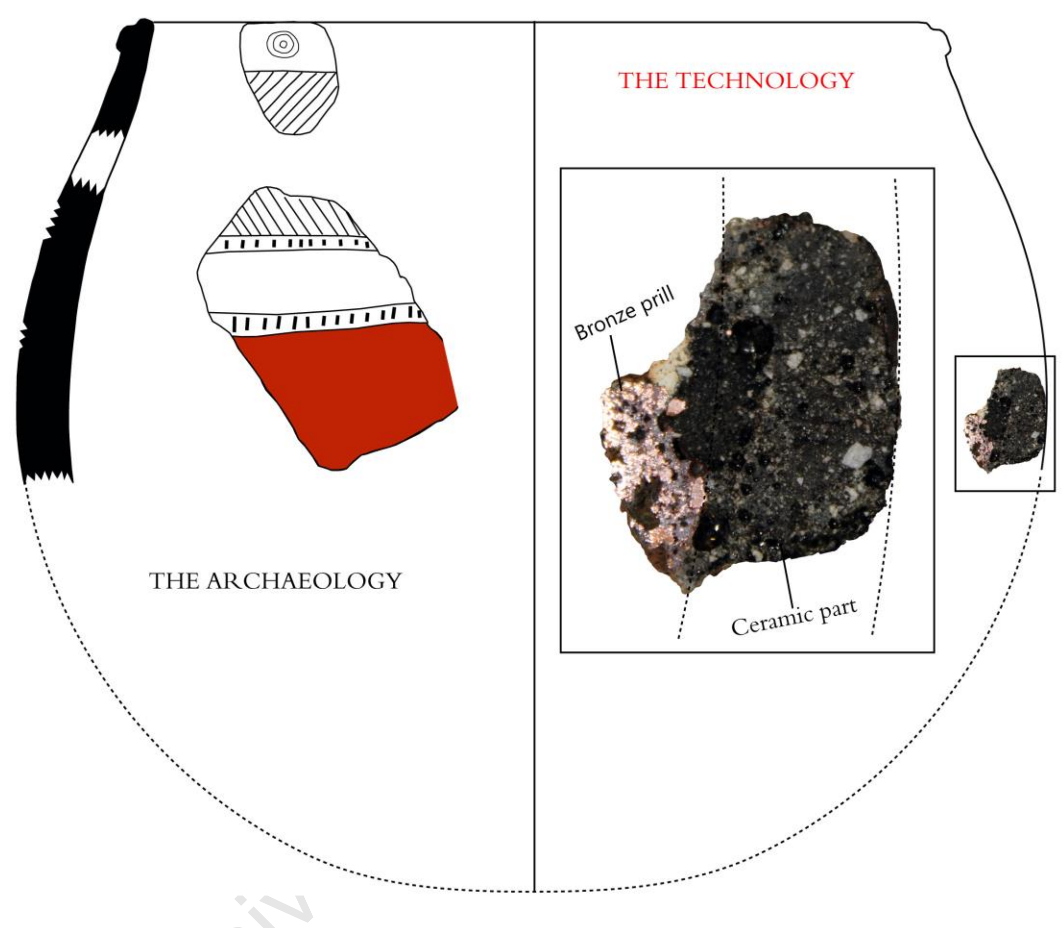
THE ARCHAEOLOGY AND TECHNOLOGY OF METAL PRODUCTION IN THE LATE IRON AGE OF THE SOUTHERN WATERBERG, LIMPOPO PROVINCE, SOUTH AFRICA



Univ

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Thesis Presented for the Degree of Doctor of Philosophy in the Department of Archaeology

UNIVERSITY OF CAPE TOWN

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DEDICATION

To our little princess, Princess Bandama

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ABSTRACT

The inception of metallurgy in southern Africa was relatively late, compared to other regions in Africa, and as a result, this part of the sub-continent was mistakenly thought to have been less innovative during the Iron Age. On the contrary, dedicated materials analyses are showing that starting from the terminal first millennium AD, southern Africa is replete with innovations that include the growth of state systems, specialised long-distance trading, the re-melting of glass beads, the working of ivory, and the weaving of cotton using ceramic spindle whorls. Additionally, the appearance of gold and tin production, against a background of on-going iron and copper metallurgy, has been interpreted by some as intimating innovation in metal technology. While some research energy has been invested into these novelties, there has only been incidental concern with the innovation in tin and bronze production. This study investigates the context of this novelty in the metallurgy of the Southern Waterberg, an area that hosts one of the unequivocal cases of pre-colonial tin mining in southern Africa. Recent trace element studies have indicated that bronzes from several elite sites in the region, were produced using tin that was sourced from the Southern Waterberg. The current chronology from the Southern Waterberg does not capture the full tin sequence that is implicated by the trace-element analyses of tin and bronze from dated contexts elsewhere and falls short by at two centuries. To bridge this gap, the present study sought, to explore the visibility of tin production in the Southern Waterberg at sites that are contemporary with the appearance of tin and bronze in southern Africa, and to investigate how this innovation was integrated into on-going iron and copper production. Rigorous methodological and theoretical approaches that include ethno-historical, archaeological and archaeometallurgical studies were employed in order to glean relevant information required to address these issues.

Ceramic typological and settlement pattern studies were used to establish the culture-historical context, while Optical Microscopy, X-ray Fluorescence Analysis and Scanning Electron Microscopy of metallurgical remains were used to identify the metals and techniques that were employed. Ceramic technological studies were used to establish relationships between the metallurgy and the ceramic typological identities. The results suggest that the Southern Waterberg may have participated in the innovation of tin production in southern Africa. More research may strengthen this observation but it is entirely appropriate, in view of several

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metallurgical and non-metallurgical innovations that were on-going in societies throughout the region at large. Researchers now need to engage more with innovations and actively explore the various novelties that southern Africa exhibited during the Iron Age.

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CHAPTER ONE: INTRODUCTION & SYNOPSIS

"It may be enough to ask some new questions in a fairly straightforward way, and to seek to answer them in adequate detail" (Renfrew, 1993: 8).

1.1: INTRODUCTION & SCOPE OF STUDY

As rightly noted by O'Brien and Shennan (2010: 3) it will be hard to find a topic that has remained as central to anthropology as innovation[1], in attempts to explain culture change and human behaviour. Given the centrality of innovation to seminal archaeological studies, it is not surprising that a great deal of research energy has been invested in this topic (Egleston, 1879; Pleinor, 1980; Stahl, 1994; Tite, 1999). Sustained interest in this topic suggests that it has not lost favour as a research agenda in anthropology and archaeology (Thurston and Fisher, 2007a; Shennan, 2009; Kusimba and Kusimba, 2010; O'Brien and Shennan, 2010). This is not surprising given that innovations and inventions are transmitted, transformed and re-contextualised through interaction, which is a universal feature of all human societies at all levels of social complexity (Tite, 1999; Kristiansen, 2005). Unfortunately, archaeologists have rarely considered pre-industrial innovation and its correlates such as interaction and specialisation that do not relate to the emergence of social complexity (Brumfiel and Earle, 1987; Parkinson and Galaty, 2010).

In southern Africa, studies of innovation and its correlates have been pre-empted in core-periphery models that elevate elite centres and relegate non-hierarchical peripheries to handmaiden roles (Antonites, 2012). As a result, areas that are historically not associated with large centralised polities such as the Southern Waterberg (Figure 1.1),are overlooked despite the fact that the latter hosts abundant tin, iron and copper resources whose exploitation may have been associated with various innovations (Miller and Hall, 2008).

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[1] Innovations and associated concepts such as interaction, specialisation and trade are defined in section 1.3 below

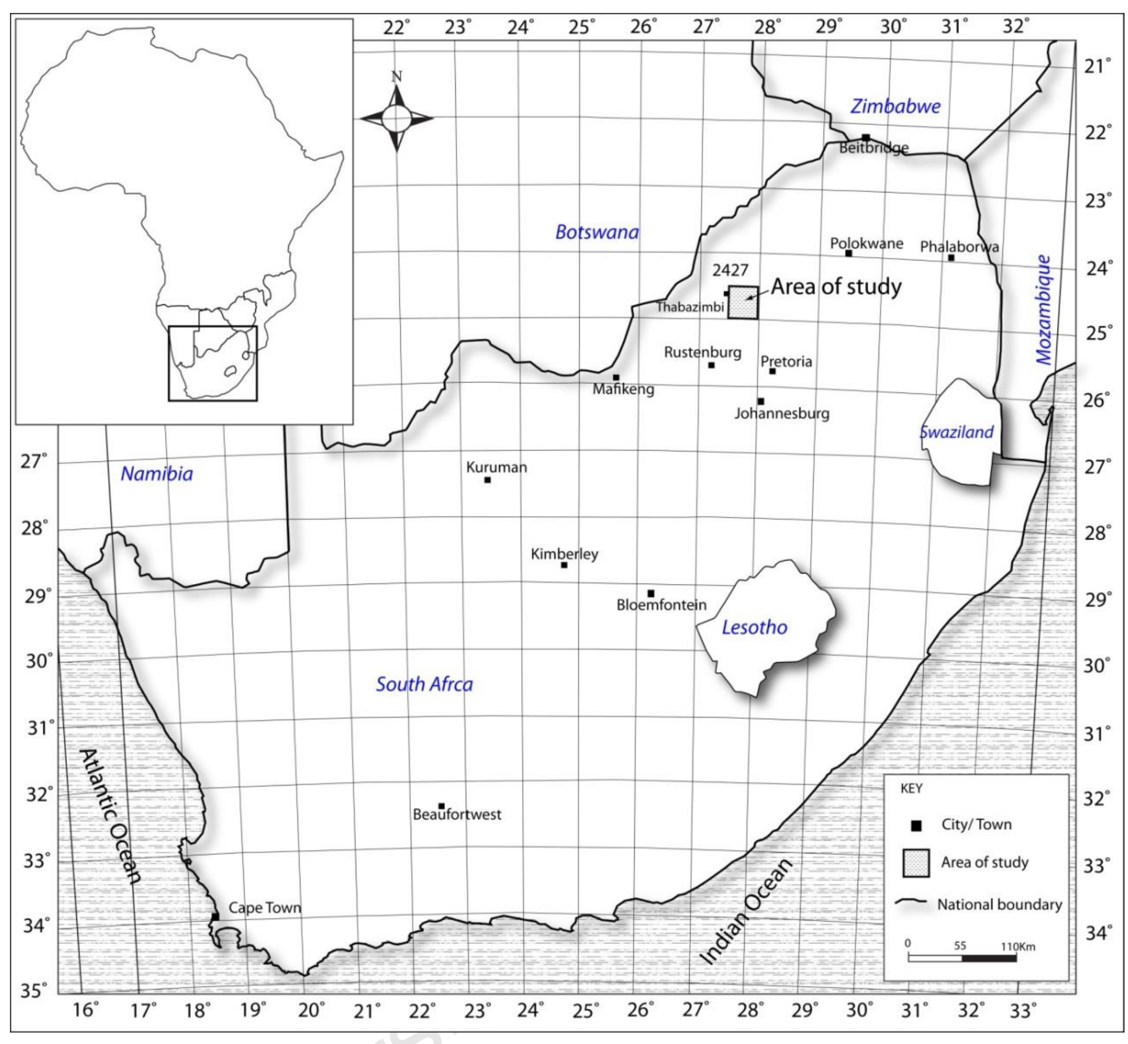

Figure 1.1: Showing the location of the Southern Waterberg.

The relatively late arrival of metallurgy in southern Africa, compared to other regions of the continent (200AD compared to west and east Africa's 900 BC), perpetuated the idea that this part of the sub-continent was less innovative (Killick, 2009a). This thinking dissuaded researchers from engaging with metallurgical novelty during the Iron Age[2] of this region (Schmidt, 1997; Chirikure, 2005). However, the appearance of gold, tin and bronze working between the terminal 1st millennium AD and the beginning of the 2nd millennium AD, against a background of on-going iron and copper metallurgy has been interpreted by some as intimating innovation in metal technology (Swan, 1994; Miller and van der Merwe, 1994; Miller et al. 2000; Miller, 2003; Chirikure et al. 2007). This is entirely appropriate, given that in the Shashe-

[2]The period ushered by the arrival of agriculturalist groups (See Chapter 2 for detailed discussion of the terminology)

Limpopo basin and parts of the Zimbabwean Plateau, this period is replete with innovations that include the re-melting of imported glass beads in clay moulds to make large garden roller beads, (Wood, 2005), the intensive working of ivory (Voigt, 1983), the weaving of cotton using ceramic spindle whorls (Davison and Harries, 1980), intensive participation in long distance trade and the gradual rise of the first state systems in southern Africa (M. Hall, 1987). Some research has been done on these innovations but there has been little more than incidental concern with tin and bronze production. The present study is concerned with the context of this innovation in tin and bronze[3] production and how this novelty was embedded within on-going iron and copper production.

On current evidence, the pre-colonial tin mines at Rooiberg in the Southern Waterberg are the only unequivocal evidence of tin mining in southern Africa. The veracity of other claims of pre-colonial tin exploitation at Kamativi near Hwange, Cornucopia near Rusape and alluvial deposits near Bikita in Zimbabwe; the Union tin fields near Mookgopong and the Zaaiplaats tin field near Mokopane, in South Africa as well as the alluvial deposits of Swaziland (Barnes Pope, 1938; Caton-Thompson, 1931; Killick, 1991) have not been tested through a systematic study. Additionally, the start date of tin and bronze production in the Southern Waterberg is still uncertain because studies conducted to date have only produced evidence dated to the 15th Century AD. Given the lack of unequivocal tin production evidence elsewhere, the uncertainty over the 15th century date for earliest tin production at Rooiberg stems from the fact that this is at least two centuries younger than the appearance of bronze at several elite sites in southern Africa such as Mapungubwe, Bosutswe and Great Zimbabwe (Miller, 2002). Furthermore, recent lead isotope analysis indicates that some bronze from these sites were produced using tin that matches the Rooiberg signature (Molofsky, 2009). This picture directs attention to the possibility that the innovation in tin exploitation in the Southern Waterberg was earlier than the 15th century AD. Thus, the current study sought to explore the chronology of tin production in the Southern Waterberg and the context of this innovation through the examination of the subsequent local sequence.

[3]Bronzeor tin-bronze is an alloy of copper and tin. When two or more metals or metallic substances are intimately mixed whether by fusion or other means, the coherent metallic mass that result is called an alloy. The term bronze is used in this thesis to designate a copper-tin alloy because some scholars feel the term tin-bronze is redundant (Muhly, 1993).

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The direct dating of the tin mines and alluvial panning has unsurprisingly been frustrating because the dateable material left most likely relates to the last miners rather than their predecessors. Consequently dating tin production has focused upon the search for, and investigation of sites in the Southern Waterberg that are earlier than the 15th century AD and have tin and bronze production. This can be done because the ceramic sequences for Iron Age groups in southern African Iron Age can be described and dated (Evers, 1988; Huffman, 2007). Thus, ceramics and associated material such as beads have been employed in the present study as a way of exploring the culture historical context and refining the chronology of metallurgy in the area under study.

While iron and copper production were exploited in the first millennium AD by agriculturalist communities in southern Africa, tin and bronze production suddenly appeared in the second millennium AD (Miller, 2003). Consequently, it is important to explore how this metallurgy was incorporated into the cultural setting and on-going iron and copper production. Additionally, this raises questions about the integration of tin production into other components of the socio-political economy such crop and animal agriculture, hunting and trade. Through the second millennium AD was tin production simply as another component to economy or did it take on greater significance? In part, I address this question through general archaeological data and through the technological characterisation of metallurgical remains. By exploring the integration of tin production into the broader political-economy, I also hope to address the issue as to whether the exploitation of tin propelled the metal workers into specialist production or not? Thus, through the use of ceramic sequence, settlement organisation and trade exotica, the study explores whether metallurgical production, which includes the production of tin and bronze, was a key variable that provided the locus for interaction in the Southern Waterberg. Such an approach activates culture historical studies away from a more passive description of stylistic layering by marrying it to the archaeometallurgy.

Addressing these issues required a rigorous methodological framework which combined desktop, field and laboratory techniques. The primary sources of information used in this study came from archaeological and metallurgical finds from specific sites and was partially historicised through relevant ethno-histories, oral traditions, and theoretical frameworks. In this regard while thestudy

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was tailored to explore metallurgical history at the local level, a focus on the innovation of tin meant that the study had to remain sensitive to the bigger picture of developments in southern Africa and beyond. The next section defines key concepts addressed in this research.

1.2: DEFINITION OF CONCEPTS

As indicated, the present study explores the innovation in tin production in the Southern Waterberg, which was an addition to on-going iron and copper production. It is therefore imperative to explore this innovation and the associated archaeology in relation to interaction, specialisation and trade. Due to the plurality of ways in which the concept of innovation and its correlates can and have been applied, it is necessary to define how these concepts are used in the current study.

1.2.1: INNOVATION

In its minimal sense, the term innovation refers to attempts to put into practice an idea or process thought to be new to a community, and the term is often contrasted with *invention*, which is the first conception of that new idea or process (Kristiansen, 2005: 151). This definition is important to remember because, unlike in Eurasia where the inception of tin was linked to its physical superiority[4] as a copper-alloy over unalloyed copper, the innovation of tin production discussed in this study does not relate to a primary innovation (invention) (Valério, 2012). In southern Africa, tin was exploited at a time when iron, which is superior over bronze in terms of hardness, was the dominant utilitarian metal and consequently, tin was appreciated differently from the Eurasia case (Killick, 2009a). This also means that the stimulus for this tin innovation in southern Africa lies in the expressive and socio-ideological sphere as opposed to the utilitarian sphere. After a long history of technological determinism in archaeology, it is now accepted that innovations are not simply practical or technical solutions or merely problem solving ideas, but socio-political and ideological novelties (Pfaffenberger, 1992; Kim, 2001). There is usually no common sense or logic wrapped up in the acceptance of innovations. For instance, in the 1920s,

[4]Pure tin is mechanically weak, but it is in combination with other metals such as copper that tin has its most uses. It is durable, malleable, non-toxic and has a high resistance to chemical attack. It has a low melting point 231.9˚ C and a high boiling point 2 270˚ C and as such has the ability to adhere to surfaces of many metals at temperatures considerably below their melting points, a factor which has made it a major element in modern solders and bearing alloys for reducing friction between moving surfaces in machinery and food preservation (Nattrass 1987: 4).

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the Kaonde people of Zambia were shown the superiority of bag-bellows over drum-bellows but they refused to adopt the new device for fear of arousing the anger of their ancestral spirits (Melland, 1923). In southern Scandinavia, the advance of iron technology, though technically superior to bronze technology, was rejected for several hundred years, because a millennium-old social principle based upon the employment of bronze in the building and maintenance of social prestige and chiefly networks resisted iron technology (Kristiansen 2005: 154).

One of the key questions that need to be asked, therefore, relates to where the impetus for the innovation of tin production in the Southern Waterberg came from and whether or not local people were simply responding to a specific demand from elsewhere? In exploring this issue, it is important to remember that innovations are generally considered to be taxing and experimental, and as such linked to elites because they can afford to risk their resources in pursuing novelties (Kim, 2001; Shennan, 2009), even though innovations can also be transmitted through social learning (imitation), which is stronger in non-hierarchical communities (Coward and Grove, 2011). No historically attested[5] large-centralised polity has been reported in the area under study during the early second millennium AD, the nearest being Mapungubwe and Bosutswe (over 200 km away).Consequently what is important is not the hierarchy or proximity to large polities but the nature of interaction that may have induced innovation.

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1.2.2: INTERACTION

Interaction is seldom defined explicitly even though the term refers to a wide variety of social processes that are frequently discussed in archaeology. In this study, Darvill's (2008) definition of interaction is adopted;

> *"A general term used in archaeology to refer to any close contacts established between communities or regions that is evidenced in the archaeological record through material culture. Where fairly extensive contact is made over a wide area the term interaction sphere may be appropriate."*

This open ended definition is more appropriate because interaction is a universal feature of all human communities at all levels of social complexity (Kristiansen, 2005). However, the term *interaction sphere* has not always been treated as open ended as described above. It was initially

[5]In terms of spatial extent and material expression at sites

coined by Joseph Caldwell (1964), who explained the wide geographic distribution of an identifiable complex of elite material culture in Hopewell, Ohio, as an expression of a shared set of supra-local values, rituals, behaviour, styles, and materials that were maintained by interactions and exchanges between communities. Caldwell's paradigm is limited to *institutionalised interaction* which attributes causality in the development of complex, elite social institutions to regional conditions via an information and exchange network among the elites rather than to localised conditions (Friedel, 1979: 50). However, Dalton (1975) suggests that some interaction spheres were also characterised by pre-state politics and population levels, lineages or clan organisations. In the Southern Waterberg there is a need to explore, at the regional scale how interaction may have contributed to the inception of the innovation of tin production, and at the local scale, how interaction produced the cultural setting for this metallurgy.

1.2.3: SPECIALISATION

Specialisation can be defined as a situation whereby "fewer people make a class of objects than use it" (Costin, 2001: 276). However, the current archaeological use of the term specialisation has evolutionary and neoclassical economic connotations that impose and presume creativity, increased output and efficiency as well as standardisation of output, on prehistoric peoples (Ottaway, 2001: 89; Clark, 2007: 20). By its nature specialisation is marked by flexibility rather than rigidity. Thus, it can be undertaken on part-time or full-time basis, by independent or attached, itinerant or sedentary communities, and can also be at a household, local or regional level (Costin, 1991; Stein, 1998; Chirikure, 2005; Li, 2007). As such the above definition by Costin (2001) can be considered to be more appropriate because it does not imply skill or competition and is applicable to all societies of all sizes and degrees of social complexity. Traditionally, specialisation has been linked to complex social and political structures, both as a cause and a result of increasing complexity (Childe, 1936; Brumfiel and Earle, 1987) but it is now known that it is also a characteristic of less stratified societies (Laforge, 2012). Linked to the question on the impetus for the innovation of tin production in the Southern Waterberg, it is important to explore whether there is metal specialisation responding to pulses of demand from further afield? Because, all types of specialisations presuppose some form of exchange, it is also important to consider the nature of trade and exchange in the area under study.

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1.2.4: TRADE

Barbara Price (1978) once remarked that archaeologists writing about trade are frequently discussing quite different phenomena, presumably because scholars consider the term to be too obvious to warrant any definition. Etymologically, the current association of the term trade with "innovative, risk-taking and profit-motivated, entrepreneurial behaviour" is almost diametrically opposed to original meanings (Adams et al. 1974). The term trade first appears in Middle-English as a borrowing from Middle-Low-German or Middle-Dutch, with the meaning of a "path, or beaten track". A cognate form of this original meaning is preserved in the Modern English word *tread* and German word *treten* (Adams et al. 1974). It is only in the middle to late 16th century that the meaning of trade was broadened to include a habitual course of action or the practice of some occupation. This habitual aspect is repeated in the 17th century appearance of the word *trade-winds,* but the principal modern meaning of the word trade (verb), "the act or business of exchanging commodities by barter or sale", appears around the mid-19th century (Adams et al. 1974: 239). It is also within this 19th century purview that trade is defined in the Oxford English dictionary.

In archaeology, trade has been viewed in different ways. Beale (1973) argued that prehistoric trade should denote a wide range of exchange relationships, from hand-to-hand (trickle-trade), to redistribution and long-distance organised trade. Some archaeologists differentiate between long-distance exchanges that are embedded in interpersonal chiefly relations from those that are embedded in the market, advocating that the word *trade* should denote only those exchanges embedded in the market (Kipp and Schortman, 1989). Other scholars prefer the flipside and regard prehistoric trade as the socially mandated exchange of goods and favours between elites in a stratified society and limited to luxury items (Earle, 1994). More recently, Oka and Kusimba (2008) define trade as the material-economic component of exchange and hence a necessary part of any social exchange. In this study, trade is viewed within the context of "commercial" traffic (exchange) of commodities between individuals or societies at any scale. The word commercial is taken in its simplicity to include considerations of value based on supply and demand, the presumption of profit and value maximisation between parties, as well as the associated socio-political concerns. As a function of interaction, trade is explored in the present study as a way of

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probing the consumption and distribution of metallurgy in the area under study. Trade is also considered because it is a vehicle for the transmission of innovations (Adams et al. 1974).

1.3: AREA OF STUDY

The Southern Waterberg lies to the south west of Limpopo Province in South Africa. It is about 100 km due north east of Rustenburg and about 60 km due northwest of Warmbaths/Bela-Bela (as the crow flies) and is literally south of the Waterberg plateau. The research area is defined by the 28° longitude to the east, the town of Thabazimbi to the west, southern flanks of the Waterberg plateau to the north and the southern flanks of the Boschoffsberg plateau to the south (Figure 1.2). It can be divided loosely into three areas; the Boschoffsberg valley (1:50 000 map 2427DC) in the south, the Rooiberg valley (2427 DC and DD) in the central parts and the Sand River valley (2427 DA and DB) in the north (Figure 1.2). The latter area has not received much attention because most researchers were interested in the exploitation of tin resources, whose mines are found in the Boschoffsberg and Rooiberg valleys. With a few exceptions (S. Hall, 1981; Hall and Grant, 1995; Bandama et al. 2013), the preoccupation with developments in the Rooiberg and Boschoffsberg valley created an impression that areas further afield, such the Sand River valley, did not participate in the exploitation of tin resources.

It is now known that tin and certainly other resources, moved within the whole of the Southern Waterberg (Hall and Grant, 1995; Bandama et al. 2013), hence the need to include areas such as the Sand River valley in this study.

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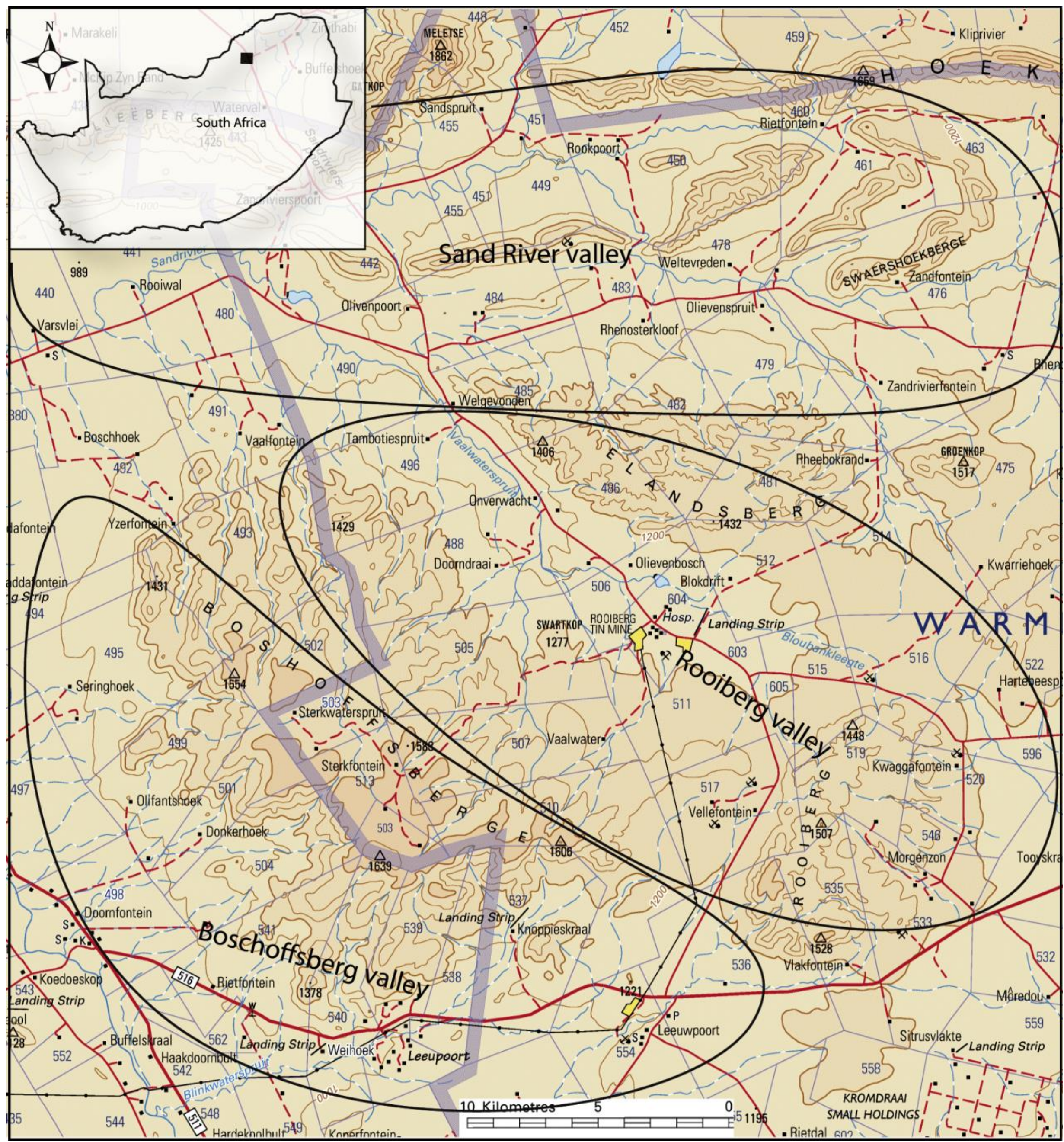

Figure 1.2: Extract from the 1: 250 000 Map of 2426 Thabazimbi, 2001 Edition, showing the location of the Southern Waterberg.

1.4: BACKGROUND TO THE STUDY

The range of metals worked in pre-colonial times in sub-Saharan Africa is limited and involve at least four metals (gold, tin, iron, copper and its alloys). Unlike the established chronology for Eurasia in which copper, was worked first, followed by bronze and then iron, in sub-Saharan Africa iron and copper appeared simultaneously, a development which ignited a decade long

debate on whether this technology is autochthonous or not (Alpern, 2005; Holl, 2009; Zangato and Holl, 2010). In southern Africa, these two metals appear around AD 200, as part of a "package" that included, crop and animal farming and sedentism, introduced from west and east Africa (Miller and van der Merwe, 1994). Iron was mainly used for utilitarian objects, with only a few exceptions but copper was almost exclusively a decorative metal (Childs, 1991; Herbert, 1984). With the "superior" metal (iron) already mastered the rest of metals and alloys (gold, tin, bronze and brass), remained largely in the realm of expressive metals[6] (Swan, 1994; Miller, 2002; 2003). The local consumption of gold appears to have been a privilege enjoyed by the elites and the majority of this metal was channelled into the export markets of Eurasia via the Indian Ocean coast (Summers, 1969; Killick, 2009a). Brass production in southern Africa seem to have focused on recycling and reworking of imported brass articles because no zinc deposits were exploited in sub-Saharan Africa prior to the nineteenth century (Maggs and Miller, 1995). Arsenical copper is yet another alloy which has been reported in artefact form, but it has not been systematically studied to confirm whether it was intentionally produced or not (Grant et al. 1994; Thondhlana and Martinón-Torres, 2009).

The pre-colonial mining operations at Rooiberg, in the Southern Waterberg area have been well described and useful sketches and maps of the mines were produced (Recknagel, 1908; Baumann, 1919a; Falcon, 1985). However, early researchers and writers in the Southern Waterberg were not trained in archaeology and as such some key issues about the archaeology and metallurgy of this area remain unanswered. With regards to smelting, there has been little systematic study until recently and there is much scope for further research (Miller and Hall, 2008; Chirikure et al. 2010; Heimann et al. 2010). Importantly, the few studies that investigated what was thought to be copper objects have shown that some of these items are actually low tin bronzes. For example, 80 years ago metallographic studies by Stanley (1929a) on objects from Great Zimbabwe and Khami showed that the artefacts were not copper but low tin bronzes. Similar studies that followed have produced the same findings (Miller et al. 1995; Miller, 2001, 2002; 2003; Denbow and Miller, 2007; Bandama et al. 2013). While some scholars quickly learnt from Stanley's (1929a) study, and treated most "copper" objects as possible bronzes

[6] Iron is also occasionally used as a decorative metal in much of southern Africa, even in areas were gold, copper, tin and bronze were also worked.

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(Robinson, 1961) others did not which is why even at prominent sites such as Mapungubwe, where several bronze objects were scientifically identified (Miller, 2003), scholars still give the impression that only gold, iron and copper were produced (Calabrese, 2007).

The only radiometric (C-14) dates[7] from the Rooiberg tin mines came from material that most likely relates to the last operation of the mines and not their start up. According to Huffman (2007: 90) the best way of dating the mines and metallurgical sites is through a combination of chronometric dating and associated culture historical methods, such as ceramic typology. Systematic work undertaken to date, at sites with tin and bronze working evidence in the Southern Waterberg have only produced C-14 dates and ceramic sequences that are at least two centuries later than the manifestation of this metallurgy at several elite sites in southern Africa. As indicated above, this discrepancy has refocused archaeological attention on the Southern Waterberg and provided the rationale for further research in the nature and timing of tin production in the region. An exclusive focus on one metal or alloy was not possible because in most cases, the production remains of different metals occurred together in the same middens. Since, production remains for these metals can only be positively separated in a full scale metallurgical analysis and not in hand specimen (Miller and Killick, 2004; Rehren and Pernicka, 2008), it was important to consider all metals that were worked in the area under study.

1.5: THESIS ORGANISATION

Chapter Two presents the background to Iron Age research on tin and associated metallurgy in the Southern Waterberg. This includes an overview of previous work on culture histories, metallurgy as well as dating and chronology. The main focus in this chapter is on establishing what is currently known about the innovation of tin production and to highlight what are considered to be gaps in the available dataset as a way of setting up the subsequent discussions and presentations. To complement this background information, ethno-histories of trade in southern Africa are then discussed in Chapter Three, because through trade innovations can also be transferred from one region to another. In this chapter emphasis is placed on issues relevant to the exploitation of tin in the Southern Waterberg but other materials on the history of long-distance trade and the distribution of key trade commodities elsewhere in southern Africa are

[7]A detailed discussion on these dates is presented in Chapter Three.

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also presented. The rationale for these overviews is that they provide comparative contextualization for the innovation of tin production in the wider region. Two cases studies of two indigenous populations found in parts of South Africa, Mozambique and Zimbabwe are presented. These background studies are concluded with a discussion on the bio-physiographical setting of the area and form the basis of Chapter Four.

The research methodology is given in Chapters Five and Six. The former describes field methods, data collection procedures, sampling procedures related to archaeological surveys and excavation, as well as the initial analyses of materials and settlement organisations in the field. Laboratory analytical methods of selected samples are described in Chapter Six. This chapter also reviews methodological principles and protocols for both culture historical and archaeometallurgical materials. Analytical procedures that provided some means of bridging the gap between the above two classes of materials are also presented in this chapter.

Analytical results are presented in Chapters Seven and Eight. Chapter Seven describes analytical results of non-metallurgical finds such as ceramics, beads and other miscellaneous objects. The main focus in this chapter is on providing the culture historical context within which metallurgical technologies were embedded. Moreover, results from ceramics and beads are also used as chronological controls. Since ordinary domestic pottery was also used as reaction vessels for melting metals (crucibles), results on their relationship to ceramics are also presented here before describing their metallurgical signature in Chapter Eight. Chapter Eight also presents metallurgical results of other metallurgical production remains and metallic objects with a view of establishing which metals were exploited and what technologies were used.

Chapter Nine then discusses the implications of the above results are within a broader context before drawing up of conclusions in Chapter Ten. Keys issues raised in the beginning chapters are revisited in the context of the data provided and recommendations for future study are given before presenting the references and appendices.

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CHAPTER TWO: WHAT DO WE KNOW ABOUT THE ARCHAEOLOGY & METALLURGY OF THE SOUTHERN WATERBERG?

"The area covered by these old workings is over 70 acres, and within that area there is very little virgin ground, most of it having been turned over, leaving behind innumerable irregular holes and excavations, separated by dumps, or in some instances by ribs of country rock" (Recknagel, 1908: 89)

2.1: INTRODUCTION

Research, in the Southern Waterberg, however rudimentary and ephemeral, has been on-going for over a century. Most of the early work was carried out by enthusiasts and non-archaeologists. This chapter reviews previous research conducted in the Southern Waterberg and how this informs the research questions for the present study. The chapter starts with a brief background review of the archaeology of agriculturalist communities relevant to the present study. It also summarises the existing culture historical sequences, as well as the archaeometallurgical research of the area.

2.2: THE IRON AGE & CULTURE HISTORICAL SEQUENCES

In the summer rainfall area of southern and south-eastern Africa, agriculturalist groups from east and west Africa, appeared around AD 200 (Mitchell, 2002). Their entry was parallel to the appearance of pastoralism and both shared the landscape with resident hunter-gatherers. Because farmers brought with them the technology of working metals, these groups have been labeled *Iron Age Communities.* This label has since been criticised for its technological emphasis and alternatives such as *Agro-pastoral Communities, Agriculturists*, *Farming Communities* or *First and Second Millennium Farming Communities* have been put forward (Sinclair et al. 1979; M. Hall, 1987; Maggs, 1992; Pikirayi, 1993; Pwiti, 1996; Mitchell, 2002). Despite the fact that the "Iron Age" label is an explicit borrowing from European prehistory (Summers, 1950) and several researchers have expressed reservations about its use, the term is still a useful short term label for a larger concept (Pwiti, 2005; Huffman, 2007). Consequently, in southern Africa, the Iron Age refers to an amalgam of settled village life, food production, pottery making and the working of metals (Pwiti, 1996; 2005; Mitchell, 2002; Phillipson, 2005; Huffman, 2007). This Iron Age package is so distinct compared to the Late Stone Age and only migration can account for the spread of these farming communities spread into southern Africa (Phillipson, 1985; Pwiti, 2005). This spread is

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linguistically linked with Bantu-speakers, even though tracing their movements archaeologically has proved to be a daunting task (Soper, 1971; Phillipson, 1974; 1977; Huffman, 1978; 1989a; 1989b).

The Iron Age of southern Africa is sub-divided into the Early Iron Age (EIA), covering a period between 200 and 1300 AD, and Late Iron Age (LIA), which covers 1000 to 1850 AD. A geographically discrete Middle Iron Age (MIA) has been proposed by Huffman (2007: 361), for the period between 900 and 1300 AD in the Shashe-Limpopo area. Clearly these sub-divisions are just convenient shorthand because there are significant overlaps. There are comprehensive syntheses of Iron Age research in southern Africa (Soper, 1971; 1982; Phillipson, 1977; 1985; 2005; Huffman, 1971; 1974; 1976; 1978; 1979; 2007; Sinclair et al. 1979; Maggs, 1984; M. Hall, 1987; Lane et al. 1996; Mitchell, 2002, 2005; Pwiti, 1996; 2005; Manyanga, 2001; 2007) and a brief synopsis will suffice for the purposes of this study.

Culture historically, southern African Iron Age falls within the Chifumbaze Ceramic Complex, which is sub-divided into two traditions (Urewe and Kalundu), followed by Branches, then sub-branches, clusters and then facies, which represent each ceramic unit (Phillipson, 2005, Huffman, 2007). In the Southern Waterberg the EIA sequence comprises the Diamant facies (750-1000 AD) (Huffman, 2007: 223) previously referred to as Rooiberg Unit 1 (RU-1) (S. Hall, 1981). This facies derives from the Happy Rest sub-branch of the Kalundu Tradition, and in the area under study, it occurs at sites such as 8/78 (Sand River valley) and 4/79 (Boschoffsberg valley) (S. Hall, 1981: 27-34). The type site of Diamant itself is about 60 km to the north of Rooiberg and about 30 km away from Thabazimbi. According to Huffman (2007: 231), the Diamant facies is distributed in a small cluster around the Waterberg, stretching northwards as far as the Tswapong Hills in Botswana. At the type site itself, glass beads that are similar to those from Schroda were recovered, and Huffman (2007) suggests that the later was the redistribution centre of these beads because it was the capital in that area at that time. This would suggest interaction and trade between this area and the Shashe-Limpopo basin. This may be an important link because it indicates a network of exchange upon which other demand driven innovations could be transferred and draws attention to the growth of social complexity in the Shashe-Limpopo basin and beyond.

There is no evidence that tin was worked during the Diamant facies. Neither is there evidence for tin production in the Eiland facies/ Rooiberg Unit 2 (RU-2) (1000-1300 AD) (S. Hall,

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1981: 22; Huffman, 2007: 227) that follows after Diamant. However, evidence from the Shashe-Limpopo basin and some parts of the Zimbabwe Plateau and south eastern Botswana, indicates that bronze was produced using Rooiberg tin, from the 13th century onwards (Molofsky, 2009). The Eiland facies is contemporary with Mapungubwe and Eiland ceramics have been reported in the Shashe-Limpopo basin (Calabrese, 2007: 24). This is clear indication that the Southern Waterberg was interacting with the region. The Eiland facies also appears in isolated clusters that are known from the Magaliesberg, parts of southwestern Mozambique and south-eastern Botswana (Evers, 1977; Denbow, 1981; Loubser, 1991; Ohinata, 2001; Calabrese, 2007). In the Southern Waterberg, S. Hall (1981) identified the Eiland facies at sites such as 44/79 (Rhenosterkloof 3, Sand River valley) and 132/78 (near Rooikrans Hill in the Boschoffsberg valley). In northern parts of the Waterberg, and in eastern Botswana, a variant of the Eiland facies known as the Broadhurst facies (1300-1430 AD) has been recorded (Denbow, 1981; van der Ryst, 1998).

In the Southern Waterberg, the beginning of the LIA is marked by the arrival of the Madikwe facies (1500-1700 AD), which is derived from the Icon facies (1300-1500 AD) of the Moloko Branch and the Moor Park facies (1350-1750 AD) of the Blackburn Branch (Huffman, 2007). The Moloko and Blackburn branches are thought to have had a common EIA Urewe origin in East Africa, before migrating separately into southern Africa (Huffman, 2004). The Moloko ceramic sequence (associated with ancestral Sotho-Tswana groups) is divided into three phases; Phase 1 (AD 1300-1500), Phase 2 (AD 1500-1700) and Phase 3 (1700-1840). The Madikwe facies (second phase of the Moloko sequence) has been reported at 108/78 (in the Rooiberg valley) and 107/78 (in the Sand River valley) but its distribution includes the Madikwe Game Reserve, on the border with Botswana (S. Hall, 1981:41; Huffman, 2007: 199). Most Phase 1 and Phase 2 Moloko settlements were relatively small in contrast to Phase 3 when they grew into towns such as Molokwane, Kaditshwene and Marothodi, housing between 10 000 and 20 000 people in centralised polities that also exhibit increased specialisation and long distance trade (Mason, 1986; Boeyens, 2000; Anderson, 2009).

The Moor Park facies in the Southern Waterberg represents one of the movements of groups related to ancestral Nguni-speakers from Kwa-Zulu Natal into the northwest parts of South Africa (Huffman, 2007: 451). In the Northern Waterberg, distinctive Melora (the Waterberg variant of Moor Park) hilltop stone walled settlements have been identified by Jan Aukema (Huffman, 1990) and in the Southern Waterberg the 17th century component of Mabotse and

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Smelterskop are also representative of the Moor Park phase (Hall et al. 2008: 70). As is well known, there is no stone walling associated with EIA sites or Phase 1 and 2 Moloko sites in this area (Huffman, 2004). Moor Park people did smelt tin (and probably produced bronze as well) because one of their 19th century oral records by chief Mokgosi of the Malete tribe stated that one his ancestors Thutlwa-a-Molaolwa, son of Motala-a-Marumo, dug for white iron (tin?) in the quarries of Ditshiping which is in former Transvaal (Ellenberger, 1937-38: 46). As suggested by Friede and Steel (1976), Rooiberg is the most likely candidate for this Ditshiping.

The other ceramic facies found in the Southern Waterberg, stems from interaction between the ancestral Sotho-Tswana and Nguni-speakers. The Uitkomst facies (1650-1820) derives from a mixture of the Ntsuanatsatsi facies (Blackburn branch) and Olifantspoort (Moloko branch), while the Rooiberg facies (formerly RU-4) is a mixture of the Madikwe and Ntsuanatsatsi/Uitkomst facies (Huffman, 2007: 173, 177). The Uitkomst facies is distributed southwards towards the Vaal River, while the Rooiberg facies is found mostly in the Southern Waterberg (Huffman, 2007: 171, 175). Some post 1700 AD migration of Nguni-speakers into the Southern Waterberg include groups associated with the Kekana and Langa Ndebele chiefdoms that may have taken control of tin trade in this area (Huffman, 1990).

This possibility is extended in references to tin production in the 19th century. In 1836, J.G.S. Bronkorst, a Voortreker diarist, recorded that their part (led by Andries Potgieter) met people at Rhenosterpoort in the Randberg (sometimes written as Ransberg or Rantsberg), who were producing tin which they called “white iron” (Schapera, 1961; de Clerq, 1962). Locating Randberg has been difficult because it is not clear which route Andries Potgieter’s party took between the Suikerboschrand and Soutpansberg but some scholars have suggested that the place referred to may be Potgietersrust (now Mokopane) or Rooiberg itself (Friede and Steel, 1976). Recently, archaeologists have documented the presence of bronze earrings of 19th century date at Marothodi in the Magaliesberg (Hall et al. 2008; Anderson, 2009).

2.3: PRE-COLONIAL MINING: WINNING THE ORES FROM THE HOST ROCKS

As indicated above, some research into the pre-colonial production of Rooiberg tin was by non-archaeologists such as miners and geologists. Consequently their focus on mining practicalities, as well as their failure to successfully engage with the subject of the identity of miners, is to be expected. However, significant research on pre-colonial mining in southern

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Africa has since been undertaken (Summers, 1969; Phimister, 1974; Swan, 1994; Miller et al. 2000; Hammel et al. 2000). Throughout southern Africa, mining for iron ores was rarely sub-surface when compared to copper, gold or even tin (Summers, 1969). Exceptions do occur as noted by the occurrence of sub-surface pre-colonial iron mines near Thabazimbi in the Southern Waterberg (Woodhouse, 1974). Ochre mines are also known throughout the Southern Waterberg at places such as Blaauwbank Farm, Onverwacht Farm and the western slopes of Elandsberg (Recknagel, 1908; Mason, 1986). At Rhino Andalusite Mine, close to Thabazimbi, Huffman (2006: 64) recorded an open trench that went upslope for over 130 m before it became an underground stope with about four vertical shafts for ventilation. He associated this mine with red ochre used in non-metallurgical processes such as pottery decoration and bodily adornment. Open stopes of copper mines have been reported on Vellefontein in the Rooiberg valley and several outcrops of malachite, azurite and others copper ores occur in the Rooiberg and Boschoffsberg valleys (Recknagel, 1908: 88; Baumann, 1919a; Grant, 1994).

