclusive evidence about the ceramic manufacturing processes and be used to elucidate the role ceramic technology played within K2 and Mapungubwe societies? Since the study confirms the presence of a local indigenous ceramic technology, it also suggests a progressive and productive knowledge of ceramic manufacture at both K2 and Mapungubwe. This also concurs with Eloff (1979) and Meyer (1980) who argued that, based on stylistic analysis, ceramic manufacture took place at both sites. Local ceramic manufacture therefore implies that the immediate environment provided the ideal conditions for natural clay sources (see Jacobson 2005) and that the preliminary compositional data in this study also reflects the local geology.

However, much more comparative fabric analysis and geochemical profiling would confirm aspects such as local clay sourcing or whether pots were exchanged, which would have much wider regional interaction implications. Nonetheless, the findings of Wilmsen *et al.* (2009) resonate with the compositional findings in this study, proving that clays could be moved from geological deposits to sites where pots were made and can be transported for considerable distances (see Wilmsen *et al.* 2009:19). This finding could serve as a similar explanation in the production of ceramics at K2 and Mapungubwe, suggesting that clay need not necessarily be sourced within close proximity or sourced nearby and could have originated from a much further distance than expected. Jacobson (2005:124-125) is also of the view that since the firing of ceramics required a lot of fuel, such resources may have been exhausted by large populations due to large scale consumption of wood for firewood and building, and suggests that it may have been necessary to travel a distance to accumulate enough wood fuel for a firing. Therefore clay and fuel resources for ceramic manufacture may not have been available near both sites, but came from some distance. This would need further investigation and is not the purpose of this study.

6.7.2. Technological variability and social choice

In this study, technological variability is interpreted in terms of how it reflects technological choices, which are themselves socially embedded (see Dobres and Hoffman 1994). Such choices can be marked by two possible influences. First, because the environment of the Shashe Limpopo Confluence Area provides a wide availability of raw materials used for the manufacture of vessels. Second, that of technological choice and knowledge, i.e. K2 and Mapungubwe potters were keenly aware of the physical and mechanical properties of clay and their effect on forming, firing and finishing techniques. Equally, these choices will also be strongly influenced by technical, functional or social factors within the K2 and Mapungubwe settlements as well and therefore are not necessarily constrained by the environment.

Choices were not only limited to raw materials, but also extended to choices of available clay sources, fuel for firing, choice of particularly temper for specific ceramics and, possibly even cultural/social choices between local and other potter communities living within the same landscape.

The variability found at both sites also implies that the potters may have used different materials for different vessels. A good example of this is that ten of the ceramics from this study, examined from burial contexts have distinct fine fabrics; they have also been well-finished in terms of quality forming and refined decorative techniques, not to mention the pyrotechnical choices. These vessels include distinctive forms such as Mapungubwe shallow bowls and K2 beakers. It is therefore suggested here that fine fabrics (possibly even explicit types of temper) were actively chosen for specific vessel types, implying variability as a result of conscious cultural or social choices rather than simply choice as determined by the environment or functional constraints.

This view also parallels other studies, such as the recognition by Hattingh and Hall (2009) of the high frequency of beakers and the preferential selection of beaker vessels in juvenile K2 burials. This suggestion has also been ethnographically observed using Shona ceramics (see Huffman and Murimbika 2003). Though these case studies explain the role of the ceramic in society, the association of burnished beakers and spouted vessels as special grave goods at K2, and the burnished shallow bowls with the gold burials on Mapungubwe Hill, could also imply restricted manufacture, which may have been controlled by high rank individuals or semi-specialist/skilled potters as a form of social convention. This 'specialized' production may only have been limited and can therefore merely be a reflection of a highly developed level of ceramic craftsmanship. Such interpretations would need much more detailed investigation, linking fabric types to specific vessel types across both sites. Nevertheless, the ceramic technology of K2 and Mapungubwe can thus be considered as essentially social, since any form of technology should be seen as a political, social and symbolic system (see Lemmonier 1989; Pfaffenberger 1992). The K2 and Mapungubwe potters may have shared a common learning network, and produced vessels that are characterized by the use of communal clay sources, thereby manufacturing vessels that are also stylistically related (any stylistically different) both in form and in some decoration, but also similar in fabric. It must also be taken into account that several potter communities within K2 and Mapungubwe were probably sharing technology or dividing ceramic manufacturing resources or responsibilities among themselves.

This social interaction between individuals or groups (such evidence cannot be definitive) can provide sources of variation, in not only access to clay sources, but to the overall constitution of their ceramic manufacturing technology. There are a number of useful ethnographic examples elsewhere in Africa (see Croucher and Wynne-Jones 2006; Gijanto and Ogundiran 2007; Gosselain 1998, 2000; Livingstone-Smith 2000; Wayessa 2011), where ceramic technology takes place along clearly defined social networks. Therefore it is possible, that the potters at K2 and Mapungubwe, like the metal workers or bone tool craftsmen, may have formed part of a skilled group of manufacturers with close social relationships. Perhaps these groups were specialized/highly skilled artisans, and their main role in the society was to produce a range of specialist crafts, i.e. bone tool making, spinning textiles, gold smelting, smithing (see Miller 2001) and in this case ceramic making.

To further this interpretation, Voigt (1983:77) for example has successfully demonstrated a similar mastery of other materials such as bone and ivory, where it was possible for craftsman to develop abilities for the production of an assured supply, thus allowing for the developments of specialised craftsmen within the community. Voigt also states that at Mapungubwe these techniques in bone tool production were definitely refined and that a group of skilled bone tool working craftsmen were manufacturing well finished tools for daily use and trade (see Voigt 1983:77). The K2 and Mapungubwe society therefore supported such artisans who created structures for learning, transfer of skills and the use of ceramic technology.

Alternatively, the evidence may also suggest some sort of social control, craftsmanship and level of manufacturing care to produce 'high value' vessels, which may be the result of small-scale investment in a selection of ceramics that are produced solely for high status or ranked individuals (i.e. K2 beakers) or even the elite (i.e. the shallow bowls). Perhaps whilst ceramic manufacture was relatively widespread, the presence of the finely made shallow bowl-type vessels, which also show some pyrotechnical skill and apt choices of temper materials, may suggest semi-specialist producers for the elite. Calabrese (2005:370) states however that potters are usually the lower status groups, can also be seen as just the providers of raw materials and manual labour needed by the high ranked groups or the elite who controlled the economy and international trade system. It has already been demonstrated that the impact of trade with the east coast would have placed an inevitable demand on all spheres of production and supply to the K2 and Mapungubwe societies (Huffman 2009; Wood 2011) and in the same way affected ceramic production on various levels. Such interpretations are however are difficult to support.

Other internal factors such as agricultural innovations, cattle wealth and technological advances in gold, copper and iron production are thought to have played a much more significant role in the development of social complexity and state formation at Mapungubwe (see Huffman 2009:45). Did ceramic technology play a similar role in such developments at both sites? Nevertheless, since K2 and Mapungubwe vessels are found abundantly in diverse contexts, it is accepted that ceramics were made for both a domestic and a social role, and were possibly produced either by family groups on a regular domestic basis or by specialist artisans who may have held social status within the community.

A useful analogy, which can be useful, is found among the Wallaga potters in Ethiopia (see Wayessa 2011). In this traditional context, specialist potters or artisans (craftsmen) such as metal workers fall within a prescribed social group together with the healers and rainmakers known as 'the skilled ones' (Wayessa 2011:305). This status is determined by birth or based on their status by paternal lineage into a group that practice skilled pottery making. There are also 'commoner' artisans such as weavers, basket-makers and woodcarvers who are not ascribed to any social category. This may have been the case at Mapungubwe, where according to Pikirayi (2007:289) the ceramics show evidence of specialization and artistic elaboration such as the highly burnished shallow bowls and reduced-fired black vessels. Even the K2 burial beakers with fine fabrics could have been manufactured by a skilled group and not necessarily a lower status group as implied (see Calabrese 2005:370). The Mapungubwe potters, in particular may therefore have played an important role that maintains the socio-political systems and technological skills of the society, but may not have necessarily shared an equal status of the elite.

While it is generally accepted that many of the ceramics transcend the domestic domain, one can also argue that there is control of ceramic production at all levels of manufacture. Ceramic technology stands in marked contrast to that of K2 and Mapungubwe metal technology (see Miller 2001, 2002), as fabrication studies have shown that the industry is solely male dominated (see Chirikure 2007). For example the finished metal objects of Mapungubwe, particularly the gold, are considered prestige items restricted to manufacture by, and for, a limited number of people who form an elite (see also Calabrese 2005). Could the opposite be concluded about the ceramic technology, that potters are labelled as 'commoners' just because of their low socio-economic status? There might have been two or more tiers or layers of ceramic potters at K2 and Mapungubwe, organized within a type of social class system. Unfortunately, none of the previous metal fabrication technology studies or the results from this study can conclusively prove such interpretations, but is none the less a stimulating perspective.