Mining for tin in the Rooiberg and Boschoffsberg valleys involved surface collection, alluvial panning and hard rock mining. Cassiterite (the richest tin ore) is a dense ore that can be easily separated from other lighter materials during panning (Tylecote, 1962: 63). Wagner and Gordon (1929: 568) record that they recovered alluvial cassiterite as part of the tin feed at some of the smelting sites on Blaauwbank Farm. Additionally, physio-chemical analyses of tin slags from sites in the Rooiberg valley, such as Smelterskop and Elandsberg Ledge, also point towards the occurrence of heavy elements such as zirconium that were most likely retained together with cassiterite during alluvial panning (Miller and Hall, 2008, Chirikure et al. 2010; Heimann et al. 2010). Unfortunately the relatively simple method of cassiterite panning leaves very little archaeological traces (Figure 2.1).

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Figure 2.1: Panning for alluvial cassiterite in India using bamboo baskets. (Babu, 2003: 178).

Recently, intensive panning for alluvial cassiterite, in countries such as Indonesia and Democratic Republic of Congo (DRC), has left larger physical traces and deeper holes (Figures 2.2.A & B).

Figure 2.2.A: Photograph of alluvial tin miners in the Kalimbi tin mine near Nyabibwe in DRC (Reuters, 2011)

Figure 2.2.B: Photographs of intensive alluvial panning for cassiterite in Indonesia. (1) shows operations in Tanjung Pesona, District Sungai Liat, Bangka (Friends of the Earth, 2012). (2) Shows operations at Nudur in Bankga where some of them go as deep as 50 metres (The Guardian, 2012)

The above cases are driven by big companies such as Apple, Samsung, Sony and LG that seek to capitalise on the global surge in tin consumption related to smart phone and other electronic gadgets (The Guardian, 2012). The same scale of alluvial tin mining cannot be suggested for the Southern Waterberg, perhaps because hard rock mining may have been emphasised over panning.

In this regards, the cursory observations by Kynaston and Mellor (1909) on the pre-colonial tin mines at Rooiberg, led them to erroneously conclude that the mines where in fact iron mines of no great economic value. A more careful assessment by Recknagel during the same year, led to the correct identification of the mines as tin working. Recknagel (1908) drew the first crude map and sketches of the geological sections of the area immediately surrounding the mines and the relatively large extent of the pre-colonial tin mines became apparent (Figure 2.3).

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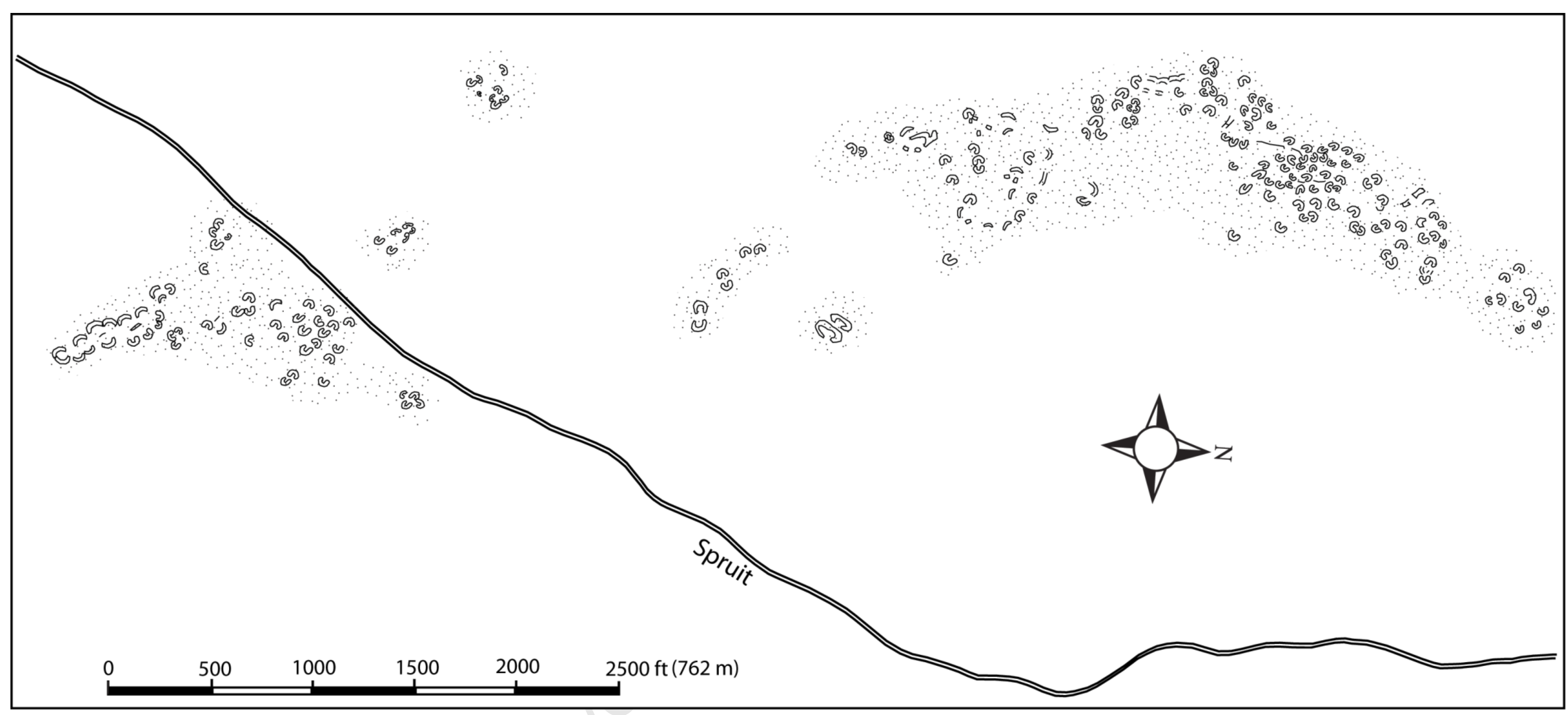

Figure 2.3: Map of the pre-colonial tin mines in Hartebeestfontein and Olievenbosch farms (After Recknagel, 1908: Plate VIII).

The majority of the ore stopes in Recknagel's map were not deeper than 3 m despite being partially backfilled subsequent to use by drifting sand (Recknagel, 1908: 89). A more detailed description of these tin mines was given by Baumann (1919a) who also noted, however, that some reached a depth of 16 m and had underground shafts and narrow adits (0.3 to 0.4 m wide and 10 m deep) (Figure 2.3). Narrow adits such as these have also been reported in the copper mines in Phalaborwa and they are probably associated with ventilation and lighting in contrast to erroneous ideas that they were used by child miners (van der Merwe and Scully, 1971; Herbert, 1984: 45). Hard rock mining commenced by following ore mineralisation by sinking vertical or inclined shafts by means of drives and breaking the hard rocks was done using iron gads (chisels) and hammers, as well as fire-setting (Baumann, 1919a; Falcon, 1985). Clearly there was significant complexity and know-how in the mining of Rooiberg tin. Innovation in tin mining, however, was not seen as being of African origin. Early European prospectors, geologists and travellers, speculated about the age, gender and identity of pre-colonial miners (Summers, 1969; Friede 1980; Hammel et al. 2000). Specific prejudice in the early writing on the Rooiberg pre-colonial tin mines was against the black African authorship of this innovation, in favour of foreign influence from Semitic or Arab races (Recknagel, 1908; 1909; Trevor, 1912; 1919; 1930; Baumann, 1919a; 1919b). Consequently black Africans were only thought have been used as labourers under coercion from superior foreigners. So strong was this thinking that even earlier writing by missionaries such as Robert Moffat who described a Hurutse (Sotho-Tswana) smith who made bronze (which Moffat misclassified as brass) by mixing tin with copper and who bought tin of the best quality from the Bakwena (Sotho-Tswana), were lost within earlier colonial prejudice about African ability. This settler mentality was widespread in southern Africa during this time and this prejudice is best known in relation to the magnificently stone built site of Great Zimbabwe (Bent, 1892; Hall and Neal, 1902; R. Hall, 1905).

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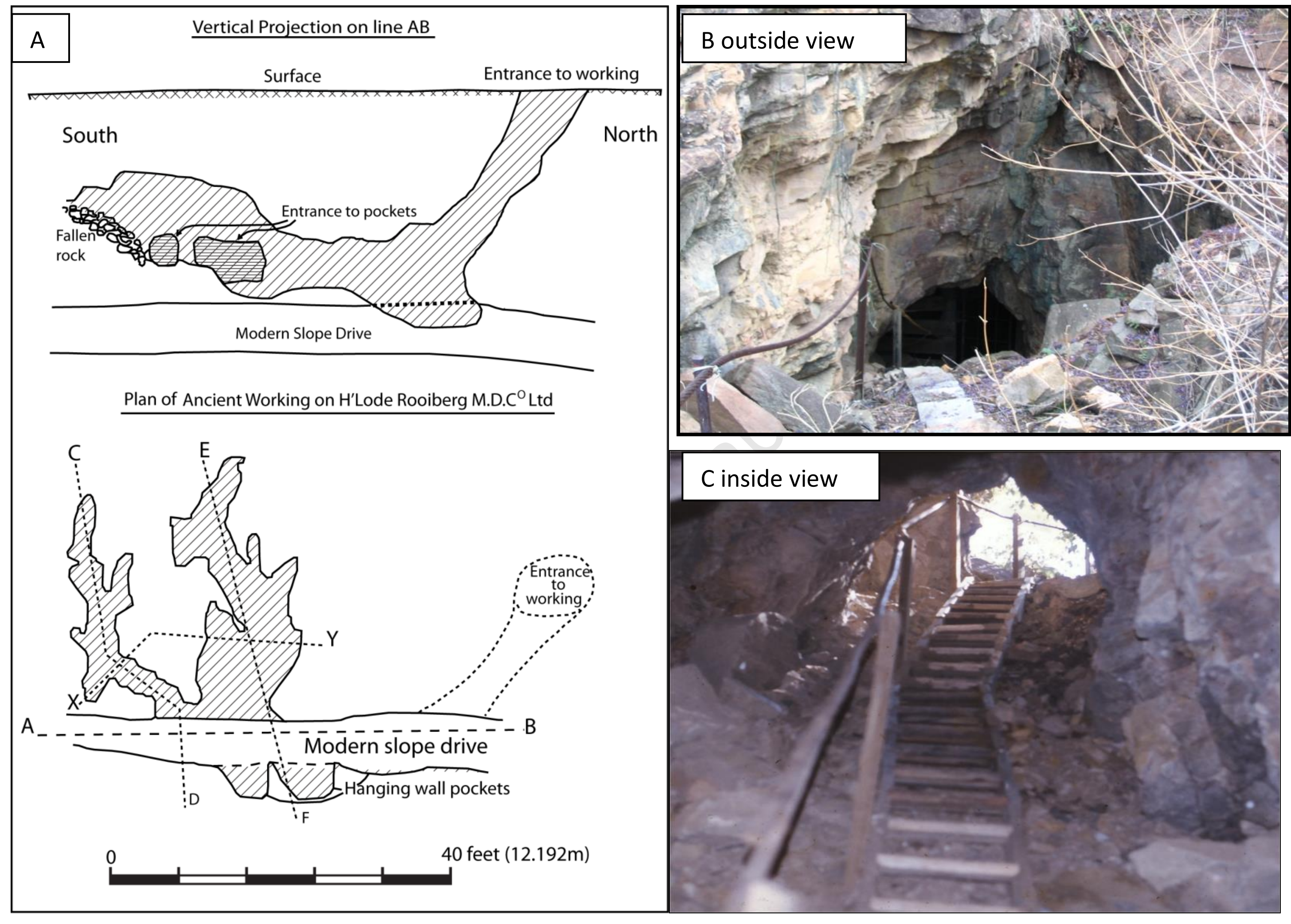

Figure 2.4: Plan and section (A) and photographs (A & B) of one of the pre-colonial tin mines at Rooiberg (Baumann, 1919a: 123). The metal and wooden stairs in C are modern. (Photo credits: University of Witwatersrand).

Others such as Dart (1924) analysed skeletal remains recovered from some of the tin mines in order to explore the question of the miners' identity. His conclusion was that the skeletal features were consistent with black African people, but these findings did little to change some researchers' attitudes about African mining abilities. What is clear in these writings is that early writers also grappled with the question of how and why the innovation of tin and bronze production came to southern Africa, but were biased in their opinions. We now know that tin mining is integral to the Iron Age sequence described in section 2.2 above. The question of the impetus behind the initial adoption of tin, however, remains critical and cannot be addressed by simply establishing the identity of the miners.

Related to the identity of the miners was the issue of scale of tin production and situating the demand for this metal. By 1912, the then Inspector of Mines for Pretoria and the Northern Transvaal, Tudor Trevor, also surveyed the Rooiberg tin mines and estimated that some 100 000 tons of ore were mined in pre-colonial times from which about 2000 tons of tin were produced. This figure was later revised downward by Baumann (1919a) to 18 000 tons of tin ore and about 1000 tons of tin. Prejudiced opinions about African abilities also suggested that the demand for this metal was very low amongst African communities when compared to overseas markets and it was automatically considered that most of the tin and or bronze from southern Africa were exported to extra-continental destinations via the east African coast (Schapera, 1933: 606; Grant, 1999).

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2.4: SMELTING TECHNOLOGIES: WINNING THE METALS FROM THE ORES

Current knowledge about iron and copper smelting techniques employed in the Southern Waterberg, is patchy, compared to elsewhere in southern Africa (Prendergast, 1974; Miller and Whitelaw, 1994; Miller et al. 1995; Miller et al. 2001; Miller, 2002; Chirikure, 2002; 2005; Thondhlana, 2012). In the area under study, isolated analyses of iron and copper slags were occasionally incorporated into work focused on the analysis of tin slags (Wagner and Gordon, 1929; Friede and Steel, 1976; Mason, 1986). Materials for analysis came from a number of pre-colonial copper, tin and iron smelting sites in the Southern Waterberg (Mason, 1986; Tomaselli, 2006).

Tin smelting has received some research attention, mainly focused on the hilltop site known as Smelterskop as well as the nearby site of Elandsberg Ledge. The former yielded significant

amounts of tin smelting residues (about 4 tons[8]) whose quantity alone makes it a unique case, probably related to metal specialisation (Chirikure at al. in preparation). Metallurgical debris from these sites were studied to reconstruct the technology (Miller and Hall, 2008; Chirikure et al. 2010; Heimann et al. 2010) and indicates that the process does not conform to the modern industrial two-stage process. In the modern process, an initial stage involves mild reduction that leaves a high proportion of unreduced tin in the slag, which is then further reduced under highly reducing conditions in the second stage (Wright, 1982; Rankin, 1986). By contrast, a nuanced one stage process was employed pre-colonially and conditions were manipulated to avoid the detrimental co-reduction of iron and tin (Miller and Hall, 2008; Chirikure et al. 2010). This was a compromise because more tin was lost to the slag, thereby reducing the metal output

Iron, copper and tin smelting furnace designs are poorly understood in the Southern Waterberg. Some descriptions of furnace types are vague and the furnace provenance is rarely given. For instance, White and Oxley Oxland (1974: 269) mention that "excavations on the farm Vellefontein adjoining Rooiberg revealed a portion of a copper-smelting oven elliptical in shape and much smaller in shape than iron ovens described". This particular furnace rose to 0.7 m and was 0.3 m wide and 0.45 m long, but no provenance information or other descriptions are given (White and Oxley Oxland, 1974: 269). Wagner and Gordon (1929) also documented a circular (plan) and saucer (section) shaped furnace base in the Blaauwbank Donga, one of which had tin slag. These furnaces did not have superstructures and they have since been lost to donga erosion (S. Hall, 1981). Seven bowl-shaped furnaces were identified by the University of Witwatersrand's Archaeology Unit in 1984 at Rhenosterkloof 1 and two of these (Furnace 2/84 North and Furnace 2/84 South) were excavated and their dimensions were recorded but nothing else was published about these furnaces (Friede and Steel, 1985: 46). Recently, Huffman (2006: 61) excavated two bowl furnaces at a site associated with the Madikwe facies near the Rhino Andalusite Mine in Thabazimbi (Figure 2.5)

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[8] Estimates based on calculations from excavated debris

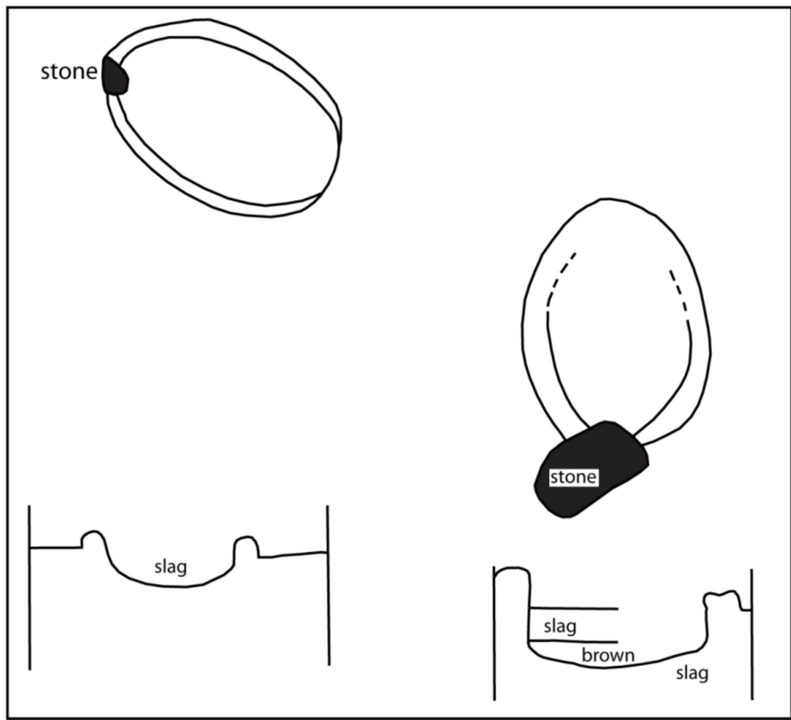

Figure 2.5: Bowl furnaces from Rhino Andalusite Mine (Huffman, 2006: 61).

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While this gives a general picture of furnace design, it is not clear whether iron, copper or tin smelting were done in similar reaction vessels or not? Clearly, there is much scope on the characterisation of furnace forms and associated smelting remains related to these metals and this was a research target in the present study.

2.5: ALLOYING: BRONZE PRODUCTION

When smelting copper ores with noticeable amounts of tin, reduction of tin is favoured in the presence of copper because of the intermetallic affinity, leading to the production of unintentional low tin bronzes (Bachmann, 1982). This explains why in Eurasia, it was possible to manufacture low tin bronzes at a much earlier date than the reduction of tin ores to metal (Craddock, 1995). Obviously, this sequence did not apply in the Southern Waterberg. Nonetheless, Recknagel (1909: 184) explored the possibility that tin may have been initially produced unintentionally because the tin mineralisation[9] at Rooiberg is associated with malachite and azurite. From this association, the production of bronze theoretically could have preceded that of tin. On the other hand if tin and bronze were produced simultaneously, it raises questions about the nature of tin/bronze innovation or how

[9] See Chapter Four for a detailed discussion on the relationship between the mineralisation of tin, copper and other elements at Rooiberg.

one would have set to produce this metal and its alloy without having prior information from elsewhere. Consequently, the chronology of bronze production is also critical.

An inventory of bronzes known in the Southern Waterberg and other parts of southern Africa suggest that most of them are standard bronzes, with around 13 % Sn content (Appendices 2.1 to 2.3). A tin content (between 1 and 5 %) is usually considered to be indicative of intentional alloying of copper with tin, although in several texts, tin percentages lower than 2-3 may indicate unintentional alloying (Oudbashi et al. 2012). Because, bronze appeared in southern Africa, at a time when iron was already in active use, this alloy was not appreciated for its hardness but for its colour as a decorative metal (Herbert, 1984). Another advantage of bronze over copper is that 1 % to about 10 % tin content makes copper more fluid and therefore easier to cast (Oudbashi et al. 2012).

The issue of deliberate alloying intensified with the early metallographic study of the famous Blaauwbank ingot and the suggestion that it was a true bronze (Trevor, 1912) but actually had too much arsenic to be classified as such (Wagner and Gordon, 1929: 571; Stanley, 1929a; 1929b; Friede, 1975). In the late 1920s Leo Frobenius, visited the Southern Waterberg and other areas in southern Africa and collected chisels, ingots, wire, rings, and beads among other things. This collection was analysed by Schulz (1950) and translated into English by Miller (1992a). In this Frobenius collection, a larger number of the objects had a near similar bronze composition of about 90% copper and 10% tin (Miller, 1992a).

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2.6: SMITHING, FABRICATION & CASTING

In southern Africa, smithing and fabrication techniques for iron, copper, tin and bronze have been very similar, with a few exceptions (Miller, 2002). Generally iron objects were shaped by a combination of hot and cold working, sometimes accompanied by annealing but without quenching (Miller, 1992a). Metallographic studies of iron objects from the Southern Waterberg have been limited and focused on chisels recovered from one of the pre-colonial tin mines in Rooiberg (Frobenius, 1931; Stanley, 1931; Schulz, 1950; Miller, 1992a). The general consensus is that these iron gads are soft iron-carbides and not Wootz steel as originally suggested by Frobenius (1931).

Casting and forging techniques for tin and bronze from the Southern Waterberg appear to be comparable to those employed for copper objects from northern South Africa (Thompson,

1949; Killick, 1991, Miller 2001; 2003) but did not involve soldering and lost-wax casting, complex techniques observable in West Africa and Eurasia (Herbert, 1984). Casting involved pouring molten metal or alloys into shaped clay moulds or prepared sand for the desired shapes, even though a limited number of the very crude ingots may have been produced by hammering (Steel 1975). In terms of morphology, tin and bronze ingots from in and around the Southern Waterberg mostly come in variations of rods, buns and bars that were produced through a combination of casting and hammering (Figure 2.6 and Appendix 2.1 to 2.3). Some rod and bar ingots suggest links with the MuTsuku (Lemba and Venda word for copper ingot) and Lerale (Sotho/Pedi word for copper ingot) that are also known in ethnographic literature (Thompson, 1949). The former looks like a miniature hat with rows of studs that are similar to the Blouberg bar, while the latter looks like golf-clubs similar to the tin lerale from Terblanche Hoek Farm, close to Musina (Figure 2.6). These ingots are poorly provenance and consequently not securely dated, and so their relationship to early phases of tin working remains unclear (Stanley, 1929a; Wagner and Gordon, 1929; Frobenius, 1930; Schulz, 1950, Friede, 1975; Friede and Steel, 1976; Grant, 1990b; Killick, 1991; Miller, 1992a).

Wire drawing was practiced in the Southern Waterberg (Hall, 1981; 98-99, 140). Contemporary in the region also used this technique (Stanley, 1931; Fagan, 1969; Steel, 1975). Ethnographic and experimental work on copper wire have been carried in various parts of Africa and it has been demonstrated that it is possible to draw softer metal such as copper and bronze using an iron drawing plate and a vice (Burchell, 1822-24; Moffat, 1842; Livingstone, 1961: 95; Friede, 1975: 234).

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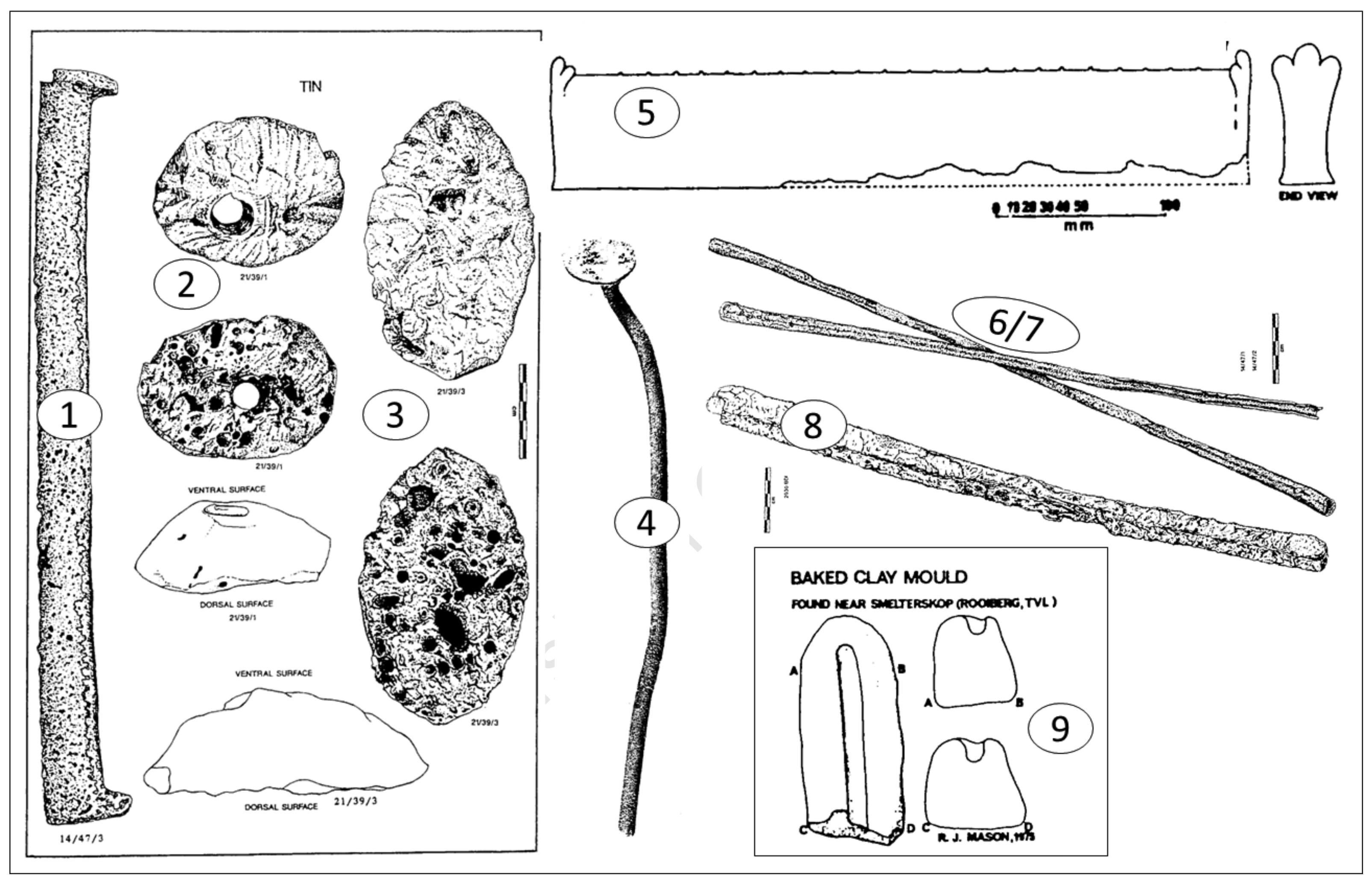

Figure 2.6: Illustrations of some tin ingots and a clay casting mould. 1 comes from Thabazimbi; 2& 3 come from Rooiberg; 5, 6, 7& 8 come from Blouberg Mountains in Soutpansberg (formerly known as Malabog), 4 comes from Musina, 9 comes from Smelterskop, (Grant, 1999: 1113, 1114; Killick, 1991: 139; Friede and Steel, 1976: 465)

2.7: METAL CONSUMPTION & DISTRIBUTION

Early geologists have posited that large quantities of tin were mined from the Rooiberg mines but they pointed out that this did not tally with the handful of tin and bronze artefacts they knew about (Baumann, 1919a; 1919b). Consequently, hypotheses about the large scale export of tin and or bronze objects to Eurasia were advanced in order to explain this disparity (Grant, 1994). However, aside from a few 18th century transactions recorded by the Dutch (Theal, 1902), these ideas were challenged by the paucity of tin and bronze listed in export catalogues. Thus, while tin and bronze may have been exported from southern Africa, the scale seems to have been negligible when compared to the emphases on gold starting from the terminal first millennium AD (see Chapter Four).

Regional patterns relating to the consumption and distribution of tin have not been fully explored. Analysing the distribution of tin and bronze in the region is hampered by the fact that few scientific analyses have been carried out and it is most bronzes housed in museums and research institutions have been overlooked because they have been automatically classified as copper objects (Killick, 1991; Miller, 2002). More complex regional distribution and consumption pattern are now emerging. Within the Southern Waterberg, it is clear that communities outside the Rooiberg and Boschoffsberg's core areas were dipping into the tin resources and smelting in their own homesteads (Hall and Grant, 1995). Early missionaries such as John Campbell who visited the Sotho-Tswana towns of the Rustenburg-Pilanesberg area, also alluded to the fact that tin was being brought from areas further north, which in all likeness points towards Rooiberg (Campbell, 1822). Some ethno-histories of trade in southern Africa are presented in the next chapter but further evidence suggesting the wider distribution of Rooiberg tin come from trace element studies.

Grant (1995, 1999) first attempted establish the sources of tin in the tin and bronze objects from southern Africa. His results implicated Rooiberg as the source. Smith et al. (1997) also attempted trace element studies using laser ablation ICP-MS, with the results also implicating Rooiberg as the source of the tin. Recently, Miller and Hall (2008) used the ICP-MS on tin droplets from the site of Smelterskop and produced that are similar to Smith et al (1997). More recently, Molofsky (2009) used lead isotope analyses on tin and bronze artefacts from Rooiberg, Great Zimbabwe, Mapungubwe, Bosutswe and Thulamela, and also concluded that most of these objects matched the Rooiberg tin signature. The implications from these trace element studies is that most of the tin and bronze objects from several parts of southern

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Africa were made using Rooiberg tin. By extension, this also gives an inferred chronology for the antiquity of tin production in the Southern Waterberg. The evidence all comes back to Rooiberg and this brings us to the issues of dating and chronology.

2.8: DATING & CHRONOLOGY

Available radiocarbon dates from the Southern Waterberg suggests an Iron Age occupation through most of the second millennium AD. The few dates associated with the exploitation of tin, however, cluster in the second half of this millennium (Table 2.1). There are only three dates before the 15th century and these are not associated with the exploitation of tin (Table 2.1). ETH7769 and ETH7770 calibrate to a period between 1025 and 1285 AD at 2 sigma, which corresponds to the Eiland facies (Table 2.1). These dates come from charcoal fragment in a copper-based bun-shaped ingot of unknown provenance. The chemical analysis of the ingot suggested that it had too much arsenic (18.8 %- Stanley, 1929a; 5.5 %- Friede and Steel, 1976; 19 %- Grant et al. 1994) to be classified as a bronze ingot, even though a tin content of 3.4 %, 1.18 %, and 1.8 % was reported by Stanley, (1929a), Friede and Steel, (1975) and Grant et al. (1994), respectively. Miller and Hall (2008: 34) suggested that it is a result of smelting olivenite. Pta9546 comes from an EIA site in the Thabazimbi area, which is associated with the Happy Rest facies (Huffman, 2007: 467) but not associated with tin production. The rest of the dates fall in the range of calendar dates between 1650-1950 cal. CE and this sis uncertainty is not helpful. At Smelterskop, a "white heart" glass beads, known to have been first produced in the 1830s in Venice Italy (Wood, 2008), was also found thereby helping to refine the chronology of the site. Significantly, these dates do not capture the full tin sequence that is implicated by the trace-element analyses of tin and bronze from dated contexts elsewhere and falls short by at two centuries (Figure 2.7).

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Table 2.1: Radiocarbon dates from the Southern Waterberg. Dates supplied by Simon Hall & David Killick are marked as (***)

Sample #	Provenance	Material	BP age	At 2 sigma calibration (AD)	Reference
Camp workings (Rooiberg valley)					
GrN5138	Mine shaft	wooden post	435±45	1405-1520	Grant, 1990a: 63
ETH5127	Tin ingot in mine shaft	charcoal	395±55	1429-1634	Grant, 1990a: 63
From Rooiberg but provenance unknown					
ETH7769	from a bun-shaped copper ingot	charcoal	860±50	1155-1285	Grant et al.1994:88
ETH7770	from a bun-shaped copper ingot	charcoal	925±50	1025-1260	Grant et al.1994:88
Smelterskop (Rooiberg valley)					
Pta2850	Revil-excavation on summit	charcoal	190±30	1664-1816,1828-1893,1919-1951	S. Hall, 1981: 144
AA77929	R5A slag layer over crushed shale	charcoal	141±32	1681-1731, 1802-1952	***
AA77936	Jackson	charcoal	211±32	1648-1711,1719-1812,1836-1882, 1923-1951	***
AA77935	Ferdie	charcoal	124±32	1690-1727, 1805-1953	***
AA77938	RT3A below crushed shale	charcoal	264±32	1517-1539,1625-1683,1730-1802	***
AA77937	RT3B above crushed shale	charcoal	225±32	1643-1700,1721-1810,1838-1846,1860-1860,1867-1878,1925-1951	***
AA77939	RT2A above crushed shale	charcoal	160±32	1673-1743 1759-1760,1772-1778 , 1797-1952	***
AA77940	R15B below crushed shale	charcoal	237±32	1637-1698, 1724-1808,1839-1842 , 1869-1876, 1947-1950	***
Elandsberg ledge (Rooiberg valley)					
AA77934	EBL-1	charcoal in slag	373±32	1464-1472, 1476-1634	***
AA77933	EBL-2 close to two tuyeres	charcoal in situ	243±32	1635-1696, 1725-1807, 1949-1950	***
Baauwbank Donga (Rooiberg valley)					
Pta2849	007/78, fire bowl hut floor	charcoal	370±30	1465-1467,1476-1636, 1515-1615	Grant, 1990a: 63
Rooikrans (Boschoffsberg valley)					
Pta2845	131/78, 20-30cm, Ash Heap I	charcoal	280±50	1493-1698,1723-1808,1839-1843,1869-1876,1935-1935,1946-1950	S. Hall, 1981:144
Rhenosterkloof 1 (Sand River Valley)					
AA77931	101/78,surface of metal dump	charcoal	192±35	1657-1817, 1827-1893, 1917-1951	***
Pta-2847	101/78, AshHeap II	charcoal	310±40	1495-1672, 1744-1756,1762-1770, 1780-1796	S. Hall, 1981:144
Rhino Andalusite mine (Sand River valley)					
Pta-9547	Rhino CB14 House 1	charcoal	320±40	1525-1655	Huffman, 2006: 53
Pta-9543	Rhino CB14 House 4	charcoal	400±10	1485–1615	Huffman, 2006: 59
Pta-9545	Rhino CB14 Inside furnace A	charcoal	530 ± 25	1420–1435	Huffman, 2006: 60
Pta-9546	Rhino CB18	?	1550±80	?	Huffman, 2007: 467

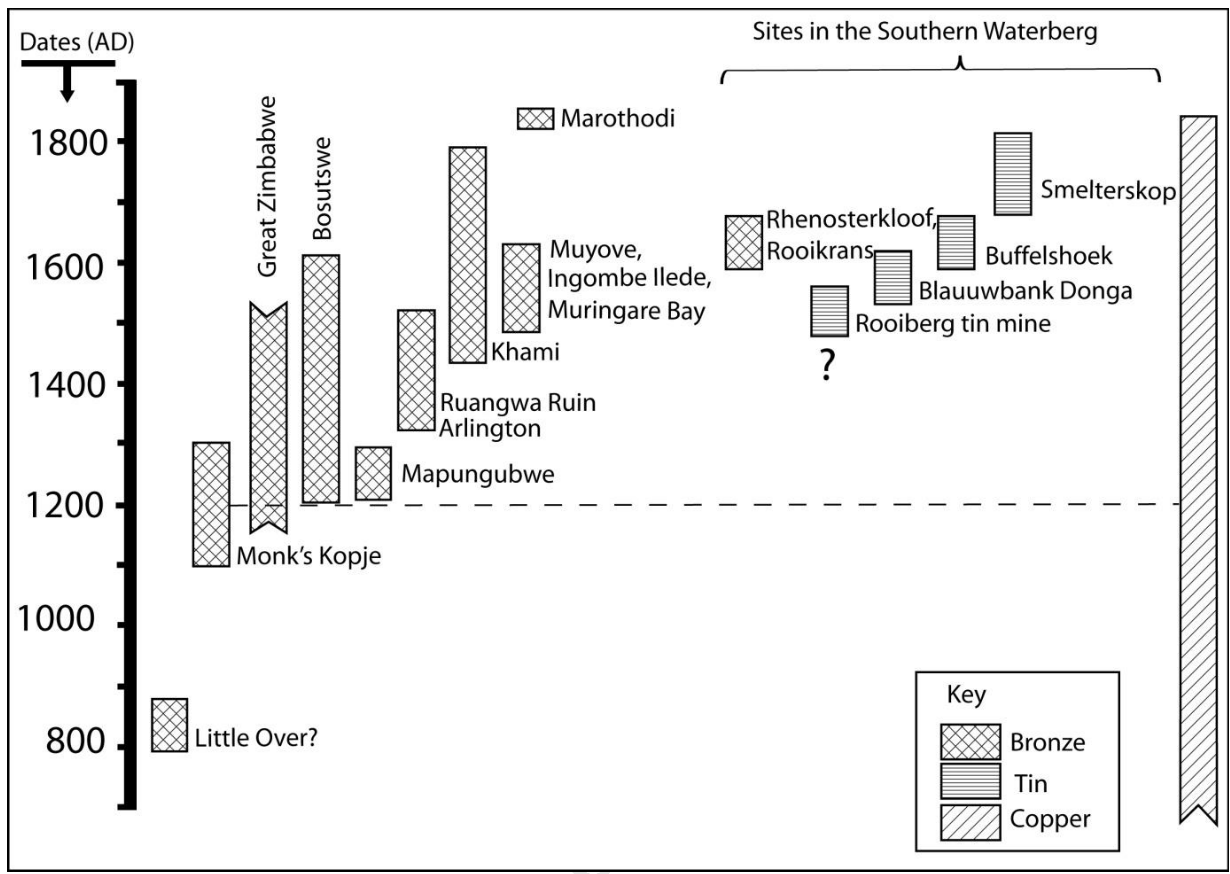

Figure 2.7: The chronology of tin and its alloy as represented by selected sites in southern Africa. Modified after Chirikure et al. (2007).

The broken line in Figure 2.7 shows the currently accepted earliest dates for bronze objects from southern Africa but some sites in the Zimbabwean plateau, such as Monk's Kop have produced bronze objects that are earlier (Thondhlana and Martinon-Torres, 2009). These early dates are contemporary with the Eiland facies (1000-1300 AD) in the Rooiberg area and these ceramics also occur at sites in the Shashe-Limpopo area including Mapungubwe. The presence of Eiland sherds at Mapungubwe clearly underpins interaction. On the other hand the presence of bronze at Mapungubwe throws the attention back onto the Eiland facies in the Southern Waterberg. The available radiocarbon dates for tin from the Rooiberg area do not bridge this chronological gap and consequently to address this I turn to the available metallurgy from local Eiland sites in the Rooiberg region. To test the veracity of this inference it was important to explore the archaeology and metallurgy of tin production in the latter, in order to see if there are any Eiland sites that are associated with the exploitation of tin resources.

2.9: SUMMARY

In the Southern Waterberg, research on tin and the contexts of tin production has been on-going for over a century. However, much of this research was unsystematic with energy channeled towards the pre-colonial tin mines and a few tin and bronze objects. Some systematic studies, including the archaeology of the area, have helped in relating the mining and metallurgy to the culture historical sequences. Unfortunately, this does not address the possible earlier phases of tin and bronze innovation in the Southern Waterberg. The inference from elsewhere indicates that this should be at the beginning of the second millennium. The present study sought, among other issues, to explore the chronology of tin and bronze metallurgy in the Southern Waterberg in relationship to the evidence from the wider region. To further provide background to local and regional patterns interaction, ethno-histories of trade in southern Africa are discussed in the next chapter.

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CHAPTER THREE: ETHNO-HISTORIES OF TRADE IN SOUTHERN AFRICA DURING THE SECOND MILLENIUM AD

"And the Zumbo vashambadzi traversed all that region, bartering for gold from village to village without necessarily ever visiting the Mambo's Court" (Mudenge, 1974: 386).

3.1: INTRODUCTION

Research into long-distance trade related to non-ferrous metallurgy in southern Africa has emphasised the link between intercontinental trade and the diffusion of gold, copper, tin and bronze. Eurasia was considered as both the source of the innovations and also the major destinations for gold, tin and bronze products (Miller, 2002). Moreover, elite sites in the interior, such as Schroda, K2 and Mapungubwe are thought to have controlled and re-distributed imports that included glass beads and cloth, among other products (Huffman, 2007). Given the clear evidence of innovations in the Shashe-Limpopo basin, starting in the second millennium AD and the intensification of trade nodes and networks, the obvious question focuses on these nodes and networks and the medium through which the demand for tin and the innovation of tin production may have been communicated to the less stratified communities that fell outside these state systems. What patterns of local, regional and long-distance trade existed in southern Africa in the second Millennium AD, which may have been useful in spreading this innovation? Moreover, what was the nature of trade relations between "heartland" polities and "hinterland" communities, and how did that influence technological crafts such as metal production in the hinterlands?

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To address the above issues, I review ethnographic and historical sources about the nature of trade in the region. The assumption is that, recent evidence, when used critically, provides structures to think about developments that pre-date written and oral sources. This chapter presents ethno-historiographies of trade patterns from the Tsonga and Shona cultural groups that come from opposite ends of resource-gradients[10] and other groups are discussed in less detail. This discussion develops a perspective for trade patterns in southern Africa.

[10]The term resource-gradient denotes the variations in the distribution and concentration of resource levels that, by definition are high at one end of a resource gradientand low at the other end (Huston, 1994: 294).

3.2: A BRIEF BACKGROUND TO LONG-DISTANCE TRADE IN SOUTHERN AFRICA

It has already been noted that the commercial exchange of products between individuals or societies vary, from simple hand-to-hand exchanges to complex and organised long-distance trade (Beale, 1973). However, the different forms of trade do not necessarily follow the resource-gradient principle because communities at different ends of the resource-gradient can either be "pulled" or "pushed" to engage in trading. Thus, while trade was an essential way of distributing risks, establishing flexible social ties and mediating local scarcity and seasonal resource crises, basically as a means of accessing non-local resources while maximising surplus, access and control of trade also underpinned socioeconomic differences (Renfrew, 1986; Oka and Kusimba, 2008). Most interestingly, trade promoted the exchange and traffic of ideas and innovations (Kristiansen, 2005). Nonetheless, the exchange of goods was always the prime focus in trade (Oka and Kusimba, 2008).

Trade between the Persian Gulf and the Mediterranean via the Red Sea has a deep antiquity, stretching as far back as 1000 BC (Huffman, 2007: 75). Perhaps the *Periplus of the Erythrean Sea*, the oldest document alluding to the integration of East African Coast into this trade network is only giving us glimpses of what existed over thousands of years between India, Persia, Egypt and East Africa before Muslimised Swahili traders extended the network to include south-eastern Africa (Kusimba 2004: 63). These Swahili traders brought the merchandise from Arabian, Indian, Chinese and Indonesia sailor-traders who were reaching the east African coast using monsoon winds, to south-eastern Africa. However, in the southern African interior, these Swahili traders, just like later European "interlopers", relied mostly on local middlemen. The Portuguese, after the mid-16th century, were an exception with a policy of direct intervention (Axelson, 1960; Pikirayi, 1993). Table 3.1 below shows a summary of the history of long-distance trade in the region.

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Table 3.1: Notable developments in the history of long-distance trade in the southern Africa

SWAHILI-ARAB TRADE	
Date (AD)	Some notable developments and events
700-800	Swahili trade expands south of Lamu. Chibuene as the major port. Glass beads reach sites in the interior such as Makuru (Wood, 2000)
800-1000	Sofala 1 as major port. Bazaruto Island as part of Sofala 1. Glass beads found at sites much further into the interior such as Ngoma in Botswana (Wilmsen, 2009)
1000-1200	Intensive ivory working and trade at sites such as Schroda in the Limpopo valley. According to the Arab writer Al-Idrisi (AD1154), gold began to overtake iron as a major export from southern Africa during this period (Tolmacheva, 1979)
1200-1500	Flourishing of gold trade via Sofala 2, linked to the rise of state systems in the interior. Bronzes begin to appear in the archaeological record of some elite sites in the interior (Miller, 2002)
1500	Arab port at the mouth of Save river ceases to function because the river was no longer annually navigable (Summers, 1969).
PORTUGUESE TRADE	
1498	Vasco da Gama reaches southern Africa and finds Bantu-speaking groups already engaged in copper and tin trade (Axelson, 1973)
1505	Portuguese annex Sofala 2 from Swahili traders (Axelson, 1960)
1531	Portuguese establish trading stations in the interior at Sena and later at Tete (Axelson, 1960)
1544	Portuguese begin trading at Delagoa Bay and Quelimane (Axelson, 1973)
1546	Portuguese begin trading at Inhambane (Theal, 1902)
1569	Portuguese in the interior reach as far as Butwa in search of gold (Beach, 1977)
1600-1700	Ivory was the major export at Sofala 2 (Theal, 1902)
POST AD1600: OTHER EUROPEANS JOIN THE TRADE	
1652	Dutch establish a refreshment station at the Cape of Good Hope & start trade in sheep and cattle with Cape hunter-gatherer and herder groups (Theal, 1902).
1661	Dutch begin trading with Namaqua hunter-gatherer and herder groups for meat (Goodwin, 1956)
1680	English bring better and cheaper goods to trade for ivory and gold at Delagoa Bay (A. Smith, 1970).
Post 1700	Direct Portuguese trade in the interior declines but continues under African middlemen (Bhila, 1982)
1716	Portuguese establish a trading station at Zumbo in the interior (Axelson, 1973)
1721-1730	Dutch commence trade at Delagoa Bay. Records confirm purchase of copper, tin and some gold from Tsonga, Venda and Sotho traders. Also the first to buy slaves at this port (Theal, 1902)
1725	French join trade at Delagoa Bay (A. Smith, 1970)
1820s	Slave trade intensifies south of Quelimane (A. Smith, 1970)
1838	Voortrekkers reach Delagoa Bay following African trade routes (A. Smith, 1970)
1800-1900	Trade continues but interrupted political upheavals and colonisation (Theal, 1902)

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As indicated above, long-distance trade intensified towards the end of the first millennium AD in southern African Iron Age. Export commodities which were much prized by Eurasian traders in this early period were ivory, gold, and probably iron that were also augmented by several other resources and their exploitation varied through time (Theal, 1898; 1902; Axelson, 1960; 1973; Summers, 1969; Chittick, 1974; Liesegang, 1977; Pikirayi and Pwiti, 1999). The requirements of societies around the Indian Ocean rim were communicated with the interior societies starting; it seems, with an increased demand for elephant ivory (Chittick, 1974; Huffman, 2007).

The distribution of trade resources in the southern African interior is informative not only on patterns of local and regional trade, but also on the subsequent mercantile contact between this region and the outside world because for the most part, the distribution of resources did not change (Figure 3.1). Marking the distribution of trade resources in this region on a map is a simplification of a complex picture. For instance, iron ores are generally ubiquitous and vary in grade and accessibility. Moreover, pre-colonial miners did not work every ore body available to them, making it difficult to map the actual distribution of exploited resources. Thus, although gold abounds in South Africa, most of it was not worked pre-colonially compared to deposits in Zimbabwe (Summers, 1969; Swan, 1994). Ivory and cattle have been omitted because of the obvious difficult in mapping their distribution. Nonetheless, it can be noted, for the recent past, that Tsonga-speaking groups resided in areas of low resource richness, when compared to other groups such as the Shona and Venda (Figure 3.1). Yet, as discussed, these communities were all pivotal in trade transactions between coastal traders and the interior.

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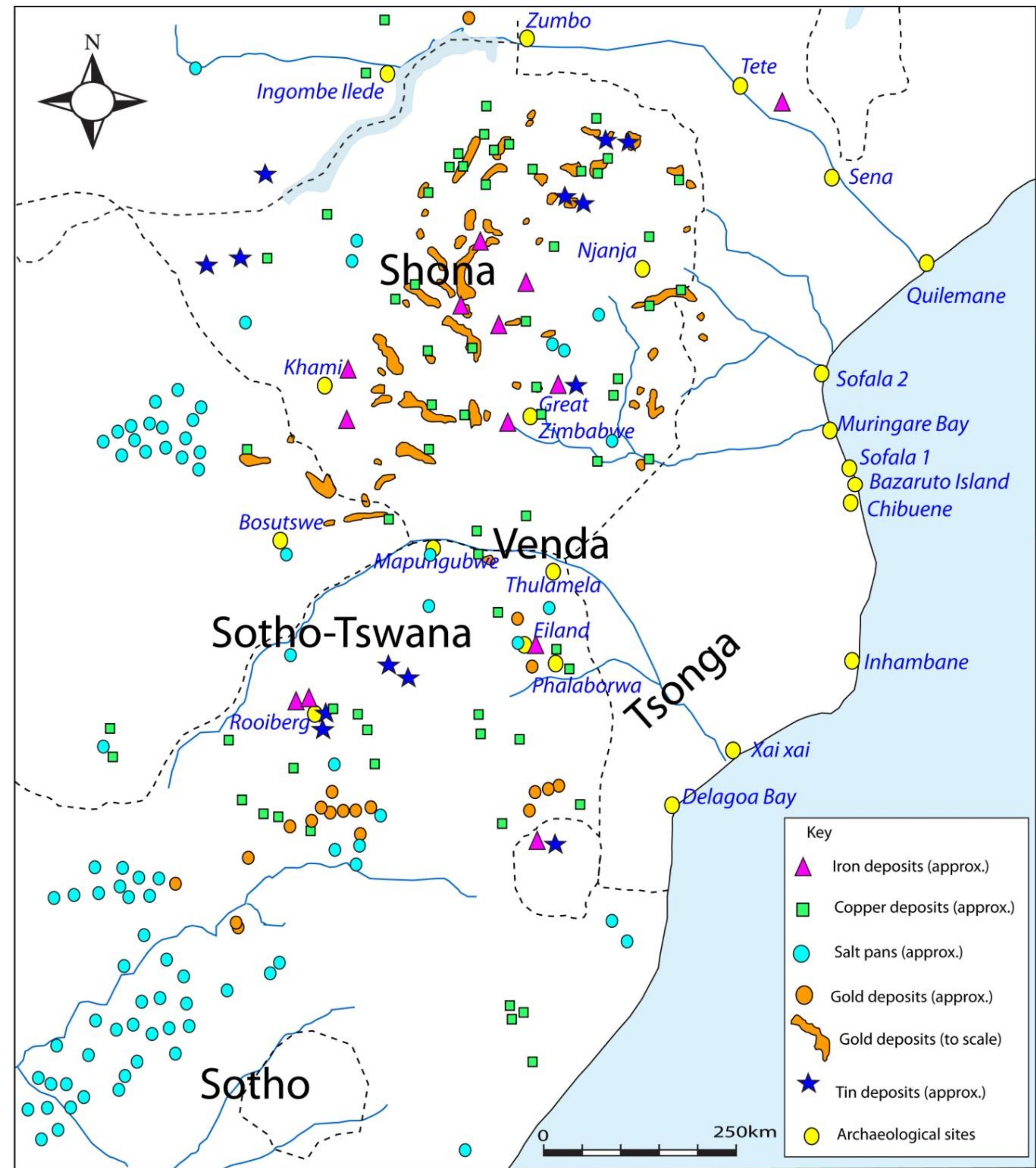

Figure 3.1: Showing the distribution of ore resources, relevant sites and linguistic identities discussed in this chapter. Adapted from Summers (1969); Miller et al. (2000); Seaman et al. (1991), Map of Mineral Resources of Zimbabwe (1988); Geological Map of the Republic of South Africa and the kingdoms of Lesotho and Swaziland (1970.

3.3: ETHNO-HISTORIES OF TRADE IN SOUTHERN AFRICA

The above prelude has suggested that Eurasian traders may have been uninterested the intensive exploitation of tin resources in southern Africa. This leaves elite centres as other possible areas

where demand for tin and its alloy (bronze) may have come from. The subsequent review of recent evidence about trading is aimed at investigating how less stratified communities interacted with elites through the exchange of, or participation in local, regional and international trade. Issues of access to local and export commodities, trade initiatives and middlemen-ship practices, levying of traders and trade partnerships are also discussed. Examples from several parts of southern Africa are used with a view of informing on issues that are relevant to the innovation of tin and the exploitation of other metal resources in the Southern Waterberg.

In most cases, the lucrative long-distance trade in southern Africa must have intensified pre-existing local and regional trading networks. In the recent past, local middlemen were transformed into a class of professional traders who began to aggressively pursue itinerant trading on full-time or seasonal basis. Ethno-historical sources indicate that throughout southern Africa, local middlemen who were innovative in their handling of trading affairs and were exploit pulses of supply and demand. Amongst the Shona-speakers, for example, this class grew into a long-lived social category called the *vashambadzi* (Bhila, 1982), which will be discussed in detail later. In other cultural groups, such categories were not always as clearly defined, even though entrepreneurial middlemen existed. For instance, in Zambia and Malawi, the Lenge, Nsenga, Yao and Bisa peoples grew as kin-based entrepreneurial traders operating in the Maravi Kingdom, around the western and eastern parts of Lake Nyasa (Lake Malawi) (Sutherland-Harris, 1970: 233; Galli, 2003). The same entrepreneurial skills and itinerancy is also associated with the Lemba people found in parts of Zimbabwe and South Africa (Liesegang, 1977). In Botswana, the BaNgwato are also another 19th century example of a Sotho-Tswana group that rose to prominence as itinerant middlemen in the trade that also involved Khoesan and Eurasian groups at the Cape (Parsons, 1977).

Tsonga-speakers (to be discussed in detail later) engaged in long-distance trading because of the need to acquire non local resources (Figure 3.1). Additionally, in areas with rich resources, the exploitation of and trade in particular commodities became associated with particular cultural groups. For instance, gold, iron and copper mining and trade are historically associated with the Shona, Lemba, Venda, Pedi and Phalaborwa speakers (van Warmelo, 1940; Parsons, 1973; Liesegang, 1977). Tin and bronze, on the other hand were produced and traded by Sotho-Tswana

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groups such as the BaKwena and BaHurutse, even though other groups also tapped into the resources (Cooley, 1833: 312; Parsons, 1973: 93; Liesegang, 1977). The BaKwena travelled to Delagoa Bay to trade by the late 18th century (Cooley, 1833) but it is not known if tin and bronze was part of their merchandise. However, they are credited for supplying most of their southern neighbours such as the Xhosas (Nguni-speakers) and the BaThlaping (Sotho-Tswana), with iron, copper, tin and bronze wares (Cooley, 1833: 312; Chirikure et al. 2007). It is also important to reiterate that individuals and non-specialised groups occasionally participated in long-distance trading in order to achieve specific goals, such as the acquisition of goods for the payment of bride price. To explore these issues in detail, I now turn to the specific case studies of the Tsonga and Shona-speakers.

3.3.1: THE TSONGA CASE STUDY

The use of the term "Tsonga" as a label for a cultural and linguistic group in southern African is historically recent and one that was coined for administrative purposes by missionaries and colonial authorities (Harries, 1989). However, one cannot deny, that there was and still is, a broad identity that can be called "Tsonga", based on linguistic similarities, social structure and a common material-cultural style (Ohinata, 2002: 23). This identity has been known collectively or individually by a number of popular names that include, but not limited to;

1. The Shangane/ Shangaan (after Soshangane)
2. MaGwamba/Makwapa (after one chief called Gwamba)
3. Thonga/Tonga/Amatonga (reference to people from the east by the Zulus)
4. Ronga/ Roka (easterners, reference to dawn, that is *vuronga*),
5. Hlanganu/Knopneusen/Knob nose (reference to the scarification of noses by one Tsonga group)
6. Hlengwe (dialect),
7. Nkuna (dialect)
8. Nwalungo (dialect)
9. Tswa (dialect)
10. Chopi (dialect)
11. Djonga/Dzonga (dialect) (Junod, 1913; Harries, 1989; Ohinata, 2002, Witter, 2010).

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Interestingly, Tsonga groups share another trait which is relevant to this discussion; "a natal inclination and addiction to trade", as described by Junod (1913: 122). This statement does not imply an *exceptio probat regulam in casibus non exceptis*[11], but simply highlights what drove the Tsonga-speakers to engage in long-distance trade, that is, the need to acquire non local resources (Figure 3.1). Moreover, these communities also resided in flood and drought prone areas, an additional factor contributing to trade as a major means of subsistence and acquiring wealth (Newitt, 1988). Consequently, Tsonga groups had to rely mostly on trade with their neighbouring groups such as the Lemba, the Venda, the Sotho-Tswana and the Shona for the acquisition of non-local resources. The arrival of Eurasian traders of the southeast coast did not only broaden this niche, seems to have transformed Tsonga-speakers from mere traders into middlemen and then into aggressive professional traders looking for other potential trade goods (A. Smith, 1970: 353). The spread of most Tsonga groups from the coastal areas westwards into the hinterland was linked to this pursuit of trade in commodities such as ivory and gold, as well as the need to maintain control of trade routes which they had established.

Early historical reference to long-distance trade involving Tsonga groups relates to the 15th century arrival of Portuguese at the mouth of Limpopo River. Hammond-Tooke (1911) suggests that it was the Hlanganu (one of the Tsonga groups) that Vasco da Gama met in AD 1498 at the mouth of the Limpopo River which he called Rio do Cobre (the Copper River). They were engaged in copper trade, probably with the Phalaborwa and Venda areas in the interior. Vasco da Gama and his men also observed that this Bantu-speaking group also had daggers with hilts of tin, which further suggests the Limpopo connection because both copper and tin were not produced anywhere near this Mozambican coast (Figure 3.1 and Appendix 2.3). Indeed, by the late 18th century, these Hlanganus were still supplying other Tsonga communities on the coast with copper obtained from the Venda in Limpopo valley (Hammond-Tooke, 1911: 84).

During the subsequent period of Portuguese trade in southern Africa, Junod (1913: 127) states that some Tsonga traders from south western Mozambique and north eastern South Africa were travelling as far as Mosapa in BaNdjao (Ndau, a Shona group) country with Eurasian merchandise for exchange. Mosapa could be a corruption of Massapa (or Baranda), a well-

[11]Exception that proves the rule in cases not excepted

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known trading fair in the gold rich heartland of Shona territory in northern Zimbabwe (Pikirayi and Pwiti, 1999). Whatever the case, it suggests that some Tsonga groups made a living through long distance trade that required ingenuity in traversing different landscapes and engaging with different cultural groups.

In northern South Africa, Venda ethnographic accounts mention that it was in fact the Tsongas of Mpfumo area that first brought glass beads, and cloth, among other things, to Vendaland from the Mozambican coast (van Warmelo, 1940). This may refer to the 16th century or earlier but in the early 18th century, groups of Venda and Sotho-Tswana traders from Limpopo were accompanying Tsonga traders to trade at Delagoa Bay. In this exchange between the Dutch and Bantu-speaking traders, the Mashakadzes (Maluleke people, Tsonga) and the Venda were bringing tin which they got from mountains further away from Venda capital[12] (Liesegang, 1977), of which the Southern Waterberg is a likely candidate. Moreover, between 1818 and 1820 and probably much earlier, Tsonga traders were arriving from Limpopo valley to trade at the Hurutse (Sotho-Tswana) capital of Kaditshwene near modern Zeerust (Parsons, 1997: 35). Since the Hurutse are also known to have received their tin from areas further north, it is probable that tin was one of the ingredients in this trade (see Hall et al. 2006; Anderson, 2009). At Marothodi, bronze earrings were found in one of the elite hut floors suggesting that tin was traded into this copper producing area.

In the early 1800s, some Tsonga individuals on the Mozambican coast were even forming trading "companies", such as *Mpfhumba* (meaning visitor) which was led by a man called *Ndjilash*, to whom the Europeans could entrust goods for barter (Junod, 1913: 127). *Ndjilash* had to recruit other Tsonga carriers with whom he would share the profit of the adventure. Amongst the Tswana of upper Limpopo in the early 19th century, the Tsonga traders were much admired for their strength as they carried the ivory they purchased on their shoulders and in some instances used pack-oxen or canoes (Parsons, 1997: 36).

Thus trade by Tsonga communities (and certainly other groups which are discussed later) was varied. Some of them were middlemen amongst Tsonga groups only, while others linked the

[12] Probably referring to Dzata

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Tsonga with other Bantu-speaking groups and others were middlemen between Eurasian traders and local Bantu-speaking groups. In some instance the trade was undertaken by individuals and in some cases it was undertaken by representatives of the whole chiefdom. Indeed, for most of the 2nd millennium AD the majority of Tsonga peoples lived in small-scale societies, based on kinship, in which political authority was exercised by a chief who claimed seniority by virtue of his royal genealogy but who may have risen to power through his access to mineral resources, hunting, or ritual skills (A. Smith, 1973: 572; Harries, 1989). An example of such a group is discussed in detail in the following case study of the Malulekes, who belong to the Chopi dialect of the Tsonga group that settled along the Limpopo River, probably from the 17th century or earlier.

THE MALULEKES

The Maluleke people belong to the N'wanati totem of the Chopi dialect. Their Maluleke kinship was founded by Chief Malenga near Xai-Xai where the Limpopo River enters the Indian Ocean. Using a combination of oral genealogies and Junod's (1962) estimation of thirty year generational spans, Witter (2010: 68) suggests that this happened around the beginning of the 18th century. This suggestion may be acceptable because Malenga was succeeded by his son Mashakadze (written in some sources as Mashaka-dzi/-tsi/-tse or Maxakatsi or as a misnomer; Machiscosje/Machicosse) whose people are reported to have traded with the Dutch at Delagoa Bay in the 1720s (Paver, 1933; Witter, 2010). Mashakadze was so popular as an elephant and rhinoceros hunter and trader that his people were often referred to as the Mashakadzes instead of the Malulekes (Junod, 1913).

Part of the information provided in this section comes from an on-going project by the Malulekes, aimed at a systematic documentation and re-writing of the history of the N'wanati people in Zimbabwe, South Africa and Mozambique. The project involves periodic visits between Maluleke sections in the three countries (South African and Mozambican sections still retain chieftainships). I was allowed to document (through one of the Malulekes, Mr. Clemence Rusenga), relevant sessions of one of their trips to Chief Rodriguez Mapai (Mapwanye) area on the Mozambican side of the Limpopo River. Although no leading questions were asked, a narrative history of the late Chief Mashakadze (ruled in the 1720s) and his people, which was

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given by Chief Mapai mentioned the dynamics of trade in which the Malulekes were middlemen between local Bantu-speaking groups and the Eurasian traders. A transcription from a video taken on 1 October 2011 at the grave site[13] of Chief Mashakadze is presented here. In his narration, Chief Mapai starts by making reference to an iron hoe and an elephant bone that were originally placed on top of the grave[14] of Chief Mashakadze and preserved by generations as reference points in the history of the Malulekes:

> *"Xakusungula anilava ekumubyela aku exikomu lexi, svikomu lesvi svihambiwako*
> Firstly, I would like to tell you that this hoe, (is one of) those hoes made
> *aZimbabye khaleni kaMunhumutapa. Sviendla lesvaku valovola hisvona*
> made in Zimbabwe in the old days of Munhumutapa. They were used for lobola
> *vakon'wana vateka ntombi, xikomu lexi. Loyi ahumesaka xikomu lexi*
> by the son in-law, who then got a bride using the hoe. Whoever produced this hoe
> *arimukon'wana atateka ntombi, mukon'wana loyi avuliwa lesvakuulovolile*
> such a hoe as a son in-law to get a bride, was considered to have paid a price,
> *svinene ngopfu, hikusa xikomu lexi axihina lisima kufana namovha…*
> big enough, because this hoe was as valuable as a car…
> *...Leli irhambo randlopfu, ahiranhuthwa...andlopfu leyi hiyona yingaendla*
> …This is an elephant bone, not a giraffe one...an elephant is the one that made
> *ekuveni vaN'wanati vahivona vakusungula kutiva tengo akamuganga lowu*
> the N'wanatis to become the first to know about trade in all this area
> *hingakawona hikwawo. Tengo nivula vuxavisi. Hikuva avasukela alwandle*
> that we are. By *tengo* I mean the art of selling. For they came from the ocean
> *vatavatahuma lomu vafamba vadhlaya tindlopfu sekurwaliwa timhonzo takona*
> into this area as they went killing elephants and carried their tusks
> *vayachichisa hivuhlalo natinguvu/tipalu. Lesvi asvita ngopfu namaFurasa*

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[13] The grave was positively identified because it was constantly used by one of Guyu's daughters (Mashakadze's granddaughter) as a rainmaking and ancestral appeasement site. This woman was married to a family that stayed behind when Guyu and his people migrated. She collected, kept and passed on to her children an iron hoe and an elephant bone that were placed on Mashakadze's grave and instructed her children to keep the two items as reference points. Her great grandchildren are still the ones in charge of performing rites at this grave, even after the return of the chiefly lineage to this area (Chief Rodriguez Mapai, 1 October 2011).

[14] This is still common practice amongst the Tsonga-speakers in south eastern Zimbabwe where I grew up

to barter for beads and cloth. These came mainly with the French *namaShipanyolo, ngopfu-ngopfu maBhaniani.*
and Portuguese?, especially the Indians.
Akunyikwa ngopfu vaNyai hikuva akurhi ndau yavaNyai
These were mainly given (sold) to the Nyai, because it was their area

The first part of this account refers to intermarriage between the Shona and the Malulekes, the former supplying the latter with iron hoes as bride price. The use of ivory and iron (and not cattle) as bride-wealth, underpins the central role played by trade amongst this Tsonga group. The Malulekes had to purchase iron hoes from the Shona (and even the Venda and Sotho-Tswana) for the same purpose as well as for farming, probably because of the absence cattle (Junod, 1913). Interaction between these groups intensified as the Malulekes engaged with Eurasian traders (probably starting in the first half of the 18th century) as Chief Mapai alluded to in his statement. The last part of the narrative emphasizes the role of elephant ivory and how it was central in the Maluleke's long distance trade. Indeed, as highlighted by Junod (1905) it was this search for elephant and rhinoceros ivory that led Chief Mashakadze to initiate the migration of his people from the Makwakwa area, to the ivory rich areas further to the northwest along the Limpopo River. Since the area was occupied by what Junod (1905) called the Ba-Lembetsu clan (Venda?), Mashakadze and his people had to use military force to subdue them and occupy their land. The desire to commandeer trade routes and acquire more trade commodities, led to the subsequent migration of the Malulekes (now under Mashakadze's successors) to the area of present-day Kruger National Park.

Van de Capelle (Dutch) reported that on 3 August 1723 the Mashakadzes brought copper and tin to trade with the Dutch at Delagoa Bay, but also bought copper from the Dutch which they preferred for mixing with tin to make bronze (Theal, 1902: 241; Paver, 1933). On 17 of February 1732, the Mashakadzes also traded 56 tin bars with the Dutch at the same place (Theal, 1902). Van de Capelle stressed that the Mashakadze people always brought these commodities each time the crew of the Dutch ship *Naarstigheid* was at Delagoa Bay (Paver 1933: 606).

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Dicke (1926) also documents subsequent conquests by Mashakadze's successors (his sons, Dlamani and Nkuri) of the area in parts of Vendaland. The Malulekes settled in the area adjoining the Limpopo and Levubu River in order to secure other trade goods such as iron, graphite, grain, skins. In their advance, Dlamani and Nkuri followed the old trade route from northern South Africa to Delagoa Bay, and in the process they also gained control of trading depots such as the Venda Matiba kop which later became Tshikundo after it was annexed by Dlamani (Dicke, 1926: 1019). Trading columns passing through the Klein Letaba valley towards Delagoa Bay had to pay tribute to the Malulekes for using the route.

3.3.2. THE SHONA CASE STUDY

Shona as a linguistic group, includes several dialects (Zezuru, Karanga, Kalanga, Ndau, Manyika and Korekore), and is the majority linguistic group in southern Zambezia (Beach, 1977; Huffman, 2007). Huffman (2007) posits, on the basis of ceramic continuities that Shona is probably the only language that can be traced to the Early Iron Age. The mainstay of Shona economy has always been agriculture, which was augmented by long distance trade in other commodities such as gold (Beach, 1977: 47). With regards to internal trade, iron and salt were the main trade items for most Shona groups (Beach, 1977: 47). Other auxiliary trade commodities were grain and livestock. For instance, in 1896 one Chiadzwa salt trader obtained 800 goats through salt trade. In the late 18th Century Shona traders from Butwa were selling ostrich eggs to Ndau groups in Manyika for copper which the Manyika traders had bought from the Duma people (Bhila, 1982). Their local, regional and international trade involved itinerant traders who would move from village to village and chiefdom to chiefdom with their merchandise.

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One sub-group of Shona-speakers, who practiced a highly specialised and well organised form of iron working and trading in east-central Zimbabwe, is the Njanja people (Mackenzie, 1975; Chirikure, 2006). This group migrated into the Wedza area from Mozambique in AD 1857 and quickly organised an iron working and trading industry through the incorporation of several forges under one supra-village supervised by a Njanja expert (Beach, 1977: 48). Apprentices, as well as women and children were encouraged to join the labour intensive industry that required the collection of ores from as far as Gutu, Seke, and Selukwe, as well as the transportation of

finished iron hoes as far as Bocha, Ndau lands and beyond the Sabi for trade (Beach, 1977). As a result, the Njanja were able to operate up to twenty furnaces using the shift system of labour (Chirikure, 2006). Their smelting operations continued all year round in the hands of a few groups and peaked during the dry season, when there were no farming activities (Mackenzie, 1975). After producing the iron objects, Njanja middlemen then took the products to trade even in areas further afield. Their durable iron hoes were preferred by most Shona groups who were willing to part with their cattle, goats and even ivory (Beach, 1977). During the same period, trading centres, where grain was exchanged for these hoes, were established at the capitals of Njanja rulers such as Ranga and Chivese. To cut the costs, some individuals from neighbouring areas would travel to buy directly at these trading centres or even at the forges. In the late 19th century, the Njanja were able to procure guns and valuable imports from their iron trade with the Portuguese from Mozambique, making them more powerful than their neighbouring rivals such as the Mbire (Mackenzie, 1975).

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THE VASHAMBADZIS

Vashambadzi is a Shona word for *itinerant traders*, derived from the word *shambadza* which literally means *to advertise or sell or trade* (Newitt, 1973). This class of Shona traders developed into a long-lived social category which became more prominent during the period of Portuguese trade. As Newitt (1973: 76) admits, vashambadzis "were an old institution in Zambesia and probably operated on the trade routes long before the Portuguese entered the country". Indeed, Swahili traders were using vashambadzis to trade, long before the arrival of the Portuguese in southern Africa (Mudenge, 1988: 44).

The status and operations of the vashambadzis varied from time to time and from one Shona kingdom to another. In theory, everyone could have his own mushambadzi (singular) or vashambadzi (plural), however during the period of Portuguese trade most vashambadzis were recruited by Portuguese traders, even though some of them were independent traders who approached the later on their own initiative. Shona kings and chiefs also had their own vashambadzis whom they organised and equipped with royal merchandise for exchange with the Portuguese or other Shona groups (Bhila, 1982: 251). This mirrored a near similar practice by the BaHurutse people (Sotho-Tswana), whose chiefs had their semi-specialised representatives

who did the haggling with external traders that came to the *dikgotla* (chief's courtyards which were also used as trading centres) (Cooley, 1833: 314).

In Shona kingdoms, the Portuguese's direct intervention approach (trying to eliminate the middlemen) was also "indirect" in some sense because of their ignorance of the geography, dialects and customs of the people, which dissuaded them from going themselves from village to village, even in areas where they had set-up trading posts (Bhila, 1982). As a result, most of the trade between the Shona and the Portuguese was undertaken through the convenient use of the vashambadzis. Sometimes this convenience came at a price, because some vashambadzis would elect to run their own merchandise using Portuguese resources. Newitt (1973: 78) reiterates that although the Portuguese often referred to the vashambadzis as their slaves, "this specialised class of traders was anything but servile and never hesitated to make its own living at the expense of its employers". In one instance, the Portuguese complained about how vashambadzis took advantage of the situation following the fall of Zumbo in the 18th century, and embezzled their goods on the pretext that these goods had been lost due to robbery or war (Bhila, 1982). However, in most cases, the relationship between the Portuguese and vashambadzis was symbiotic.

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In the Manyika and Mutapa kingdoms, vashambadzis enjoyed less privileged positions because locals could directly trade with the Portuguese at the nearby trading centres of Sena, Tete, and Zumbo or even at Sofala on the coast (Beach, 1977). The majority of vashambadzis in these kingdoms were not full time itinerant traders but only operated after the end of the harvest season (Bhila, 1982). Most transactions between individual miners and the vashambadzis took place at the mines themselves, where some of them entered into contracts for daily or monthly supplies. Those who had monthly contracts would agree on trading dates in advance. Thus vashambadzis were allowed to move freely from village to village and from one region to another, as long as they paid tribute and brought presents to the Kings and respected the customs of the Mutapa and Manyika kingdoms (Mudenge, 1974).

In the Butwa and Rozvi kingdoms, vashambadzis enjoyed more prestige and probably protection because of the people in the kingdoms depended on them for exotic supplies, unlike the situation

in Mutapa and Manyika Kingdoms where some indigenous traders went directly to the Portuguese feiras to buy exotic goods for themselves (Bhila, 1982). As a result, vashambadzis operating in these kingdoms became rich, as they were the major conduits to Portuguese exotica. One rich mushambadzi Nyamuza, who operated between Zumbo and Butwa, was rich in cattle and in 1769 was robbed of 800 head of cattle he had acquired through this trade (Bhila, 1982: 107). However, in the Rozvi kingdom, certain grades of gold were a preserve for the Rozvi King and could only be bought by vashambadzis from the King's representatives, or sold directly to the Portuguese by the king's vashambadzis (Mudenge, 1974: 381).

Some Shona groups chose to act as middlemen to the vashambadzis. For instance, in the Mutapa Empire, some polities acted as middlemen themselves and vashambadzis would then come to buy from them or alternatively, they would carry the merchandise themselves to the Portuguese feiras, where they got a much higher price. Phimister (1974: 50) gives an example of Chief Hwata, the ruler of a small Hera polity that occupied an area at the head of the Mazoe valley, who with his people acted as middlemen in the trade between the Portuguese and other Shona groups in the 1870s. This elimination of the vashambadzis was of added importance, especially in the 19th century because goods bought from the vashambadzis were much more expensive than those bought directly from the Portuguese.

With time trade relationships amongst local groups and between the local Bantu-speakers and Eurasia became complex to the extent that some trade goods ended up being relayed towards the coastal or inland feiras, along indirect routes. Beach (1977: 52) gives an example of ivory, which the Bocha people (Shona) would exchange for iron ore with the Wedza people, who in turn would use this ivory for paying lobola or other internal exchanges before the ivory reached the Portuguese traders. To the south, Gordon Cumming, the first white trader to reach the BaNgwato kingdom in 1844, observed that the BaNgwato were exchanging ivory from the Khoesan hunters on the Boteti River with glass beads, some of which came from vashambadzis of Mutapa kingdom (Parsons, 1977: 117). The ivory was then relayed towards the Cape through a network of trade. In a similar pattern, the BaThlaping purchased glass beads, iron, copper, tin and bronze wares from the BaKwena and BaHurutse, and exchanged these items with the Khoesan groups to the southwest (Goodwin, 1956: 256).

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3.4: SUMMARY

The expanding network of sailor-traders from the east African coast, commandeered by Muslimised African traders, referred to as the Swahili, reached southern Africa towards the end first millennium AD. The recent ethnographic and historical data underpin the intensity of the trade, the people and commodities involved. The data also emphasizes strongly the antiquity of the networks and that they must have been integral to the transport and exchange of commodities. Additionally, it points towards the existence of powerful nodes and networks of communication, along which knowledge about land and resources, ideas and the impetus for innovations must have flowed. More importantly, it indicates that it is not only between elite centres that trade networks ran, but networks implicated smaller communities over considerable distances. This observation redirects attention to small scale nodes such the Southern Waterberg, where one can explore the dynamics associated with the exploitation of tin as a point resource in the bigger network of a trading system.

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CHAPTER FOUR: THE BIO-PHYSIOGRAPHY OF THE SOUTHERN WATERBERG

"Archaeology is far more than excavating and using a background in anthropology or classics to tell a plausible story about the human past. To get the fullest possible understanding of ancient peoples and events, it is necessary to study the context of everything humans interacted with: plants, animals, rocks and minerals, the landscape, and so forth." (Rapp, 2007: 3)

4.1: INTRODUCTION

Only a pragmatic view of the Southern Waterberg and its archaeology can enable a sustainable reconstruction of pre-colonial metal production processes that have been attempted in this thesis. A thorough understanding of culture and culture change is not possible without an appreciation of the environmental context within which it took place (Rapp, 2007: 3). Consequently, this chapter describes the bio-physical setting of the area under study. The natural environment is examined with reference to the geology, vegetation, soil and topography, drainage and climate, all of which underpinned the organisation and character of metal production on this landscape. These aspects define the potentials and constraints for subsistence and thereby contribute towards the supplemental role of trade and exchange. The chapter also exposes misconceptions about the "hostility" of the area that emanates from generalisations that are used in modern land use planning (Low and Rebelo, 1996), by offering a balanced review of the traditional knowledge systems (see also Manyanga, 2001; 2007). That pre-colonial societies in southern Africa were well acquainted with their environment cannot be gainsaid. The use of ores, for instance, underpins this because agriculturalist groups exploited most of the gold, copper, iron and tin mineral bodies found in the region, some of which are obscure and difficult to locate (Summers, 1969). The visibility of their mining activities is high and directed modern prospecting, for example, at Phalaborwa, Musina, Umkhondo, Thabazimbi, Rooiberg and the Zimbabwean gold mines. It is important to consider the physical environment in order to contextualize reconstructions of metal production processes.

It hoped that a review of the bio-physiography will shed more light on the nature and distribution of currently available sites in the area under study (Figure 4.1).

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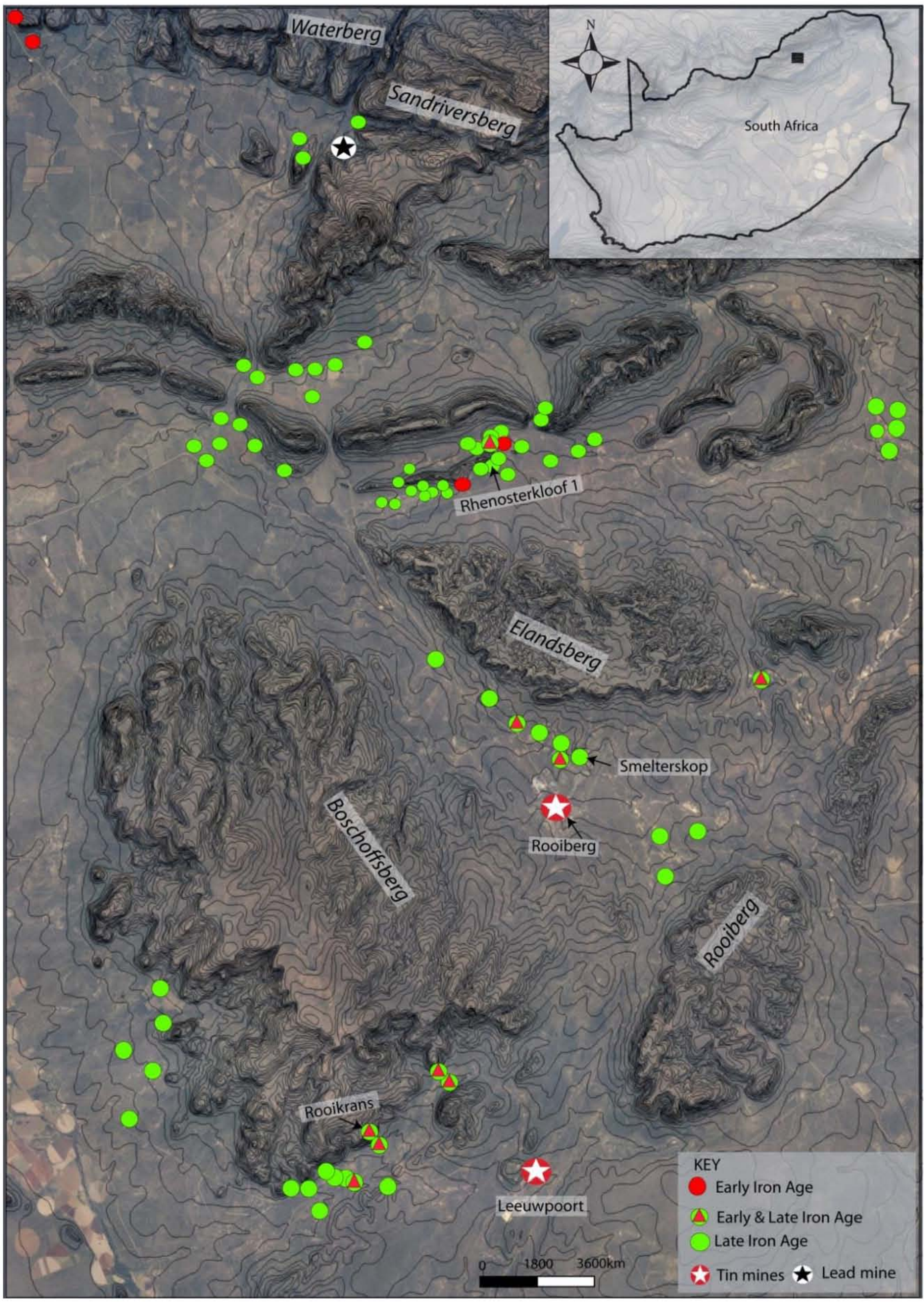

Figure 4.1: Area of study showing the distribution of currently known Iron Age sites. Based on S. Hall (1981).

In the context of modern land use planning, the Southern Waterberg falls within the *Mixed Bushveld* and the *Waterberg Moist Mountain Bushveld*, both belonging to the *Savanna Biome* (Rutherford and Westfall, 1986; Low and Rebelo, 1996). The former is warmer, drier and has a great variety of plant communities with poorer soils, while the latter is wetter, cooler and has pockets of richer soils in elevated and rugged terrain. At a micro level, the Southern Waterberg exhibits even more diverse environmental conditions but still retains the general "hostile" character, which is typical of most parts of the province. The harshness has to do with erratic summer rains, coupled with hot summer temperatures, as well as being prone to tsetse fly (especially in the Mixed Bushveld) and malaria carrying mosquitoes. Notwithstanding the significant role played by environmental factors, this study is not environmentally deterministic but accepts that pre-colonial communities in this region were innovative and not simply victims of their physical surroundings. Thus, the environmental constraints mentioned above may not have been deterrents for Iron Age occupation because even much more hostile areas such as the Shashe-Limpopo Basin, were continuously occupied by Iron Age communities (Manyanga, 2001; 2007; 2013). Thus it can be argued that, it was the overall landscape rather than any one aspect of the bio-physical environment that was more important to pre-colonial societies. I now turn to the detailed discussions of these various aspects of the bio-physical environment.

4.2: GEOLOGY

The area under study falls in the Transvaal System, the Bushveld Igneous Complex (BIC) and the Waterberg System (Figure 4.2).

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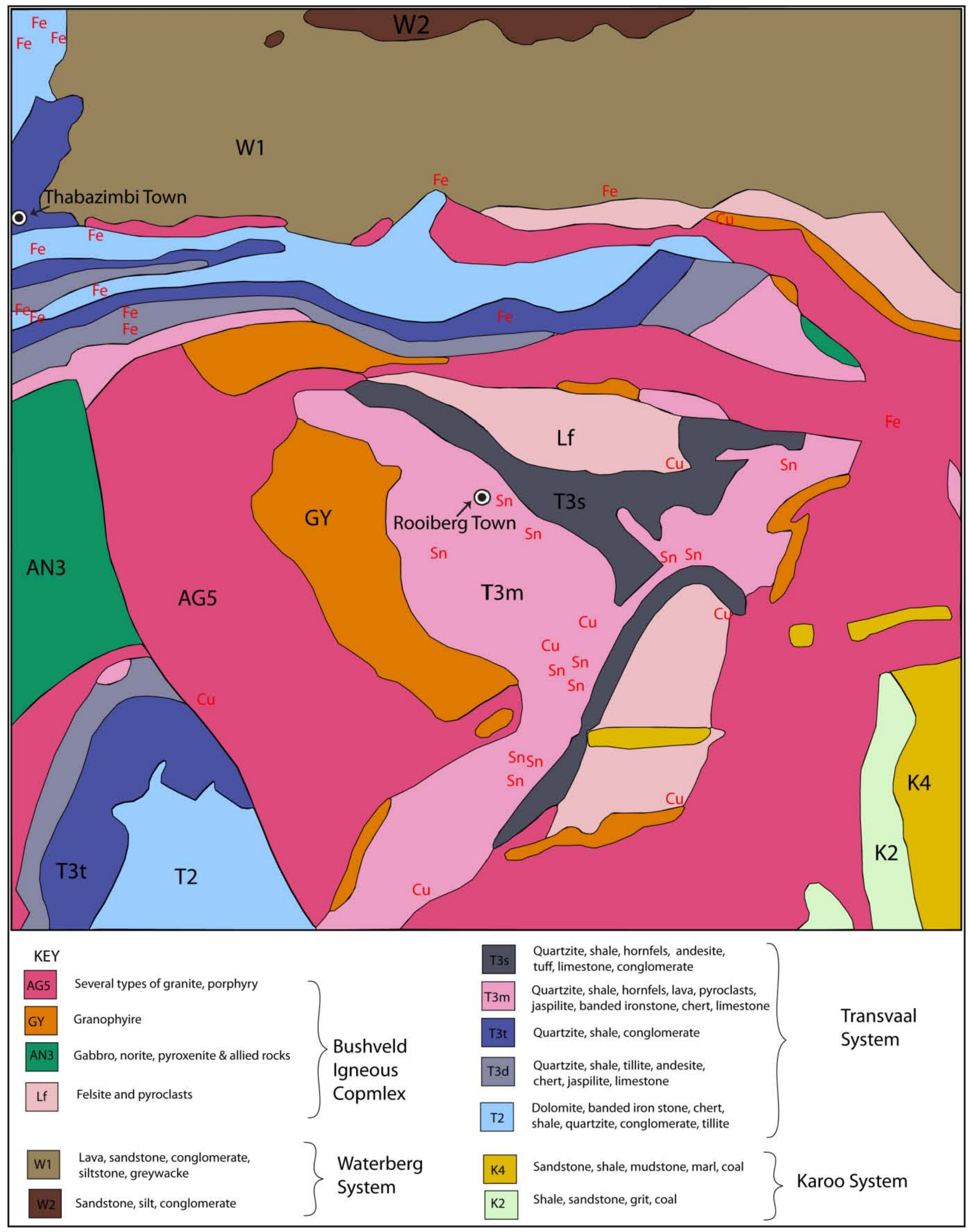

Figure 4.2: Geological map of area under study. Modified after the Geological Maps 1: 250 000 series of 2426 Thabazimbi 1974 and 1: 1000 000 series of the Republic of South Africa and the Kingdoms of Lesotho and Swaziland 1970.

About 2060 million years ago, the older geological formations (such as the Transvaal and Waterberg systems) were overlain by enormous volumes of mafic and ultramafic magma that intruded into the upper levels of the earth's crust in south western Limpopo (Viljeon and Reimold, 1999: 116). This intrusion BIC covered an estimated 66000km^2 and produced one of the world's largest known resources of platinum group metals (platinum, palladium, ruthenium, rhodium, osmium and iridium) as well as huge reserves of iron, chromium, vanadium, titanium, copper and tin (Geological 1:250 000 series 2426 Thabazimbi 1974; Guilbert and Park, 1986: 315). It is in this intrusive complex that the occurrence of tin and copper ores is mostly related. Iron ores on the other hand are mostly derived from the Older Transvaal System and are concentrated to the northern part while copper and tin ores are found mostly in the central and southern part (Figure 4.2). This observation is important because it makes unlikely that the production of tin resources may have been mistakenly triggered by the misidentification of tin and iron ores, which is possible where magnetite and cassiterite co-occur (Pigott, 1980). Some scholars have mooted on the unlikely possibility of mistaking copper ores for tin ores in the Southern Waterberg (Grant et al. 1994: 89). The unintentional production of low tin bronzes through the exploitation of mixed copper and tin ores has been argued at some of the older Cornish mines such as Dolcoath, which were first worked as copper mines but as the ore was followed in depth, it changed gradually from copper to copper-tin, to tin-copper and eventually to tin (Charles, 1975: 20). Iron Age sites in the Southern Waterberg also appear to be concentrated around these areas with rich deposits of either iron or tin and copper (Figure 4.1 and 4.2). However, the current pattern may reflect research coverage more than the actual distribution of sites in the Southern Waterberg. With more systematic studies the relationship between the geology and the distribution of Iron Age sites may become clearer.

Iron ores were extensively mined pre-colonially in the Southern Waterberg, although in most instances the ore was simply picked up from the surface. Quarries are also not easy to find archaeologically. In the area under study, iron ores occur more widely but significant lodes occur in the banded ironstone and ferruginous chert that form the top of the dolomite series of Transvaal System in the north. In the southern range a peculiar type of haematite (Fe_2O_3) that is composed of alternating layers of haematite and red dolomite, occurs (Geological Survey, 1959: 234). One other type of iron ore related to pre-colonial mining in the Southern Waterberg is

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specularite, which occurs mostly in the northern parts. Ochre and specularite were used for non-metallurgical purposes such as pottery decoration, and probably bodily adornment (S. Hall, 1985). Elsewhere, this type of mining has some antiquity, with about 40 000 years of exploitation on the Bomvu Ridge in Swaziland (Dart and Beaumont, 1968; 1969; 1971). All in all, the area hosts a wide range of iron ores that range from low grade laterite to the high grade haematite. This meant that ore selection for smelting required erudite choices and was a skill not held by everyone.

Significant copper deposits occur mainly in the south central parts of the Southern Waterberg, on the farms Kwaggafontein, Vaalwater, Leeuwpoort and Rooiberg, mainly as malachite, azurite, chalcocite, cuprite and little bornite (Geological survey 1959: 218-219). The gangue material is mainly quartz and limonite. No sub-surface copper mine is known in the area under study but there is evidence of pre-colonial copper smelting. This evidence is not only limited to the copper rich parts of the Southern Waterberg, but can also be found in other parts as well such as the Sand River valley (Geological 1:250 000 series 2426 Thabazimbi 1974).

The occurrence of tin mineralisation in the Southern Waterberg is within the metasomatically altered sediments in the Rooiberg Group Felsites and a remnant of the older Transvaal Super Group that were floated up by the emplacement of the BIC (Chirikure, et al. 2010). Important tin deposits occur at Olievenbosch (Rooiberg Mine proper), Leeuwpoort, Vellefontein, Blaauwbank, Niewpoort, Kwarriehoek and Weyneck (Geological Survey, 1959: 303). These deposits occur as fracture fillings, cylindrical pipes and strata-bound pockets, suggesting that shear and tension fractures served as channels for the epithermal tin bearing solutions of the highly evolved BIC (Chirikure et al. 2010). Just like copper, pre-colonial tin smelting is visible even in those areas further afield from the ancient tin mines (Bandama et al. 2013).

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4.3: TOPOGRAPHY

The Southern Waterberg is an area dominated by narrow and low ridges rising to about 1300m above sea level although the Waterberg plateau rises to about 2100 m above sea level. Like most granites of southern, central and eastern Africa, the Bushveld granites weather into pale-coloured sandy soils, giving rise to flattish ground interrupted by residual hills or ridges (Eales, 2001: 43).

The majority of these ridges are predominantly narrow on the top although they occasionally offered typical defensive locations. All the same, the ridges were by no means an impediment to movement because they could be easily traversed. The topography unlocked a number of opportunities for the pre-colonial metal working communities in this area. For instance, prehistoric people could have located ores by following the scree eroding from rocky outcrops on ridge slopes. Furthermore, the gentle terrain, coupled with isolated springs ensured that most rivers flowed throughout the year.

4.4: DRAINAGE

The Southern Waterberg is mainly drained by the Sand River (perennial) and the Sundays River (perennial) in the north, while the south-central parts are largely drained by the Vaalwaterspruit (perennial) and the Bloubankleegte River (non-perennial) and the western area is dominated by the Bierspruit River (perennial) and the Crocodile River (perennial). Although some of these rivers, such as Sand River and Sundays River do not have large catchments, the gentle terrain ensures that run-off is not fast flowing, which leaves the rivers with water for most of the time. Proximity to water sources may have been a major consideration during the Iron Age as shown by concentration of sites closer to perennial rivers (Figure 4.2). The network of perennial rivers must have worked in favour of occupation by metal working communities and Stone Age communities. To the Iron Age communities, alluvial deposits along the riverbeds, water colour and water taste, could have been initial pointers to the occurrence of tin or copper deposits in the area leading to the discovery of hard rock deposits. Ottaway (2001) posits that indigenous communities occasionally used the colour and taste of water near a mineral source as indicators for the presence of metals. The working of alluvial tin has already been confirmed at several sites in the study area (Miller and Hall, 2008; Chirikure et al. 2010; Bandama et al. 2013). Thus indeed the network of rivers in the Southern Waterberg offered more than just a sure supply of water but unlocked a number of opportunities that could have attracted occupation and use of the landscape by metal working communities.

4.5: SOILS

Most areas within the Southern Waterberg have immature soils (Adamson, 1938: 72). On the rocky ridges, the soils are generally shallow. While the soils are predominantly sandy and poor

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on the slopes up the ridges, pockets of rich red and grey loams do occur in the valley floors, especially in the Sand River valley where the earliest Iron Age manifestation (Diamant facies) in the area is known (S. Hall, 1981). Generally, red and reddish colours are the commonest in the Sand River valley, with brown, chocolate and dark soils also occurring (Adamson, 1938: 72). These soils are generally easy to till and are well drained but becomes hard and intractable when dry. The Rooiberg and Boschoffsberg valleys generally have shallow and poor soil, although this did not inhibit Iron Age occupation, this factor being negated due to the geological richness of the area. It may be significant that no Diamant phase settlements are known in these areas (S. Hall, 1981; Figure 4.1).