Again, to highlight this view, the Oromo potters in Wallaga in Ethiopia (see Wayessa 2011) as example are marked by common potters who take up pottery making just for economic reasons producing utilitarian vessels, and those which specialize in making certain types of vessels as full-time specialists with inherited/skilled knowledge, where pottery making is linked directly to kinship ties and is passed down through generations of potters. It is interesting to speculate that specialised or highly skilled ceramic technology may have been controlled at higher social and economic levels at Mapungubwe. Why? Because a potter's social identity corresponds to an intricate set of boundaries or social interaction networks, which are multifaceted and experienced by individuals (Gosselain 2000:189).

Unfortunately, there is no direct evidence to suggest that ceramic technology was concentrated in a single K2 or Mapungubwe potter community, or what social group or individual manufactured which ceramics. Jacobson (2005:124) previously posed the question of whether each family unit produced its own pottery or whether specialised potters made an appearance, particularly in light of the large populations inhabiting both K2 and Mapungubwe. He suggests that that potters living away from the main sites could have produced the pottery specifically for sale or exchange, but unless the variability of local clay and clay sources are pin pointed, these interpretations cannot be confirmed.

Southern African archaeology has yet to fully address such issues and provide more social interpretations for the K2 and Mapungubwe ceramic assemblages. There is no doubt a great deal of technological research remains to be done on ceramic manufacture before a clearer understanding of ceramic technology at K2 and Mapungubwe can emerge.

6.8. Closing remarks

This study provides preliminary evidence of ceramic technology of the K2 and Mapungubwe ceramic assemblages, which can be characterized by suggestions of technological continuity and assimilation, or the merging of choices between possible social groups (whether specialised or just highly skilled individuals). Yet, the evidence suggests no distinct fundamental changes in ceramic technology over the broad period AD 1000 – AD 1300. The K2 and Mapungubwe potters refined their vessel repertoires and made socially or personally-induced choices for particular shapes, forming methods, firing conditions, selective fabrics and specific techniques and even ceramic styles. Whilst ceramic style can include such technological choices, it is not limited to form, function and decoration. It is after all the potters who choose to select their clay sources, make particular vessel forms, a variety of shapes, surface finishing and decisions on how and why to decorate.

The apparent resistance to distinct technological change in the K2 and Mapungubwe ceramics over time, in spite of the already known major social, political and settlement changes suggests that potters continued manufacturing vessels with the same technical knowledge and may have transmitted such skills to and from generations. This statement supports the view of Manyanga (2007:8) that intermarriages, across ethnic and linguistic boundaries, trade and the grandmother/mother/daughter apprenticeship in pottery making and individual innovation may cause complications in the understanding of ceramics. It is suggested that the K2 and Mapungubwe potters adapted vessel forms and decorative motifs to the new concepts and changes mirrored by their social, political and immediate environment, but basic technological principals continued to guide a constant manufacturing sequence from AD 1000 to AD 1300.

This study has presented new findings regarding ceramic fabrics, forming and finishing techniques, as well as highlighted firing conditions, thereby elucidating aspects of ceramic technology at K2 and Mapungubwe during the second millennium AD. The study also demonstrates that the complete K2 and Mapungubwe ceramics should not be overlooked as analytical material in favour of potsherds as they also have the potential to provide answers beyond their typology. The undecorated vessels and sherds should also not be neglected in ceramic analysis as they not only dominate the assemblages but are just as integral to the ceramic repertoire of K2 and Mapungubwe as the ones that are decorated.

In addition, this study supports the view that "ceramics and their manufacture were not just conservative items of material culture or passive technological tools" (Lindahl and Pikirayi 2010:148). It is clear that the K2 and Mapungubwe potters did not just make beakers, shallow bowls or recurved jars with narrow necks and thin walls without having experienced and learned those technical skills from someone else. In their *chaîne opératoire*, knowledge and skills were necessary to understand the properties of clay, to transform a formless mass of clay into a desired vessel that will retain its shape. The technical knowledge to be a successful potter requires practice. It is a socially embedded process, a technical skill, which is socially transmitted through time and space. It is hoped that the K2 and Mapungubwe ceramic assemblages will be re-examined and viewed beyond their stylistic use. Future research ought to be more informed about ceramic technology of how and why potters make pots as a means to explore the social implications for transformation in southern African Iron Age societies.

Final conclusions will be drawn in the following chapter, the research questions from Chapter 1 will be addressed, and it is hoped that this study and future ceramic technological research, including fabric analysis and local clays, will be the basis for the research into the continuity and change of ceramic traditions found at K2 and Mapungubwe. Less typology and more technology studies on southern African Iron Age assemblages should also receive justifiably more attention as a potentially valuable tool in archaeological ceramics research in South Africa.

CHAPTER 7

7. Conclusion

This study has revealed ceramic technological evidence from the K2 and Mapungubwe vessels dated from AD 1000 to AD 1290, in the Shashe Limpopo Confluence Area. A salient problem that has persisted for decades is that ceramic technology of the K2 and Mapungubwe ceramic assemblages has been poorly understood. As Dobres and Hoffman (1994:214) state, "it is only through detailed empirical identification of technical attributes, sequences, and the *chaînes opératoires* that a more comprehensive… understanding of prehistoric technology can emerge'' The complete vessels within the K2 and Mapungubwe ceramic assemblages have therefore provided the ideal opportunity to elucidate aspects of early second millennium AD ceramic technology of southern Africa's Iron Age.

The aim of this study was to provide ceramic manufacturing evidence using integrated methods and the *chaîne opératoire* approach, to allow for broad suggestions to be made that ceramic attributes or variables reflect technical choices within this assemblage. This perspective concurs with the views of Van der Leeuw (1993) that technology works within broader social and cultural contexts by investigating each step in the operational sequence while questioning the choice of particular techniques used in the ceramic manufacturing process. The *chaîne opératoire* has therefore provided a conceptual perspective for bridging the gap between ceramic attributes and technical choices. To test this hypothesis a range of analytical variables were used to characterize the morphological, compositional and technological properties of the K2 and Mapungubwe ceramics.

This technological study is also the first of its kind on the complete vessels within the K2 and Mapungubwe ceramic assemblages. The research has further achieved its main goal of identifying technological traces of evidence left on the surface of the ceramics. The thesis adopted a three-pronged approach to characterize ceramic technology of twenty-six vessels. This included a morphological (including typological), technological and compositional analysis to provide a multi-dimensional characterization of both the macroscopic and microscopic composition of the ceramics. This holistic approach outlined particular choices made at the various steps in the operational sequence of ceramic manufacture and brought to light aspects of technology relating to raw materials, vessel formation and firing conditions.

Not all the steps in the *chaîne opératoire* were however investigated as these were beyond the scope of the study. Therefore other aspects related to ceramic technology such as tools used to the shape the ceramics, manufacture sites and ceramic production as such were not detailed. Results from the study focused on four major factors within the operational sequence: fabric, forming, firing and finishing. Evidence has shown that the ceramic fabrics relate to the types of clay, some of which were rich in calcium while other clays were more iron rich, as well as to clay selection, preparation and quality of the clay. Three fabric groups were identified namely fine, medium and coarse fabrics that enabled interpretations to be made about the variability of raw materials, their exploitation and the manipulation of clay used in the ceramic manufacturing process. The results reveal that the mechanical and thermal properties of the ceramics were, intentionally or unintentionally, modified by the introduction of tempered inclusions whose density, frequency and size affected the overall properties of the ceramics.

These choices of temper in turn have an effect on the final product when forming, shaping, firing and finishing the ceramics, thereby controlling to a certain degree the final quality of the vessel produced. Although evidence was not clearly visible to determine patterns relating to specific primary forming techniques, macroscopic analyses demonstrated that the vessels were scraped to further the shaping and forming process, then wiped and smoothed, then afterwards selectively burnished or decorated. The finishing processes related more to fabric than to vessel types. Burnishing was also not restricted to only Mapungubwe vessels but to beakers and K2 burial vessels as well. As opposed to the commonly high glossy burnish of the Mapungubwe vessels, the K2 vessels also exhibited low burnish finishes. Therefore, for the first time, this study provided physical evidence from complete vessels that revealed evidence for both primary and secondary forming techniques, which are rarely visible on ceramic sherd analysis.

This study further provided a plausible explanation for the variable colour observed on the ceramics, as a result of the chemical and elemental composition of the clay as well as from the firing process. Three firing conditions were identified, i.e. oxidized, unoxidized and partially oxidized, and provided information on the effects of the firing process that relate to temperature, atmosphere and duration. The manufacturing of the shallow bowls for example required a selection and refinement of raw materials to produce fine-tempered clay, as well as uniform oxidized firing conditions to produce a high quality vessel. Chemical analyses also revealed the use of kaolinite clay not commonly associated with the immediate geology of the Mapungubwe landscape.

This suggested that the production of high-quality vessels was based perhaps on a selective clay source, which required more labour and specialized skills. This further demonstrates that certain ceramic technological traditions may have been informed by technical choices within socially relevant groups and not necessarily determined by environmental constraints.

The compositional analysis for this study has further provided valuable information on the mineralogical and chemical composition of the ceramics, enabling the physical properties of the vessels to elucidate surface traits that relate to technology (Rice 1987). This study has also proven that XRF and XRD as non-invasive methods are found to be relevant and appropriate techniques for ceramic characterization *in situ*, as well as a useful accessory method for ceramic technological studies. Overall the identification of the physical properties of the clay and the chemical composition has contributed to a greater understanding of choices in ceramic technology and the social implications related to it (Sillar and Tite 2000).

This study has shown that raw materials, ceramic fabric, temper inclusions, forming, firing and finishing affect the manufacture process, as well as the quality and durability of the end product. It is suggested that the K2 and Mapungubwe potters progressively understood the boundaries of influencing the physical composition and quality of the ceramic, perhaps determining its eventual use and function within a burial or domestic context. It is apparent that that a comprehensive understanding of ceramic technology and its social implications can be obtained through an integrated approach, validating the potential of technological analysis going beyond the usual stylistic typology for southern African archaeological ceramics in particular.

This study has also demonstrated that whilst K2 and Mapungubwe potters supposedly shared the same basic technological principles about local ceramic manufacture, subtle differences are also present and the evidence alludes to better chances of continuity as opposed to any distinct changes in technology. Though, typological and stylistic changes did occur during the K2 Transitional period, as some characteristic vessel forms were discontinued like the spouted vessel for example, new vessel forms such as the shallow bowls were introduced. This transition from K2 to Mapungubwe remains poorly understood and only further ceramic analysis focusing on this particular period, AD 1220 – AD 1250 will prove constructive.

The question of whether a single ceramic technological tradition created the diverse amount of ceramics at K2 and Mapungubwe, or whether there were several ceramic communities for two chronologically distinct sites cannot yet be answered.

Ceramic technology is assumed to have been small-scale and performed at a domestic level at K2, and thus relying mainly on personal or social choices and preferences embedded within the rank-based society. In contrast, within the elite-based society, Mapungubwe potters may have manufactured ceramics within more stricter socio-cultural parameters such as choices of shaping techniques, for example preferences for finer vessels such as shallow open forms and in the application of quality of decoration, particularly for those vessels, which served an elite purpose. These slight but significant variations observed between the K2 and Mapungubwe vessels seem to be a result of dynamic and changing principles of technical constraints, choices and preferences of the potters, either determined by daily consumption or by elite demand. The daily use of utilitarian vessels by the commoners would differ from the vessels valued by the more important elite, thus possibly changing ceramic technology from 'domestic' amateur to specialist 'professional'. In order for this assumption to be conclusive though, much more ceramic evidence would be needed and compared within the Mapungubwe social, economic and political context.

This study has provided significant insights into the nature of ceramic technology within the Shashe Limpopo Confluence Area. The broader picture of K2 and Mapungubwe that emerges is one of an expanding technological society, changing technical commonalities, vessel forms, selection of decoration and in the process making, if only subtle, technological choices. It appears that from about AD 1220 with the emergence of the hierarchical social elite, ceramic quality-making changed, although only considered minor technological changes in vessel manufacture, the elaborate Mapungubwe Hill shallow bowls serve as significant examples. Ceramics as indicators of social and cultural change, as well as economic change, would conceivably result in the development of a more standardized and diverse repertoire of vessels as seen manufactured from the early K2 vessels to the later vessels found on Mapungubwe Hill, although technologically there is only a slight change over time.

Over this approximate two hundred and fifty-year time span, ceramic changes are inevitable but appear more evident of a transitional ceramic technology than a definitive change. There is a continuation of ceramic technological tradition between the K2 and Mapungubwe periods, with little indication for the Transitional K2 period, but no evidence for a complete cultural technological break. The technological similarities within the ceramic assemblage are neither accidental nor simply constituted. The ceramics essentially reflect decisions regarding material choices that relate to the understanding of clay and its properties within social and cultural traditions; these in turn reflect individual and group interactions, movements of people, choices and notions of conformity or individual identity and creativity.

Owing to the archaeological significance of these ceramic assemblages within the context of understanding changes and continuity in the second millennium AD, there are still major short-comings and areas of ceramics research, which may be recommended for future studies. In addition, the mass of ceramic evidence available and accessible in existing stored collections allows evidence for objects-based research opportunities without the need for further destructive excavations. Future research could build on the results of this study by including much wider sampling and comparative strategies extending compositional analysis to the Transitional K2 period, as well as Mambo and Zhizo vessel types in the K2 assemblages. While, analytical restrictions on museum collections may be limited, functional and technological studies can be expanded to determining quantitative relationships between whole vessels and diagnostic sherds. Furthermore, much more detailed fabric analysis of the vessels such as K2 beakers and Mapungubwe shallow bowls would be useful to determine whether fine tempered vessels were restricted to these vessel types.

Contextual studies of burial ceramics, use-wear and residue analysis may shed light on their symbolic and social uses as well. On a more holistic level there is a need for supplementary integrated methods of approach, chemical analysis to understand ceramic signatures and more studies needed on ceramic function, use and ceramic production. The linking of clay sources to the ceramics, discovery of firing pits or kilns and excavation of ceramic production sites within the K2 and Mapungubwe landscape could further serve to evaluate some of the findings put forward in this thesis. Although many typological, stratigraphic and chronological studies have been done on the ceramic assemblages, the surviving few complete vessels have received very little analytical attention.

One of the major hindrances to furthering research on the Mapungubwe collection is the restriction of destructive analysis and most often the restrictive limitations of analysis on complete artefacts, coupled with lack of funding for research and permitting for example may take a number of years for final approval. Nonetheless, despite these limitations, this thesis addressed an obvious research gap in the K2 and Mapungubwe ceramic assemblage and it is hoped that others will pursue more ceramic fabric analysis. This preliminary ceramics research is significant as it contributes technological information with non-invasive analysis required, nor were required further excavations required on an already sensitive and nationally important world heritage site. Even though this technological analysis had to be selective on the basis of using whole museum vessels, taking into account unavoidable constraints on national heritage ceramics, it is difficult to assess whether these preliminary findings carry potential resolve, as the results are not always immediately expressive without more quantitative data.

As in archaeological research, the choice of data is not only determined by the questions to be answered, but also by accepted limitations of the choice of approach as well as any restrictions placed on research process by permitting, funding and time frames. Technology, nevertheless remains an important avenue for archaeological ceramics research, and reflects only a small fraction of the amount of analysis still needed to be done in order to fully comprehend the broader regional continuity and change of ceramic manufacturing within the Shashe Limpopo Confluence Area during the second millennium AD in southern Africa.