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4.6: VEGETATION COVER

The area is part of the Bushveld Zone that stretches from the Botswana border in the west, the Pilanesberg and Magaliesberg in the south and to present day Pretoria in the east. This classification masks the actual diversity evident at a micro scale. Much of the area is covered by the sourveld in the valleys, a pure grassveld on mountain tops and a scrubby thornveld on the escapements and slopes (Acocks, 1988: 29). The north eastern parts of the area under study fall under the mixed veld, which is intermediate between the sweetveld and the sourveld while the later represents grassveld that produces palatable grazing with fairly high nutritive value but only in the growing season (van Oudtshoorm, 1992: 38-39). In general, the Southern Waterberg is now dominated by thorny tree of the savanna type, although a continuous layer of grass used to take precedence over trees and the area was better described as grassland with open trees (Acocks, 1988; S. Hall, 1981). This vegetation cover must have been attractive for animal grazing.

Adamson (1938: 147) noted that tree distribution in the Southern Waterberg, correlated with soil characters: *Acacia* and *Peltophorum* dominate on loams, *Burkea and Terminalia* on sands, *Combretum* on red sandy loams and *Acacia* on black soils. The evergreen shrubs with pale heavy leaves (*Protea Abyssinia and P. roupea*) and *faurea saligna* are more pronounced on the rocky slopes. Other trees of less general occurrence include: *Trichilia dregeana, Pterocelastrus echnatus* and *Trchocladus grandiflorus* (Acocks, 1988: 29). The open nature and dwarf character of trees is a result of frost prevalence but where trees are protected from frost, their height is not

restricted. It is probably these pockets of thick forest that offered a sure source of charcoal for smelting.

Various tufted species of grass such as *Themeda triandra, Cymbopogon plurinadis, Elionuris argenteus* (dominant), *Setaria, Panicum* and *Ischaemum*, form a continuous layer that rise to about 1m at flowering time (Acocks, 1988; 33; Adamson, 1938: 147; S. Hall, 1981: 5). These sour and mixed grasses provided adequate pasture for game as well as domestic grazing. In pre-colonial southern Africa, animals did not only augment food supply, but also produced raw material for clothing while having social and economic value such as the use of cattle as bride prize or tribute to leaders.

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4.7: CLIMATE

The Southern Waterberg falls within the Midsummer Zone, which means that it receives its rainfall between October and April, with peak rainfall in January (Schulze, 1997). Rainfall is high on the higher ground going to over 650mm but it generally varies between 350mm and 650mm with hot and wet summers; dry and cold winters as well as occasional frost (Adamson, 1938: 145; S. Hall, 1981: 5). In this area, rainfall was augmented by isolated springs that ensured perennial flowing of some rivers. Temperature ranges between 18˚C and 26˚C (Schulze, 1997). Generally the climate is less tropical than the adjacent Low veld, with altitude and dryness mitigating the effects of the latitude (Adamson, 1938: 145). This means that the rainfall is not as unpredictable, compared to the adjacent areas further to the north and northeast. With this kind of climate, the cultivation of sorghum and millet was possible, especially in the relatively fertile areas of the Sand River valley. Huffman (1996) posits that annual precipitation averaging 500mm was sufficient for the cultivation of sorghum and millet, the cereal staple crops in pre-colonial southern Africa before the introduction of maize.

4.8: SUMMARY: OPPORTUNITIES AND CONSTRAINTS

The chapter has dealt with the descriptions of the bio-physical environments in the area of study. This area is part of the savanna biome that incorporates the northern and eastern portions of the country (Rutherford and Westfall, 1986). Modern land use planning recommends the biome be used for commercial and communal grazers, with crop farming being relegated to small parts of

the biome (Low and Rebelo, 1996). However, the diverse micro environments offered a wide range of opportunities and constraints to Iron Age agriculturalist communities who settled on the landscape in pre-colonial times. For instance, cattle may have been moved to the higher latitude areas on the Waterberg plateau to avoid tsetse flies that do not survive above 600 m (Tayler et al. 2003: 41). Some favourable micro environments such as those offered by springs and perennial rivers may have meant made the area was more habitable, despite the fact that most parts had poor soils and was prone to drought, malaria-causing mosquitoes and tsetse flies. More spatial archaeological work is still needed in order to understand the relationship between Iron Age sites and the diverse bio-physical environments in the Southern Waterberg. To glean more information on how Iron Age communities on the landscape exploited the environmental opportunities and dealt with the challenges, there was a need to carry out more fieldwork and collect some materials for laboratory analyses. The next chapter presents field methods and data collection processes, that contribute to the above issue and other research questions outlined in the previous chapters.

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CHAPTER FIVE: FIELD METHODS & DATA COLLECTION

"In the past the study and analysis of artefacts revolved around museum collections but appreciation of the potential of newly-excavated material is changing this. What is important is not where the material is kept, but rather the questions that are driving the investigation" (Bayley et al. 2008: 31)

5.1: INTRODUCTION

To draw informative conclusions on the issues under investigation, there was a need to generate more data using desktop surveys and field methods. Desktops surveys were conducted as a prelude to field methods and to refine research questions. The latter involved a literature survey on archaeological, geological, geographical and historical work done in the area under study. This information was useful in devising sampling strategies for archaeological surveys and excavations. For a combined metallurgical and archaeological study such as the present study, it was necessary to conduct these fieldwork strategies in order to observe and document (in the field) information about the distribution and nature of sites, and to collect relevant samples for further study (in the laboratory). To redress research gaps (both geographic and conceptual), and to explore the potential of the area, fieldwork was conducted in the Sand River valley. Standard archaeological fieldwork procedures were utilised (Barker, 1997; Roskams, 2002) in three field seasons conducted between July 2009 and September 2011. Preliminary findings from each field season were used to refine strategies for the next season. Iron Age sites were identified on the basis of features and objects such as stone walled cattle kraals, hut rubble, pottery and metallurgical debris. Controlled surface collections were carried out at six sites and excavations were also carried out at four sites. Samples from excavated contexts were also collected for further laboratory analysis.

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5.2: DESKTOP SURVEYS

The value of desktop studies has already been demonstrated by several reviews presented in previous chapters. In this section, I discuss desktop surveys that were undertaken to inform field methodology. The focus was on establishing the nature of Iron Age sites in the study area and devising the practical methodologies such as sampling, surveys and excavations. Relevant literature and databases, which included satellite imagery, orthophotos, photographs, maps, theses, journal articles and books, were consulted as part of the desktop

surveys. Thus it was noted, for instance, that archaeological sites could not be located using satellite imagery and orthophotos, because of thick vegetation cover (S. Hall, 1981; Mason, 1986). S. Hall's (1981) archaeological surveys were conducted by one person with the focus on constructing the general Iron Age sequence of the area. Consequently, his surveys, just like those conducted by Mason (1986), were extensive rather than intensive. Extensive surveys are a low-resolution approach designed to target the identification of archaeological sites across a large area but the latter is a complete or near-complete coverage of the survey area at high-resolution which usually achieved by having a survey team walk in a systematic way over the target area (Banning et al. 2006). Extensive surveys cover large areas, but the "grand" focus means that detail is lost within the sampled area. On the other hand, intensive surveys afford one an opportunity to cover the surveyed area in greater detail but at a much slower pace and ultimately a smaller area than extensive surveys. Intensive field walking was chosen as a way of building on existing extensive surveys were already conducted by previous researchers. This brings us to the issue of sampling and survey strategies that are explained in detail in the next section.

5.3. FINDING SITES: SAMPLING & SURVEY STRATEGIES

Before surveying for sites, one must come up with a sampling strategy for finding relevant sites. Sampling by definition denotes the selection of a relative quantity of material or individual object (sample unit), from which the quality of the mass, group or species (sample universe), which it represents may be inferred (C. Orton, 2000: 1). In most cases sampling obviates limits on time and resources, by generating enough datasets to adequately address research questions. Sampling can exist on a number of different levels (Bayley et al. 2008: 7) but the sampling discussed here relates to the selection of areas for archaeological surveys. The main objectives of these archaeological surveys were to establish the nature and density of human activity as evidenced by surface remains and features. This is a long standing approach, which treats archaeological surveys as sources of information in their own right and not solely as curtain raisers to excavations (Plog et al. 1978; Pwiti, 1996). Surveys also have the potential to address archaeometallurgical questions, as demonstrated by the Castle Bytham Fieldwalking Project in the Weald and in south Lincolnshire, where survey results contributed to the understanding of the Roman and medieval iron industries of these regions (Bayley et al. 2008: 24)

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With the three farms of Rhenosterkloof, Tembi and Meletsi[15] (in the Sand River valley) as my sample universe, intensive surveys were employed at the first two farms because of their relatively good ground visibility. On the other hand, our access to Meletsi Farm was very limited because of the politics of land ownership and it was not possible carry out intensively surveys here. However, to increase local knowledge I also talked to farmers and their workers about the occurrence of sites on these farms.

Following S. Hall's (1981) previous experience in which different sites conformed to different settlement modes; Valley-floor, Hill-slope and Hill-top, there was need to adopt a sampling strategy that catered for these three contexts. The idea was to test if settlement organisation varied according to relief location. As a result stratified systematic sampling was adopted for Rhenosterkloof and Tembi farms. Field walking in Rhenosterkloof and Tembi farms was organised by means of 25 m wide transects covered by eight people. These narrow transects were chosen because they are easy to survey and involve less error in terms of staying within the prescribed boundaries and covering the entire quadrant (Read, 1975: 53). Nonetheless, there were also a few inaccessible areas where field walking was possible and only local knowledge and road driving were employed. On Meletsi Farm, we did not have control over areas to survey and so, field walking was limited to small portions to the east and west, where we were taken to by the farm supervisor (Figure 5.1).

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[15] Rhenosterkloof is the original farm name but Tembi is the trade name of what was originally Koppieskraal Farm, while Meletsi is a trade name of seven original farms; Rookpoort, Rietfontein, Weltevreden, Zandfontein, Rhenosterhoekspruit, Groothoek and Nooitgedacht.

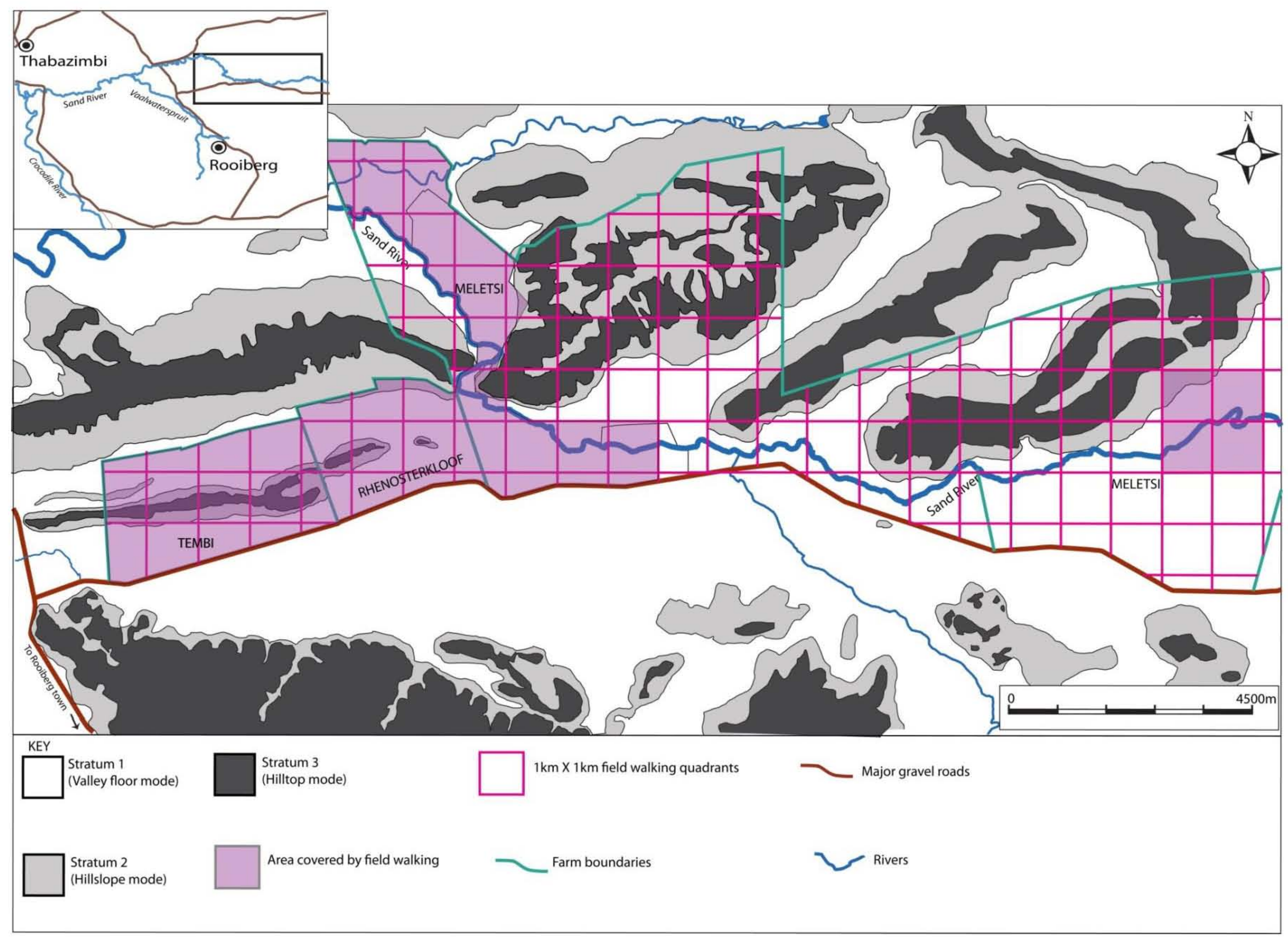

Figure 5.1: Map showing the surveyed areas

DEFINITION OF A SITE

Because site documentation and analyses were major components of the archaeological surveys, it is worthwhile to define an "archaeological site". A simple definition offered by (Renfrew and Bahn, 1994: 42) in which archaeological sites were defined "as places where significant traces of human activity are identified" was adopted because it is easy to apply. To define "the significance of traces", Pwiti"s (1996) definition of an archaeological site as any area with more than ten surface objects per square metre or other features, was also found to be useful. In most instances it was easy to identify apparent drops in the densities of surface remains and it was possible to see "empty spaces" between sites but there were instances when it was difficult to recognise discrete artefact-clusters to which one could assign boundaries. It was important to establish site boundaries because of they have implications on site sizes. Based on surface remains, sites were also marked as *simple* if they were smaller (stretching for less than 100 m) and exhibited limited activity, or *complex* if they were larger (stretching for more than 100 m) and revealed a wide range of activity. The density of deposits was also important in determining the size of sites because some had large middens while other only produced scatters of artefacts.

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SURVEY RESULTS

Archaeological surveys in the Sand River valley resulted in the documentation of 46 sites (Appendix 5.1 and Figure 5.2). Most sites had evidence of metal working in the form of slag and tuyeres, and sometimes fragments of furnace walls and crucibles. As a rule, sites in this area are generally small in spatial extent and do not have large middens. However, in terms of metallurgical debris, Rhenosterkloof 1 and 2 exhibited exceptionally large metal working dumps that contrasted to smears of domestic debris at the same sites. Tembi 1 was also relatively larger than the rest of the sites in spatial extent and size of kraals but its metal working dumps were smaller than those of Rhenosterkloof 1 and 2. Further details on the nature of target sites are discussed below.

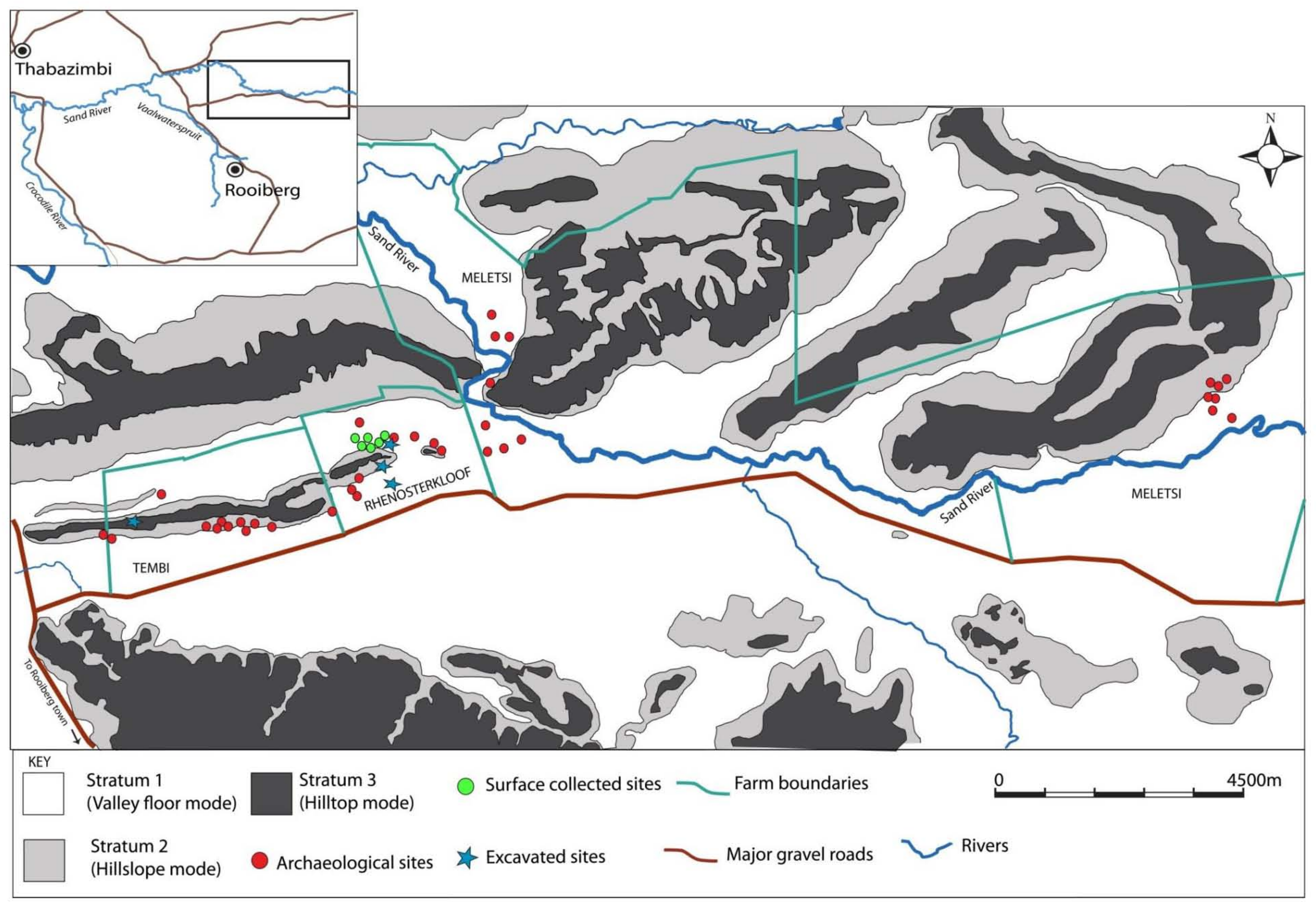

Figure 5.2: The distribution of documented and excavated sites

CONTROLLED SURFACE COLLECTIONS

In order to gain more information on the nature of site occupations during archaeological surveys, it was necessary to conduct controlled surface collections at selected sites. Thus for the majority of the sites, surface remains were listed and photographed, and left in situ. To generate more datasets, surface materials of diagnostic pottery (potsherds with decoration or a recognisable profile) and metallurgical remains were collected at six sites; Rhenosterkloof 4-9 (Figure 5.3).

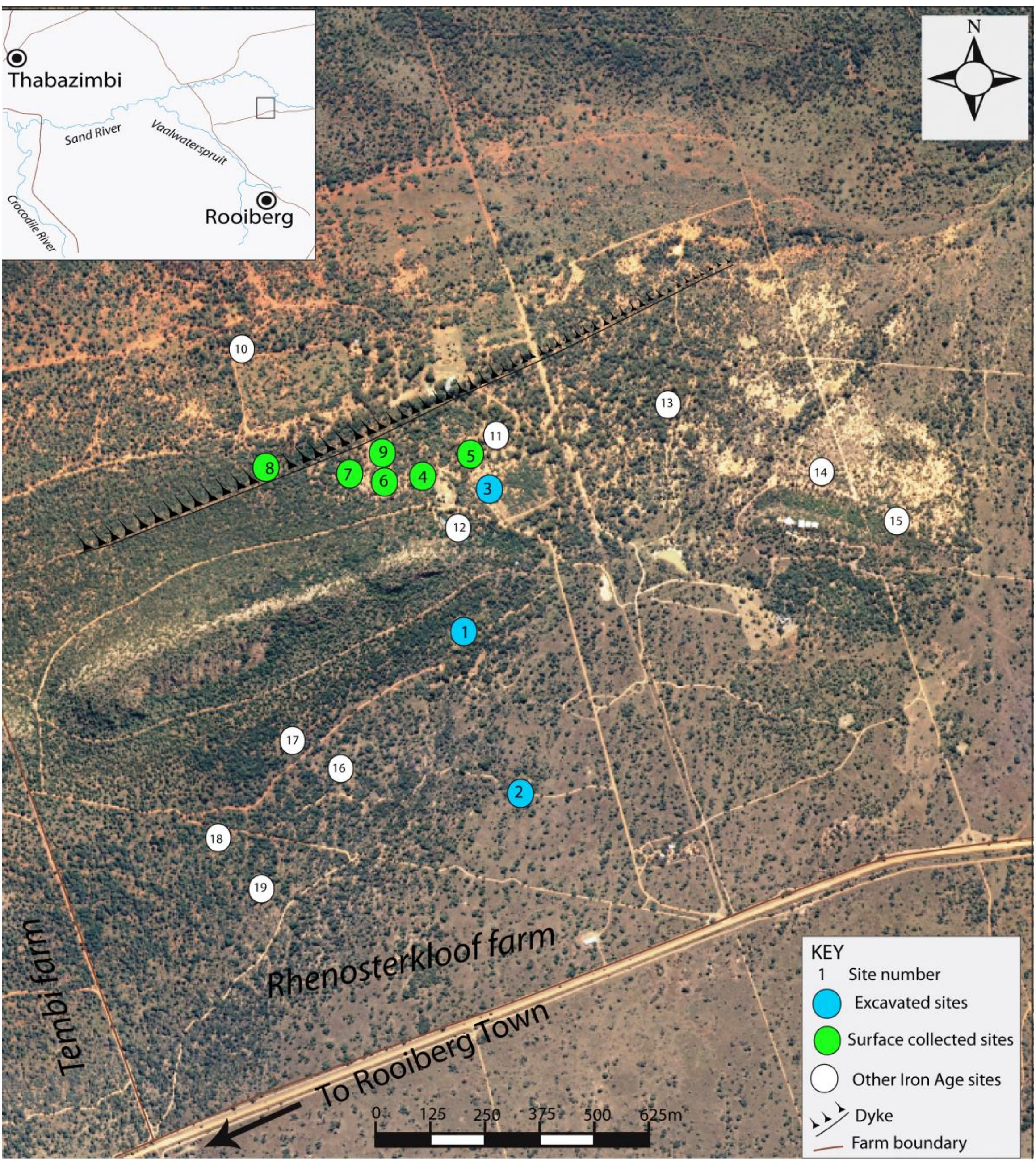

Figure 5.3: An ortho-rectified image of sites in Rhenosterkloof Farm

The surface finds from these sites became the basis for further laboratory analyses and a permit (Permit No. 80/09/06/009/51) was obtained from the South Africa Heritage Resources Agency to collect and study the materials in a laboratory. The policy for sampling surface remains was determined by abundance and where materials from all stages of metal production were available, as well as the presence of diagnostic ceramics. A 9 m X 9 m grid divided into smaller 1 m squares was used to control the recovery of surface material at each site.

5.4: DIGGING SITES: EXCAVATION STRATEGIES

Excavations were aimed at retrieving contextual material for further laboratory analyses and at investigating the vertical and horizontal distribution of material at each site. This meant that all excavations had to be preceded by intra-site surveys aimed at establishing site boundaries and activity areas. The term *activity area*, as described by Kent (1987), relates to the locus for particular events. In this work, the potential distribution of activity areas was informed by surface distribution of materials and features and excavations targeted some of these features and areas with dense concentrations, such as middens.

Standard archaeological excavation procedures were used (Roskams, 2002). Vertical control was applied using arbitrary 10 cm spits for middens and natural stratigraphy for structures. Horizontal control was by 1 m^2 grids, unless otherwise stated. At Rhenosterkloof 3 and Tembi 1, there was strategic use of larger grids where shoveling was appropriate. A 2 mm sieve was used to ensure the capture of smaller finds. Sampling was necessary, especially with regards to the voluminous metal working debris. This process was informed by the need to represent all types of metals worked as well as all stages of production present. Different materials such as slag, tuyeres, glass beads, shell-beads and crucibles, were bagged separately with contextual information, in preparation for further laboratory analyses.

EXCAVATIONS ON RHENOSTERKLOOF FARM

Rhenosterkloof farm is 13 km due north, as the crow flies, from the modern Rooiberg Tin Mine (Figure 1.2 and 4.1). The farm lies within a gently undulating plain that is split by the eastern end of the 6 km long Koppieskraal ridge. The Sand River flows through the north eastern corner of the farm, where it cuts through the Swaershoekberge ridge as it drains westwards towards the Crocodile River. There is a concentration of Iron Age sites around the northeastern, eastern and south eastern end of Koppieskraal ridge (Figure 5.3).

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Archaeological excavations on Rhenosterkloof Farm by S. Hall (1981) focused on two middens. His selection was based on the presence of simple stone wall kraals that he referred to as the valley floor mode. I return to these stone walls below. In 1984, seven bowl furnaces were discovered at this site by the University of Witwatersrand's Archaeology Research Unit (UWARC), which went on to excavate two of them (Furnace 2/84 North and Furnace 2/84 South). Nothing was published about these furnaces, except their dimensions (Friede and Steel, 1985). These furnaces are some of the rare reaction vessels in the Southern Waterberg that still have intact superstructures, besides the ones excavated by (Huffman, 2006: 61) near Thabazimbi (Figure 2.5). Without any published provenance, we could not relocate these furnaces. Recent site inspection by metallurgists; Professor David Killick (University of Arizona) and Doctor Shadreck Chirikure (University of Cape Town) suggested that the site had evidence of tin smelting and S. Hall's (1981) work at this site identified Eiland pottery. Thus it was important to revisit the site in order to sort its chronology, explore its metallurgy (especially at the large metal dump) and the possibility of assessing tin working in the terminal EIA It was also hoped that Rhenosterkloof 2, about 400 m to the south of Rhenosterkloof 1, would provide comparative data. The less well-preserved site of Rhenosterkloof 3 was selected for excavations mainly because it has the highest concentration of Eiland ceramics (S. Hall, 1981).

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5.4.1: RHENOSTERKLOOF 1: SITE DESCRIPTION & EXCAVATIONS

Rhenosterkloof 1 lies at the south eastern base of the 6 km long Koppieskraal ridge (Figure 5.3 and 5.4). The most obvious features on the site are three isolated stone wall cattle enclosures. They have an average internal diameter of about 9 m and rise to about 1 m in height. Their walls were built by placing irregular boulders on the outer surfaces with an infill of smaller rocks. Domestic middens, metal working dumps and other subtle stone wall features are also evident. An overview of the settlement layout gives an impression of two overlapping layers of occupation, mainly because the stone walled cattle kraals are facing away (upslope) from the rest of the smaller stone features and middens (Figure 5.4). However, the paucity of cultural materials that could be associated with the large stone enclosures may mean that the cattle kraals may be associated with the rest of features and middens at this site.

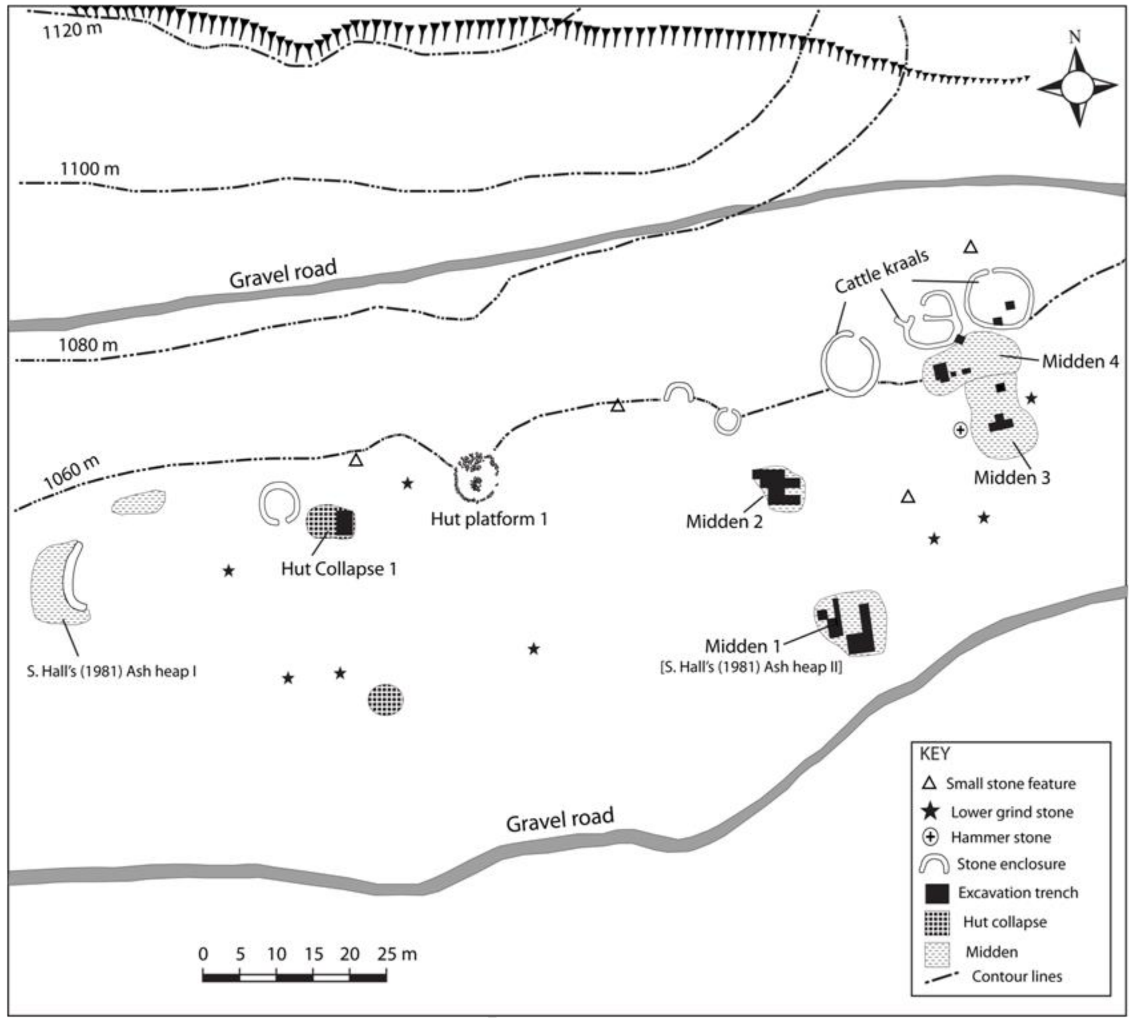

Figure 5.4: Site plan for Rhenosterkloof 1

Excavation trenches and test pits were placed in kraals, middens and hut platforms in order to test their spatial and temporal relationship and to retrieve material for laboratory analyses. Excavations on Ash heap II (S. Hall, 1981) were extended to increase the ceramic sample.

DOMESTIC MIDDENS

Domestic middens are here defined as dumps not mainly used for disposing metallurgical debris, even though they may have a few remains from metallurgical activity. Three domestic middens (Midden 1, 2 and N-Midden 1) were excavated (Figure 5.4). Midden 1 is located on the lowest point of this site. We re-opened a 0.5 m strip on the western edge of S. Hall's (1981) trench in order to create a new section and to increase the sample size (Figure 5.5).

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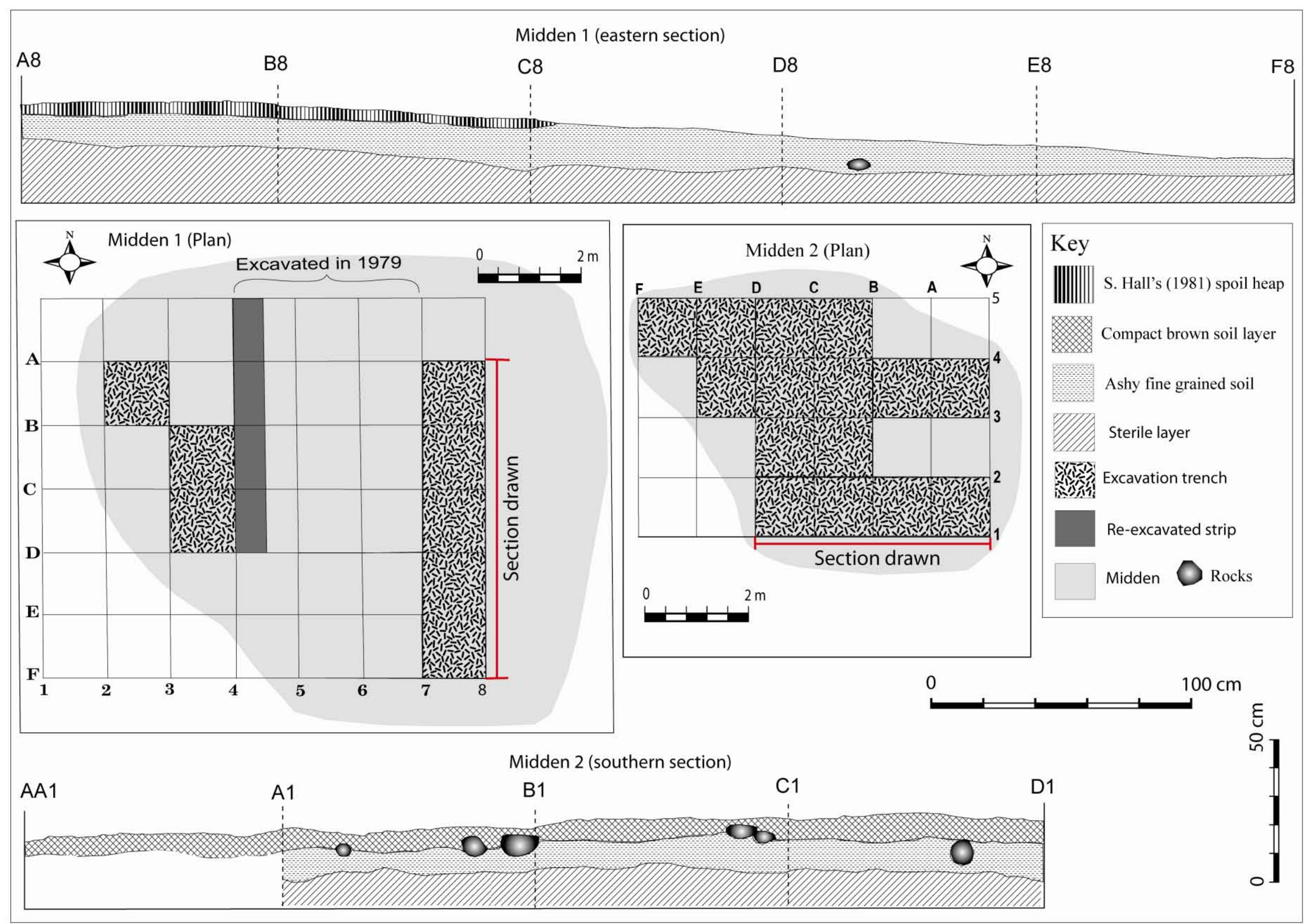

Figure 5.5: Plans and sections for domestic middens at Rhenosterkloof 1

Subsequently, twelve 1 m^2 blocks were extended in the western, eastern and southern parts of the midden. The excavation was shallow with a maximum depth of 0.3 m. The stratigraphy for this excavation was straightforward, consisting of a continuous ashy layer that rested on a rocky layer mixed with sterile brown soil (Figure 5.5).

Midden 2 lies about 30 m due north from Midden 1. It was identified by its light brown soil and stunted grass cover that contrasted with the surrounding areas. Initially, a 1 m^2 test trench was sunk in the centre and then extended (Figure 5.5). The deepest part of this midden was also 0.3 m. The stratigraphy for this midden was similar to that of Midden 1, except that the former appeared to have been deliberately capped with soil that covered the ashy layer (Figure 5.5). The capping of middens is a practice that is invariably associated with a belief amongst the Nguni-speaking groups that ash from middens can be manipulated negatively by means of witchcraft against the kin unit, and the belief that middens also underpin kin solidarity (Raum, 1973; Schoeman, 1997; Anderson, 2009). As a result the Nguni-speakers tend to place their middens in front of their huts and sometimes next to the court midden where they can be monitored (S. Hall, 2012).

FEATURES & STRUCTURES

Excavations were also conducted at Hut Collapse 1, Hut Platform 1 and the stone wall cattle enclosures (Figure 5.4). Hut Collapse 1 is located about 56 m due west of Midden 2. To the west, the midden was overgrown with bushes, but to the east the midden was relatively well preserved. This location was selected for excavation because it was one of a number of rubble mounds that were intermingled with cut-and-fill hut platforms along the hill slope. Six 1 m^2 trenches were opened and excavated to 0.3 m (Figure 5.6).

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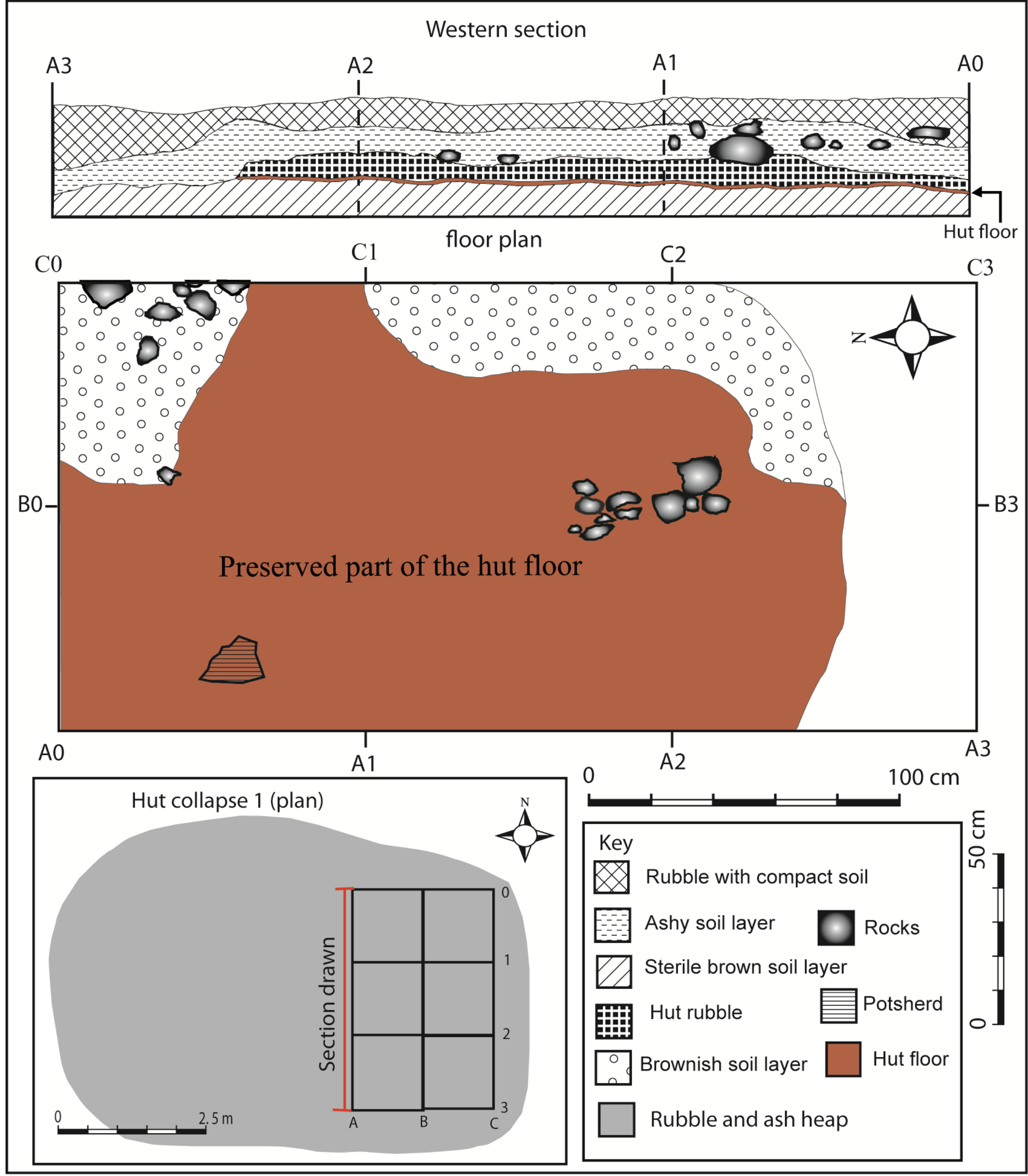

Figure 5.6: Plans and section for Hut Collapse 1

Below the rubble, excavations exposed an ashy layer that in turn lay on top of burnt hut rubble and a poorly preserved floor surface (Figure 5.6). The small lumps of pole-impressed daga showed that this was a hut that had burnt down. The ash was therefore not a midden but burnt thatch. The hut floor appears to have been deliberately capped by a rubble mound. The shallow layer of the burnt clay rubble (0.1 m) suggests that the hut may have been a variant of the beehive type, generally associated with Nguni-speaking groups (Kuper, 1980; Hall and

Maggs, 1979; Schoeman 1997; Huffman, 2004). Beehive huts are made of poles and thatch and had thin floors such that when they burn they leave very little burnt clay fragments. Friede and Steel (1980) also describe another type of beehive hut associated with the Swazis in the Newcastle area in Natal, which had a short (about 0.6 m) and narrow (about 0.4 m) circular mud wall upon which the pole and thatch rested. Hut collapse 1 probably fits the latter case because its thin layer of burnt clay does not fit the cone-on-cylinder type which generally has substantial daga. This feature was not fully excavated because of possible future Optically Stimulated Luminescence (OSL) sampling.

Some of the "platforms" on the hill slope are backed by low stone walling that tend to form half circle crescents. The crescent walls are identical to the back walls of households found at sites such as Smelterskop and to features noted on other Rhenosterkloof sites such as Rhenosterkloof 15 (Figure 5.3). A test excavation was carried out on one platform (Hut platform 1), which lay about 30 m due northwest of Midden 2 (Figure 5.4). It exposed a stone circle (one stone high) that may have been the base of a beehive hut. The back of this circle was obscured by a greater density of rocks that may have collapsed from the cut- wall at the rear of the platform (Figure 5.7).

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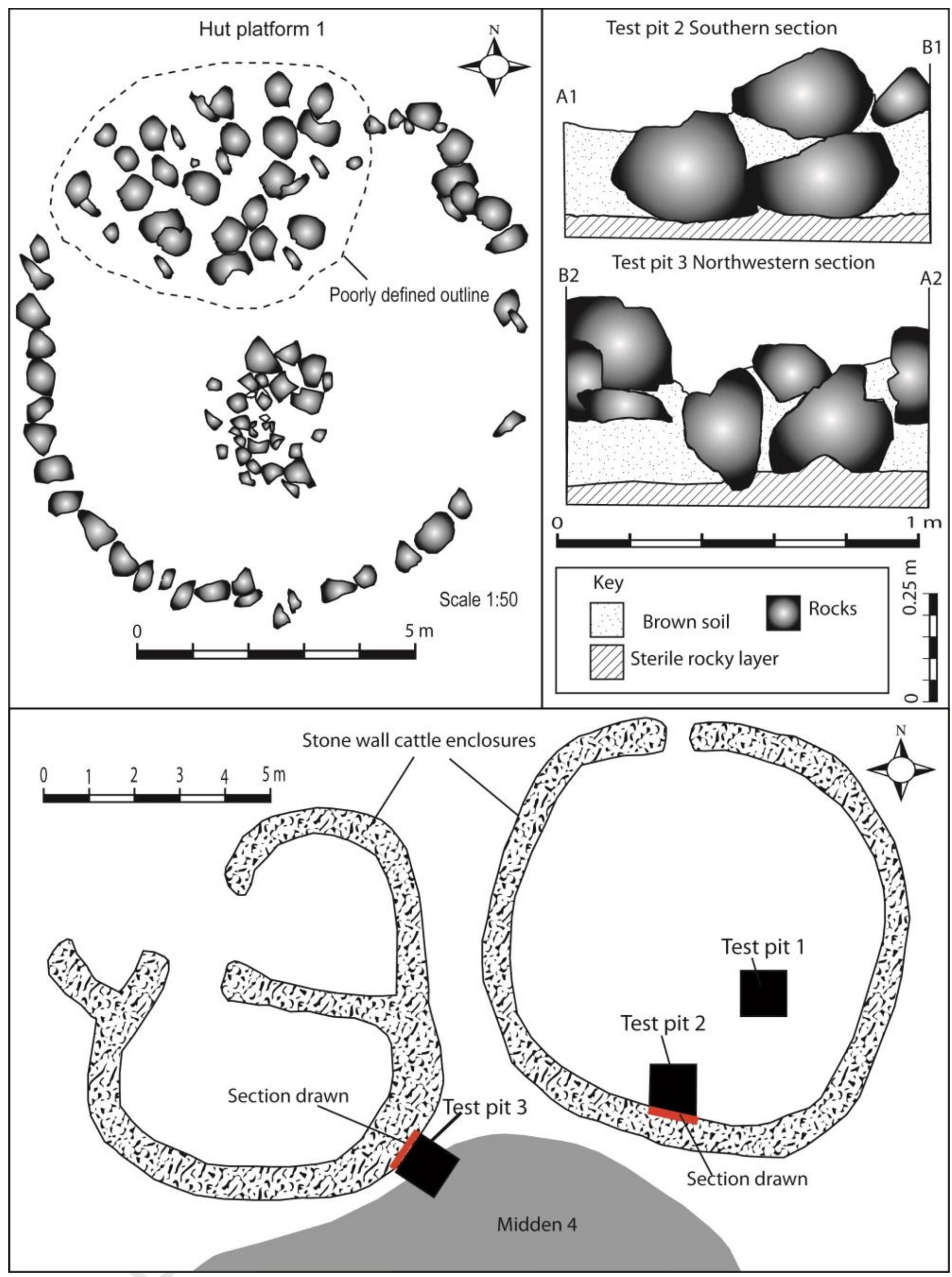

Figure 5.7: Plans and sections of features excavated at Rhenosterkloof 1

It was clear that the rock circle does not mark courtyard space but probably marked the foundation anchors for a hut. The hut was probably a beehive type, because similar rocks anchors have been associated with beehive huts at Buffelsfontein in the Northern Waterberg (see Aukema in Huffman, 1990: 94). A test excavation on the centre of the stone circle was a concentration of stones that may mark the position of an internal hearth (Figure 5.7). S. Hall (1981) noted the packing of stones into possible hearths in the Blaauwbank Donga.