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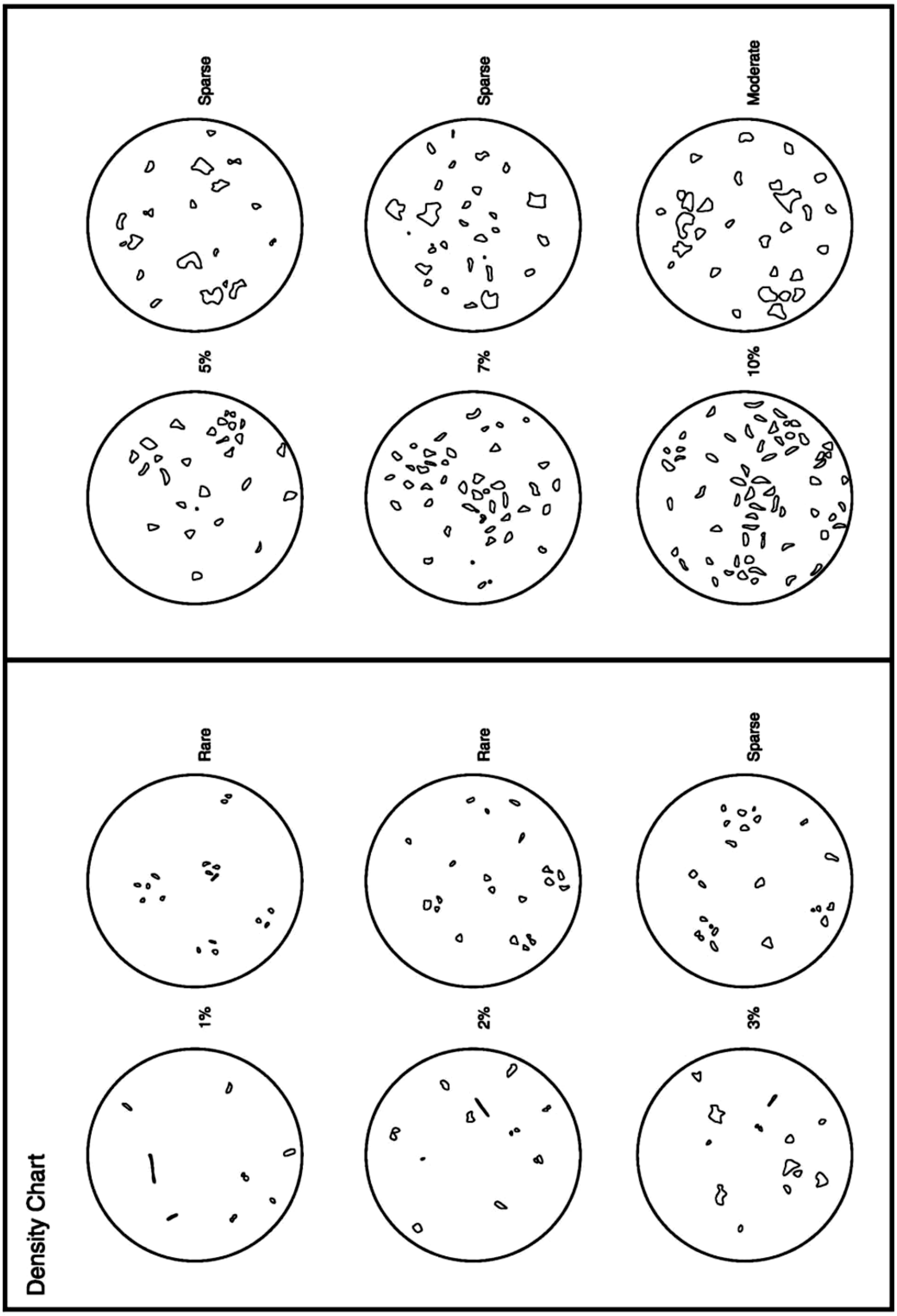
Appendix 1: Summary of vessel chronology and context data

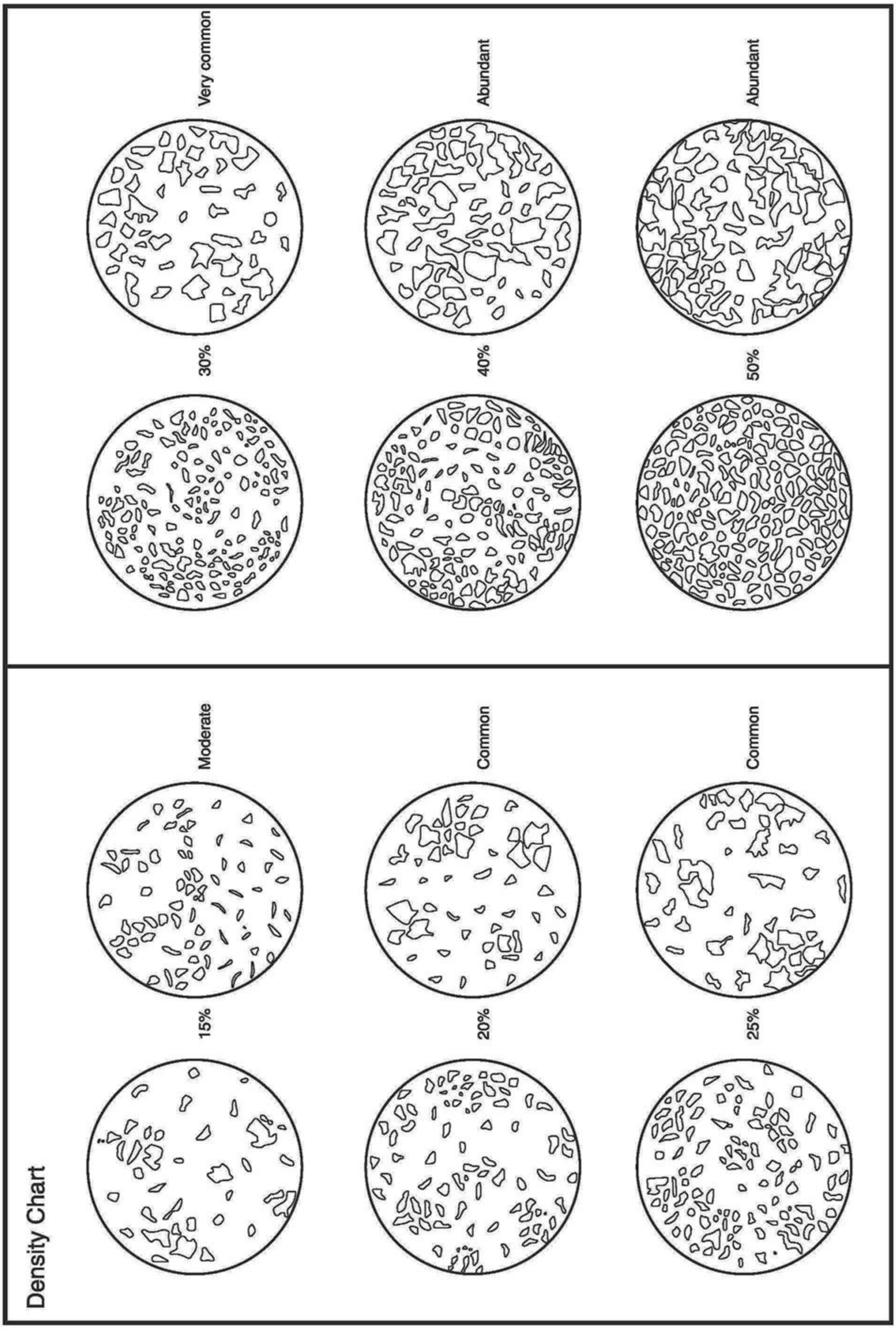
ID.	# Acc. Mus. nos.	Fabric Type	Ceramic Type	Locality	Site Context	Excavation Context	Estimated date range
1	N/248	Medium	Zhizo	K2	Block 4 Section 7 3' 10' 3' (no 30/37)	Occupation area (midden)	AD 900/ 1000 – AD 1030
2	N/252	Medium	Mambo	K2	KS 38 (skel.). Block 3 Section 5 10' 2' 2"	Human burial (juvenile)	AD 900/1000 – AD 1030
3	N/283	Fine	K2	K2	KS 48 (skel.). Block 3 Section 7 15' 21' 2"	Human burial (juvenile)	AD 1030 – AD 1220
4	N/280	Fine	K2	K2	Block 3 Section 9 depth 3' 22' 3'	Occupation area (midden)	AD 1030 – AD 1220
5	N/273	Fine	K2	K2	Beast burial 6 Block 4 Section 6	Cattle burial	AD 1030 – AD 1220
6	N/433	Fine	K2	K2	Block 2.2. Section 12 12' 6' 2' (No.4)	Occupation area (midden)	AD 1030 – AD 1220
7	N/259	Medium	K2	K2	Beast burial 6, Block 4 Section 6 4' 7' 56"	Cattle burial	AD 1030 – AD 1220
8	N/264	Medium	K2	K2	K2 surface	Surface area	AD 1030 – AD 1220
9	C/421	Medium	K2	K2	Test Pit 8 no.4	Occupational area	AD 1030 – AD 1220
10	C/2198	Fine	K2	K2	Block 2 Section 2	Occupation area (midden)	AD 1030 – AD 1220
11	N/275	Medium	Transitional K2	Mapungubwe Hill	Block 5 Section 1 14' 42' 3' (1939)	Occupation Area	AD 1200 - AD 1250
12	N/397	Medium	Transitional K2	Mapungubwe Hill	Mapungubwe Hill Block 7 Section 6	Occupation area	AD 1200 - AD 1250
13	N/398	Medium	Transitional K2	Mapungubwe Hill	Mapungubwe Hill Original grave area 33.161	Grave area burial	AD 1200 - AD 1250
14	N/390	Medium	Transitional K2	Mapungubwe Hill	Eastern excavation area erosion near peg.C.	Palace area	AD 1200 - AD 1250
15	N/404	Coarse	Mapungubwe	Mapungubwe Hill	Trench JS4 120' 2' 6"	Occupation area	AD 1220 - AD 1290
16	N/403	Fine	Mapungubwe	Mapungubwe Hill	Mapungubwe grave area west ext. no 1A	Human burial	AD 1220 - AD 1290
17	N/219	Medium	Mapungubwe	Mapungubwe Hill	Mapungubwe Hill Skel. 14 Grave Area Exc. Nos. 00	Grave area/burial	AD 1220 - AD 1290
18	N/220	Fine	Mapungubwe	Mapungubwe Hill	Grave Area Burial, skel.11	Human burial	AD 1250 - AD 1290
19	N/221	Fine	Mapungubwe	Mapungubwe Hill	Mapungubwe Hill Grave Area Exc. Nos.00	Grave Area/burial	AD 1250 - AD 1290
20	N/266	Coarse	Mapungubwe	Mapungubwe Hill	Block 1 Section 4, 10' 41' 4'	Occupation Area	AD 1220 - AD 1290
21	N/484	Medium	Mapungubwe	Mapungubwe Hill	Block 5 Section 4 15' 4' 8'	Occupation Area	AD 1220 - AD 1290
22	N/224	Medium	Mapungubwe	Southern Terrace	Trench JS 2b	Court area	AD 1200 – AD 1250
23	C/428	Medium	Mapungubwe	Mapungubwe Hill	Mapungubwe Hill grave area	Grave area/ burial	AD 1250 - AD 1290
24	C/427	Medium	Mapungubwe	Mapungubwe Hill	Mapungubwe Hill surface/ trench JS5	Palace area	AD 1220 - AD 1290
25	N/376	Medium	Mapungubwe	Mapungubwe Hill	Block 5 Section 5 ,60' 1' 9'	Occupation Area	AD 1220 - AD 1290
26	C/2196	Fine	Mapungubwe	Mapungubwe Hill	Block 5 Section 2 25' 5' 5'	Occupation Area	AD 1220 - AD 1290

Appendix 2: Summary of vessel descriptions, typology and morphology

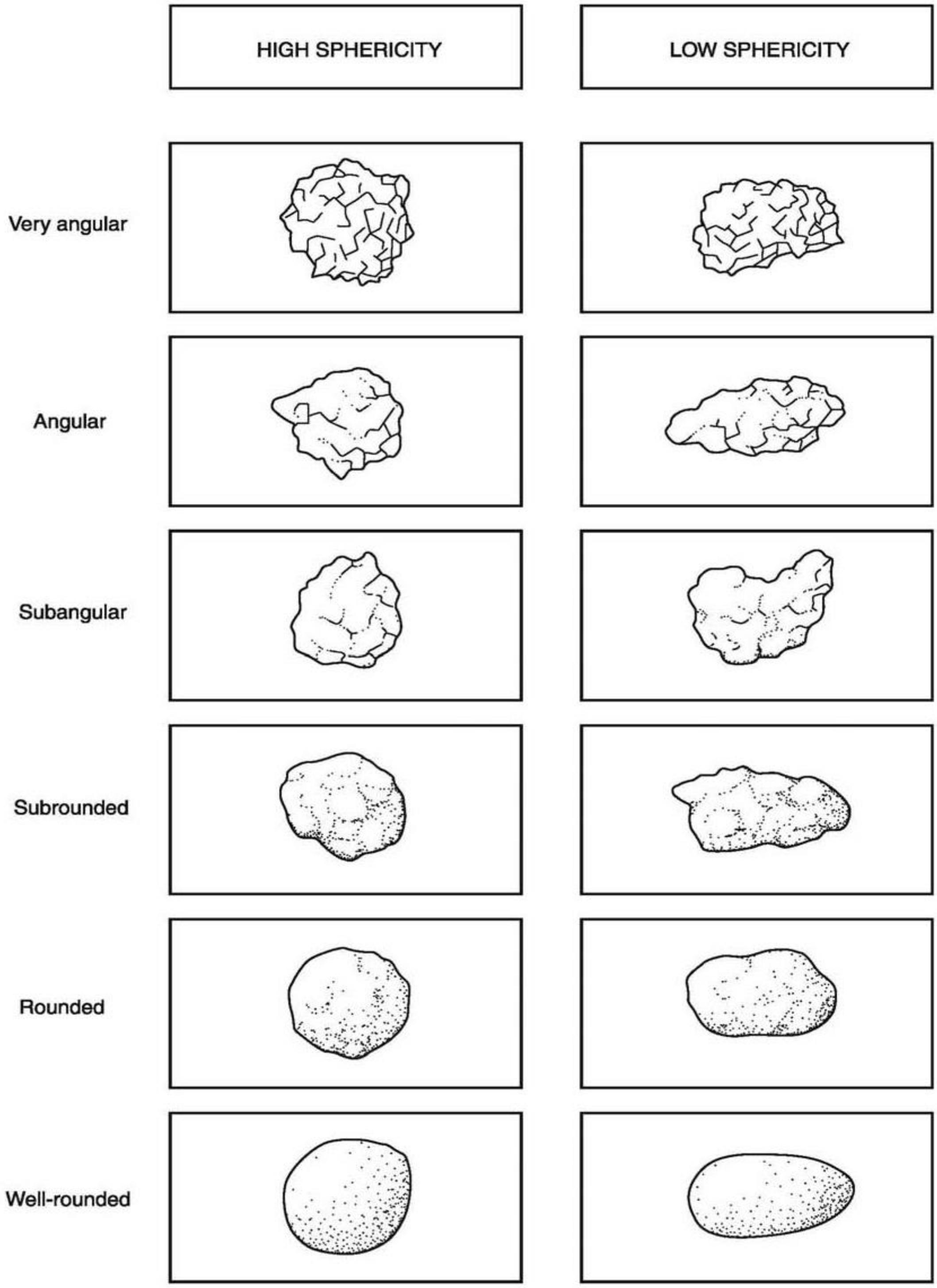
ID.	Fabric	Forming	Ceramic Type	Vessel Shape	Vessel Type	Structural Type	Measurements height x width	Orifice mm	Decoration /and form elements
1	Medium	Undetermined	Zhizo	Ovaloid	Globular jar	Restricted	334mm x 277mm	103mm	Comb-stamped diagonal band, central neck
2	Medium	Undetermined	Mambo	Spherical	Recurved jar	Restricted	145mm x 152mm	99mm	Incised arcades upper neck
3	Fine	Possibly coiled	K2	Cylindrical	Vertical beaker	Unrestricted	108mm x 91mm	80mm	Incised cross-hatch band, perforations
4	Fine	Undetermined	K2	Cylindrical	Flared beaker	Unrestricted	122mm x 119mm	112mm	Incised band on body, single boss/flange
5	Fine	Undetermined	K2	Cylindrical	Beaker bowl	Unrestricted	114mm x 197mm	188mm	Incised diagonal triangle band on lower body
6	Fine	Undetermined	K2	Spherical	Spherical jar	Restricted	125mm x 167mm	98mm	Incised diagonal triangle band on upper rim
7	Medium	Undetermined	K2	Spherical	Spouted jar	Restricted	196mm x 270mm	202mm	Undecorated with tubular spout
8	Medium	Possibly coiled	K2	Ellipsoid	Deep bowl	Unrestricted	137mm x 350mm	335mm	Undecorated
9	Medium	Undetermined	K2	Hemispherical	Bowl	Unrestricted	76mm x 166mm	156mm	Undecorated
10	Fine	Possibly pinch	K2	Hemispherical	Bowl	Unrestricted	43mm x 98mm	88mm	Undecorated
11	Medium	Possibly coiled	Transitional K2	Cylindrical	Beaker bowl	Unrestricted	144mm x 170mm	147mm	Scored, shallow rounded incisions
12	Medium	Possibly coiled	Transitional K2	Ovaloid	Recurved jar	Restricted	417mm x 420mm	300mm	Incised upright triangles, upper shoulder
13	Medium	Undetermined	Transitional K2	Spherical	Recurved jar	Restricted	350mm x 458mm	262mm	Incised downward triangles, upper shoulder
14	Medium	Undetermined	Transitional K2	Spherical	Recurved jar	Restricted	215mm x 277mm	163mm	Incised downward triangles, upper shoulder
15	Coarse	Undetermined	Mapungubwe	Spherical	Recurved jar	Restricted	356mm x 440mm	214mm	Undecorated
16	Fine	Possibly coiled	Mapungubwe	Ellipsoid	Recurved jar	Restricted	295mm x 362mm	204mm	Undecorated
17	Medium	Possibly coiled	Mapungubwe	Ellipsoid	Globular jar	Restricted	265mm x 360mm	114mm	Incised cross-hatch triangles and diamond
18	Fine	Undetermined	Mapungubwe	Ellipsoid	Shallow bowl	Unrestricted	47mm x 250mm	214mm	Punctates, incised zigzags, ridged flanges
19	Fine	Undetermined	Mapungubwe	Ellipsoid	Shallow bowl	Unrestricted	66mm x 225mm	184mm	Incised band, triangles on base, ridged flanges
20	Coarse	Possibly pinch	Mapungubwe	Ellipsoid	Shallow bowl	Unrestricted	86mm x 323mm	295mm	Undecorated, raised horizontal cordons/feet
21	Medium	Undetermined	Mapungubwe	Spherical	Deep bowl	Restricted	117mm x 197mm	153mm	Incised single band on upper body
22	Medium	Undetermined	Mapungubwe	Ellipsoid	Incurvate bowl	Restricted	97mm x 202mm	105mm	Incised downward cross hatch triangles
23	Medium	Undetermined	Mapungubwe	Ellipsoid	Incurvate bowl	Restricted	67mm x 124mm	63mm	Undecorated
24	Medium	Possibly pinch	Mapungubwe	Ellipsoid	Incurvate bowl	Restricted	69mm x 120mm	75mm	Undecorated
25	Medium	Undetermined	Mapungubwe	Sub-spherical	Incurvate bowl	Restricted	115mm x 137mm	88mm	Undecorated, perforation upper rim
26	Fine	Pinch formed	Mapungubwe	Ovaloid	Pinch pot	Unrestricted	49mm x 47mm	35mm	Undecorated