Three 1 m^2 test pits were sunk at two stone walled kraals that are located next to the metal working middens (Figure 5.7). These kraals lie just above the basal contour of the adjacent ridge, with all entrances facing upslope. In form, they appear to be linked to the 15th–17th Century AD settlement pattern related to the Ntsuanatsatsi (Type-N) and Uitkormst ceramic phases from the Free State Province and to the area of Gauteng and North West Province, immediately to the south (Maggs, 1976). The Rhenosterkloof kraals are a simpler version of the Type-N settlements. These can have several cattle enclosures at the centre, linked by other walls and a perimeter wall that encloses the whole settlement (Maggs, 1976; Sadr, 2012). The test excavations were sunk to see if the relationship between the slag mounds and the kraals could be established. Kraal test pit 1 and 2 were sunk inside the larger kraal, the former in the centre of the kraal and the latter against the inside wall (Figure 5.7). Kraal test Pit 1 was excavated to 0.2 m while Kraal test pit 2 went to a depth of 0.3 m before reaching sterile bedrock. The other square (Kraal test Pit 3) was sunk just outside the smaller kraal and adjacent to Midden 4. This test pit went to a depth of 0.3 m before reaching the sterile layer. The profiles of the three test pits composed of a single layer of brown soil with cattle dung, resting on top of the sterile rocky layer (Figure 5.7). The walling does not overlay any material culture and the stratigraphic relationship with the smelting midden is also not clear from these tests.

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METAL WORKING MIDDENS

Midden 3 and 4 are mounds within a single dump situated about 40 m due east of Midden 2 due and about 70 m due northeast of Midden 1 (Figure 5.4 and 5.8). Midden 3 is the less disturbed and bigger midden, lying down slope to the south east. Midden 4 is the northern extension of the midden, which incorporates a depression and a mound. The depression probably marks a furnace bay, with the mound being the spoil heap (Figure 5.8). Alternatively, this depression could have been created by the 1984 excavations by UWARC and consequently Midden 4 could be their spoil heap.

Excavation of Midden 3 comprised four $1m^2$ trenches and a 1 m^2 test pit. The contiguous squares were excavated to a depth of 0.6 m while the latter only went to a depth 0.4 m, before reaching sterile rocky ground. In order to understand the stratigraphic relationship of Midden 4, trenches were run from the mound into the depression (Figure 5.8). On the mound, a 1 m X 0.5 m test was excavated, while another 0.5 m X 0. 5 m test pit was sunk down slope towards the depression. Another 2 m X 1 m trench was dug in the depression. A 0.5 m strip was later

extended to the west and northern side of this trench in order to expose two paired bowl furnaces (Furnace 2/84 South and Furnace 2/84 north), encountered at 0.3 m depth and exposing until reaching the sterile layer at 0.6 m (Figure 5.9).

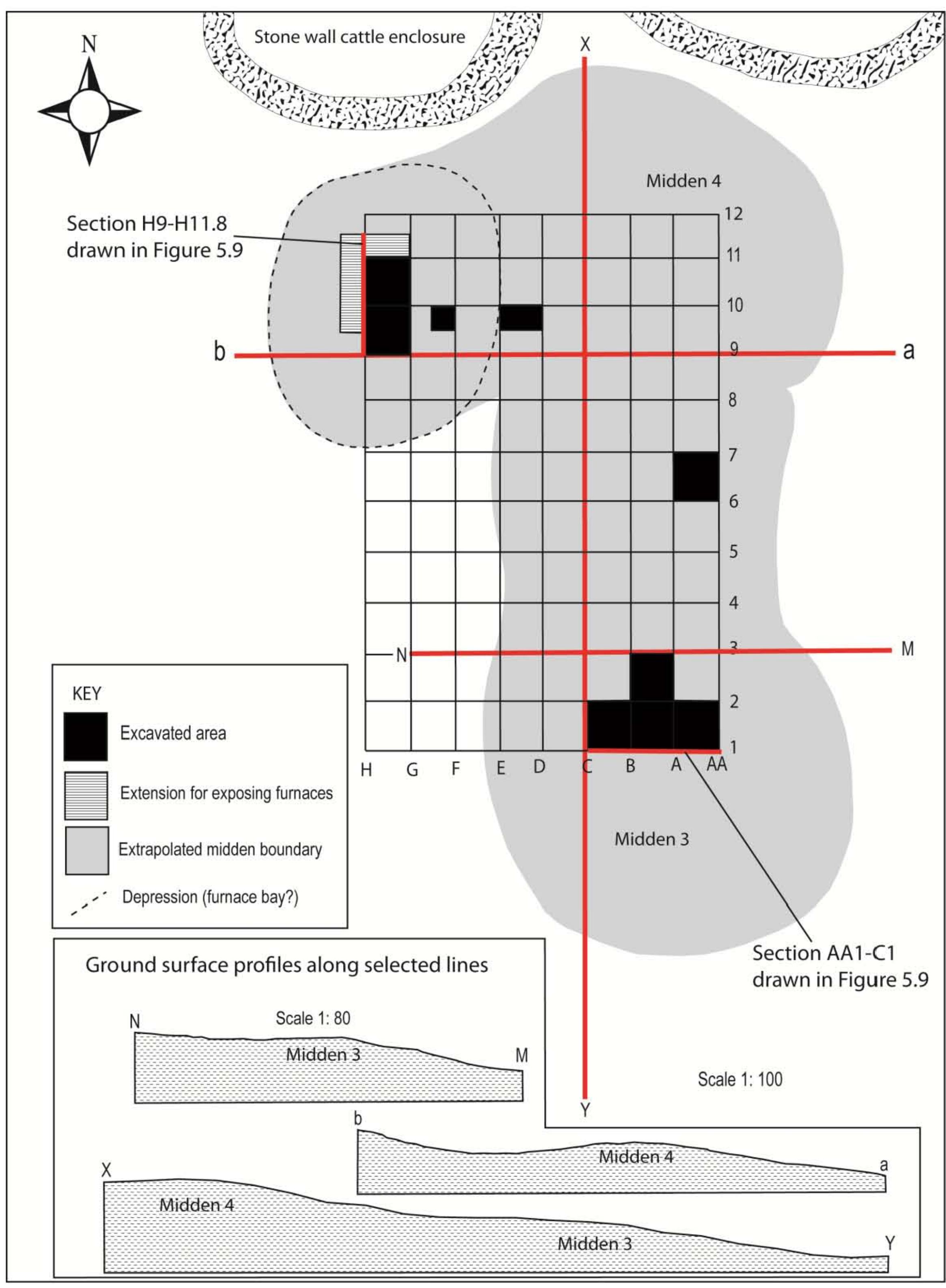

Figure 5.8: Plan and ground profiles of Middens 3 and 4

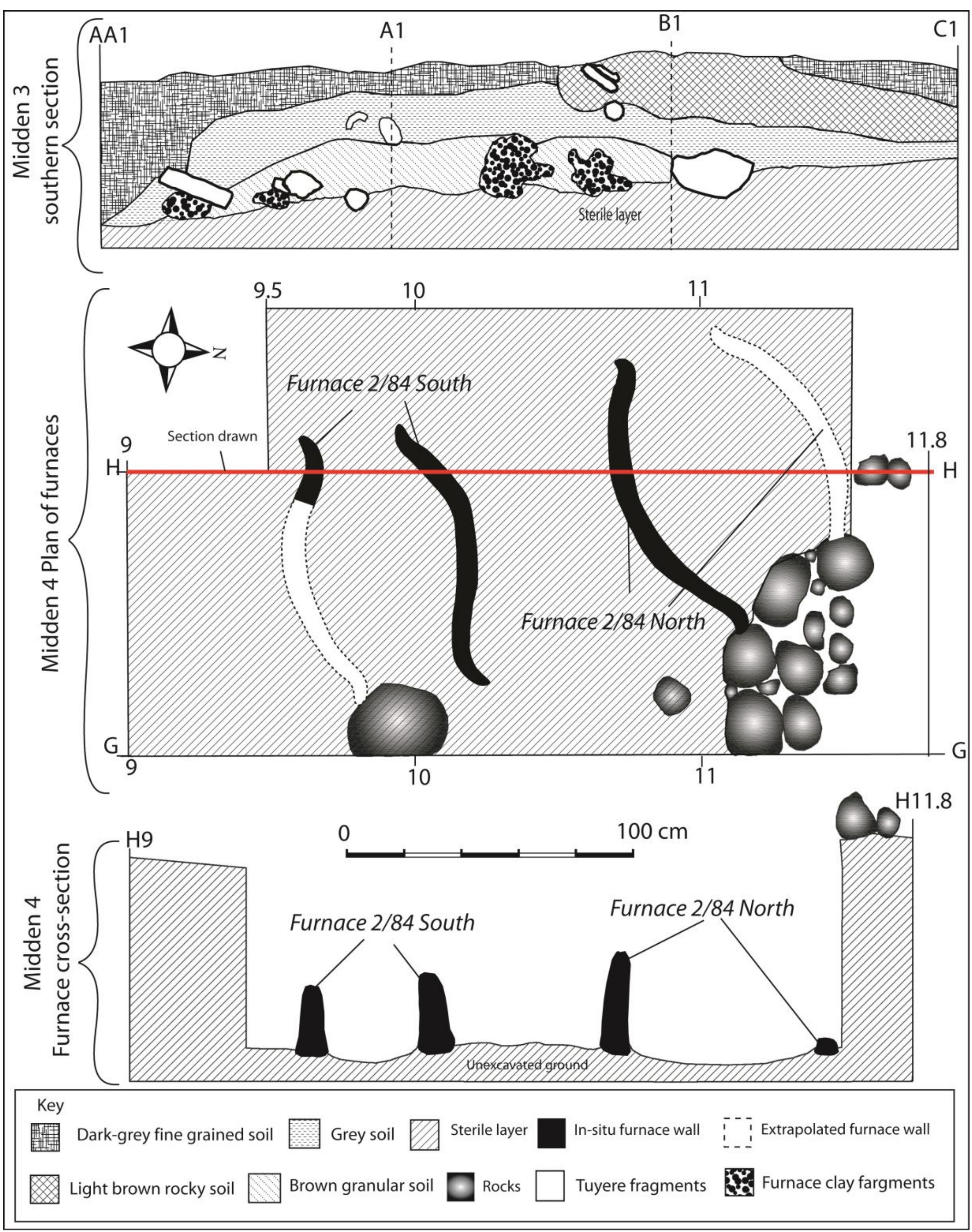

Figure 5.9: Excavation plan and sections for Middens 3 and 4 (plans in Figure 5.8)

The furnaces were paired and are reminiscent of the 'butterfly type' discussed by Maggs (1982) in the KwaZulu-Natal region. The stratigraphy of middens 3 and 4 was complex and probably reflects rapid episodes of dumping different materials such as furnace wall, slags and tuyeres as cycles of smelting and bloom processing were completed. Profiles at Midden 3

comprised dark grey, light grey, grey, light brown and brown soil layers that did not have any lateral extent, and mark short and sharp bursts of dumping activity (Figure 5.9). The Midden 4 mound had a very thin layer of metal working debris resting on top of a sterile rocky layer, while the depression trench exposed compact grey soil resting on the sterile rocky layer (Figure 5.9).

5.4.2: RHENOSTERKLOOF 2: SITE DESCRIPTION & EXCAVATIONS

Rhenosterkloof 2[16] lies on the valley floor, about 400 m, due south, from Rhenosterkloof 1 (Figure 5.3). A large metal working midden and a cattle kraal deposit are the most visible features at the site (Figure 5.10). The cattle kraal was not enclosed by a stone wall and was identified by the presence of a large circle of partially vitrified dung. Two more subtle stone features were identified. One of these was a cluster of rocks that probably mark a granary foundation. In appearance, the rock cluster is similar to other rock foundations for grain bins (Huffman, 2007: 11). It lies about 7 m due west, from the cattle kraal and about 14 m from the large metal dump (Figure 5.10). The other stone feature is a circular outline of rocks located about 4 m from the cattle kraal to the northeast. The rock circle was probably a foundation anchor for a reed and grass structure such as a bee-hive hut. In appearance, it is similar to Hut platform 1 from Rhenosterkloof 1, except that the latter has a smaller feature in the middle. About 7 m due north east, from the metal working midden, an iron spearhead was recovered next to a rock anvil.

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[16]Site located through oral interviews with the farm foreman, Mr Elias

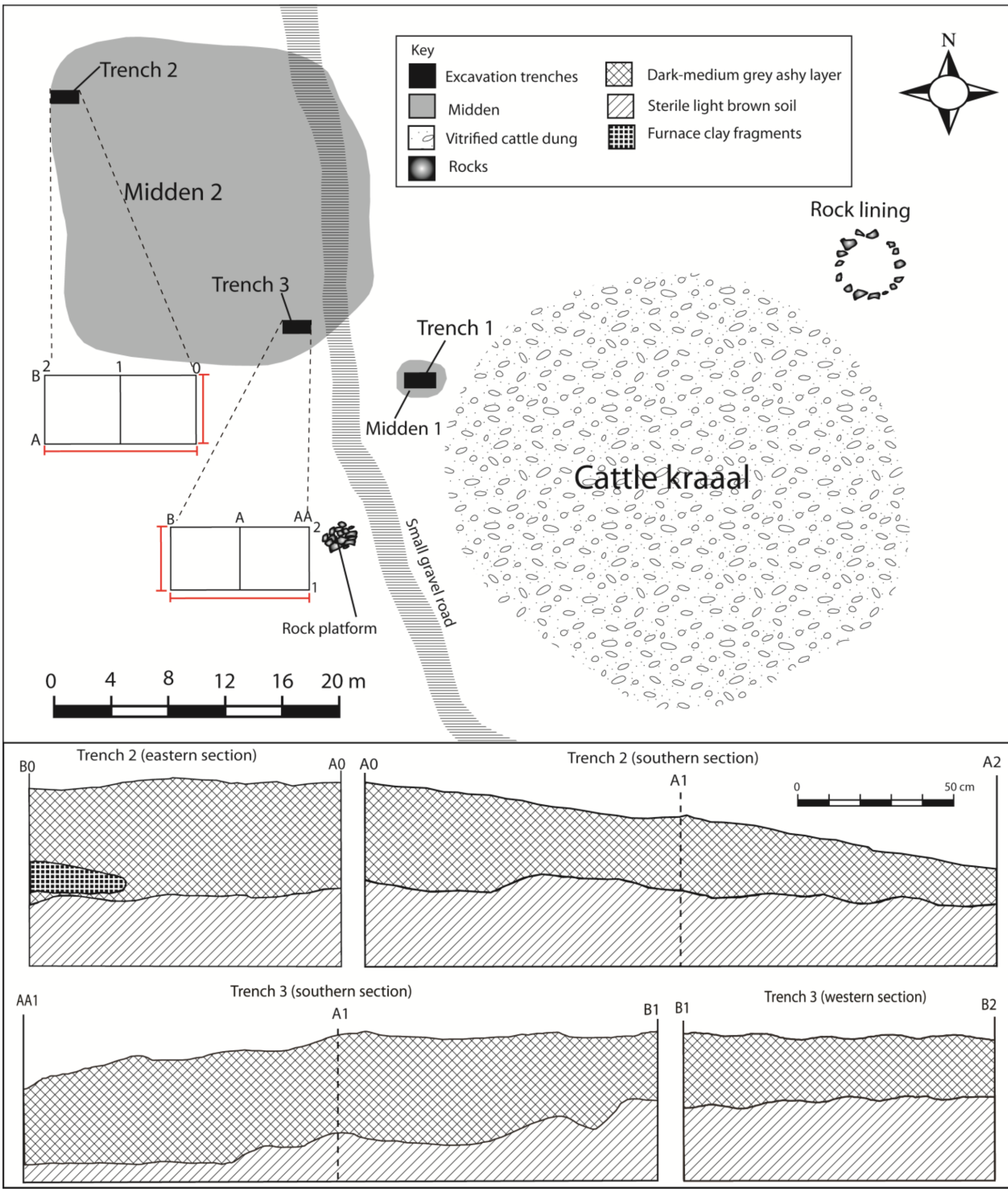

Figure 5.10: Rhenosterkloof 2 site plan and sections

DOMESTIC MIDDEN

The only cluster of potsherds was around Midden 1, a very subtle dump that is sandwiched between the cattle kraal and the metal dump (Figure 5.10). The visibility of this midden was high because there was little growing on it. A 1 m X 2 m trench (Trench 1) was sunk in the centre of this midden. Excavations reached sterile ground at 0.1 m, confirming that the

midden was very shallow. Other excavations targeted the large metal dump (Midden 2) in order to retrieve metal working samples and estimate the scale production.

METAL WORKING MIDDEN

Midden 2 is situated about 7 m northwest, from the cattle kraal. It is a mound full of slag, furnace wall and tuyeres, and is about 22 m long and 20 m wide (Figure 5.10). A gravel road cuts the eastern edge of the midden and some parts of the midden were also disturbed by animal burrows. Two 1 m X 2 m trenches (Trench 2 and Trench 3) were sunk at opposite ends of the midden, avoiding the disturbed areas (Figure 5.10). Trench 2 exposed a 0.4 m section, while Trench 3 was excavated to 0.3 m before reaching sterile ground. In both trenches, the stratigraphy comprised a single layer laden with slag and fragments of furnace wall and tuyeres (Figure 5.10).

5.4.3: RHENOSTERKLOOF 3: SITE DESCRIPTIONS & EXCAVATIONS

Rhenosterkloof 3 is located on the eastern valley, about 200 m from Koppieskraal ridge and 1800 m due west of the Sand River. It lies about 15 m from a small dam to the east and rests on a gentle slope whose top soil is being washed towards the Sand River, and the site's integrity has been compromised by water erosion (Figure 5.11).

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Figure 5.11: Photograph of eroded patches at Rhenosterkloof 3, with the eastern end of Koppieskraal ridge visible in the background

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Nevertheless concentrations of potsherds and slag were still visible on the surface. To the south, a cattle kraal was also identified based on the presence of partially vitrified dung. This kraal appears to be on the fringes of the site. Northwards, the site boundary is poorly defined and there may be an overlap between this site and Rhenosterkloof 5. The area of overlap has surface concentrations of slag and potsherds, as well as an in-situ furnace bottom (Figure 5.12).

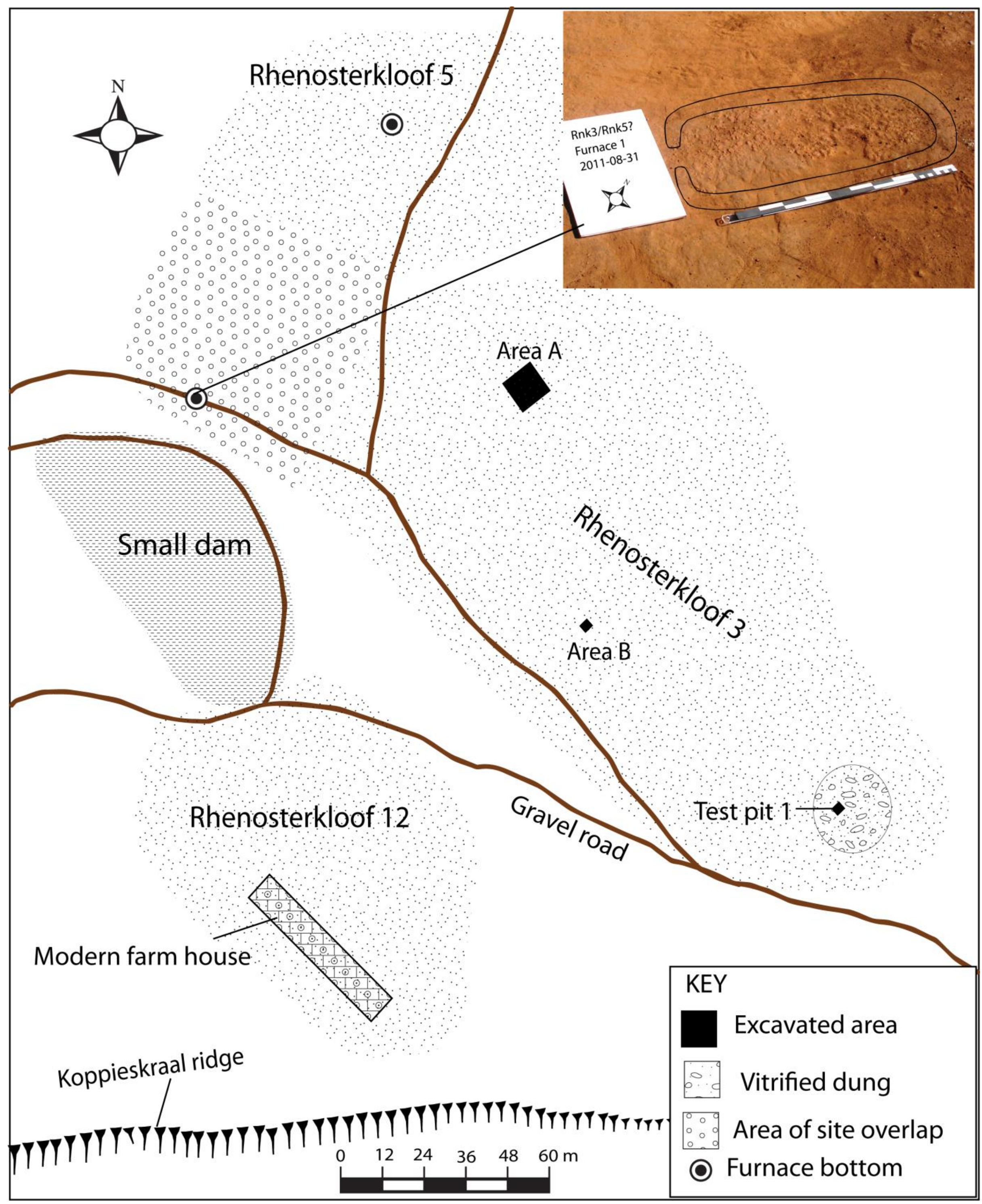

Figure 5.12: Site plan for Rhenosterkloof 3 with an insert of a furnace base.

Three areas were chosen for excavations (Area A and B and Test pit 1). The first area lies northwards of the site and was selected because it exhibited the largest concentration of surface ceramics at the site. A 1 m X 1 m test was excavated with a shovel so as to break the sunbaked upper layers of the soil. Sterile ground was reached at 0.1 m, after which a decision

was made to extend the test pit into a larger trench (9 m X 9 m) in order to maximize material recovery (Figure 5.12).

Area B is located on the central parts of the site, about 100 m due south, from Area A. It also lies on eroded patches. During the initial survey season (September 2010), it was noted that the area had a small mound with substantial burnt daga that appeared to be resting on a partially exposed floor. However, some ten months later (August 2011), the mound was now reduced to a few fragments of pole impressed daga. A 1 m X 1 m test pit was sunk on this area, to establish if there was any feature associated with the burnt clay (Figure 5.12). Sterile ground was reached at 0.1 m and no feature was recovered. Another 1 m X 1 m test pit was sunk in the cattle kraal and also reached sterile ground at 0.1 m, having only produced vitrified dung. This is finding is consistent with S. Hall's (1981: 23) observation that most Eiland sites in the Southern Waterberg, occurred within arable land. The disturbed nature of this site meant that it was not possible establish which features were associated with the cattle kraal.

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EXCAVATIONS ON TEMBI FARM

Tembi Farm is lies to the western boundary of Rhenosterkloof and hosts the longest part of Koppieskraal ridge. Iron Age sites are concentrated on the southern side of the ridge, probably because of poor drainage on the northern side, and the only two sites (Tembi 1 and 2) on the latter are situated on high ground (Figure 5.13). Most of these sites have evidence of metal working, but the density is generally low. Stone walled cattle enclosures and other low half-circle enclosures are some of the prominent features at these sites. Some of the crescent like features at sites such as Tembi 6, 7, 8 and 9, abut the basal contours of Koppieskraal ridge in a pattern that is similar to those at Rhenosterkloof 1 and Rhenosterkloof 15. To this generalisation, Tembi 1 is an exception because the site is situated on the summit of the ridge and has more stone wall enclosures. It was therefore important to excavate this site in order to generate comparative data on the archaeology and metallurgy of sites in this area

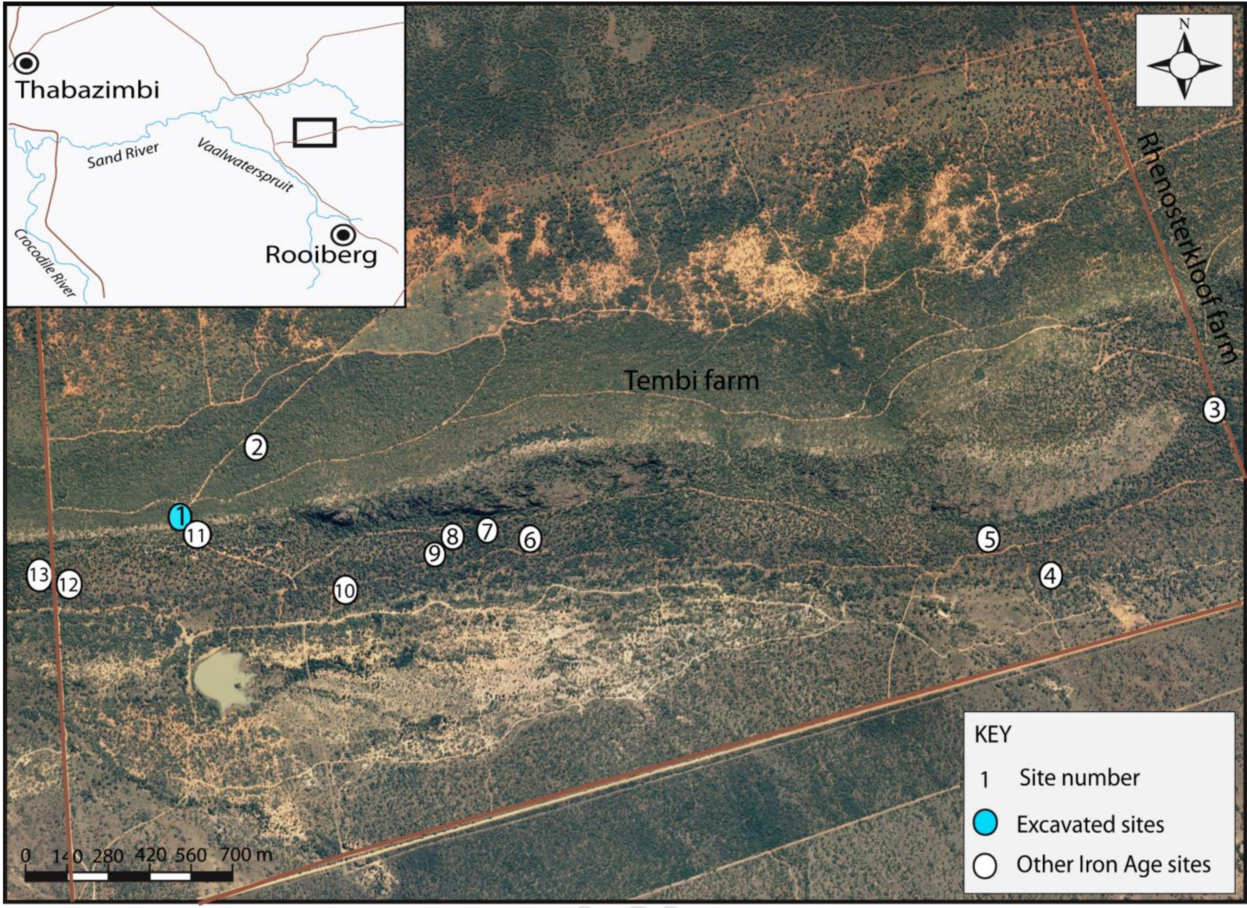

Figure 5.13: An ortho-rectified image showing Iron Age sites in Tembi Farm

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5.4.4: TEMBI 1: SITE DESCRIPTIONS & EXCAVATIONS

Tembi1 is a hilltop stone walled site, located next to the modern farm houses in Tembi Farm. A gravel road that cuts Koppieskraal ridge from the southern side to the northern side, also divides the site into two halves because the site runs parallel to ridge for about 400 m (Figure 5.14). A continuous back wall runs along the site on the up-slope side, leaving the down-slope open. The location of the site on the hill may have been for defense but the height of the perimeter walls and the fact that the northern side was left open do not seem to support this. Occasionally some stone enclosures were extended to the southern side where the modern houses now stand and Tembi 11 may have been part of Tembi 1. Most enclosures appear to emphasize the back/front dichotomy as they are arranged facing either down-slope or up-slope. The back/front axis is conceptually similar to the 14th-16th Century AD Moor Park pattern associated with Nguni-speaking groups from Kwa-Zulu Natal (Huffman, 2004).

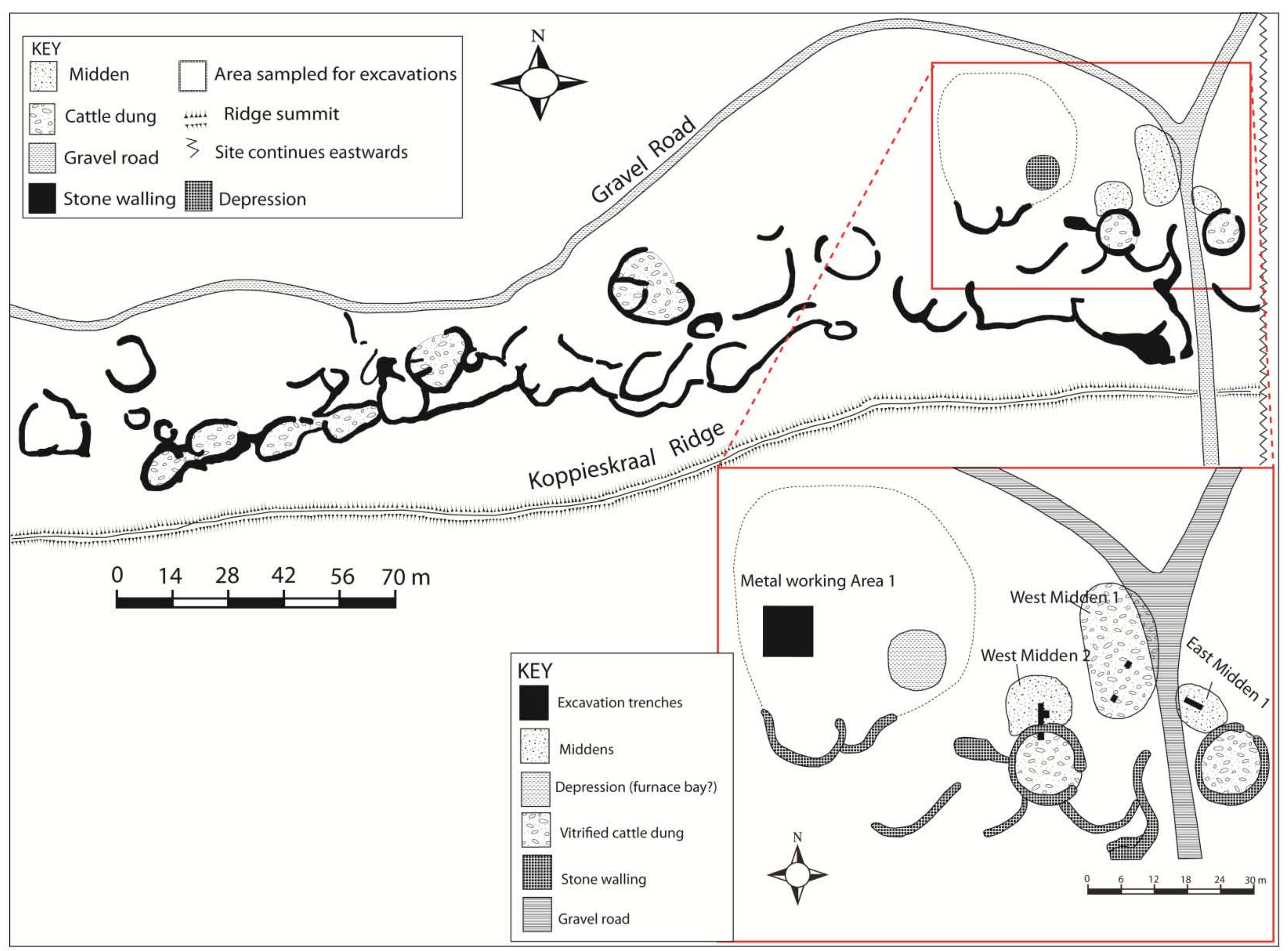

Figure 5.14: Tembi 1 site and excavation plan

At the type site of Moor Park, a perimeter wall enclosed about two-thirds of the site leaving the steep side of the hill open (Whitelaw, 2000). Variants of this pattern have been reported at Melora in the Waterberg region (Huffman, 1990) and in Mpumalanga (Schoeman, 1997; Huffman, 2004)

The stone walls at Tembi 1 rise to a maximum of 1.5 m and were built by placing large irregular rocks on the outer surfaces and filling up the middle with smaller stones and rubble. The eastern half of the site appears to have more regular boulders than the western half of the site. Clusters of metal working debris were also identified within some crescent stone enclosures and in open spaces. Ashy-like mounds, associated with either vitrified cattle dung or middens are also evident at this site. Excavations were limited to middens and a metal working area in the central part of the site (Figure 5.14).

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DOMESTIC MIDDENS

Three domestic middens (East Midden 1, West Midden 1 and West Midden 2) were selected for excavation. East Midden 1 lies to the eastern side of the gravel road that bisects the site. To the east, the midden extends towards the adjacent stone walled cattle enclosure where there is vitrified dung that is eroding towards the midden (Figure 5.14). A 1 m X 3 m trench was excavated to a depth of 0.3 m before reaching sterile ground. West Midden 1 is about 2 m due west of East Midden 1 and the two middens are separated by the gravel road. Two separate 1 m^2 test pits were excavated to a depth of 0.4 m before reaching sterile rocky layers (Figure 5.14). About 2 m to the south west of this midden, is West Midden 2. This midden banks up against the northern side of a nearby stone walled cattle kraal (Figure 5.14). A decision was made to excavate outside and inside the stone enclosure in order to test the stratigraphic relationship between the enclosure and the midden. Four 1 m^2 trenches were sunk outside the enclosure and 1 m^2 inside the enclosure. Trenches outside the wall reached sterile bedrock at 0.3 m and the one inside went to a depth of 0.4 m before reaching sterile ground.

The stratigraphy of East Midden 1 and West Midden 2 were similar comprising an ashy layer sandwiched between a slightly compact light grey layer above and a sterile rocky layer below (Figure 5.15).

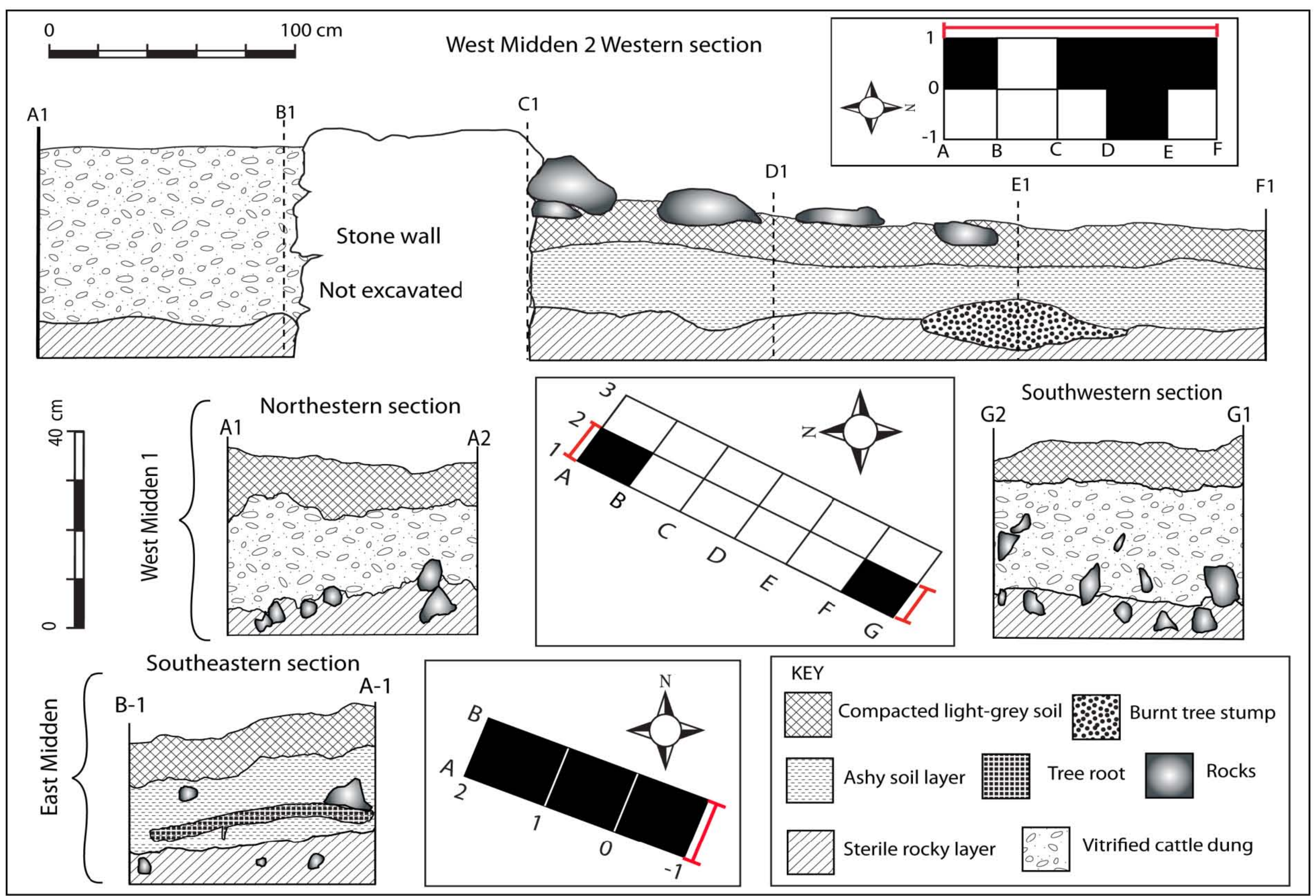

Figure 5.15: Plans and sections for domestic middens at Tembi 1

The apparent capping of the midden may reinforce Nguni connections as discussed at Rhenosterkloof 1 (Anderson, 2009). East Midden 1 and West Midden 2 were disturbed by tree growth. At the latter, some rocks falling from the stone enclosure were also identified in the upper layer. On the other hand, the stratigraphy of West Midden 1 was slightly different because the deposit was predominantly composed of vitrified cattle dung with a capping layer on top (Figure 5.15). This suggests that the area was once used as a cattle kraal, which would explain the thick accumulation of cattle dung below the thin midden layer.

METAL WORKING AREA

Metal Working Area 1 is situated about 8 m from West Midden 2. Its southern boundary appears to be defined by two wide-open stone arcs that face downslope (Figure 5.16).

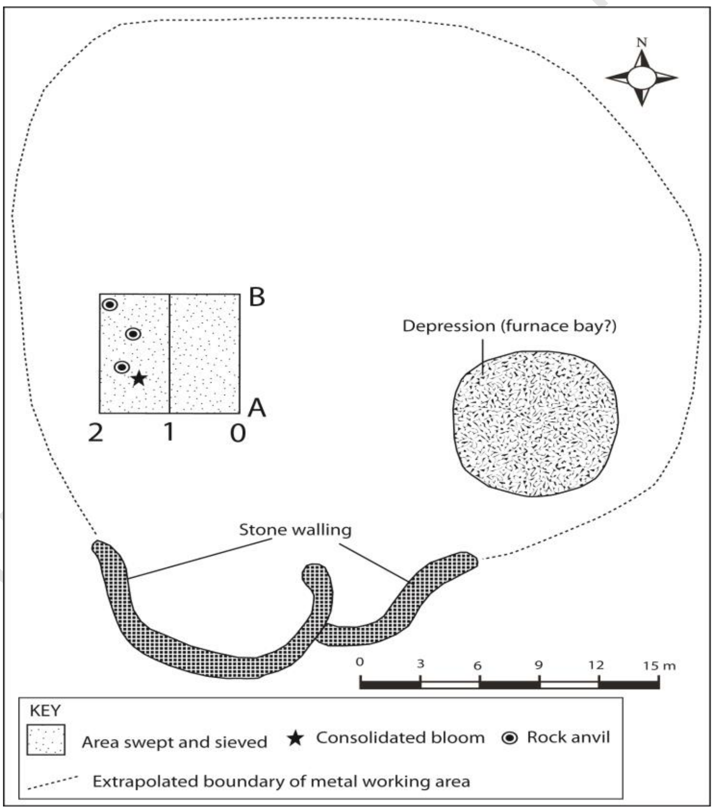

Figure 5.16: Plan of Metal Working Area 1

The area with greatest surface concentration of slag and tuyeres covered about 30 m in diameter. There is a depression, measuring about 7 m in diameter, which is located to the south east of this

area. Three rock anvils and a large piece of a consolidated iron bloom were also visible on the surface to the west (Figure 5.16). A 7 m X 7 m trench (divided into two sections in order to separate the area with anvils from other areas) was excavated using shovels because the area was shallow (maximum depth of 0.05 m).

5.5: RADIOCARBON DATING OF SITES

Charcoal samples were collected from excavation contexts at Rhenosterkloof 1 and 2, and Tembi 1 and submitted to BETA ANAYTIC for radiometric dating. At Rhenosterkloof 1 and 2, charcoal collected from upper and lower levels of the middens produced BP dates that are stratigraphically consistent, even though they overlap in terms of the calibrated ages. The calibrated ages for the three sites also overlap and at best these dates are only indicative of the probable ranges because of the diminished utility of radiocarbon dating as one gets closer to 1950 (Table 5.1).

Table 5.1: Radiocarbon dates from Rhenosterkloof 1 and 2, and Tembi 1. (Rnk =Rhenosterkloof)

Sample #	Site	Provenance	Depth	Material	BP age	2 sigma (AD)	Reference
Pta-2847	Rnk 1	Ash Heap II C3	25-30 cm	charcaol	310±40	1495-1672	S. Hall 1981
						1744-1756	
						1762-1770	
						1780-1796	
AA-77931	Rnk 1	Midden 3 surface	surface	charcaol trapped in slag	192±35	1657-1817	Courtesy of S. Hall & D. Killick
						1827-1893	
BETA-336278	Rnk 1	Midden 3 A1	50 cm	charcoal trapped in slag	250±30	1530-1540	Current study
						1550-1550	
						1630-1670	
BETA-336279	Rnk 2	Midden 2, Trench2 A1	10 cm	charcoal	140±30	1670-1780	Current study
						1800-1890	
BETA-333838	Rnk 2	Midden 2, Trench2 A1	40 cm	charcoal	340±30	1450-1640	Current study
BETA-333839	Tembi 1	East Midden 1, A2	30 cm	charcoal	300±30	1490-1600	Current study
						1610-1650	

The above dates are generally similar in range to the dates presented in Table 2.1 and with the chronology suggested by settlement typology. The dates therefore, do not contribute to the possibility that these sites represent earlier phases of tin production outside of what is already known. Rhenosterkloof 3 is undated but the presence of Eiland ceramics indicates a date range between the 11th and 14th centuries (Huffman, 2007). To further refine this chronology, bead and ceramic typologies (discussed in Chapter 7) were used.

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5.6: SUMMARY

Findings from desktop surveys were employed to refine research questions and to define appropriate sampling, survey and excavation strategies. The Sand River valley was targeted for this fieldwork and resulted in the documentation of 46 Iron Age sites, four of which were excavated to yield samples for laboratory analyses. The nature of the Iron Age sites in this area has been described and it is shown that metal working remains and cattle kraals are ubiquitous but generally limited to small scales of production at the homestead level. The two sites of Rhenosterkloof 1 and 2 are the exception. To gain more information on the developments in the area under investigation, laboratory analyses of various materials collected during the fieldwork, were carried out and the findings are discussed in the next two chapters.

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CHAPTER SIX: LABORATORY METHODS: PRINCIPLES & PROTOCOLS

"The reason for this [state of flux] is that traditional theories and methods have failed to solve many of the problems for which they were intended" (Hill, 1972: 61).

6.1: INTRODUCTION

Research output is only as good as the research strategy employed (Hill, 1972:101). As such it is not good enough to formulate sound research agenda without backing it with appropriate theoretical and methodological strategies. This chapter describes the analytical methods applied to archaeological and metallurgical remains from the sites described in previous chapter, in order to answer research questions raised in Chapter 1. The underlying principlesand analytical protocols are also explained with a view of making clear the applicability of each method to the research questions. To recap, key issues in the present study relate to innovation, interaction, metal specialisation and trade, centred around tin, bronze, iron and copper metallurgy. The study is subdivided into two related research strands. The first focuses on the archaeology of the culture-historical sequence and the other is driven by the application of science-based approach within an archaeometallurgical perspective. For the former, non-metallurgical finds such as ceramics and beads are the chief material category, but for the latter metallurgical finds, both production remains (such as slags, furnace wall fragments, and tuyeres) and metallic artefacts (finished and semi-forged objects such as spearheads and bangles) were analysed. Some pottery was used as crucibles and consequently, straddles both domains, making it possible to explore connections between the archaeology and the metallurgy. Additionally, since metallurgical finds are also a form of material culture, and can illuminate on archaeological issues such as group identity, which is central to the research agenda pursued in the present study.

6.2: MATERIAL CULTURE & GROUP IDENTITY

Archaeologists throughout the world, use material objects as symbols or "badges of affiliation to" specific cultural groups (Boas, 1927; Schofield, 1948; Evers, 1988; Hodder, 1982; de Boer, 1985; Shennan, 1989; Sackett, 1990; Loubser, 1991; Hegmon, 1992; MacEachern, 1998; Gosselain, 2000; Bowser, 2000; Fennell, 2000; Kus and Raharijaona, 2000; Phillipson, 2005; Huffman, 2007; Pikirayi, 2007; Gijanto, 2011). A commonly held assumption in these studies is

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that style, as expressed on buildings and or quotidian objects, such as items of clothing, beadwork, woodwork and ceramics, can be group specific. However, in Southern Africa scholars such as Huffman (1982; 2007) assert that ceramic style is the main variable and common artefact category that can be used to establish group identity. This assertion is supported by Evers (1988) who demonstrated that amongst the Pedi, Gwembe-Tonga and Zulu people, ceramics retained most of the design repertoire that also appeared on mural art, wooden dishes, buildings, drums, beadwork, skirts, pipes, baskets, and milk pails and chairs. Other scholars also noted the co-occurrence of ceramic decorative style on other media such as female bodies (Collett, 1993), granaries (Bent, 1892; Collett, 1993), furnaces (Ndoro, 1991; 1996), stone walling (Robinson, 1965), and terracotta (Evers, 1982; Inskeep and Maggs, 1975). Emphasis is placed on language as the medium through which a people's worldview (and therefore style) is conveyed. This promoted a general acceptance of the relationship between ceramic style, language and group identity. For this to hold, Huffman has argued that producers and users of the same style must belong to one group unless one group makes the pottery solely for trade.