Appendix 3: Inclusion density chart for estimating proportions of inclusions identified in the ceramic fabric for visual representation (Prehistoric Ceramics Research Group 2010: 48-49)




Density Chart
15%
Moderate
20%
Common
25%
Common
30%
Very common
40%
Abundant
50%
Abundant

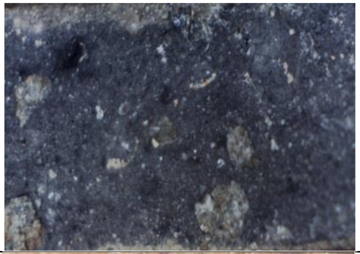
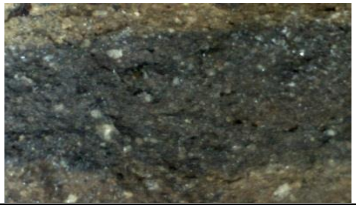
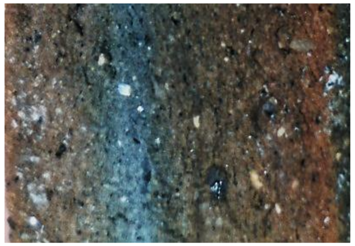
Appendix 4: Categories of roundness grain and shape chart (Prehistoric Ceramics Research Group 2010:52)

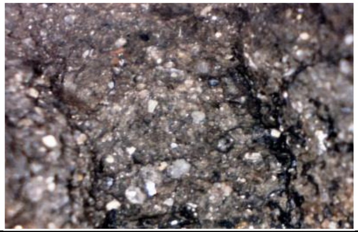
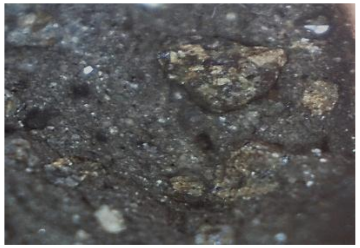


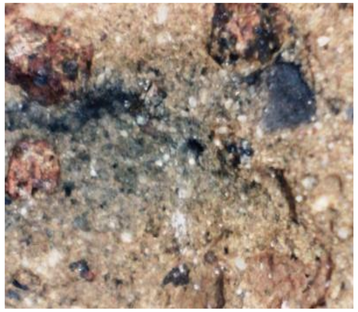
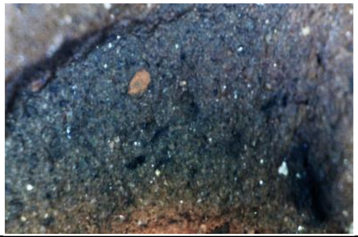
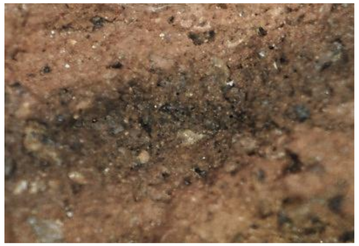
Appendix 5: Summary of elemental concentrations (in ppm) for all vessels characterized by XRF

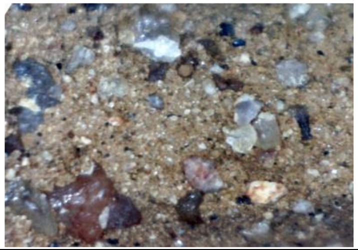
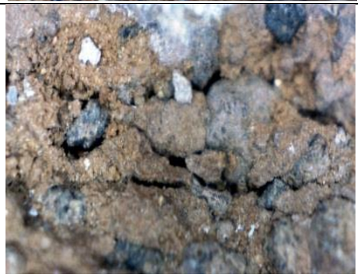
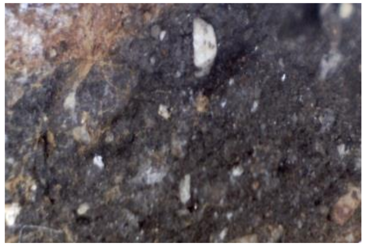
ID.	Source	Fabric	K	Ca	Ti	Mn	Fe	Zn	Zr	Sr	Rb	Th	Cu	Ni	Cr	V	S
1	K2	Medium	30535.97	64105.33	3247.2	524.71	29065.3	156.37	218.11	336.6	47.96	17.27	103.73	52.67	26.88	74.7	0
2	K2	Medium	37325.55	61546.57	6005.93	837.06	44144.08	83.61	367.6	454.5	68.09	10.35	58.59	62	77.15	64.8	8364.07
3	K2	Fine	22823.59	39270.09	5982.03	524.19	36200.54	56.8	477.54	289.4	47.36	21.57	114.03	0	98.81	81.1	6476.44
4	K2	Fine	23089.12	38294.4	6707.2	503.59	43917.79	58.07	666.55	308.2	88.13	0	43.99	66.75	100.34	50.8	22419.4
5	K2	Fine	51898.61	22717.31	6476.78	2085.4	42152.65	96.81	414.37	555.8	73.03	8.1	60.26	134.56	99.39	71	634.32
6	K2	Fine	20150.31	15240.48	6030.13	965.02	35745.84	80.75	427.97	271.7	67.71	0	55.25	53.45	36.3	38.1	6586.31
7	K2	Medium	31529.8	18528.72	7334.46	736.59	47439.47	48.36	396.01	352.8	84.34	14.59	69.38	145.09	137.8	131	18044.1
8	K2	Medium	40916.45	71310.62	3596.11	458.59	23134.34	95.4	284.23	518.2	95.01	7.35	67.23	112.78	110.29	76.4	647.45
9	K2	Medium	27814.09	26460.25	5112.64	544.23	34260.85	84.52	213.36	321	90.39	9.33	56.7	75.57	136.82	83	1637.84
10	K2	Fine	30248.46	44204.15	6746.65	513.99	35844.16	51.59	406.99	333.6	94.36	8.15	61	85.32	105.78	66	3563.81
11	Transitional	Medium	28672.08	99937.74	4485.43	1391.1	30741.55	61.67	389.2	324.8	106.22	9.73	58.42	105.47	40.16	33.9	3121.21
12	Transitional	Medium	22208.39	92108.22	3978.87	560.96	32100.43	113.3	229.16	288	90.77	11.89	50.56	47.77	64.53	394	0
13	Transitional	Medium	16118.04	49954.37	3009.74	472.42	28491.41	52.66	373.18	228.5	35.24	0	42.99	71.05	96.96	45.1	4991.09
14	Transitional	Medium	20666.65	123504.6	2416.55	639.13	28101.24	72.96	399.23	283	54.7	10.16	99.91	81.82	117.94	98.8	5022.1
15	Mapungubwe	Coarse	21736.3	17658.68	6428.45	528.07	35164.09	59.82	390.22	286.4	97.33	12.12	59.19	58.51	164.42	76.5	11138.3
16	Mapungubwe	Fine	20498	30861.2	5264.35	497.56	37612.6	114.08	174.47	282.4	84.29	14.69	63.04	0	0	0	15042.3
17	Mapungubwe	Medium	18652.45	52850.01	6041.71	837.24	40931.79	50.97	352.19	271.1	51.87	17.55	65.47	0	0	390	0
18	Mapungubwe	Fine	31143.38	24140.69	6910.93	679.71	40140.72	95.66	503.48	345.3	75.09	0	104.38	148.65	63.77	57.1	14425.3
19	Mapungubwe	Fine	34940.84	27052.16	6588.35	657.47	39146.63	174.21	396.14	448.5	90.92	9.63	66.41	81.71	143.53	73.1	1247.94
20	Mapungubwe	Coarse	34269.17	19824.32	7292.67	674.05	34395.46	94.49	409.53	382.4	83.52	11.83	65.55	35.07	99.52	94.4	4490.66
21	Mapungubwe	Medium	18221.75	48025.29	2758.45	195.94	21460.02	25.22	277.6	263.7	97.4	6.88	44.44	0	125.05	36	7963.59
22	Mapungubwe	Medium	16335.82	34000.88	3330.95	400.31	31197.36	58.6	369.66	246.4	42.73	7.07	41.24	32.71	47.09	54.7	3379.17
23	Mapungubwe	Medium	15329.81	51767.92	5689.28	522.67	38660.95	58.81	341.2	214.7	69.03	5.95	44.84	48.11	136.79	102	3052.17
24	Mapungubwe	Medium	34901.44	21738.43	6655.16	1555.9	33243.46	58.97	408.22	424.8	89.03	9.3	42.88	79.16	181.55	67.7	9802.07
25	Mapungubwe	Medium	32672.03	22062.99	7394.2	583.38	39236.13	66.34	532.11	357.2	103.83	11.1	65.77	70.33	84.66	110	5371.39
26	Mapungubwe	Fine	26564.51	28531.95	5375.42	541.64	31086.32	75.36	451.91	308.5	68.02	0	76.08	72.4	112.54	74.7	8117.51

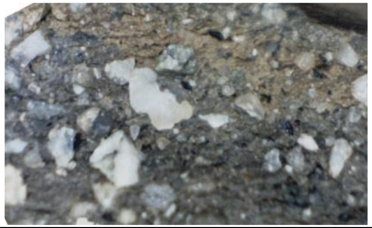
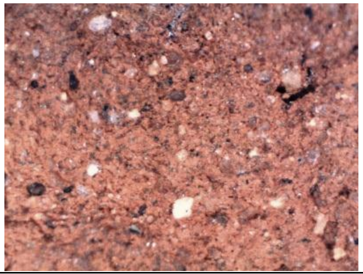
Appendix 6: Summary data of ceramic composition and fabric analysis

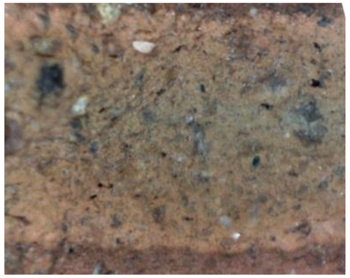
ID	FABRIC TYPE	MACROSCOPIC IMAGE	TYPE OF INCLUSIONS	FREQUENCY	SHAPE	SORTING	SIZE RANGE	XRF	XRD
1	Medium		Predominant clusters of clear (glassy) white (<30%-common) inclusions within a dense, seemingly non-porous smooth fabric. Exposed area on lower exterior body exhibits distinct red/brown (oxide possibly) inclusions (<1.0mm). Reflective micaceous specks also present.	<26-40% Common	Rounded	Poorly sorted	0.25mm to 0.41mm	X	-
2	Medium		Moderate amounts of glassy white, 0.21mm and dark black shiny, (rare 1%) inclusions with clusters of red earthy inclusions (0.53-0.74mm) and reflective specks. Fabric has a distinctive sand-papery nature resulting in a sandy texture.	<11-25% Moderate	Sub-rounded and angular	Poorly sorted	0.21mm to 0.74mm	X	-
3	Fine		Very small fragments of mostly opaque and clear white inclusions, irregular voids (10-15%) are visible as well as reflective micaceous specks. Irregular voids with smooth textured fabric.	<11-25% Moderate	Rounded and sub-rounded	Well sorted	0.6mm to 0.25mm	X	-
4	Fine		Very small fragments of light and dark inclusions, opaque white (quartz) inclusions are dominant with <1% dull black inclusions as well as reflective micaceous specks are visible. Smooth fracture, no visible irregularities, dense, non-porous appearance of fabric.	<3- 10% Sparse	Some angular, rounded and sub-rounded	Well sorted	0.18mm to 0.34mm	X	-

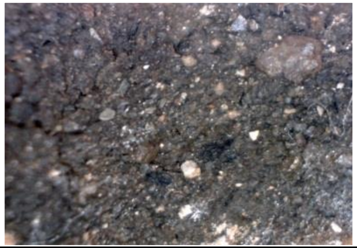
5	Fine		Size of light and dark inclusions generally small, clear glassy white (quartz) are dominant with <3% dull black inclusions. Presences of 2% very small voids are visible as well as reflective micaceous specks.	<26-40% Common	Rounded	Well sorted	0.10mm to 025mm	X	-
6	Fine		Very small opaque and translucent glassy white inclusions in abundant quantities (>25%). Shiny and dull black inclusions (>15%) as well as reflective micaceous specks. Relatively grainy, sandy irregular fabric texture.	<40% Abundant	Rounded, sub-rounded and sub-angular	Poorly sorted	0.6mm to 0.25mm	X	-
7	Medium		Very small sandy (angular) light brown (0.15mm) and rounded black shiny (0.34) inclusions in rare quantities (visible on surface) with very common opaque white (rounded) and dominant clusters of glassy white (0.48) inclusions of more than 30% in a sandy fabric.	<26-40% Common	Rounded and angular	Poorly sorted	0.15mm to 0.48mm	X	-
8	Medium		Light white (quartz) inclusions (5%) and dull black inclusions within a sandy, irregular friable matrix with a more porous appearance. Exposed surface exhibits voids which form ovals or spheres (>1mm).	<3- 10% Sparse	Sub-rounded and angular	Poorly sorted	0.32mm to 0.52mm	X	-

9	Medium		Several types of various coloured inclusions. Mostly white opaque sub-angular inclusions (0.98mm) with common amounts <25% of dull black, clusters of glassy white as well as small (0.13-0.39mm) red-earthy inclusions. Minerals identified are quartz, albite and microcline feldspars, diopside and muscovite.	<26-40% Common	Round, angular, sub-angular	Poorly sorted	0.19mm to 0.98mm	X	X
10	Fine		Sandy coloured (0.17mm) grains, very small fragments of white and black inclusions. Very small opaque white (calcite/quartzite) and large clear glassy grains probably quartz , albite, muscovite (mica) and rutile (red mineral)	<3% Rare	Rounded	Well sorted	<0.25mm	X	X
11	Medium		Moderate amounts (>10%) of light opaque and glassy white (0.14mm) rounded inclusions and sparse quantities (3-5%) black, 0.12-0.38mm inclusions. Sub-rounded voids (0.61mm) 2% with a sandy appearance, irregular and widely spaced gaps also visible.	<11-25% Moderate	Rounded and sub-rounded	Poorly sorted	0.12mm to 0.61mm	X	-
12	Medium		Sparse frequency of glassy quartz (0.45mm) and opaque calcite (0.34mm) white inclusions, including dull black (magnetite) angular (0.41mm) inclusions Minerals present quartz, calcite magnetite, albite, orthoclase, gypsum, muscovite and enstatite.	<3-10% Sparse	Sub-rounded and sub-angular	Poorly sorted	0.34mm to 0.45mm	X	X

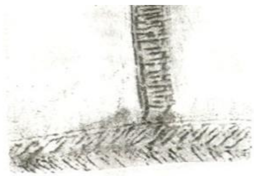
13	Medium		Common amounts of glassy and opaque white inclusions. Sandy textured with spaces created between more porous matrix. Minerals identified are quartz and calcite, albite, rutile, microcline, montmorillonite gypsum, cristobalite, anorthite.	<26-40% Common	Rounded and sub-rounded	Poorly	>0.25mm to 1.00mm	X	X
14	Medium		Clearly composed of several types of abundant colour inclusions, white (glassy and opaque), dull black (0.61mm) and shiny black (0.16mm) red (0.30mm) and grey grains, and reflective micaceous specks. Few spaces between matrix with a smooth fine, non-porous appearance.	>40- 50% Abundant	Rounded and sub-rounded	Well sorted	0.16mm to 0.61mm	X	-
15	Coarse		Granular fragments of dull black, shiny black (>0.43mm- 1.11mm) and very small white inclusions (<1%) visible on exposed rim. Very sandy texture with friable inclusions with gravelly nature and large voids present. Minerals identified are quartz, microcline, enstatite, albite and muscovite.	>40- 50% Abundant	Rounded, sub-rounded and angular	Poorly	<1.00mm to 3.00mm	X	X
16	Fine		Very small fragments of sparse amounts of mostly white glass and opaque (sub-rounded) white inclusions. Few voids with smooth texture, dense appearance of matrix. Minerals present are quartz, calcite, albite, microcline, diopside, rutile, gypsum, hydrophilite and tremolite.	<3-10% Sparse	Rounded and Sub-rounded	Well sorted	<0.11mm to 0.25mm	X	X