There have been reactions to Huffman's advocated method from some scholars (M. Hall, 1987; Lane, 1994/5; 1997; McEachern, 1998; Gosselain, 2000; Pikirayi, 2007) who feel that a gross structural stance such as this cannot account for all the variability across space and time. For instance, in Mpumalanga there are sites with ceramics that represent a regional Pedi identity but masking smaller-scale identities that are ethnographically known and expressed in settlement typology and house types (Schoeman, 1997; Delius and Schoeman, 2008; Maggs, 2008; Delius et al. 2012). However, as cautioned by S. Hall (2012: 305), "rather than reject an archaeologically recognised regional ceramic style as too coarse to address historical detail, the on-going challenge is one of problematising the disparity between the archaeological and historical scales of identity, and to ask why people from diverse backgrounds in the Mpumalanga area chose a common regional style that expressed shared norms". All the same, Sadr (2008) maintains that reactions against Huffman's ceramic typology have had relatively little effect on approaches to Iron Age ceramic analysis and interpretation in southern Africa. Thus, there is still room for ceramic style in studies of group identity, even though other forms of material culture are necessary because they provide more contextual detail. In this thesis I used Huffman's Multi-

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Dimensional Analysis (MDA) together with the analyses of settlement patterns and beads in order to see if there was correspondence in the data sets.

As material culture, metallurgical remains can also throw some light on human interaction in the past (Kingery, 1996). Cyril Stanley Smith observed that as products of high temperature processes, both metallurgical remains, retain partial histories of the processes which they have undergone (Bachmann, 1982). This observation enchanted archaeometallurgists because it allowed them to read not just the technological particularities, such as temperatures operating in the furnaces and smelting recipes (Charlton et al. 2010), but also the skills of the smelters and their ability to influence and modify the technical sequences (Morton and Wingrove, 1972; Rehren et al. 2007). This information is central to defining a group's technological practice and inter-site or regional comparison of technological practices can shed light on technological cross borrowing, human interaction and group identity (Gordon and Killick, 1993). Such an approach of using archaeometallurgical techniques to address broad questions relevant to main stream archaeology is at the heart of archaeometallurgy, as defined by Rehren and Pernicka (2008: 234) and activates the sub-discipline away from creating highly technical reconstructions that are largely indigestible to non-archaeometallurgists.

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While the analysis of interaction and trade using archaeological and archaeometallurgical remains may be fairly straightforward, that of innovation and specialisation is not because issues of skill, scale and context impinge. Skill is important in exploring innovation and specialisation, but it is hard to measure archaeologically (Rice, 1991: 263). Moreover, locations such as mines and quarries are "specialised" places without necessary association with producer specialisation (Morrison, 2001: 7680). Scale and context of innovations and specialisations, all depend on the organisation of production which is inevitably inferential. Costin (1991: 3) suggests key pointers of specialisation such as the amount of time spent in the activity, the proportion of subsistence obtained from the activity, the presence of recognised title, name, office for the person, payment in money or kind for the product of the specialist, standardisation in manufacture, proficiency and efficiency and regional variation. The last three points apply to innovation but it is important to stress that they may be as variable as the subject matter. For the present study, only scale, (proportion of domestic debris to metal working remains), context (affiliation of producers and

the sociopolitical component of demand) as well as proficiency and efficiency, were considered relevant. I now turn to the principles and protocols of laboratory analytical methods used in this study.

6.3: ARCHAEOLOGICAL APPROACHES

Some of the relevant approaches to the culture-history of the area, such as settlement typology have already been described in the previous chapter. Ceramic and bead typologies are the key archaeological approaches described in this section.

6.3.1: CERAMIC TYPOLOGY

The Multi-Dimensional Analysis[17] (MDA) of ceramics, advocated by Huffman since the 1980s is still the dominant method of establishing culture-historical sequences in the Iron Age of southern Africa. In the Southern Waterberg, ceramics have been subjected to MDA by S. Hall (1981), Huffman (2006), Tomaselli (2006), and Chirikure et al. (in preparation). To ensure consistence and comparability, I also used the same method for the pottery recovered in the present study. Stylistic types are formed by the combination of Profile, Design layout and Motif categories. Alternative methods such as the *Technique Taxonomy* (Phillipson, 1968; Maggs, 1976) and the S*hape and Decoration List* (Soper, 1971; Robinson, 1973) are not constrained by these three attributes. In order to demonstrate the reliability of his method, Huffman (1980) tested these methods on contemporary ethnographic samples and concluded that his approach was the only one that correctly assigned ceramics to the correct control groups.

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To generate a stylistic class, however, one must ideally have all the three variables (profile, design layout and motif categories). Profile refers to the vessel shape, while design layout refers to the organisation of decoration in view of decoration placement. The motif categories refer to the complete decoration combinations. The last two variables mean that whole vessels are needed to define stylistic classes (Huffman, 2002). Complete vessels do include sherds that retain all the possible decoration areas observable within an assemblage. Undecorated sherds with rim or a recognisable profile are also retained as diagnostic pottery because they are useful

[17] Some scholars consider “multi-variant” to be more appropriate than “multi-dimensional” because it does not involve any measure of spatial extent

in establishing profile categories but they cannot be used to establish stylistic classes. Several related stylistic classes will then form a ceramic unit, called a facies and belong with a tradition (cluster of facies) (Huffman, 2007).

6.3.2: BEAD TYPOLOGY

Different types of beads (as defined by raw material) illuminate different types of information. For instance, glass bead styles represent different time periods and localities of manufacture and consequently, can serve as temporal markers and inform on trade and interaction (Wood 2000; 2011; Robertshaw et al. 2010). On the other hand, ostrich egg shell (OES) bead sizes have been argued to be distinctive cultural markers, especially between hunters and herders (Smith et al. 1991; Yates and Smith, 1993; Tapela, 1995). Hunter-gather OES beads are thought to be smaller than those of herder and agriculturalist counterparts (Tapela, 1995). Other typical bead types include bone beads and metal beads that are generally not associated with issues of group identity. Beads were initially grouped by material (glass, shell and bone) and subsequent analysis was done following standard procedure for particular groups.

Standard procedure in glass bead classification is basically visual; recording translucency, colour, size (diameters), shape and method of manufacture (Wood, 2005). This procedure was followed and images were also sent to Marilee Wood (a specialist in southern African glass beads) for further identification. Recently, researchers have also undertaken chemical analyses of glass beads in order to further refine visual classifications by comparing recipes found in the chemical makeup of the different bead-series (Robertshaw et al. 2010). Glass beads under study were submitted to Christel Tingley of the Department of Geology at the University of Cape Town, for chemical analyses. They were mounded in resin and polished before running the analysis using a JEOL JXA-8100 Electron Microprobe, in spot mode.

The analyses of shell and bone beads were based on visual and metric properties such as colour, charring, method of manufacture, breakage and size. Charring of OES beads was recognised as a category because previous work by Kandel and Conard (2005) had demonstrated that the practice was intentional, aimed at achieving a grey-black colour and done to make the beads

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thinner due to the delamination of the shell. Incomplete beads as well as shell rough-out fragments were also included in the analyses.

6.4: WHEN THE ARCHAEOLOGY MEETS METALLURGY: THIN-SECTION PETROGRAPHY OF CRUCIBLES & DECORATED SHERDS

It has already been noted in Chapter 5 that the site of Rhenosterkloof 3 was seriously disturbed; leaving behind clusters of materials whose relationship is uncertain. Decorated pottery from the site places the site in the Eiland phase. Associated with Eiland pottery is undecorated crucible[18] sherds but without decoration, their place in the culture historical sequence is uncertain. Since this was the only excavated site related to the Early Iron Age (EIA) occupation, there was a need to build some confidence in the possible relationship between the Eiland decorated ceramics and the metallurgy through the analysis of crucibles. As noted above, crucibles were targeted for analysis because they are the only artefacts from this Eiland context that provided a potential bridge between the metallurgy and the Eiland phase.

This analytical focus draws on the fact that ceramic technological style can also be used to supplement decorative style in the definition of identity. The idea that ceramic style is more than surface decoration is not new (Gosselain, 1998; 2000; Fredriksen, 2009: 50). Gosselain's study of southern Cameroon potters noted that different stages of the production chain, such as clay processing, fashioning of vessels and firing of pots were executed in ways that made the potters unmistakable members of a specific community (Gosselain, 2000: 189). Thus, decoration is the final stylistic attribute added after several earlier technical choices (styles) such as temper, making ceramic style inseparable from a technology of style (Hall et al. 2008: 67). This does not imply that technological style is at loggerheads with decorative style. For instance, in northwestern South Africa, both stylistic and technical attributes have been useful in separating late 18th and early 19th century Tswana pottery from sites such as of Olifantspoort 20/71, Molokwane, Kaditshwene and Mmakgame pottery (Buispoort), from contemporary pottery (made by people who have cultural inheritance linked to a Nguni) found at Marothodi (Rosenstein, 2008). The Tswana pottery had distinctive graphite, talc and lustrous micaceous

[18] Ceramics used for smelting or melting metals are called crucibles (Bayley and Rehren, 2007). In the present case, these ceramics are domestic pots used for metal processing.

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temper that were absent in the Nguni-influenced pottery, irrespective of geological availability (Hall et al. 2008: 67; S. Hall, 2012: 10). These findings make the pursuit of ceramic technological style a rewarding one, especially when faced with the situation at Rhenosterkloof 3, where undecorated crucibles cannot be typologically linked to an Eiland phase.

It was with this question that thin section petrography of undecorated crucibles and decorated sherds from Rhenosterkloof 3, was undertaken. To build more confidence in the results, Madikwe (LIA) ceramics from the nearby site of Rhenosterkloof 5 were also analysed, in order to compare the technological style between the EIA and LIA ceramics. Thin section petrography was chosen because it allows one to characterise raw materials, fabric preparation and tempering practices associated with ceramic manufacture (Kreiter et al. 2009: 101). Initially these specimens were analysed macroscopically following standard procedures (Whitbread, 1986), so as to establish the vessel types and shapes, forming techniques, surface treatments, colours and degree of firing. The specimens were then sent to the Geological Science Department at the University of Cape Town (UCT), for preparation of thin sections. The analysis of prepared thin sections was done using Optical Microscopy (OM)[19] in both reflected and transmitted light.

6.5: ARCHAEOMETALLURGICAL APPROACHES

Initial archaeometallurgical analysis commenced in the field where preliminary sampling of materials for laboratory analyses took place. Field sampling for metallurgical remains sought to represent all metals and production stages. Subsequent sub-sampling then took place at the Materials Laboratory, University of Cape Town, this time being guided by the combination of macro analysis and the use of a portable X-Ray Fluorescence (pXRF). All the materials were cleaned for enhanced macro observations and classification.

In archaeometallurgical projects the first task of macro analysis is to determine whether the collected materials do actually relate to metal production processes or not, because there are several materials, as such rocks and vitrified earth or dung that can be mistaken for metallurgical remains (Bachmann, 1982; Pryce, 2008). Once done, one must divide the materials into a number of categories based on visual and morphological properties. The classification and

[19] This technique is explained in detail under archaeometallurgical approaches described below.

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interpretations can still be modified by later laboratory analyses (Pryce, 2008). Preliminary classes of metallurgical remains are illustrated below (Figure 6.1) and a detailed description is given in Appendix 6.1. Where the materials in a class were few (as was the case with crucibles, casting spills and metallic artefacts), all the specimens were automatically considered for further analysis. Target specimens from the bulky classes such as slags, furnace wall fragments, tuyeres and ores, were chosen with the aid a pXRF machine. This device is much more effective as a means for field screening because it is quick and non-destructive, but is equally useful in the laboratory for the same reasons, especially when dealing with large quantities of material (Helmig et al. 1989: 181; Gliozzo et al. 2010). The precision of pXRF is still limited when compared to conventional desktop XRF but the presence/absence analysis is usually enough for sampling purposes (Shackely, 2011).

Subsequent analysis sought to determine the elemental compositions and microstructure of these specimens using Wavelength Dispersive-X-ray Fluorescence Spectrometry (WD-XRF), Optical Microscopy (OM), and Scanning Electron Microscopy with EDS (SEM-EDS). The WD-XRF was useful in determining elemental composition while OM and SEM-EDS helped in reconstructing the microstructure. The latter also produced compositional data. The extracted information was used to reconstructing technological particularities of extant communities in the area of study. Details of sample preparation and analytical protocols are discussed below.

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Figure 6.1: Photographs of classes of metallurgical remains identified in this study with the aid of a pXRF machine.

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SAMPLE PREPARATION

Photographs, illustrations and weights were taken before destructive sample preparation. WD-XRF, OM and SEM-EDS[20], all require adequate sample preparation before information is extracted from the metallurgical remains. Additionally, matching faces of specimens must be analysed with at least two techniques in order to make the results comparable (Miller, 2001). Accordingly, specimens were sectioned into three parts; one for OM and SEM-EDS, the other for WD-XRF and the third portion was kept for reference purposes.

Polished surfaces are required in order for one to study the micro-structural conditions of metal working remains microscopically. These were prepared by mounting sectioned specimens in acrylic resin mixed with a hardener, following standard procedures (D. Scott, 1991). Mounted samples were then ground manually on water cooled silicon carbide laps from the coarsest grit (180) to the finest (1200). Subsequent polishing was done using diamond paste ranging from 6 micron to ¼ micron, while using an oil based lubricant. To bring out the micro structure (grain boundaries and sizes), metallic artefacts were etched using a nital etchant (5 % nitric acid and 95% ethanol) for iron objects and a ferric chloride etchant (120 ml ethanol, 30 ml hydrochloric acid, 10 g ferric chloride) for copper-based objects. For SEM-EDS analysis, non-metallic polished samples were carbon coated using a sputter coater in the Electron Microscope Unit, after OM analysis was completed. The added carbon layer touches the metal skeleton of the SEM and allows the analytical surface to conduct electrons whilst being analysed, and grounds the sample so it does not become charged.

Non-metallic samples with faces that match those prepared for OM and SEM-EDS were sent to Professor David Reid of the Geological Sciences Department of the UCT for quantitative XRF analysis. Sample preparation here involved crushing and grinding samples into a powder, in order to homogenise each sample. The homogenisation process ensures that the analysis will be representative of the whole sample. Homogenised samples were then left overnight to dry before the powders were fused with borate based flux and pressed to form fusion discs. The powders were weighed before and after heating overnight at 100 °C so as to measure loss of absorbed

[20]SEM-EDS does always require sample preparation, except when microstructure is required or when one is analysing materials that can chage during analyses.

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water (H_2O^-). Once again the samples were placed overnight in an oxidizing muffle furnace at 850 °C and cooled in a desiccator to room temperature before being weighed again in order to measure the change of mass (Loss On Ignition- LOI). A brief comment on H_2O^- and LOI is necessary. A positive LOI means the sample lost structural water and carbon dioxide, but a negative LOI means it gained weight on ignition, for instance metallic Fe and Fe^2 can be oxidised to Fe^3+ (Chirikure et al. 2010). Unfortunately most archaeometallurgical publications do not report these variables, leaving totals that are either far too short or in excess of 100 %. In this study, these variables have been reported and data have been normalised before making comparisons between samples.

6.5.1: BULK CHEMICAL ANALYSIS BY WD-XRF

Bulk chemical analysis is usually the first laboratory analyses to be conducted on archaeometallurgical remains with the view of identifying the materials and testing the veracity of tentative macro observations (Bachmann, 1982; Veldhuijzen, 2003). The method is based on the principle that materials emit energy characteristic of their chemical composition when excited by high-energy radiation. The x-raybombardment of the samples results in the production of a spectrum of characteristic radiation (peaks) emitted by each element (Tite, 2001; Bayley et al. 2001; Pollard et al. 2007). This chemistry can then be used to establish the metal which was being produced, and to establish relationships between the ores, slags, technical ceramics and metallic artefacts. These analyses characterise the reductive skills of the smelters (Bachmann, 1982; Joosten, 2004; Miller and Killick, 2004; Chirikure 2005). The main concern with this method is that sample homogenisation, assumes and imposes homogeneity on pre-industrial remains that were rarely homogenous to begin with (Pryce, 2008). Homogenisation will evenly distribute the chemistry of individual phases, which tends to skew the bulk compositional data in favour of the predominant phase (Humphris et al. 2009). The invariable occurrence of unreacted minerals in slag, for instance, will then cause problems in liquidus calculations (Bachmann, 1982) but the combination of both bulk and micro compositional analyses, meant that these problems were avoided.

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ANALYTICAL PROTOCOL

Fusion discs were used in the determination of major elements such as Fe, Mn, Ti, Ca, K, S, P, Si, Al, Mg and Na. A Philips PW1480 Wavelength Dispersive XRF spectrometer with a dual target Mo/Sc x-ray tube was used. Intensity data were collected using the Philips X40 software. However, traces were measured using powder briquettes, and gross peak intensities for background and spectral overlap as well as mass absorption coefficient corrections, were processed using the computer program TRACE. A nuanced approach was used for blooms.

QUALITATIVE WAVELENGTH DISPERSIVE SPECTROMETRY

The recovery of "true" blooms on the surface at Tembi 1 raised questions about their chemical and physical make up. For instance, are these specimens really blooms or just pieces of meteoric iron? If they are, was there anything chemically or physically "wrong" with them that may have led to their discard on the surface at the site? Another critical question relates to whether these objects are products of the indigenous bloomery process or modern blast furnace process? To address these issues, metal disks were cut from the specimen and polished forXRF Qualitative Wavelength Scans using a Panalytical Axios Wavelength Dispersive Spectrometer in the Geology Department at UCT. The scans were run using Rh Tubes at 60kV and 66 mA. Three analysing crystals; LiF200 (for heavy elements), PET (intermediate elements) and PX1 (light elements) were run.

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6.5.2: MICROSTRUCTURE ANALYSIS BY OM

In archaeometallurgical projects OM is used to describe and identify physically homogeneous portions (phases) that relate to the physio-chemical (such as redox) conditions that were extant when the material was formed (Bachmann, 1982; D. Scott, 1991). As noted above, most pre-industrial metallurgical remains were not fully in equilibrium conditions, which means the definition of a phase in this context must be interpreted loosely (Pryce, 2008). OM involves the use of high resolution microscopes to direct light on to a polished surface of a sample, which then reflects or transmits that light to a receiver according to its optical properties (Bachmann, 1982). Interpretation of the reflected image is based on the principle that metallurgical remains have minute crystals with distinct shape, structure, alignment and size, all of which are governed by specific conditions that include the fabrication processes (Killick, 1996; Bayley, 1982).

A microscopic study can also help in identifying the metal that was being produced and in probing into the skills of the metal worker's ability to influence and modify the technical sequences (Prendergast, 1974; Crew, 1991; Miller, 1995). OM was considered to be a rewarding tool in this study because of its ability to compare microstructure that is sometimes not possible with bulk chemical analysis (Morton and Wingrove, 1969; Schmidt, 1997). The technique is also sensitive to small quantities of certain phases and enables the researcher to detect and interpret corrosion (Bousfield, 1972; Craddock, 2000). However, its image resolution is limited by the wavelength of light (5000-700Å), which can be improved through the use of an SEM because the latter uses electrons at a much higher resolution that is possible with a light microscope (Pollard et al. 2007: 109). The main weakness of OM is that all the information about the micro-structure of the whole sample is limited to the polished surface. This may be a concern, especially when working with inhomogeneous material, because it would mean that other portions of the sample will not be represented. However, as argued by Pryce (2008: 106), trying to identify and explain all the phases seen in typically, heterogeneous samples will not necessarily help an archaeological interpretation of the material and technology. Macro analytical work should be largely focused on addressing questions generated by the bulk chemical data, whilst remaining vigilant for phases of interest.

ANALYTICAL PROTOCOL

Polished blocks were analysed using a trinocular Nikon microscope in reflected plane light at magnifications between 10 and 1000 times. The microscope was linked to an Olympus camera which was used to capture images using the AnaLyses GetIT software. Phase descriptions were based on the optical properties of the samples as highlighted in standard texts (Rostoker and Bronson, 1990; D. Scott, 1991; Greaves and Wrighton, 1957). Hand-drawn sketches were also produced to aid in the location of phases of interest during SEM examination. The SEM-EDS was required in order to identify and quantify particular phases that were visible but unidentifiable in OM and were also detected in quantitative XRF.

6.5.3: MICROSTRUCTURE & CHEMICAL ANALYSIS BY SEM-EDS

To the archaeometallurgist, SEM-EDS analysis is important because of its compositionally-reinforced phase identification and the interpretation capacity (Bayley et al. 2001). This can help

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in confirming or modifying the reconstructed *chaîne opératoire* generated by macro, bulk, and microscopic analyses (Pryce, 2008). Moreover, the technique provides larger depth of focus and a high magnification range than light microscopy (Tite, 2001; Pollard et al. 2007). However, the technique is limited by its inability to produce colour imagery which is possible with OM (Killick, 1996). It is also less sensitive to minor elements that can be detected by WD-XRF (Bayley et al. 2001; Tite, 2001).

ANALYTICAL PROTOCOL

A Leica/LEO Stereoscan S440 Scanning Electron Microscope fitted with a Fison Kenex wavelength Dispersive X-Ray system was used. The analyses were carried out in the backscatter mode under the following conditions: a working distance of 25.0 mm, an excitation voltage of 20.0 kv, a beam current of 1.0 picoAmps, a tilt angle of 0.0 degrees and a takeoff angle of 35.0 degrees. The acquisition dead time was 60 seconds and the results were expressed as weight percent and normalised to 100%. Spot and area analyses were done at least three times and averaged for the final reading in order to make valid estimates about the bulk composition for specimens. However, complex materials such as crucibles were analysed differently. Their ceramic parts, slagged parts and metal prills were analysed separately in order to permit a realistic understanding of the composition of the materials and the contribution of various elements to the slagging process.

6.6: SUMMARY

This chapter was concerned with the laboratory analytical techniques employed in order to draw out pertinent information required for addressing the research questions. A combination of archaeological and metallurgical techniques was used. The applicability of the chosen methods is discussed in the descriptions of the theories and analytical protocols. Findings from these laboratory analyses are discussed in the following two chapters.

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CHAPTER SEVEN: ANALYTICAL RESULTS: CERAMICS & OTHER NON-METALLURGICAL FINDS

"It is in fact possible to demonstrate with archaeological data the articulation of cultural traits according to a cultural meaning system." (Evers, 1988: 4)

7.1: INTRODUCTION

The chapter presents results of laboratory analyses of non-metallurgical specimens collected during the field seasons described in Chapter 5. The rationale for undertaking the analyses has been discussed in Chapter 6. The results discussed here also build upon settlement data gathered during fieldwork. Ceramics and beads are the mainly material categories presented here but other miscellaneous finds such as worked bone and smoking pipes are also described. Ceramic typology is a key outcome, as a building block for contextualising the metallurgical analyses presented in Chapter eight. As indicated, an analysis of decorative and technological style is critical in order to bridge the metallurgical analyses and ceramic typology. Some correspondences between ceramic typology and glass bead chronologies are also noted. Results from miscellaneous finds are also informative for inter-site comparison. I start by describing these miscellaneous finds, before presenting the beads and ceramic analyses.

The miscellaneous finds comprise ceramic smoking pipe fragments, bone scrapers, bone and shell pendants. All were recovered from Rhenosterkloof 1, with the exception of two smoking pipe fragments that came from Tembi 1 (Figure 7.1). Most of the worked bones appear to be scrapers that were cattle-size ribs abraded into smooth curvilinear shapes across the shaft axis of the ribs. These worked bones are similar to the range of bone artefacts recovered by S. Hall (1981: 133) at the same site. From my experience amongst Tsonga groups in south eastern Zimbabwe, these bone scrapers are typically used to shape and smooth clay pots, whilst the pointed example (No. 12) are used to peel fruits such as *amarula* (not nuts) (Figure 7.1). Elsewhere, these abraded ribs are interpreted as hide working tools (Maggs, 1976; Mason, 1986). No. 13 is a denticulate that may have been used as a comb for decorating (stamping) pots (Figure 7.1). S. Hall (1981: 133) recorded a wider number of abraded bones (ribs, shafts, scapula, and skull fragments) and an ivory bangle from Rhenosterkloof 1.

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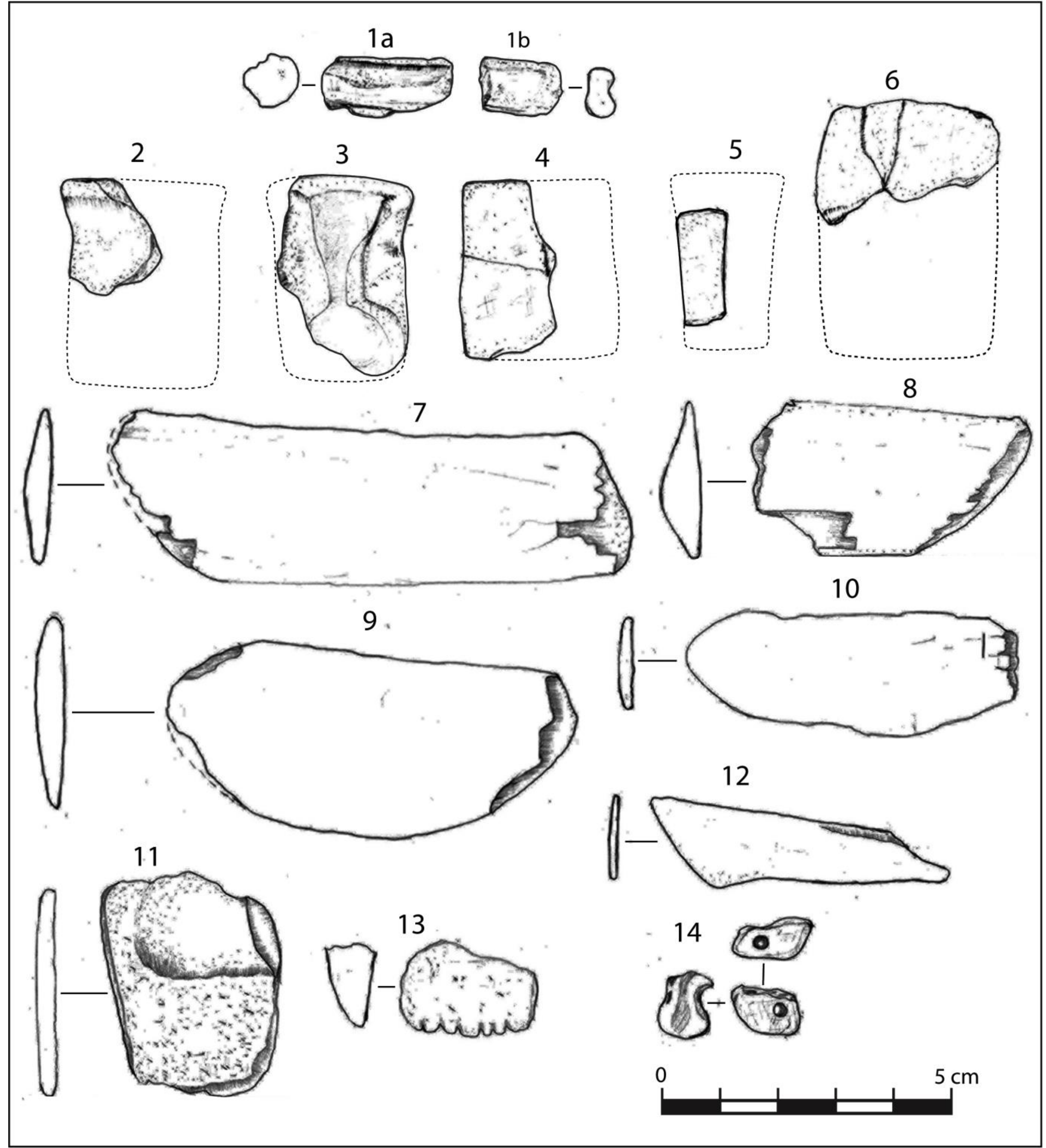

Figure 7.1: Miscellaneous finds from Rhenosterkloof 1 and Tembi 1. 1a and 1b = clay figurine?; 2–6 = clay smoking pipes (5 and 6 came from Tembi 1); 7-13 = worked bone; 14 = bone pendant.

A bi-valve marine shell pendant recovered at Rhenosterkloof 1 complements other trade objects linked to long distance trade (Figure 7.2).

Figure 7.2: A bivalve marine shell from Rhenosterkloof 1

A photograph of the fragment was sent to Alwyn Marais, a marine shell specialist based at the Centre for Molluscan Studies in Pretoria, for identification. Marais suggested that it belonged to a species of Vasticardium called *Insulare vidal, 1997* or *flavum (Linnaeus, 1758).* This species is confined to the Tropical-Indo-Pacific rim (East Africa between Mozambique, Madagascar, Tanzania and Kenya, Seychelles). Nonetheless, the specimen most likely came from the Mozambican coast and this suggests the Southern Waterberg was incorporated into the trade and exchange networks of the wider region.

7.2: BEAD TYPOLOGY

Only Rhenosterkloof 1 and Tembi 1 produced beads related to different materials. Fourteen (one was broken) glass beads, 270 shell beads and 2 bone bead fragments were recovered from the former site and only 12 shell beads and fragments were recovered from the latter.

7.2.1: GLASS BEADS: RHENOSTERKLOOF 1

The fourteen glass beads from Rhenosterkloof 1 came from Midden 1 and Hut Collapse 1. They range between opaque and translucent in their diaphaneity but do allow very little light, a powerful source of light such as a microscope, to pass through their edges. They are green to blue-green, except one bead from Hut Collapse 1, which is deep blue (Figure 7.3).

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Figure 7.3: Cylindrical glass beads from Rhenosterkloof 1

The slight variation in this green to blue-green group is expected because glass bead colours were not standardised in early glass, and even beads from the same glass batch could vary in hue (Wood, 2005). In terms of the method of manufacture, they all appear to have been made by chopping a drawn cylinder and reheating it to reduce the sharpness of the edges. However, they were only reheated for a short time because they still retain the cylindrical shape even though one can still classify them as oblate. Their average internal diameter is 0.76 mm (0.60 mm minimum and 1.01 mm maximum) with the external diameter of 3.57 mm (4.22 mm maximum and 2.96 mm minimum). According to Wood's (2005) bead size classification, six of these would belong to the small category (2.5 mm – 3.5 mm) and eight to the medium category (3.5 mm – 4.5 mm). A photograph of these beads was sent to Marilee Wood who tentatively identified them as Khami Series (14th – 17th Century AD). She however, stressed that they appeared different from other Khami beads she had analysed because they are more regular (less oblate) than typical Khami Series. Whatever the case, these beads are comparable to the radiocarbon dates from Rhenosterkloof 1

Results from the electron microprobe are also comparable with the chemistry of Khami beads, except that the Rhenosterkloof 1 results have low Na_2O than (Robertshaw et al. 2010: 1904; Table 7.1).

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Table 7.1: Chemistry of major elements of glass beads from Rhenosterkloof 1

Sample ID	SiO2	MgO	TiO2	K2O	Al2O3	Na2O	Cr2O3	CaO	FeO	Total
RGB1	76.02	0.85	0.31	1.34	12.26	3.51	0.02	3.21	2.50	**100**
RGB2	79.58	0.99	0.39	1.28	9.00	2.37	0.00	3.90	2.48	**100**
RGB3	82.15	0.92	0.37	0.93	7.47	2.48	0.02	3.25	2.42	**100**
RGB4	73.53	1.36	0.36	1.65	10.84	4.31	0.02	5.46	2.49	**100**
RGB5	78.96	1.11	0.42	0.98	8.59	3.43	0.05	3.74	2.76	**100**
RGB6	78.70	1.22	0.32	1.52	7.90	2.96	0.01	5.36	2.01	**100**
RGB7	74.35	1.33	0.45	1.12	10.66	3.35	0.01	5.07	3.66	**100**
RGB8	73.71	1.39	0.30	1.54	10.95	4.29	0.01	5.38	2.45	**100**
RGB9	76.04	1.40	0.52	1.74	9.88	3.91	-	3.88	2.63	**100**
RGB10	77.55	1.51	0.48	1.23	9.60	3.19	-	3.94	2.50	**100**
RGB11	77.51	1.34	0.33	0.89	8.91	2.99	-	5.64	2.40	**100**
RGB12	81.37	0.87	0.39	1.43	7.16	2.97	0.01	3.37	2.42	**100**
RGB13	75.83	1.39	0.55	1.84	9.77	3.96	0.03	3.94	2.69	**100**

Robertshaw et al. (2010: 1907) also note that Khami beads in Zimbabwe and South Africa had a lower MgO than those from Botswana and suggested that the latter may have been made from plant-ash glasses while the former were made from soda-alumina glasses. Fourteen of their analyses of Khami beads in came from Melora, in the northern Waterberg (Robertshaw et al. 2010: 1901) and it can be assumed that these beads entered these sites as through trade, the network of which may have stretched to northern capitals such as Khami and Thulamela. The chronology of Melora is also consistent with the presence of these beads and a possible contemporary chronology with Khami and Thulamela (for radiocarbon summary see Huffman, 2007: 468-469). The deep blue bead (Figure 7.3) is similar to two of the beads recovered from Smelterskop in the Southern Waterberg. The fact that a post European contact bead known as the White heart was also found at Smelterskop in the same midden as the blue bead does not complicate the may complicate the chronology at Rhenosterkloof 1 because beads can remain in use for a long time after they are imported. White hearts are drawn translucent-red-on-white cylinders and oblates that were first made in Venice in the mid-1830s (Francis, 1988; Wood, 2008).

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7.2.2: SHELL BEADS: RHENOSTERKLOOF 1

Ostrich egg, giant land snail (*Achatinidae*) or freshwater bivalves (*Unionidae sp.*) are the most common shell beads associated with both Iron Age and Late Stone Age sites. In the present study, only ostrich egg and freshwater mussel beads were recovered, but some beads may have been misclassified because when burnt or corroded, distinguishing between

achatina, freshwater mussel or ostrich egg shell beads is not easy (Ward and Maggs, 1988). At Rhenosterkloof 1, S. Hall (1981) identified four slate beads from Ash Heap I but these were not found in the present study. Shell beads and fragments from Rhenosterkloof 1 came from Midden 1 (96 beads and 32 shell fragments), Midden 2 (43 beads and 11 shell fragments), Midden 3 (7 beads), as well as Hut Collapse 1 (65 beads and 16 shell fragments). The metrical comparison of these beads across the different excavation contexts suggests significant similarities in bead types, sizes and method of manufacture. These similarities may be suggesting that the excavated areas represent a single occupational component, even though radiocarbon dates from this site are highlighting that S. Hall's (1981) Ash Heap II could be slightly older than Midden 3 (Table 5.1).

Some of the beads had a red ochre pigment stain on one surface and while others were charred (Figure 7.4). It is also possible that charring was a deliberate move aimed at producing a light brown colour hue that would provide colour or contrast with the red-ochre stained beads. The average internal diameter of the shell beads is 2.59 mm (1.48 mm minimum and 3.79 mm maximum) and the external diameter is 8.14 mm (3.57 mm minimum and 13.81 mm maximum). These diameters are within the range of those documented by S. Hall (1981: 136-137) at the same site but they are slightly outside readings for Tapela's (1991) hunter-gatherer sites (3.3-7.4 mm external diameter and 0.6-2.2 mm internal diameter) and small-herder sites (6.1-13.6 mm external diameter and 1.1-3.1 mm) in Botswana. However, they are comparable to large-herder sites (1.5-13.5 mm external diameter and 1.2–3.2 mm internal diameter) (Tapela, 1991). There has been some critique of the use of shell bead sizes as cultural markers because there are cases in which foragers made larger beads for trade with farmers and kept smaller beads for their own use (Jacobson, 1987: 58).

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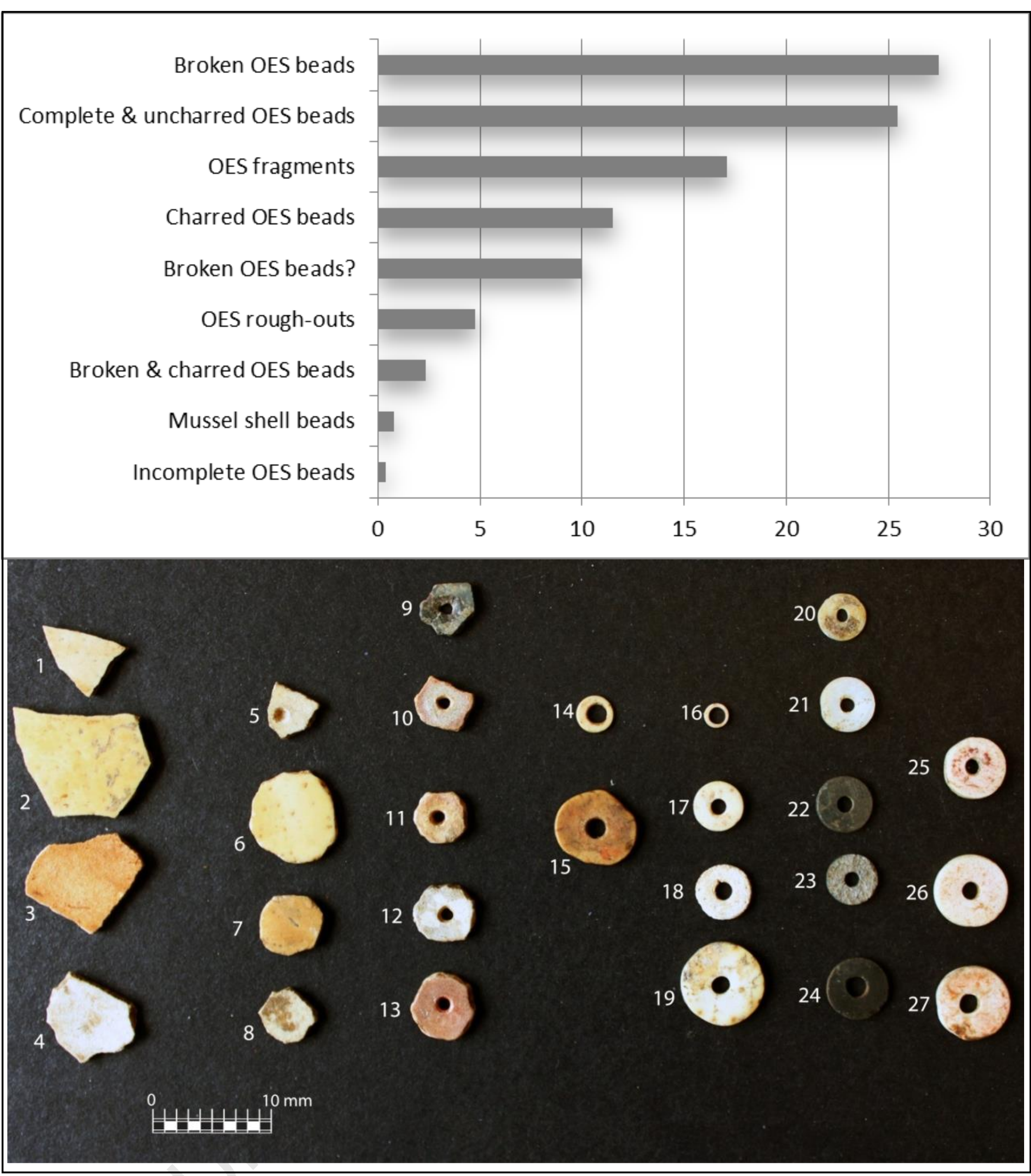

Figure 7.4: Shell beads and fragments at Rhenosterkloof 1. 1-4 = OES fragments; 6-8 = OES roughouts; 5, 9-13 = pierced roughouts; 14-19, 22-27 = complete OES beads and 20-21 complete mussel shell beads.

Two methods were used to make OES beads. The first involved the drilling of eggshell fragments before trimming, while the second involved trimming the fragment into a circular disc prior to drilling (J. Orton, 2007). Ostrich eggs obviously served nutritional needs and shells may also have been utilised for storage purposes but bead making began when they were deliberately or accidentally broken (Kandel and Conard, 2005: 1712). Once broken, OES fragments were further broken them into smaller but irregular shapes (Nos. 1-4 Figure 7.4). The next stage depends on the method chosen. Method 1 involved perforation (Nos. 5, 9-10) but Method 2 involved trimming (Nos. 6-8) (Figure 7.4). From this stage onwards, it is

difficult to separate beads made by the two methods, unless one finds partially perforated but trimmed fragments (Method 2) and partially trimmed but perforated fragments (Method 1). Stage three in Method 1 involved trimming while the equivalent stage in Method 2 involved perforation, before grinding the beads into the required shape and smoothness. Whichever method was chosen, it is clear that shell beads from Rhenosterkloof 1 were produced at the site because of the occurrence of all stages of manufacture, especially trimmed fragments (Nos. 4, 6, 7, 8) and incomplete perforation (No. 5) (Figure 7.4).

7.2.3: SHELL BEADS: TEMBI 1

Shell bead and fragment frequencies from Tembi 1 were low compared to Rhenosterkloof 1 but there are clear similarities in the range of bead types and sizes. Red ochre pigmentation and charring were also noted at this site (Figure 7.5). The average internal diameter is 2.23 mm (1.79 mm minimum and 2.68 maximum) and the external diameter is 8.58 mm (5.72 mm minimum and 11.18 mm maximum). The full production sequence is evident but it is not clear which method of manufacture was used, even though Nos. 1, 2 and 5 (Figure 7.5) seem to suggest that Method 1 was employed.

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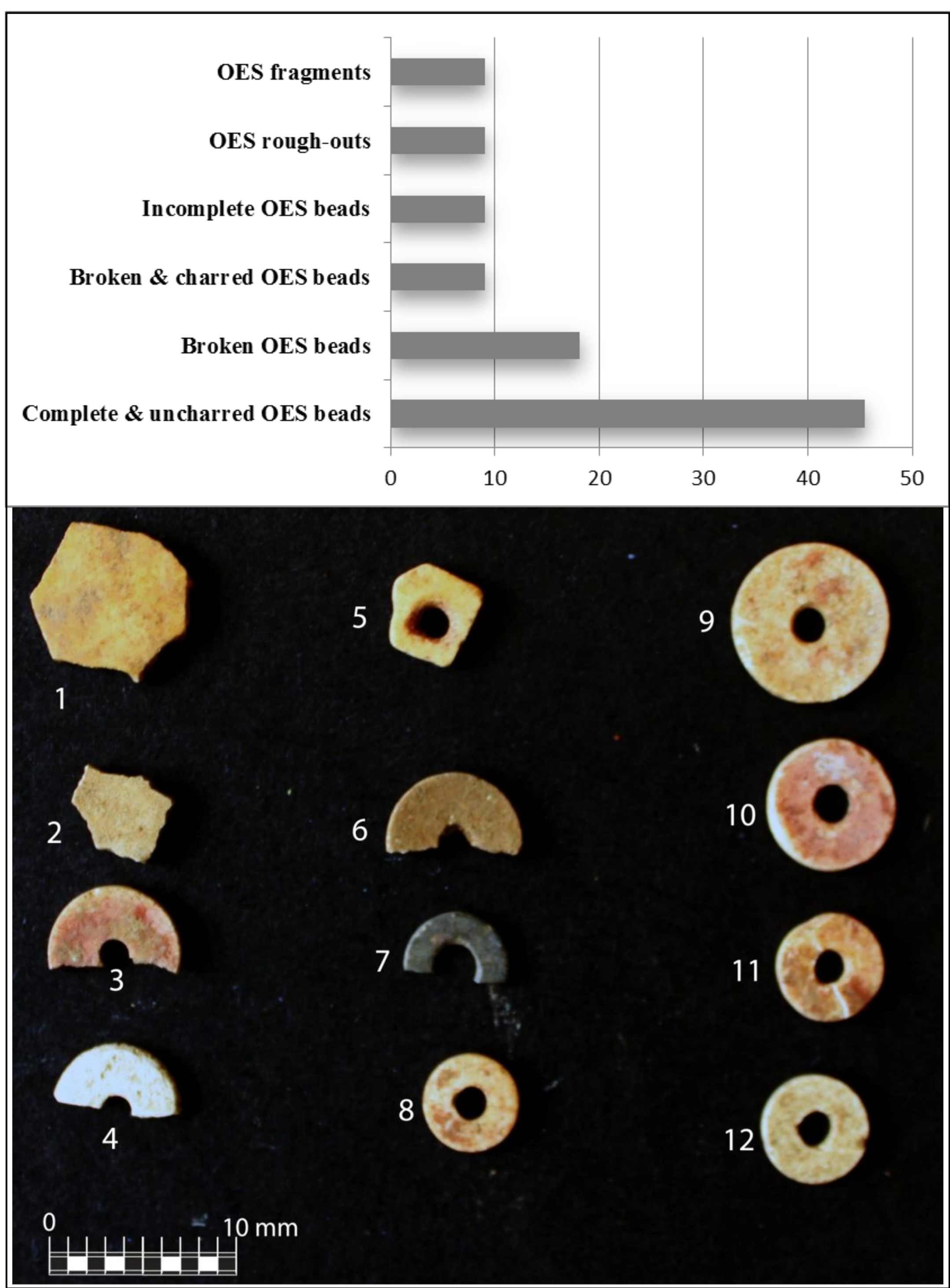

Figure 7.5: OES beads and fragments from Tembi 1

7.2.4: BONE BEADS: RHENOSTERKLOOF 1

Two bone beads were also recovered from Midden 1 at Rhenosterkloof 1. These are represented by 4 fragments (Figure 7.6).