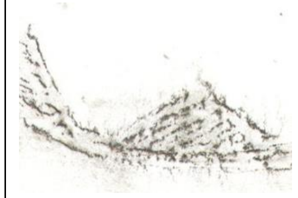
17	Medium		Dominant clear, glassy (>0.55) white (quartz) inclusions (50%) and opaque (calcite/quartzite) white /grey (0.16-0.38mm) inclusions. Sparse amounts of very small shiny black rounded inclusions (<3%) also visible in sandy dense texture fabric.	>40% Abundant	Rounded, sub-rounded, sub-angular	Well sorted	>0.10mm to 0.55mm	X	-
18	Fine		Size range of light and dark inclusions is small. Very small fragments of dull black grains are dominant (30 -40%), with grey, opaque white and clusters of glassy white grains. Reflective specks as well. Minerals identified as quartz, hematite, albite, kaolinite and microcline.	>40% Abundant	Angular rounded and sub-rounded	Well sorted	0.06mm to 0.22mm	X	X
19	Fine		Very few visible inclusions, very small fragments of glassy white, with the exception of a few larger white (<0.56mm) inclusions visible on abraded surface on the base. Micaceous reflective specks also present	<3% Rare	Rounded	Well sorted	<0.025 to 0.32mm	X	
20	Coarse		Abundant quantities of shiny and dull black inclusions (>1.00-3.00mm) as well as grey, red/brown inclusions with sparse smaller clear glassy and opaque white (0.16-0.43mm) inclusions visible on exposed abraded surface.	>40% Abundant	Rounded and sub-angular	Poorly sorted	0.14mm to 1.03mm	X	-

21	Medium		Small fragments of light and dark coloured inclusions in sparse quantities with clear glassy grains (quartz) and white glass grains (quartzite). Rare amounts of very small black shiny inclusions as well as reflective micaceous specks. Smooth texture with dense non porous appearance	<3- 10% Sparse	Sub-angular and angular	Poorly sorted	0.21mm to 0.69mm	X	-
22	Medium		Abundant >50% of clear glassy and translucent light-grey inclusions (quartz) and very small (0.03-0.07mm) fragments of black, round inclusions in moderate amounts (10-15%), reflective micaceous specks present. Distinct sand paper nature with dense non-porous matrix.	>40% Abundant	Rounded and angular	Poorly sorted	0.03mm to 0.84mm	X	-
23	Medium		Fabric based on visible surface inclusions on partially exposed rim, predominantly shiny black (>0.68mm) and white glassy inclusions >0.67 mm in common quantity. Smooth texture amount or size range of inclusions is small.	<26-40% Common	Rounded and sub-rounded, sub-angular	Poorly sorted	<0.25mm to 0.82mm	X	-
24	Medium		Light and dark coloured inclusions, mainly moderate amounts of clear white glassy (10-19%) and opaque white inclusions (0.26mm). Grey (0.21mm), shiny black (some elongated) and dull black angular inclusions in granular texture fabric.	>11-25% Moderate	Round, angular	Poorly sorted	0.21mm to 0.49mm	X	-

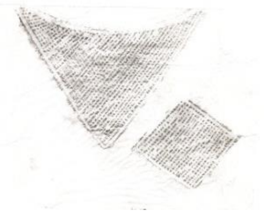
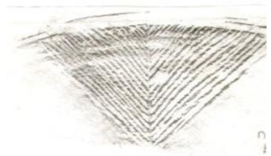
25	Medium		Fabric contains both moderate amounts of sub-rounded clear glassy (quartz) inclusions and opaque angular (quartzite) white inclusions. Dull black round inclusions are rare <1%. Sandy texture appearance with spaces between matrix and inclusions.	>11-25% Moderate	Sub-rounded, rounded and angular	Poorly sorted	0.30mm to 1.00mm	X	-
26	Fine		No existing fracture, few inclusions visible on exposed surface. Mainly very small white glassy (very rare <3% somewhat larger <0.68mm) overall a fine, dense fabric with sporadic voids and reflective micaceous specks also visible.	<3% Rare	Rounded	Well sorted	0.11mm - 0.25mm	X	-

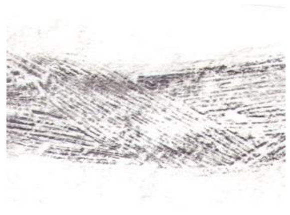
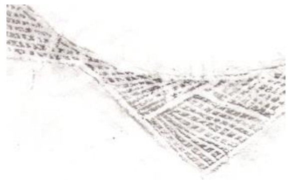
Appendix 7: Summary data of forming, firing and finishing process

ID	Fabric Type	Primary Forming	Evidence of Firing				Secondary Forming and Surface Treatment				
			Firing Conditions	Carbon core	Firing Munsell colour	Exterior surface colour	Scrape marks	Smooth marks	Wipe marks	Burnish	Decorative Detail
1 K2	Medium	N/D	Partially oxidized with unoxidized core, thin oxidized inner and outer margins	Black	10YR 4/3 Brown		✓	✓	NO	✓	
2 K2	Medium	N/D	Incompletely oxidized, dark grey core partially present	Dark grey	7.5YR 3/2 Dark Brown		✓	✓	NO	NO	
3 K2	Fine	Possibly coil	Partially oxidized with unoxidized core, oxidized inner and outer margins	Dark grey/ black	10YR 4/2 Dark greyish brown		NO	✓	NO	NO	
4 K2	Fine	N/D	Partially oxidized with unoxidized core, oxidized inner and outer margins	Grey	2.5YR 4/6 Red brown		NO	✓	NO	✓	

5 K2	Fine	N/D	Partially oxidized with unoxidized core, oxidized inner and outer margins	Dark Grey	7.5YR 4/3 Brown		✓	✓	NO	✓	
6 K2	Fine	N/D	Incompletely or partially oxidized with unoxidized core, oxidized inner and outer margins	Black	10YR 3/2 Very dark greyish brown		NO	✓	NO	✓	
7 K2	Medium	N/D	Incompletely or partially oxidized with unoxidized core, very feint oxidized inner and outer margins	Black	7.5YR 3/3 Very brown		NO	NO	NO	✓	NO
8 K2	Medium	Probably Coil	Incompletely oxidized, almost no margins visible on exterior and interior	Dark grey	10YR 3/2 Very dark greyish brown		✓	✓	✓	✓	NO
9 K2	Medium	N/D	Not determined	No	2.5YR 7/2 light grey to Light brownish grey10YR 6/2		NO	✓	✓	NO	NO

10 K2	Fine	Pinch/Hand forming from lump of clay	Possibly incompletely oxidized	No	2.5Y 7/2 light grey surface 5YR 4/4 Reddish brown (fabric)		✓	✓	✓	NO	NO
11 TK2	Medium	Possibly coil	Incompletely or partially oxidized with unoxidized core, thin oxidized inner and outer margins	Dark Grey	5YR 5/4 Reddish brown		✓	✓	✓	✓	
12 TK2	Medium	Probably coiled	Incompletely or partially oxidized with unoxidized core, thin oxidized inner and outer margins	Dark grey	10YR 3/1 Very dark grey		✓	✓	✓	NO	
13 TK2	Medium	N/D	Incompletely or partially oxidized with unoxidized core, oxidized inner and outer margins	Black	7.5yr 4/3 Brown		✓	✓	✓	NO	
14 TK2	Medium	N/D	Not determined	No	7.5YR 5/4 brown		✓	✓	✓	✓	

15 Map	Coarse	N/D	Not determined	No	5YR 4/4 Reddish brown to 5YR 3/2 dark reddish brown		✓	✓	✓	✓	NO
16 Map	Fine	Possibly Coiled	Incompletely or partially oxidized with unoxidized core, oxidized inner and outer margins	Black	5YR 4/4 Reddish brown to 5YR 3/2 dark reddish brown		✓	✓	✓	✓	NO
17 Map	Medium	Possibly Coiled	Incompletely oxidized with unoxidized core, oxidized tan colour outer margin	Dark Grey	7.5YR 4/3 Brown		No	✓	N0	✓	
18 Map	Fine	N/D	Uniform red cross section fully oxidized	Red	2.5 YR 5/6 Red		✓	✓	✓	✓	
19 Map	Fine	N/D	Unoxidized, uniformly black cross section	Black	10YR 2/1 Black		✓	✓	✓	✓	

20 Map	Coarse	Possibly hand formed from lump of clay	Not determined	No	5YR 4/3 Reddish brown		✓	✓	✓	NO	NO
21 Map	Medium	N/D	Incompletely or partially oxidized with unoxidized core, thin oxidized inner and outer margins	Grey	5YR 4/3 Reddish brown		✓	✓	✓	✓	
22 Map	Medium	N/D	Partial oxidation or irregularly fired	Sandy	7.5 YR 3/2 Dark brown		NO	✓	NO	✓	
23 Map	Medium	N/D	Not determined	No	10YR 3/2 Very dark greyish brown		NO	NO	✓	NO	NO
24 Map	Medium	Possibly pinch forming	n/d	No	10YR 3/2 Very dark greyish brown		✓	✓	✓	NO	NO

25 Map	Medium	N/D	Partially oxidized with unoxidized core, thin oxidized inner and outer margins	Black	7.5YR 3/2 Dark brown		✓	✓	NO	✓	NO
26 Map	Fine	Pinch formed	n/d	No	7.5YR 3/1 Very dark grey		NO	✓	✓	NO	NO