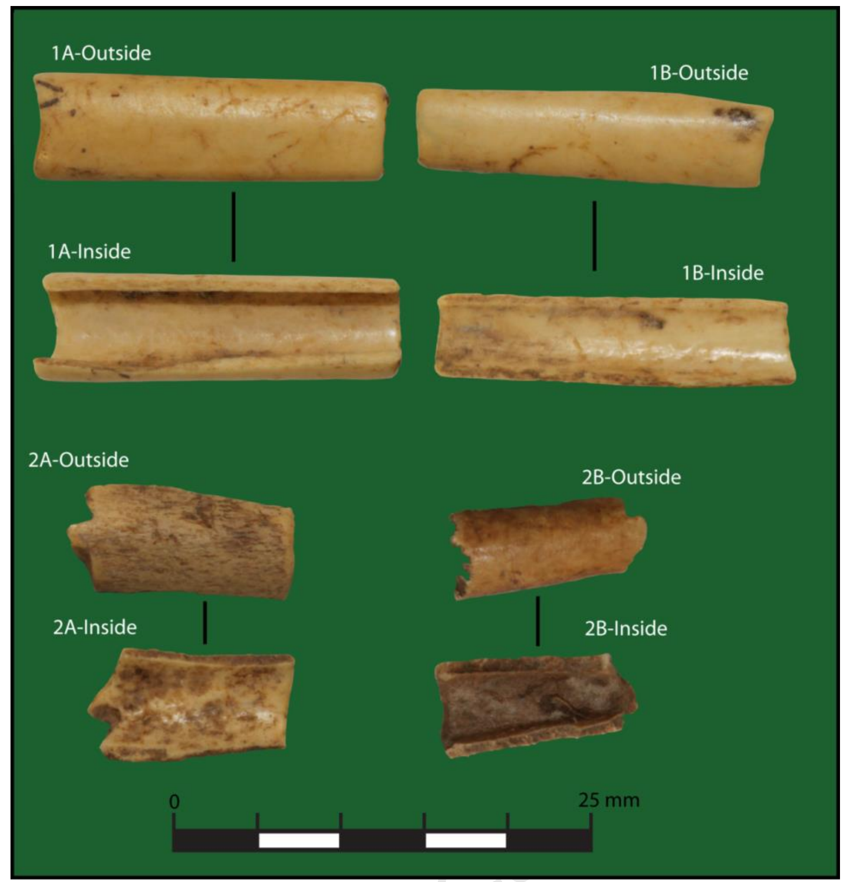

Figure 7.6: Bone bead fragments from Midden 1, Rhenosterkloof 1

They are tubular in shape and were made from shaft bones (probably bird or young bovid) which meant that no perforation was required (Figure 7.6). Their ends were ground and polished but No. 2 is broken (Figure 7.6). These beads may have been used as spacers for shell beads.

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7.3: CERAMIC TYPOLOGY

Archaeological sites in the Southern Waterberg have few diagnostic ceramics, an observation which is commensurate with contemporary LIA sites in the adjacent areas such as the Magaliesberg to the south (Mason, 1986). Additionally, there is a high rate of fragmentation and consequently a high frequency of undecorated potsherds, all of which constrain multi-variant analysis (Huffman, 2002). However, even fragments when considered carefully, can establish ceramic styles and indicate position in sequences as demonstrated by several scholars (Evers and van der Merwe, 1987; Sampson, 1988; Loubser, 1991; Sadr and Sampson, 1999; Ohinata, 2001). With this in mind, ceramic analysis in the present study was predominantly limited to decoration motifs. Motifs were easy to establish, compared to

finding their decoration-positions. Motifs comprised decoration using incision, comb-stamping and impressions. The resultant motif types were then compared with previous studies in the Southern Waterberg (Fichardt, 1957; Hall, 1981).

Where possible, at least three profile modes (necked jars, globular/neckless jars and bowls) were recognized, as well as three decoration positions (1, 2, and 3) (Figure 7.7).

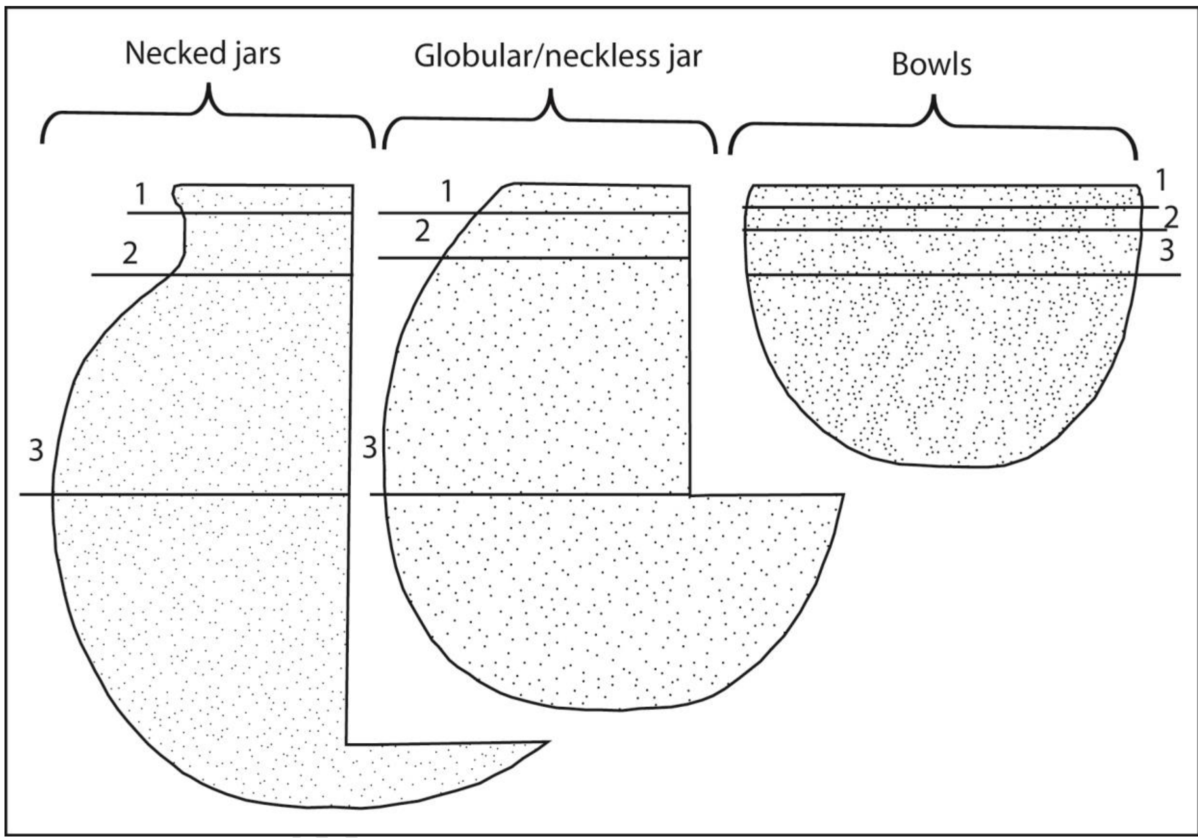

Figure 7.7: Profile and layout modes from sites under study

Decoration positions were rim (1), neck (2) and shoulder (3) for jars (Figure 7.7). The fragmentary nature of the assemblages did not allow for the identification of design layout. In the ceramic illustrations, red and orange colours represent shades of ochre while grey represents graphite.

7.3.1: RHENOSTERKLOOF 1

At Rhenosterkloof 1, 1546 sherds were recovered in this study. Three hundred and forty four (22 %) of these sherds were diagnostic and seventy eight of these were decorated. Ceramics from different excavation areas were first analysed separately. The results showed a general

similarity of motifs across the different excavations. A total of 21 motifs were identified (Figure 7.8).

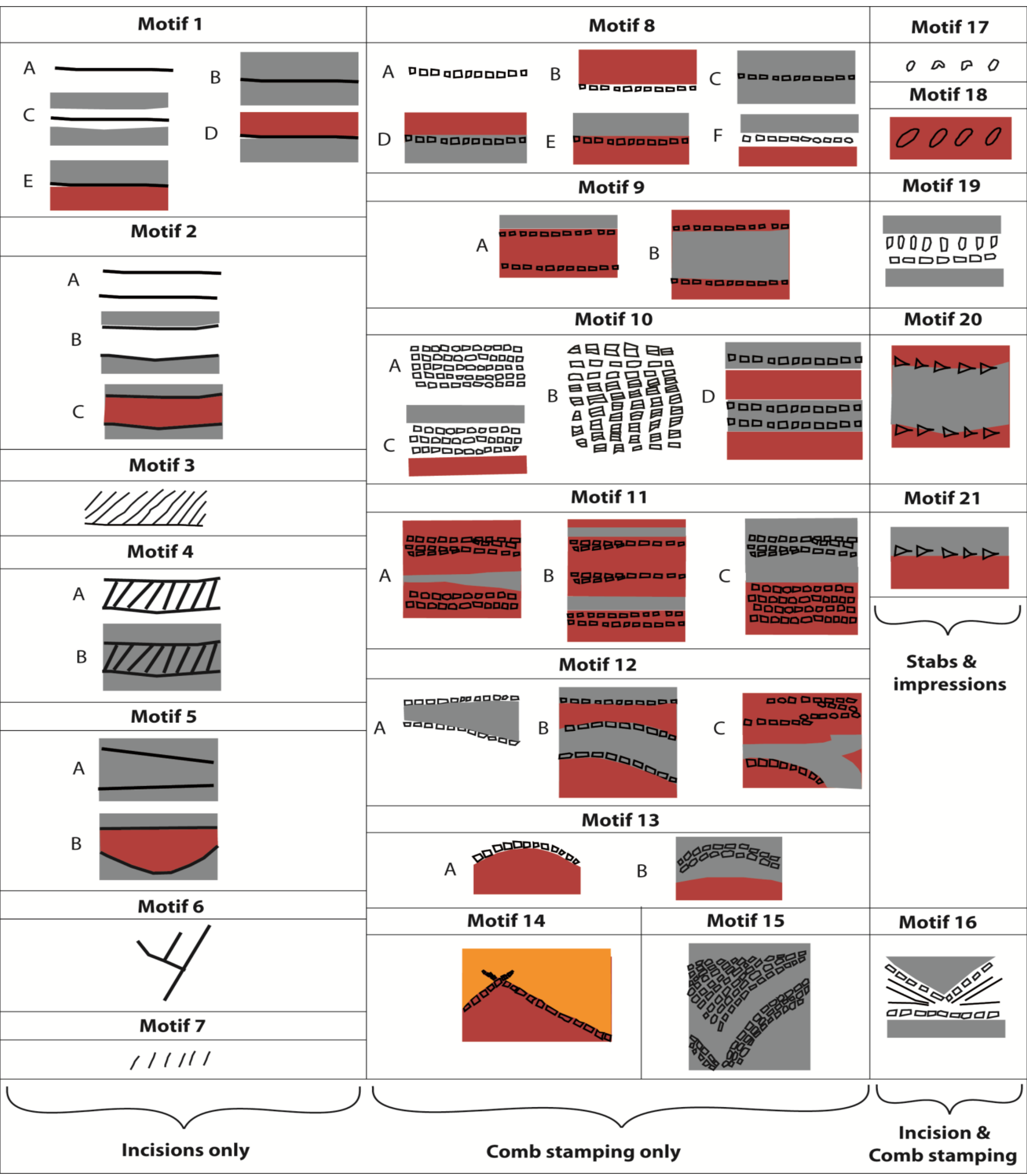

Figure 7.8: Ceramic motifs from Rhenosterkloof 1

The predominant technique for motifs is comb-stamping (38 %), followed by incisions (33 %), stabs and impressions (24 %) and incisions and comb-stamping (5 %). Clearly, incisions and comb-stamping are rarely combined on the same vessel. The motifs are the same as S. Hall's (1981: 123) motifs, with the exception that his analyses produced the unusual

occurrence of herringbone motifs in this facies. Herringbone is a characteristic Eiland motif whose rare occurrence in the Madikwe facies has been noted in the Southern Waterberg (S. Hall, 1981) and the Marico district to the south (Boeyens, 2003). The apparent absence of this motif in Icon facies (the precursor to the Madikwe facies) suggests that Eiland and Madikwe communities must have co-existed on the same landscape.

The above motifs relate to the Rooiberg facies (1650-1750 AD), whose key features are stamped rim bands, arcades and triangles in the neck and mixture of stamped and incised bands (S. Hall, 1981; 1985; Huffman, 2007). However, in this study, only one sherd (No. 22, Figure 7.9) has comb-stamping and incision on the same vessel. This emphasises the different origins of the incised and comb-stamped motifs, because the two techniques do not co-occur on the same vessel. The incised component comes from the Madikwe phase, present in the Southern Waterberg between 1500 and 1700 AD (Huffman: 2007: 199). Madikwe is a second phase of the Moloko Tradition (ancestral Sotho-Tswana. S. Hall (1981) originally labeled this phase Ru-3. The comb-stamped component at Rhenosterkloof 1 does not come from Madikwe but is derived from the Ntsuanatsatsi/Uitkomst facies (1450-1650 AD/1650-1820 AD). A re-assessment of several other Rooiberg assemblages (Fichardt, 1957; S. Hall, 1981) also confirmed this observation. The paucity of vessels that combine incised motifs and comb-stamped motifs on the same vessel is clearly not incidental because incisions also appear together with stabs and impressions in other Rooiberg assemblages (Fichardt, 1957: 54, 56, 58; S. Hall, 1981; 90, 106, 108, 111, 123, 127, 128). Stabs and impressions are part of the Madikwe style (Huffman, 2007). Thus the dichotomy affirms Huffman's (2007: 433) suggestion that incisions and comb-stamping have separate origins.

The ceramic profiles consist of short necked jars, globular vessels and open bowls and these are consistent with a Madikwe and Ntsuanatsatsi/Uitkomst origin (Figure 7.9). Recently, Huffman (2007) has challenged Maggs's (1976) initial identification of Ntsuanatsatsi sites as related to ancestral Sotho-Tswana, suggesting instead that their ceramics and settlement type are the material expressions of ancestral Nguni-speakers. This then makes the Rooiberg facies, a ceramic merger between decorative components of ancestral Sotho-Tswana and Nguni related ceramics.

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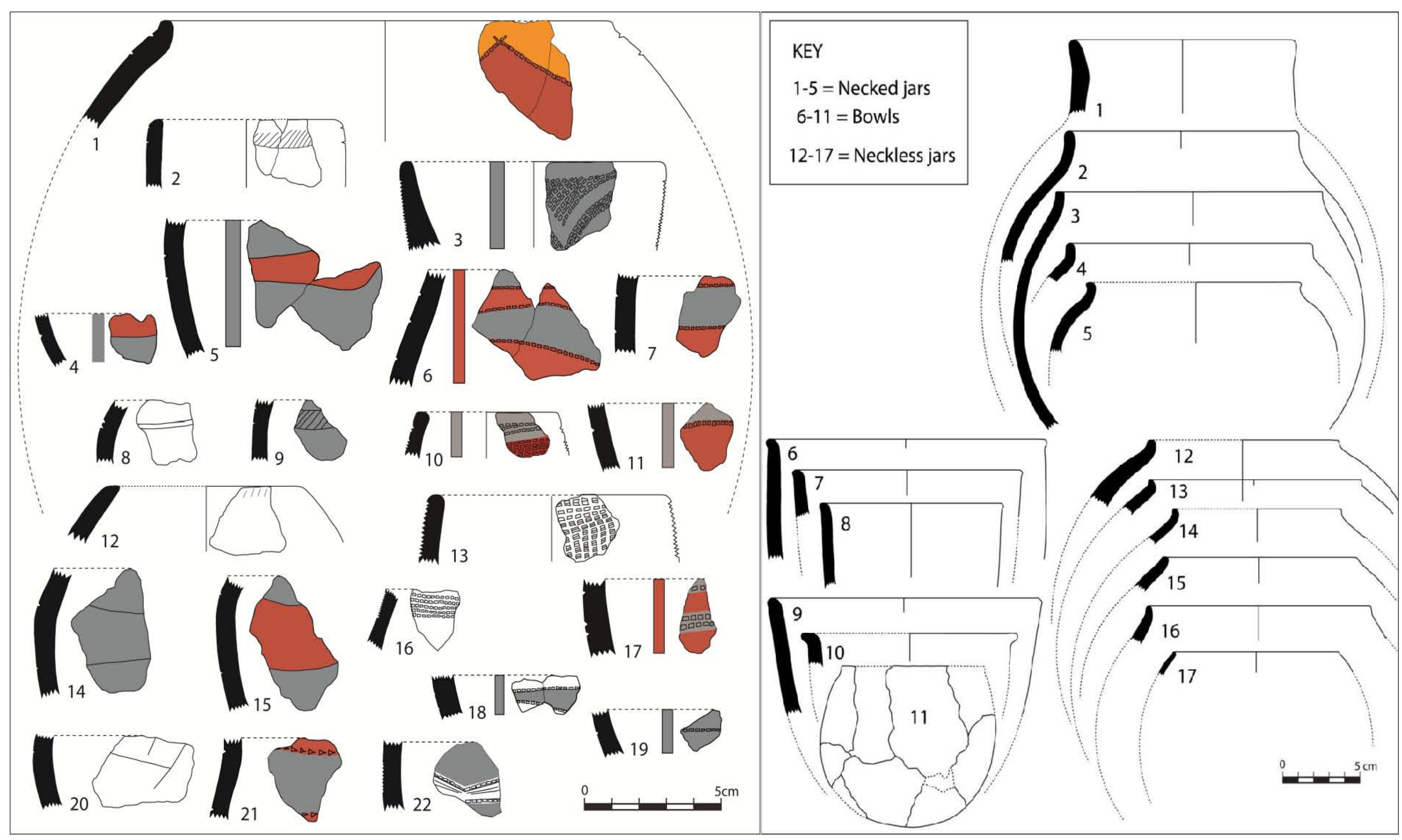

Figure 7.9: Pottery from Rhenosterkloof 1

7.3.2: RHENOSTERKLOOF 2

Forty eight potsherds were recovered from Rhenosterkloof 2. Only 8 (17 %) of these had a recognisable profile and none had decoration. The profiles were comparable to those from Rhenosterkloof 1 (Figure 7.10).

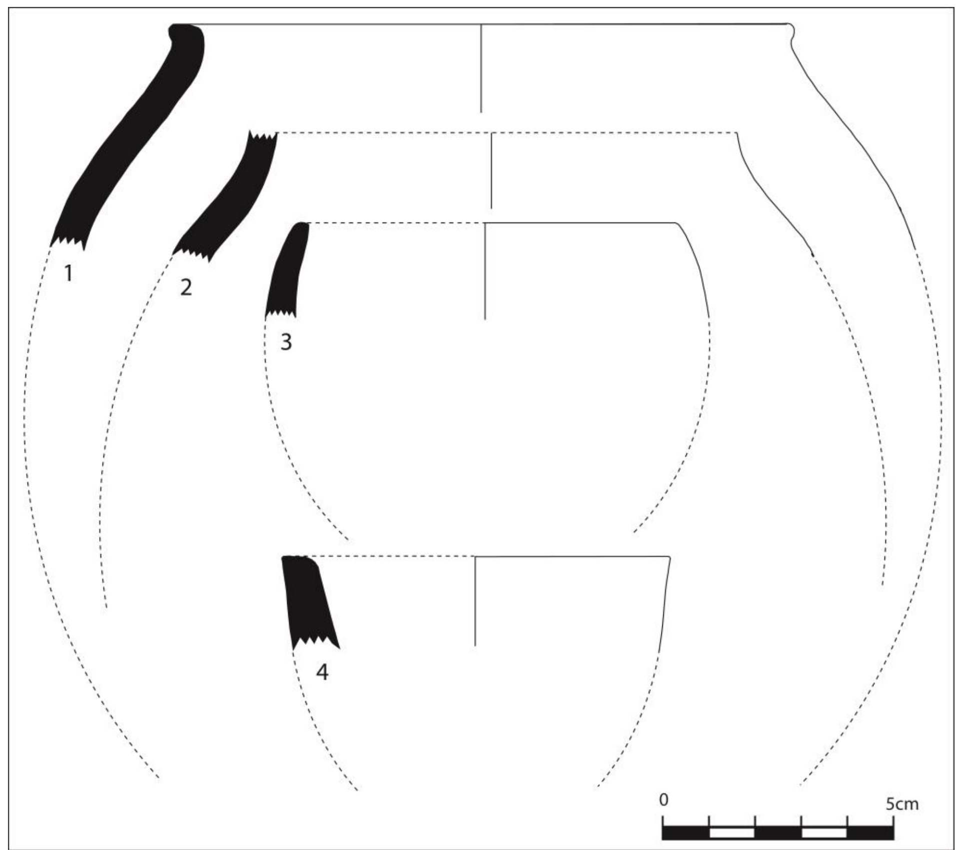

Figure 7.10: Pottery from Rhenosterkloof 2. No.1 (neckless jar), Nos.2 (necked jar); No.3 & 4 (bowls).

7.3.3: RHENOSTERKLOOF 3

The ceramics from Rhenosterkloof 3 were much more fragmentary than those from Rhenosterkloof 1 and 2 but there are a higher percentage of decorated sherds. From a total of 94 potsherds, 59 (63 %) were decorated. The analysis identified 23 motifs (Figure 7.11).

Key
1 & 5 = Stabs & impressions (8.70%) 2 = Applique (4.35%) 3 = Applique & incisions (4.35%)
4, 6-16, 9-23 = Incisions (73.91%) 17 & 18 = Incisions & stabs (8.70%)

Figure 7.11: Ceramic motifs from Rhenosterkloof 3

Incision is the dominant technique at this site (74 %). Stabs and impressions, as well as incisions and stabs, account for 9 % each, and the rest is appliqué (4 %) and appliqué and stabs (4 %). The dominant motifs are oblique incised bands, crosshatched bands and especially distinctive bands of herringbone. Based on the decorative techniques and motifs identified, it is clear that these ceramics are related to the Eiland facies (1000-1300 AD). S. Hall’s (1981: 36) analyses of surface collections from this site produced similar motifs but his sample had more arcades than observed in the present analysis. It was difficult to reconstruct the profiles for Rhenosterkloof 3, but it is clear that the profiles are different from those observed at Rhenosterkloof 1 and 2 (Figures 7.9 and 7.10). Jars especially have longer and more shallowly curved necks (Figure 7.12).

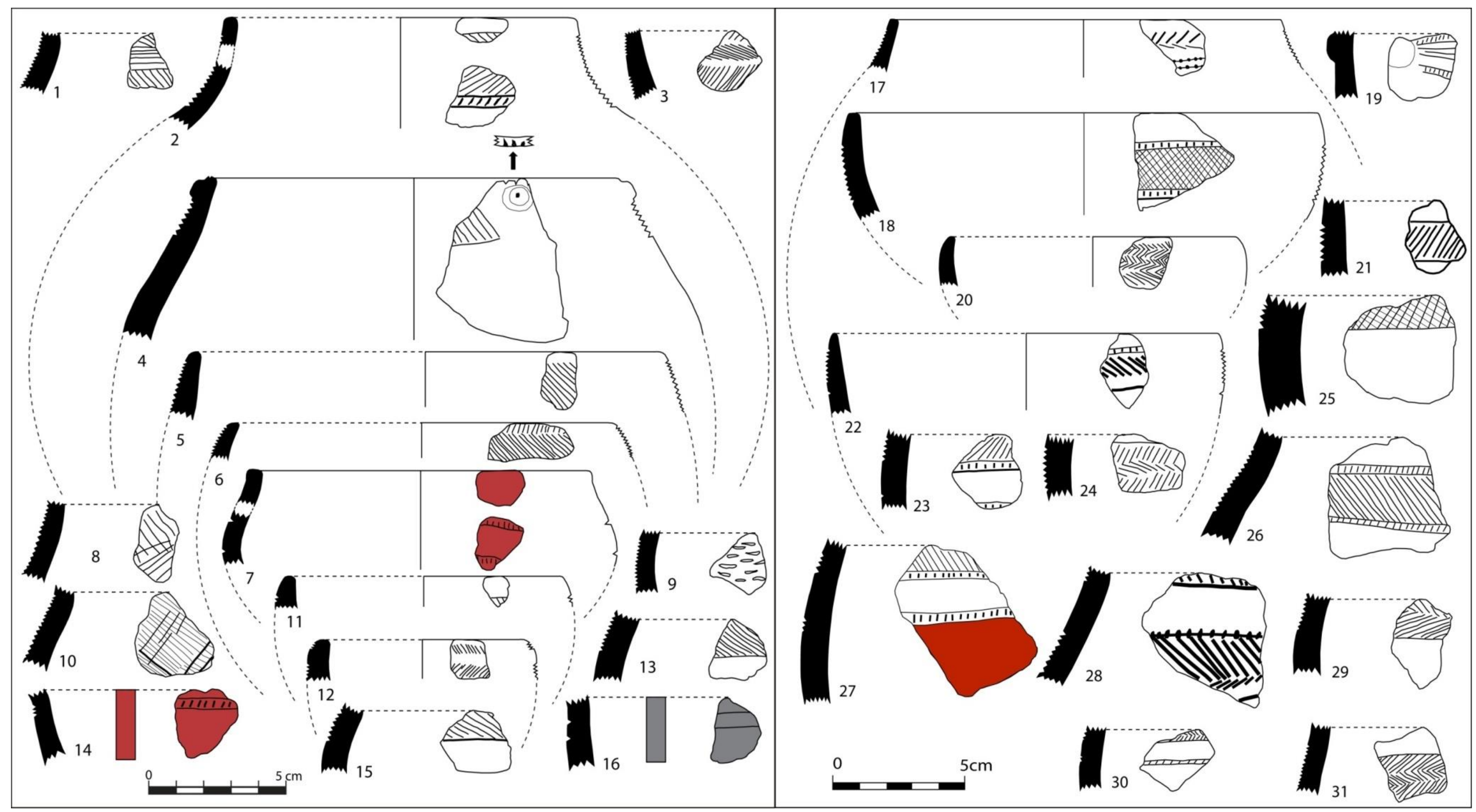

Figure 7.12: Pottery from Rhenosterkloof 3.

7.3.4: RHENOSTERKLOOF 4-8

A total of 30 decorated potsherds were recovered from Rhenosterkloof 4-8. These localities are eroded and consequently, the material is mixed. Having established the clear stylistic affinities of Rhenosterkloof 1 (Rooiberg) and Rhenosterkloof 3 (Eiland), it is clear that both of these phases are represented. On the basis of S. Hall's (1981) wider regional characterization of Ru-3 (Huffman's (2007) Madikwe), the other decorated sherds clearly fall into this phase and provide immediately local evidence for its presence (Figure 7.13).

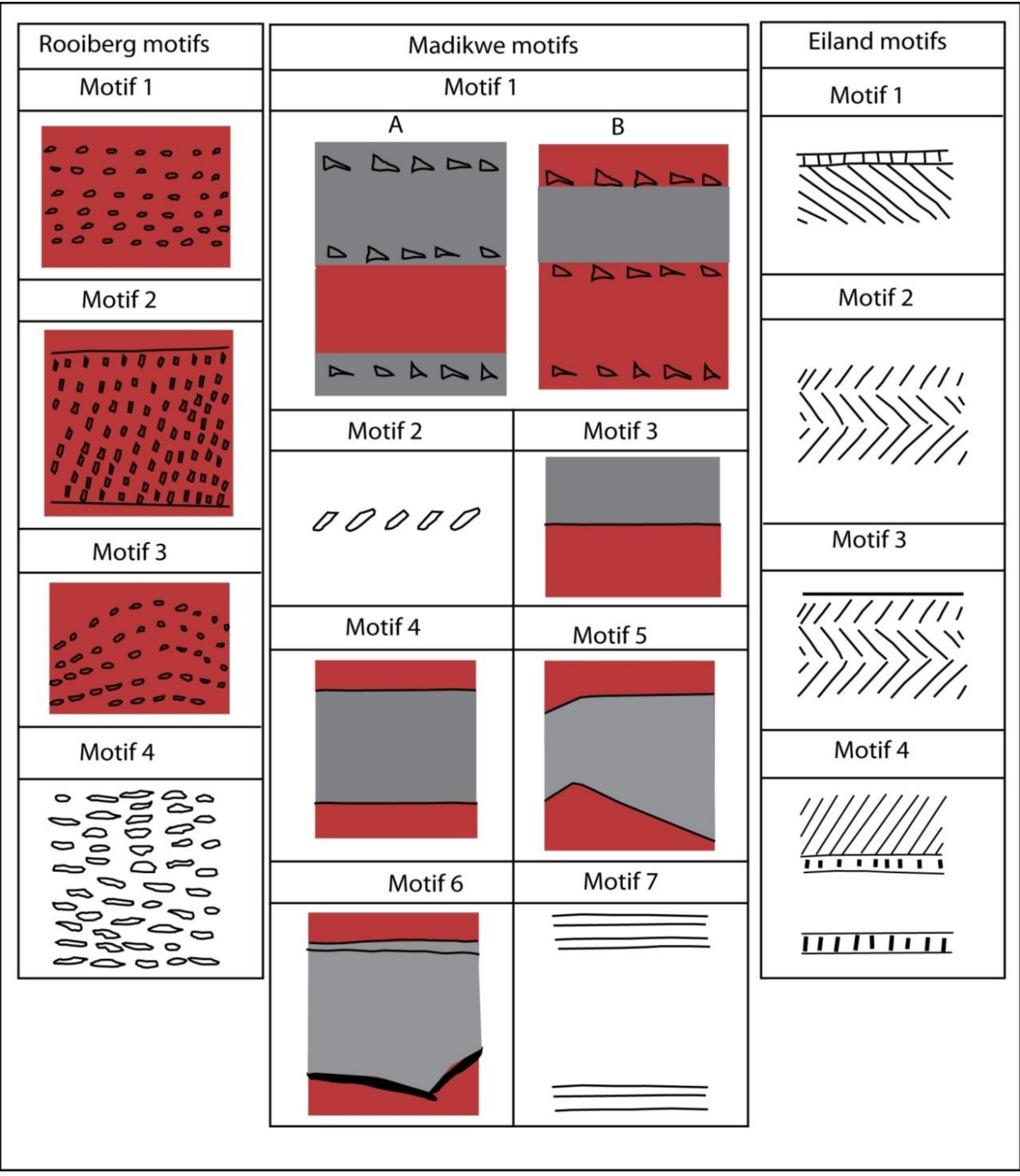

Figure 7.13: Ceramic motifs from Rhenosterkloof 4-8

The Eiland facies (RU-2 Hall, 1981) is mainly defined by fine herringbone motifs with ladder stamping, but also include oblique bands, crosshatching, and punctates that are placed between incised lines (S. Hall, 1981: 35). However, while the current assemblage was small, there is more than enough diagnostic material to identify the phase. The Eiland facies is derived from the Diamant facies (RU-1, 750-1000 AD), which represent the earliest Iron Age ceramics in the Southern Waterberg. A later expression of the Eiland facies, known as Broadhurst (1300-1430 AD), has not been documented in the Southern Waterberg, but typical ceramics were reported from 15th Century AD sites in the Northern Waterberg and northeastern Botswana (Denbow, 1981; van der Ryst, 1998). The Eiland ceramics have chronology that overlaps with the K2 and Mapungubwe phases and therefore demands an analyses of the metallurgical debris associated with it in order to assess whether the inferred tin chronology from the Shashe-Limpopo is represented at the Rhenosterkloof sites. This task is complicated by the eroded context of the current assemblage of the Eiland ceramics and that surface collections are mixed with Madikwe ceramics.

The Madikwe facies is made up of incisions, impressions and alternating patterns of graphite burnishing and red slipping (Huffman, 2007). The Madikwe facies is chronologically associated with the currently known dates for the production of tin in the Southern Waterberg. The overlap between the Moloko phases, especially Madikwe, with Eiland/Broadhurst terminal EIA phases has also been recognised in the Southern Waterberg. In several instances, individual EIA motifs were used on Madikwe vessels (S. Hall, 1981: 46, 128) and clearly this small indication of continuity was underpinned by contemporary juxtaposition of communities

With regards to the Rooiberg facies, it also interesting to note that only one sherd (No. 2) had both incisions and comb-stamping (Figure 7.14) but the separation of these motifs has already been noted.

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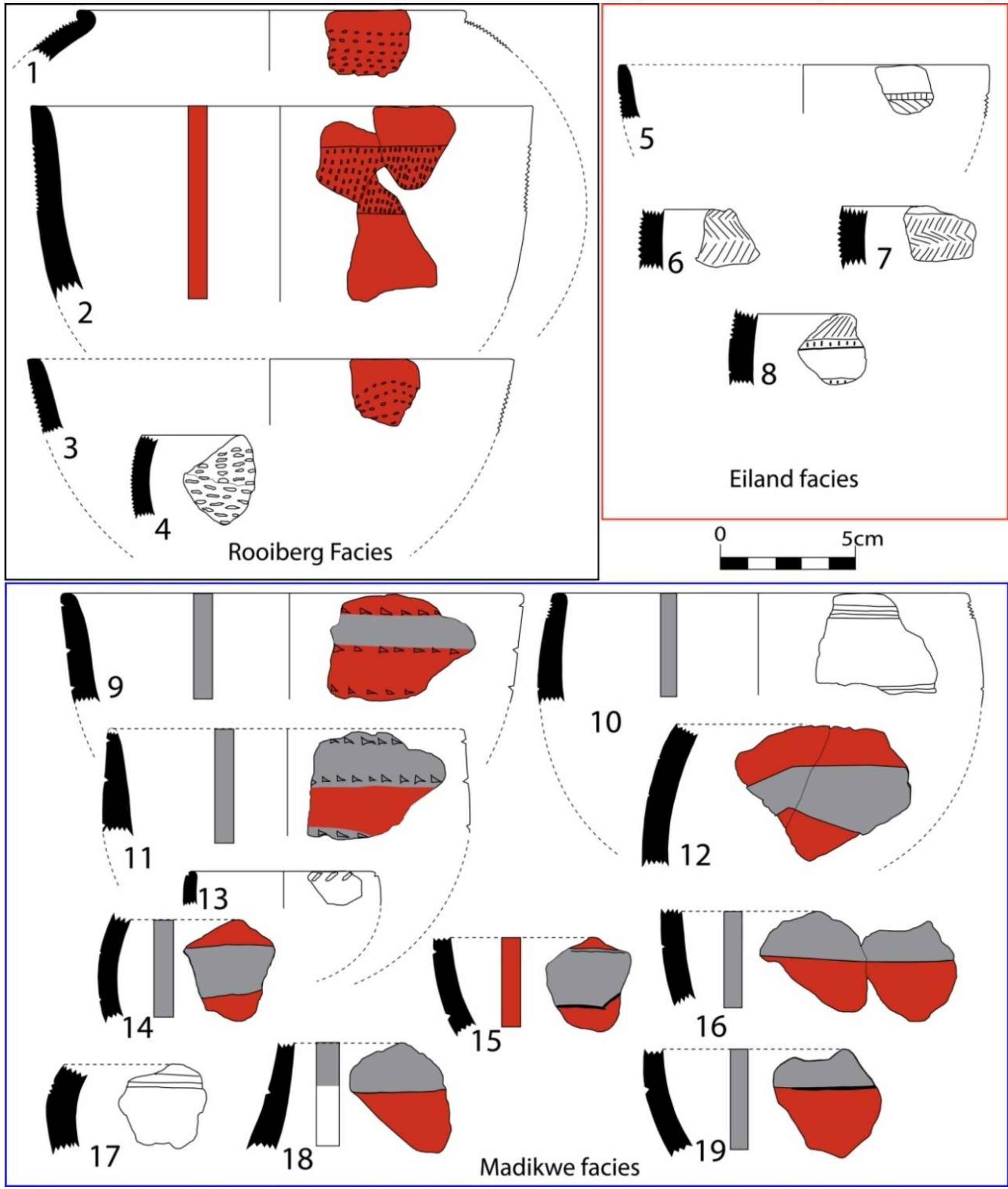

Figure 7.14: Pottery from Rhenosterkloof 4-8. Nos.1-3 (Rhenosterkloof 4); Nos. 5-8, 15 & 19 (Rhenosterkloof 5); Nos. 9-14 (Rhenosterkloof 6); No. 4 (Rhenosterkloof 7) and Nos. 16-18 (Rhenosterkloof 8)

7.3.5: TEMBI 1

Excavations at Tembi 1 recovered 148 potsherds of which only 32 (22 %) were diagnostic. Within the diagnostic sherds, only 8 (5 %) were decorated. A motif analysis of the decorated sherds produced six motifs (Figure 7.15).

Motif 1	Motif 2	Motif 3
Motif 4	Motif 5	Motif 6

Figure 7.15: Ceramic motifs from Tembi 1.

The predominance of comb-stamping over incisions was evident, even though the assemblage was very small. The sample is small but the higher frequency of comb-stamping indicates that the assemblage represents the Rooiberg phase, supported by the presence of some incision. The incised motif in this assemblage (Figure 7.15), however, is not typical of Madikwe derived motifs found in the Rooiberg phases. As noted in Chapter 5, the settlement layout of Tembi 1 suggested some Moor Park (Nguni) connections, which may lead one to suggest that these ceramics may be a variation of the Ntsuanatsatsi/Uitkomst ceramics. The Ntsuanatsatsi facies is dominated by broad band of stamping in the neck, stamped arcades on the shoulder and appliqué, while the Uitkomst facies is made up of stamped arcades, appliqué, blocks of parallel incisions and stamping and code impressions (Huffman, 2007: 169, 173).With regards to profiles, globular, short necked jars and wide open bowls that are similar to those from Rhenosterkloof 1 and 2, were recorded (Figure 7.16).

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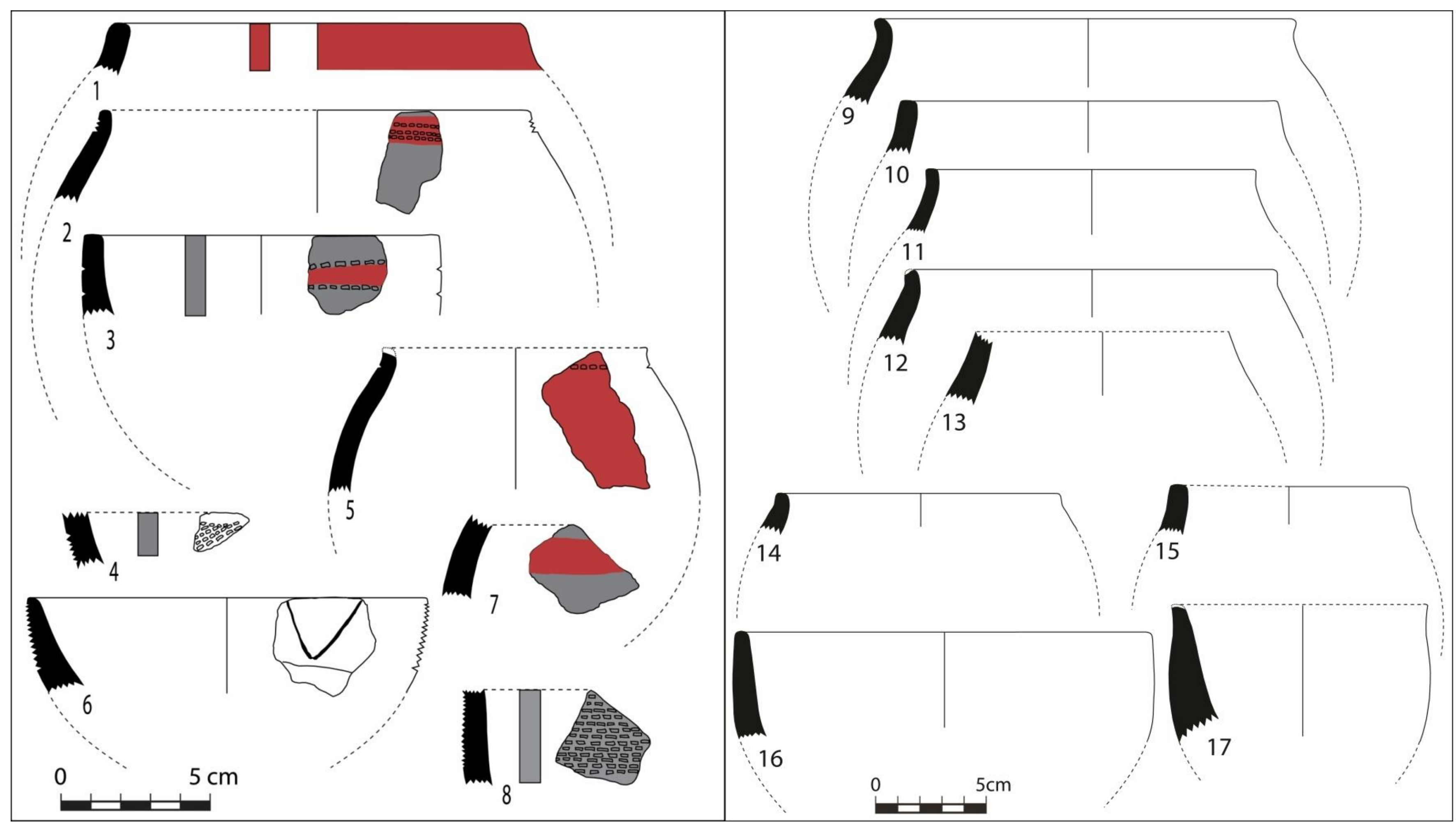

Figure 7.16: Pottery from Tembi 1

Thus the ceramic and settlement sequence of the sites under investigation indicates considerable continuity in occupation of the area from early second millennium AD. I now briefly turn to the issue of technological style, particularly in relation to the undecorated crucible sherds and their possible Eiland association.

7.4: COMPARING CERAMIC TECHNOLOGICAL STYLES BETWEEN CRUCIBLE SHERDS & DECORATED EILAND CERAMICS

As noted earlier, the chronology and metallurgical character of Rhenosterkloof 3 is crucial in terms of exploring the chronology of tin and bronze production in the Southern Waterberg. In southern Africa, ceramic vessels used for processing metals provide the obvious bridge between metallurgy and culture-history style of the ceramics because they are made from ordinary pots (Calabrese, 2007). In instances where decorated ceramics were used as crucibles, the ceramic style can obviously place the crucible within a chronological sequence. However, in the present case, the crucibles under question, while directly associated with an Eiland context, are not decorated. In order to explore a possible association, thin section petrography was used to compare the ceramic production styles of the Eiland pottery with the undecorated crucible sherds.

The targeted crucible specimen was only one (Rnk3-19). Another crucible, Rnk3-20, did not have enough ceramic portions for this kind of analysis. Five decorated Eiland sherds (Nos. 18, 26, 27, 28 & 31 in Figure 7.12) from Rhenosterkloof 3 provided the comparative pottery. In addition, four decorated Madikwe sherds (Nos. 9, 10, 12 & 17 in Figure 7.14) from the nearby site of Rhenosterkloof 5 were also analysed (Figure 5.12). The results show that the crucible sherd was made using the same technical process as the decorated Eiland sherds. This process involved mixing fresh clay with grog[21]. Grog is not present in the decorated Madikwe sherds (Figure 7.17).

[21] Previously fired clay being mixed with fresh clay.

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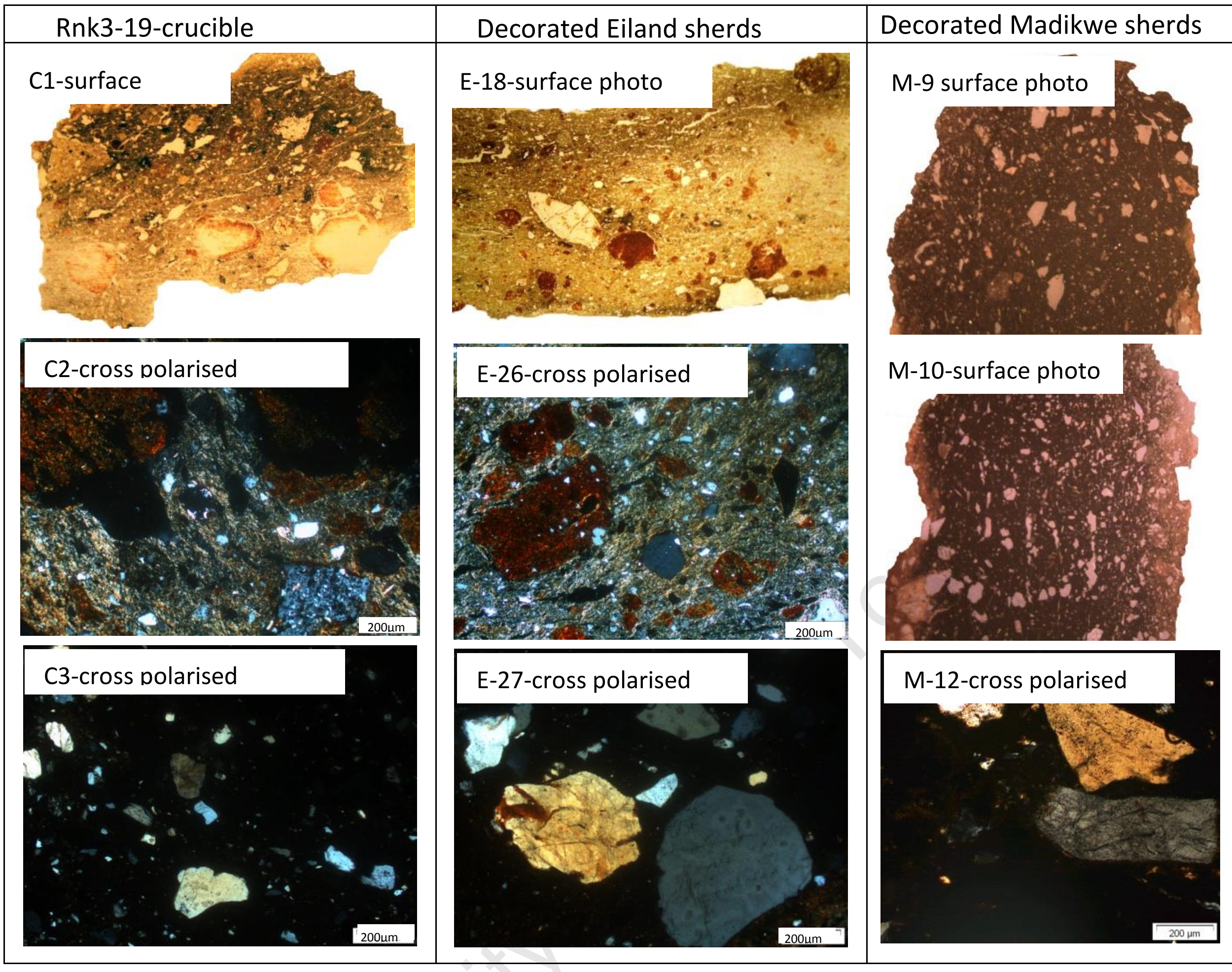

Figure 7.17: Thin section images and micrographs of the crucible, and selected Eiland and Madikwe sherds. C1 and E-18 show clusters of grog (appearing as red and black) in a clay matrix with rock inclusions. M-9 and M-10 show rock inclusions in a clay matrix without grog. C2 and E-26 show cross polarised view of the specimens with grog and rock inclusions, while C3 and E-27 are close ups of grog fragments in which the clay matrix has turned into glass. A higher magnification of M-12 also shows that some clay turned glassy under firing.

Grog is identified in thin sections as isolated inclusions of angular to sub-angular inhomogeneities within clay pastes (Whitbread, 1986). They appear different in texture or fabric to the surrounding clay body, often in darker shades due to refiring. No attempt was made to identify the rock inclusions as this was beyond the scope of the present study but there is a strong indication that the addition of grog was associated with the crucible and the Eiland ceramics from Rhenosterkloof 3. Importantly, the same is not so for the Madikwe sherds from Rhenosterkloof 5 but more samples are required in order to strengthen these observations.

The addition of previously fired pottery fragments into fresh clay enhances workability and or thermal shock resistance during firing (Whitbread, 1986) but equally, this is also a cultural practice (Krieter et al. 2009). This technique did not compensate for a lack of naturally occurring inclusions in the clay [as was the case with the hunter-gatherer communities of southern California (Quinn and Burton, 2009: 287)] because there are abundant rock inclusions in both the Eiland and Madikwe ceramics. Bulk SEM-EDS readings for some of the Eiland and Madikwe sherds also suggest that the clay used for making these ceramics was similar, which suggests that the use of grog in the Eiland sherds may have been a specific cultural choice (Table 7.2).

Table 7.2: SEM-EDS chemistry for some decorated sherds from Rhenosterkloof 3 and 5.

Sample ID	Na2O	MgO	Al2O3	SiO2	P2O5	K2O	CaO	TiO	MnO	Fe2O3	Total
Eiland No.18	2.3	2.8	10.7	56.4	6.8	2.3	3.8	2.5	3.0	9.5	100
Eiland No.26	2.5	4.5	7.6	58.6	8.6	3.3	2.3	1.9	2.9	8.0	100
Madikwe No.17	3.4	2.7	9.7	55.5	6.1	2.8	3.7	2.7	3.9	9.6	100
Madiwke No.12	4.3	3.2	8.9	52.9	5.5	3.1	2.9	3.1	5.3	10.7	100

It is possible that the crucible sherd (Rnk3-19) is associated with the Eiland phase rather than the Madikwe in this local context. The crucible did come from the same excavation context as the Eiland pottery. However, there is still a pressing need to investigate more Eiland and Madikwe ceramics in order to test the veracity of the observation that grog was a cultural practice associated with the local Eiland technology and no the Madikwe sherds. The suggested similarities in the technological styles for the crucible and the Eiland decorated sherds also confirms the initial suggestion that the crucible was not fashioned as a specific reaction vessel for melting metals but instead, was an ordinary pot that was later used for metallurgical purposes.

7.5: SUMMARY

Results from the analyses of different types of non-metallurgical remains were presented as a way of sorting out the culture historical sequences of individual sites, and exploring their intra- and inter-site relationships in the area under study. The chronology of glass beads is comparable to that of radiocarbon dates and the typology of these beads informs on possible trade links that connect the Southern Waterberg with the wider region stretching as far as the Indian Ocean.

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Indeed sea shells endemic to the Mozambican coast have also been identified in the Southern Waterberg.

The ceramic sequence in the Southern Waterberg sites reported here, conforms to what has been established previously (S. Hall, 1981; Huffman, 2007). In the survey area, this sequence is as follows:

Eiland facies (1000-1300AD)
Madikwe facies (1500-1700 AD)
Rooiberg facies (1650-1750 AD)

What is emphasized here is that these phases are not discrete and chronologically isolated blocks of distinctive style. At all junctures throughout this sequence there is evidence that phases chronologically overlapped and that people from different stylistic phases shared the landscape and clearly interacted. The hints of some stylistic attributes following through from Eiland into Madikwe and the incised and comb-stamped character of Rooiberg ceramics shows that Eiland and Madikwe people interacted. Rooiberg is evidence of further interaction at the interface between Madikwe and Ntsuanatsasti/Uitkomst.

The culture historical sequence is further complicated by the appearance of Moor Park type settlements after 1500 AD. While the evidence from Tembi 1 indicates that Moor Park people used Rooiberg style ceramics, the distinctiveness of the settlement layout at this site, unequivocally links the occupation with Nguni-speakers. Indeed the appearance of Moor Park settlements in the Southern Waterberg maybe linked with the arrival of Ntsuanatsatsi/Uitkomst farmers with distinctive settlement layouts that seem to be simplified versions of Type-N settlements (Maggs, 1976).

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CHAPTER EIGHT: ARCHAEOMETALLURGICAL STUDIES

“Archaeometallurgy is not an island, but an integral and inseparable part of archaeology” (Rehren, 2000: 967).

8.1: INTRODUCTION

This chapter presents archaeometallurgical analyses of excavated and surface collected materials from the study area. The focus is on the identification and characterisation of the metallurgical remains using science-based approaches as opposed to the “archaeology of a metal…free from any scientific input” (Rehren, 2000: 967). Archaeological methods alone cannot positively assign particular production remains to their respective metals or production stages without the use of science-based approaches (Sillar and Tite, 2000; Miller and Killick, 2004; Rehren and Pernicka, 2008). In the present study, the positive identification of metals worked and their associated techniques was important because, as discussed in Chapter 1, this thesis sought to identify all the metals worked pre-colonially and to expose their technology. Additionally, reconstructing metallurgical techniques would also enhance our knowledge of issues such as technological cross borrowing, metal specialisation, interaction and trade (Rehren et al. 2007; Charlton et al. 2010). Over and above the practical metallurgical concerns, such as the types of ores worked, metal production was also affected by cultural choices and the broader socio-political economy (Childs and Killick, 1993; Childs, 2000; de Barros, 2000; Haaland, 2004; Barndon, 2004). Where applicable, estimates of the scale of production are also provided because they also have a bearing on the organisation of production. Having outlined the culture history sequence in the previous chapter, this sequence provides the structure across and through which metallurgical analyses can be compared.

The archaeometallurgical remains analysed in this chapter focus on iron, copper, tin and bronze. A stepwise approach that involved macro observations and three laboratory based techniques was used to identify and characterise the suite of metallurgical remains under study (see Chapter 6). Since this suite represents different stages of the operational chain of different metals, target specimens were selected based on count and not weight. Eventually 148 samples were selected (Table 8.1).

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Table 8.1: Metallurgical specimens per site[22]. Rb=Rooiberg, Md=Madikwe &El=Eiland

	Excavated sites				Surface collected sites						Total	
Material	Rnk1	Rnk2	Rnk3	T1	Rnk4	Rnk5	Rnk6	Rnk7	Rnk8	Rnk9	**No**	(%)
Ores	3	2	1	0	0	0	0	0	1	0	**7**	5
Tuyeres	4	5	2	1	0	0	0	0	0	0	**12**	8
Furnace wall	3	2	0	0	0	0	0	0	0	0	**5**	3
Furnace slag	7	5	3	3	0	1	0	0	0	0	**19**	13
Flow slag	8	5	5	3	1	0	0	1	0	0	**23**	15
Smithing slag	3	0	0	2	0	0	0	0	0	0	**5**	3
Glassy slag	2	4	4	2	2	1	1	0	1	0	**17**	11
Glassy tuyeres	3	2	5	7	0	0	1	2	1	2	**23**	15
Glassy furnace wall	3	0	0	0	0	0	0	0	0	0	**3**	2
Bloom/crown material	3	2	1	2	0	0	0	0	0	0	**8**	5
Unidentifiable slag	1	0	0	0	0	0	0	0	0	0	**1**	1
Casting spills	1	0	0	0	0	0	0	0	0	0	**1**	1
Metallic artefacts	15	1	0	2	0	0	0	0	0	0	**18**	12
Crucibles	1	0	2	0	0	1	0	0	1	2	**7**	5
Total No.	**57**	**28**	**23**	**22**	**3**	**3**	**2**	**3**	**4**	**4**	**149**	100
(%)	38	19	15	15	2	2	1	2	3	3	100	
Ceramic phases	Rb	Rb?	El	Rb	Rb	Md/El	Md	Rb	Md	?		

8.2: BRONZE PRODUCTION

It has been suggested that the crucibles from Rhenosterkloof 3 may be related to the Eiland ceramic phase (Chapter 7) but it has not yet been established which metal or alloy was worked in these ceramic vessels. To do this, samples Rnk3-19 and Rnk3-20 were analysed microscopically and chemically. Other crucibles from Rhenosterkloof 1 (Rnk1-40), Rhenosterkloof 5 (Rnk5-3), Rhenosterkloof 6 (Rnk6-1), Rhenosterkloof 8 (Rnk8-3) and Rhenosterkloof 9 (Rnk9-2 and Rnk9-4), were also analysed. At macro level, all the crucibles were undecorated and resembled ordinary pottery in form but Rnk1-40 had graphite burnishing on the outside. They were heavily slagged and vitrified on their interior surfaces (Figure 8.1), which suggests that they were fired from above or inside (Miller, 2001: 95; Bayley and Rehren, 2007).

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[22] In this table and throughout the rest of the thesis, T1 stands for Tembi 1, Rnk1 stands for Rhenosterkloof 1, Rnk2 stands for Rhenosterkloof 2 and so on

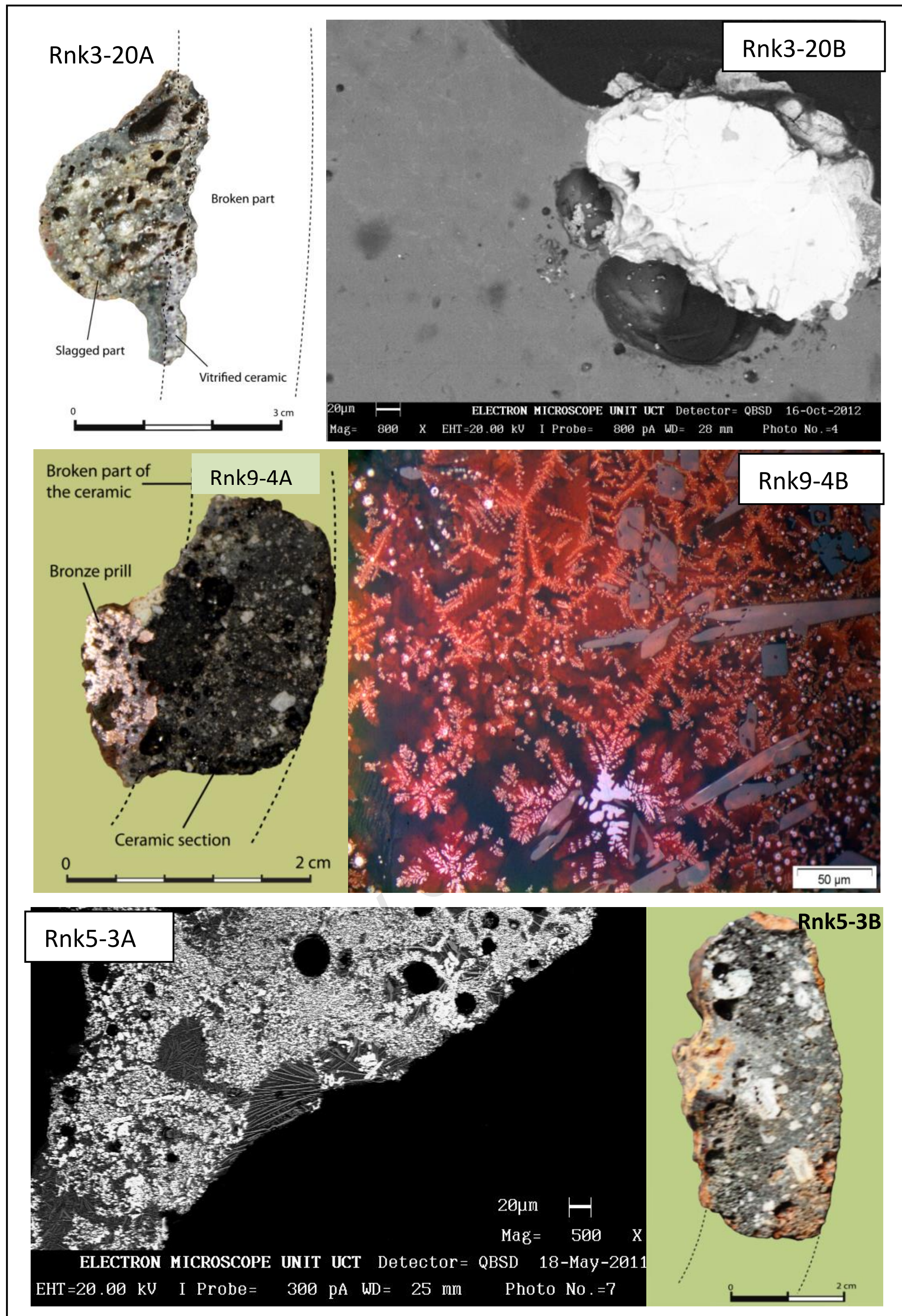

Figure 8.1: Photographs and micrographs of bronze production crucibles. Rnk3-20B: shows a bronze prill in a glass matrix with tiny cuprite (Cu_2O) dendrites and gas bubbles. Rnk9-4B shows cuprite dendrites, tin droplets, secondary tin oxide laths, zoned structures and clay minerals. Rnk5-3A shows bronze crystals, circular structures of exsolved tin oxide, tiny cuprite dendrites, a glass matrix and voids.

Thornton et al. (2010: 306) have recently rebutted claims that crucibles with slag attachment on their interior surfaces were fired from outside and they have also argued that in Eurasia,

firing crucible from inside was a general practice in pre-Roman crucible metallurgy. In southern Africa, heavily slagged potsherds with slag adhering on the upper parts of the pots are generally labeled as slag skimmers used to remove dross floating on molten copper during the refining (Calabrase, 2000). However, limited research on crucibles has been undertaken in this region and as such there is limited baseline data (Friede and Steel, 1975; Maggs and Miller, 1995, Miller, 2001, Hall et al. 2006, Grant and Huffman, 2007; Thondhlana, 2012). All the same, the vitrification and slag attachment on the current suite of ceramic vessels suggest that they were used in metal processing. SEM analysis of the slagged portions confirmed that these crucibles were used to produce bronze (Figure 8.1).

The absence of unreacted tin or copper oxide inclusions in the microstructure of the crucibles may suggest the melting of metallic tin and copper to produce bronze (e.g. Tylecote, 1987; 1992; Tylecote et al. 1989; Yener and Vandiver, 1993, Rovira, 2004; Figueiredo et al.2010, Valério et al. 2012; Valério et al. 2013). Several scholars have described different ways in which bronze could be produced, as well as the inherent difficulties in relating microstructure to these options (Coghlan, 1975; Tylecote, 1992; Lechtman and Klein, 1999; Pigott et al. 2003; Rovira, 2004; Nezafati et al. 2006; Hauptmann, 2007; Figueiredo et al.2010). These options are as follows:

Option 1: Smelting tin ore and copper ores together (intentional co-smelting).
Option 2: Adding one of the metals to the other still as ore (cementation).
Option 3: Smelting a natural copper-tin ore (natural co-smelting).
Option 4: Melting metallic copper and metallic tin together as a mixture.
Option 5: Recycling or re-melting scrap bronze produced elsewhere

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Option 1, 2 and 3 are difficult to identify but can be strongly argued for when there is a considerable abundance of partially reduced or unreacted oxides (Rovira, 2004). When oxidised, tin and copper oxides usually produce euhedral tin oxide inclusions and dendritic or globular cuprite inclusions that are also formed during the solidification process of Option 4 and 5 (Yener and Vandiver, 1993; Rovira, 2007; Figueiredo et al. 2010). The present evidence suggests that all specimens represent the alloying of metallic tin with metallic copper (Option 4).

Large bronze prills (about 1.5 cm in diameter) occur in sample Rnk9-4 but in the rest of the samples, the prills are in the order of a few microns (about 50 μm) (Figure 8.1). The chemical make-up of the prills confirms that standard bronzes were produced (Table 8.2).

Table 8.2: SEM-EDS results for bronze production crucibles

Ceramic portions													
Sample ID	Na2O	MgO	Al2O3	SiO2	K2O	CaO	TiO	MnO	Fe2O3	NiO	CuO	SnO	**Total**
Rnk1-40	0.0	2.5	15.2	52.9	0.0	4.8	2.0	3.4	18.7	0.0	0.0	0.0	100
Rnk3-19	1.0	3.9	15.7	50.3	1.7	4.2	3.3	2.5	17.4	0.0	0.0	0.0	100
Rnk3-20	2.0	4.6	16.8	42.0	0.0	4.4	2.0	4.7	24.0	0.0	0.0	0.0	100
Rnk5-3	1.7	4.5	15.2	39.6	2.2	6.3	2.9	4.4	23.5	0.0	0.0	0.0	100
Rnk6-1	2.0	4.7	10.5	44.1	1.9	7.9	3.7	3.9	21.0	0.0	0.0	0.0	100
Rnk8-3	1.9	2.4	10.0	46.4	3.3	8.1	0.5	3.6	24.1	0.0	0.0	0.0	100
Rnk9-2	0.7	1.5	13.3	40.2	3.2	14.8	1.3	3.4	21.8	0.0	0.0	0.0	100
Rnk9-4	1.0	2.8	15.0	48.5	3.5	12.6	0.5	5.3	10.9	0.0	0.0	0.0	100
Slagged portions													
Sample ID	Na2O	MgO	Al2O3	SiO2	K2O	CaO	TiO	MnO	Fe2O3	NiO	CuO	SnO	**Total**
Rnk1-40	0.0	1.7	4.3	30.1	1.9	2.8	0.0	0.0	11.7	0.0	35.7	11.8	100
Rnk3-19	1.5	2.1	5.6	40.8	2.8	6.8	0.0	1.5	12.3	0.0	18.7	8.3	100
Rnk3-20	0.0	1.9	5.2	28.6	2.8	5.7	1.0	2.2	17.3	2.3	27.2	6.0	100
Rnk5-3	0.0	1.2	5.0	44.3	0.0	4.3	0.5	3.0	22.2	0.0	9.4	10.5	100
Rnk6-1	0.0	0.8	8.7	33.4	0.0	7.7	2.1	1.5	17.0	0.0	20.9	8.1	100
Rnk8-3	0.0	0.9	10.5	46.5	1.7	3.9	2.0	2.5	14.9	0.0	10.5	6.2	100
Rnk9-2	0.0	2.1	10.9	37.6	2.0	5.4	2.0	2.1	20.9	0.0	12.9	4.3	100
Rnk9-4	0.0	1.5	2.6	27.0	1.1	6.6	3.4	3.7	14.3	2.6	30.5	6.6	100
Metal prills													
Sample ID	Na	Mg	Al	Si	K	Ca	Ti	Mn	Fe	Ni	Cu	Sn	**Total**
Rnk1-40	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	93.0	5.4	100
Rnk3-19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	90.0	8.4	100
Rnk3-20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.7	11.3	100
Rnk5-3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.7	0.0	0.0	97.3	100
Rnk6-1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	89.4	10.9	100
Rnk8-3	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	2.0	0.0	89.0	8.0	100
Rnk9-2	0.0	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	92.2	6.8	100
Rnk9-4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.1	3.7	88.0	7.2	100

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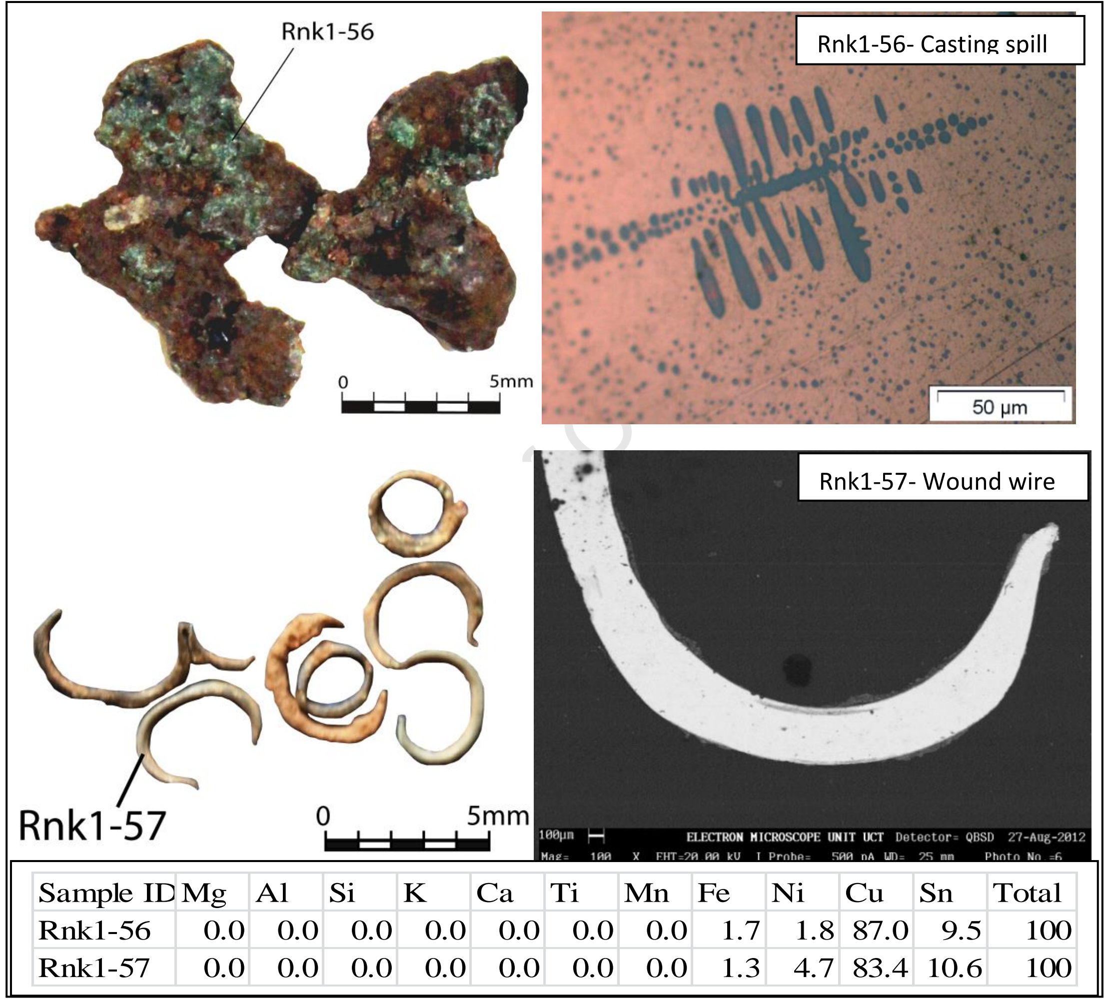
The readings for the prills are within the range of several bronzes from southern Africa (Stanley, 1929a; Grant, 1994; Miller, 2003). Iron also occurs in some of these prills, but in very low quantities (Table 8.2). Some metal droplets are made of tin with only a few iron impurities (Rnk5-3, Table 8.2). This is significant because it suggests the melting of pure tin in the process of bronze production, as opposed to the use of tin oxide (Wheeler et al. 1975;

Craddock, 1995; Figueiredo et al. 2009). The ceramic vessels under study were not very refractory (Table 8.2) but they were undoubtedly sufficient for the relatively limited duration of melting operations involved (Freestone, 1989; Tite et al.1990; Bayley and Rehren, 2007).

A record of bronze production at the sites under study was also represented by a casting spill (Rnk1-56) and a piece of wound wire (Rnk1-57) from Rhenosterkloof 1. In hand specimen, the casting spill was brown to light brown in colour, with some green patination (Figure 8.2).



Sample ID	Mg	Al	Si	K	Ca	Ti	Mn	Fe	Ni	Cu	Sn	Total
Rnk1-56	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.8	87.0	9.5	100
Rnk1-57	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	4.7	83.4	10.6	100

Figure 8.2: Photographs, micrographs and SEM-EDS readings of a casting spill and wound wire from Rhenosterkloof 1. Rnk1-56 is an OM micrograph showing a large cuprite dendrite (dark, centre) in a matrix of copper metal (red), with numerous small cuprite inclusions (dark particles). Rnk1-57 is an SEM micrograph showing slag stringer islands and voids in the copper rich phases.

Minute soil grains were visible on one side suggesting that the fragment was still in semi-liquid form when it came into conduct with the ground. It also has a flow structure and fresh breaks reveal a golden reddish colour.

In contrast to the casting spill, the wound wire fragment was light brown with less green patination on the outside (Figure 8.2). Fresh breaks revealed a yellowish golden colour. The wound wire was clearly made into a bangle-like object probably through twisting tightly around a bundle of fibres to form a hollow tube (Oddy, 1984). Fagan (1967) argues that by the 11th Century AD, this technique was well established in southern Africa. The wire also had visible longitudinal striation marks on the outside but it was difficult to see if it had been drawn or produced by simple hammering because of the abundant corrosion. Oddy (1984; 1994) argues that longitudinal striations may result from the smoothing process and as such they do not necessarily indicate wiredrawing, especially if the diameter is variable along the axis, because drawn wire has the same diameter throughout the axis. Unequivocal evidence for wire-drawing has been reported in the Southern Waterberg (S. Hall, 1981) and wire-drawing tools have also been reported at Great Zimbabwe, Danangombe and Ingombe Ilede (Fagan, 1969; Steel, 1975; Lagercrantz, 1989). However, the origins of this technique remain unclear in in southern Africa and both autochthonous and external origins are possible (Fagan, 1969; Oddy, 1984; Childs, 1995).

Microstructurally, the casting spill was very heterogeneous, in accordance with most pre-industrial bronze casting drops (Stanley, 1931; Rajpitak, 1983; Miller, 2001; Rovira 2004; 2007; Denbow and Miller, 2007; Hauptmann, 2007). In some portions, interdendritic alpha/delta eutectoids which indicate fairly rapid cooling from above 1000 ˚C without subsequent annealing were visible (D. Scott, 1991; Rajpitak, 1983). This microstructure is characteristic of molten bronze spills that are lost during melting or casting operations (Valério, 2012). The presence of secondary cassiterite, frequently in needle like crystals with a rhombohedral cross-section was also noted in some parts of this specimen. On the other hand, the wound wire had slag stringers that are in keeping with pre-industrial metallurgical processes (Figure 8.2). No twinned alpha and delta eutectoids were visible under the microscope, which shows that object may have been rapidly cooled and annealed (Rajpitak, 1983; D. Scott, 1991; Valério et al. 2012).

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Chemically, both the casting spill and the wound wire had Sn values that are consistent with bronzes known in the region and they were relatively pure with low Fe impurities. However, the wire also had significant nickel levels of about 4.7 % (Figure 8.2). Nickel is associated with the tin mineralisation at Rooiberg (Baumann, 1919a) and several scholars in southern Africa reported bronzes with nickel (Denbow and Miller, 2007; Miller and Hall, 2008; Thondhlana and Martinón-Torres, 2009), but this element is prominent in the copper metallurgy from the Pilansberg (Killick *Pers. Com.* 2013). Could this high nickel value indicate that copper from the Pilanesberg area may have been used in producing this bronze specimen because this element is not characteristic of bronzes from the Southern Waterberg? This is possible because Campbell (1822) observed that residents of Kaditshwene were producing bronze using tin which was obtained from areas to the north (most likely referring to Rooiberg).

Thus, the emerging picture from the analysis of the crucibles is that there is significant visibility of bronze production in the Sand River valley. This visibility is not unexpected for the Madikwe and Rooiberg phases. It may be significant that the undecorated crucibles from Rhenosterkloof 3 (Rnk3-19 and Rnk3-20) were also used for bronze production because of a possible association with the Eiland phase earlier in the second millennium AD.

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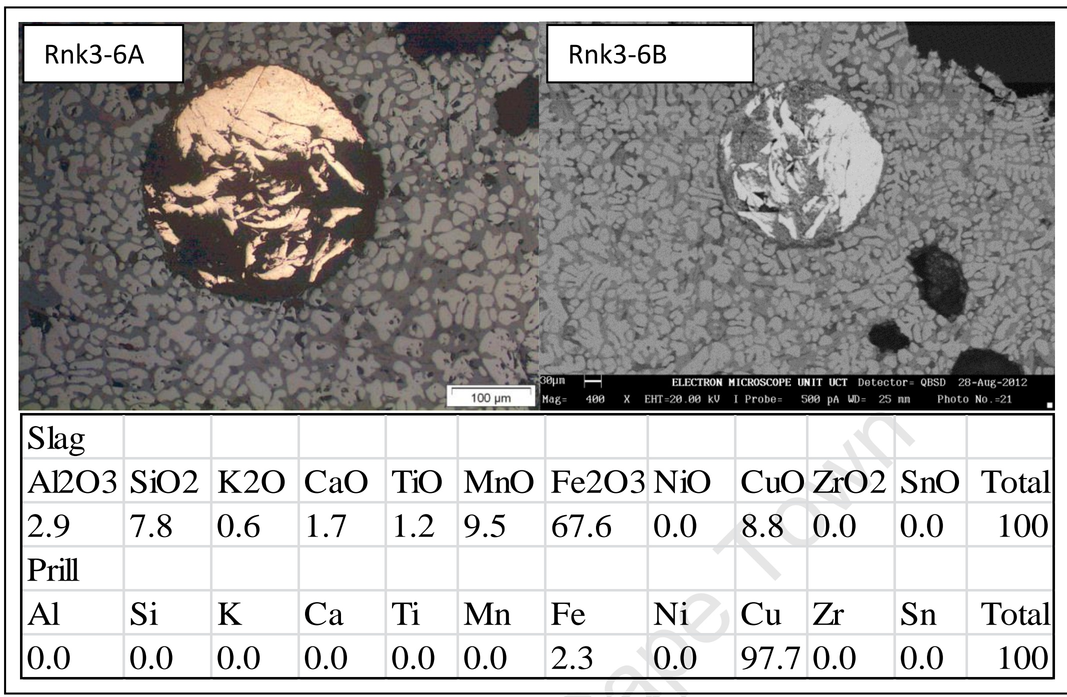
8.3: COPPER PRODUCTION

The separation of copper slags from iron slags (or even tin slags) in hand specimen, is notoriously difficult, because of several reasons. Both copper and iron smelting produce iron silicate slag because they all involved the same slag formulation to eliminate silica (SiO_2) and other rock components of the ores (Rostoker and Bronson, 1990; Miller and Killick, 2004). It is also possible to produce high levels of iron in copper smelting (Craddock and Meeks, 1987). Additionally, there are instances when iron ore was used as a flux in copper smelting, thereby leading to the production of typical iron slags (Rostoker and Bronson, 1990). Usually, it is the presence of small quantities of copper metal in the slag that can help in identifying copper slags. These copper nodules are usually identifiable microscopically, leaving very little evidence for bulk chemical identification.

One possible copper slag (Rnk3-6) was identified at Rhenosterkloof 3. This specimen had a flow structure, very similar to iron slags described below. However, no large metal prill was macroscopically visible to suggest slag crushing and the specimen was clearly not

mechanically altered by crushing (Pryce, 2008). In microsection, it exhibited a few metallic copper lumps embedded in iron phases and a glass matrix (Figure 8.3).



Slag											
Al2O3	SiO2	K2O	CaO	TiO	MnO	Fe2O3	NiO	CuO	ZrO2	SnO	Total
2.9	7.8	0.6	1.7	1.2	9.5	67.6	0.0	8.8	0.0	0.0	100
Prill											
Al	Si	K	Ca	Ti	Mn	Fe	Ni	Cu	Zr	Sn	Total
0.0	0.0	0.0	0.0	0.0	0.0	2.3	0.0	97.7	0.0	0.0	100

Figure 8.3: OM (Rnk3-6A) and SEM (Rnk3-6B) micrographs of a copper slag from Rhenosterkloof 3. The micrographs show a drop of copper metal, surrounded by wüstite, blocky fayalite and a glass matrix. Dark areas are voids.

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Wüstite is the predominant phase in the microstructure, suggesting that “unnecessarily” high reducing conditions were achieved (Craddock and Meeks, 1987). Interstitial glass was significantly less and the fayalite (Fe_2SiO_4) was blocky (Figure 8.3). Both wüstite and fayalite are usually expected to form under reducing conditions, typically associated with iron smelting rather than copper smelting (Miller and Killick, 2004). A quantitative analysis of the largest prill (>300 µm) shows that it consists of copper with some iron impurities but tin was not detected (Figure 8.3). Copper ores and smelting do occur in some parts of the Southern Waterberg (Figure 4.2), although it is also possible that some copper were acquired from areas further afield such as Pilanesberg to the south or even Phalaborwa and Musina to the north east.

8.4: TIN PRODUCTION

Tin ores were not recovered at the sites under study,[23] but tuyeres (at Rhenosterkloof 1, 2, 6, 7, 8, 9 and Tembi 1), furnace wall fragments (at Rhenosterkloof 1 and 2) and slags (at Rhenosterkloof 2, 3, 4, 5, 6, 8, and Tembi 1) that all relate to tin production, were present at most sites. The tentative separation of glassy tuyeres, furnace walls fragments and slags from the non-glassy ones (Appendix 6.1), was significant because the former proved to be related to tin working while the latter were mostly related to iron production. The presence of furnace wall fragments with glassy streaks shows that tin was not smelted in crucibles. The use of crucibles for tin smelting has been reported in Europe at sites such as Göltepe, where no less than 500 crucibles were recovered (Yener et al. 1993; Earl and Özbral, 1996). Unfortunately, the morphology of the tin furnaces in the Southern Waterberg remains unknown because of the lack of superstructures.

The slagged portions of glassy furnace wall fragments and tuyeres were mostly green-bluish but some were black and brownish. It was not possible to estimate the original length of the tuyeres because they were fragmentary. In microsection, the slagged portions of these technical ceramics comprised of either slender laths of tin oxide and dendrites of skeletal magnetite spinels or spherical tin drops in a glassy phase (Figure 8.4). Heavy inclusions of sub-angular quartz were also visible in some specimens (Figure 8.4). Some of the grains were partially dissolved and the formation of crystobalite in the cracks was also noted (Chirikure et al. 2010). No hardhead, fayalite or wüstite were visible and the tin droplets were too small (<1 mm) to have required crushing to recover them. Generally, tin smelting may have taken place under non-equilibrium conditions that enabled the iron to remain in an oxidised state in slag and was not available to refuse with tin (Earl and Özbral, 1996: 291; Miller and Hall, 2008: 33). The above microstructure is comparable to tin slag analyses that were reported in the Southern Waterberg (Miller and Hall, 2008; Chirikure et al. 2010; Heimann et al. 2010). SEM-EDS analyses also detected tin in these specimens (Table 8.3).

[23] Neither do they occur anywhere else in the Sand River valley but the possibility that shallow and localised tin ores may have occurred in the Sand River valley must not be overlooked.

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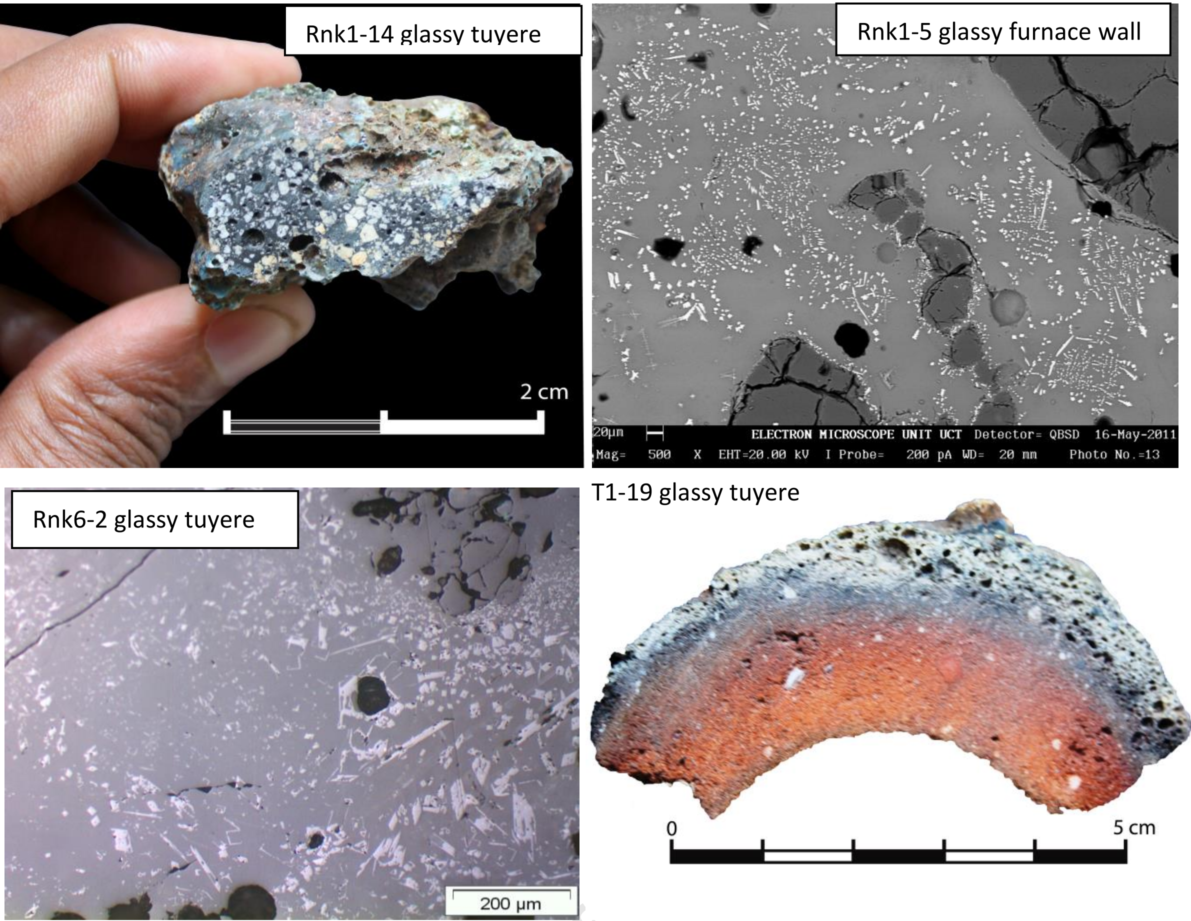

Figure 8.4: Photographs and micrographs of glassy tuyeres and furnace wall fragments. Rnk1-5 is an SEM image showing fractured quartz grains and small magnetite spinels in a matrix of glass and isolated voids. Secondary tin oxide is also visible as white needle-like structures. Rnk2-11 shows a tin drop in a glass matrix with fractured quartz grains and voids. Rnk6-2 shows a fractured quartz grain, slender laths of cassiterite and magnetite spinels in a glass matrix.

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In the slagged portions of both glassy tuyeres and furnace wall fragments, tin ranged between 4 and 23 % and only a few specimens had zirconium (ZrO_2) (Table 8.3). These observations will be discussed together with glassy slags.

Table 8.3: SEM-EDS readings for glassy tuyeres and furnace wall fragments

Ceramic portion for glassy tuyeres														
SampleID	Na2O	MgO	Al2O3	SiO2	K2O	CaO	TiO	MnO	Fe2O3	NiO	CuO	ZrO2	SnO2	Total
Rnk1-14	1.5	2.3	12.3	54.2	2.1	5.3	2.0	2.8	17.5	0.0	0.0	0.0	0.0	100
Rnk1-27	3.4	2.7	9.7	52.1	2.5	4.9	2.7	3.9	18.1	0.0	0.0	0.0	0.0	100
Rnk1-28	2.4	3.8	11.5	49.9	3.2	4.5	3.0	2.2	19.9	0.0	0.0	0.0	0.0	100
Rnk2-10	1.9	3.9	13.1	56.8	2.0	5.9	2.0	2.7	12.0	0.0	0.0	0.0	0.0	100
Rnk6-2	3.0	2.0	12.2	55.3	2.3	4.8	1.9	3.2	15.4	0.0	0.0	0.0	0.0	100
Rnk7-2	2.5	4.0	10.7	50.0	1.8	4.6	1.8	4.0	20.2	0.0	0.0	0.0	0.0	100
Rnk7-3	1.5	2.4	14.3	57.7	2.0	3.4	1.5	2.9	14.4	0.0	0.0	0.0	0.0	100
Rnk8-1	3.3	1.7	10.6	53.4	3.6	4.9	2.3	3.9	16.4	0.0	0.0	0.0	0.0	100
Rnk9-1	0.9	3.2	13.0	47.4	2.2	3.7	3.0	4.2	22.7	0.0	0.0	0.0	0.0	100
T1-18	1.3	4.0	10.8	50.9	1.9	4.2	1.8	3.4	21.3	0.0	0.0	0.0	0.0	100
T1-19	2.0	2.0	12.6	53.6	2.7	3.5	2.3	3.1	18.3	0.0	0.0	0.0	0.0	100
Slagged portion for glassy tuyeres														
SampleID	Na2O	MgO	Al2O3	SiO2	K2O	CaO	TiO	MnO	Fe2O3	NiO	CuO	ZrO2	SnO2	Total
Rnk1-14	0.0	2.9	7.9	38.8	2.1	3.7	1.0	2.0	26.0	0.0	0.0	0.0	15.6	100
Rnk1-27	0.0	1.7	9.6	36.9	1.9	4.5	1.8	1.8	29.2	0.0	0.0	0.0	12.3	100
Rnk1-28	0.0	2.5	6.8	35.3	2.0	4.9	1.9	2.5	24.8	0.0	0.0	0.0	19.4	100
Rnk2-10	0.0	2.3	9.1	40.8	3.2	3.9	1.4	2.7	23.1	0.0	0.0	0.0	13.0	100
Rnk6-2	1.0	1.1	7.8	33.0	1.3	0.9	2.5	1.6	29.1	0.8	0.0	2.2	18.6	100
Rnk7-2	1.0	2.8	10.1	29.8	2.2	1.5	1.1	3.3	26.2	1.0	0.0	0.0	21.3	100
Rnk7-3	0.0	0.7	9.4	42.2	2.7	3.2	0.8	3.3	28.5	0.0	0.0	0.0	9.6	100
Rnk8-1	1.0	0.4	3.2	30.4	3.5	3.2	2.7	1.8	27.5	0.8	0.0	2.7	23.3	100
Rnk9-1	1.3	2.5	8.2	41.6	2.1	2.9	0.9	1.4	22.5	0.8	0.0	2.9	12.6	100
T1-18	0.0	0.0	7.8	37.9	2.3	6.5	3.3	3.5	29.2	0.0	0.0	0.0	9.8	100
T1-19	1.6	1.5	11.2	41.3	1.9	5.7	3.2	3.1	19.8	0.0	0.0	0.0	10.3	100
Ceramic portion for glassy furnace wall fragments														
SampleID	Na2O	MgO	Al2O3	SiO2	K2O	CaO	TiO	MnO	Fe2O3	NiO	CuO	ZrO2	SnO2	Total
Rnk1-5	2.4	1.9	11.2	48.8	3.1	4.4	1.4	3.9	22.4	0.0	0.0	0.0	0.0	100
Rnk1-21	3.2	3.4	14.1	50.7	2.0	5.2	1.9	2.9	16.2	0.0	0.0	0.0	0.0	100
Rnk1-25	2.0	2.8	10.3	55.0	2.5	4.2	2.2	3.3	17.5	0.0	0.0	0.0	0.0	100
Rnk2-11	3.0	2.9	12.5	52.0	1.2	3.9	1.7	4.2	19.0	0.0	0.0	0.0	0.0	100
Slagged portion for glassy furnace wall fragments														
SampleID	Na2O	MgO	Al2O3	SiO2	K2O	CaO	TiO	MnO	Fe2O3	NiO	CuO	ZrO2	SnO2	Total
Rnk1-5	0.0	2.6	10.2	41.3	1.9	5.8	1.2	3.1	20.8	0.0	0.0	0.0	13.3	100
Rnk1-21	1.2	2.2	7.8	43.1	2.0	4.3	2.3	3.7	22.8	0.0	0.0	0.0	10.6	100
Rnk1-25	1.7	3.0	9.2	40.5	2.6	4.6	2.9	3.6	27.6	0.0	0.0	0.0	4.4	100
Rnk2-11	0.0	3.0	8.9	39.4	1.7	6.0	1.9	2.5	16.6	0.0	0.0	0.0	20.3	100

At macro level, glassy slags were either dark-dense or pale-vesicular (Appendix 6.1). The former were mostly black to dark brown in colour and the latter were pale grey (Figure 8.5).

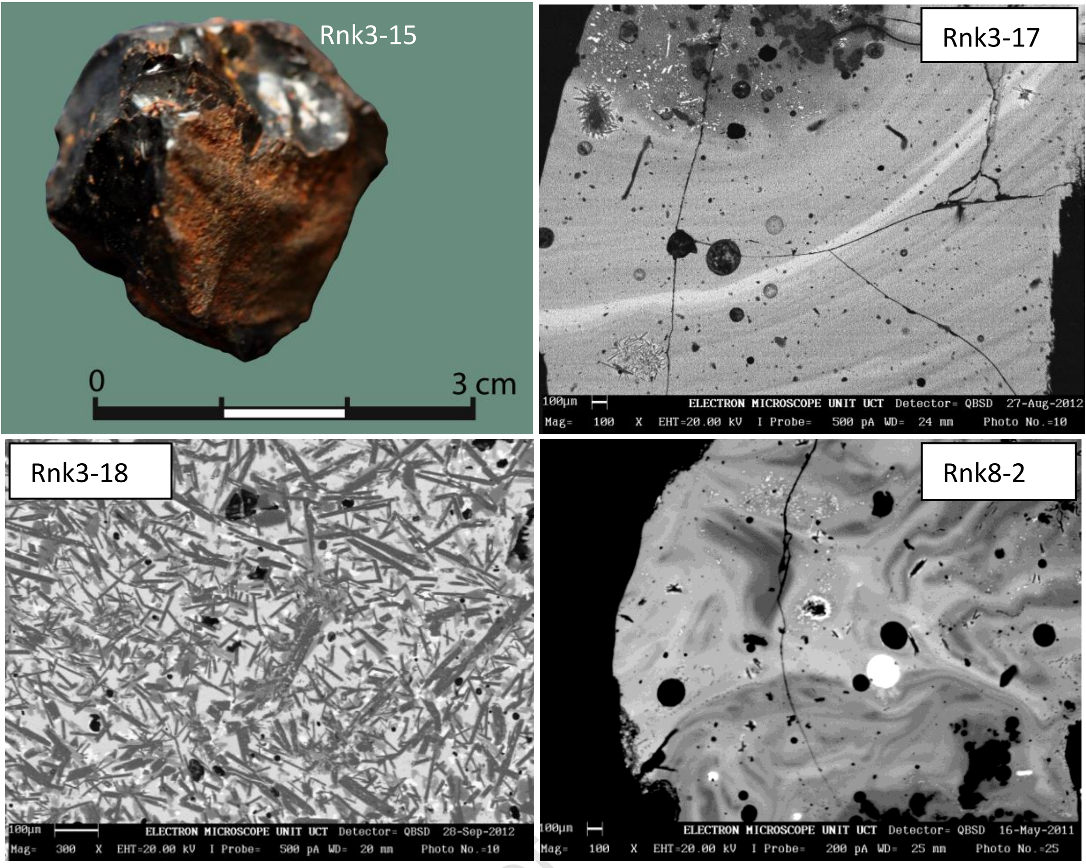

Figure 8.5: Photograph and micrographs of tin slags. Rnk3-17 shows dissolving quartz grains, opaque crystal laths forming clusters of acicular structures and a glass with a schlieren structure. Rnk3-18 shows tiny spherical tin droplets and gas bubbles interspaced with acicular structures of opaque crystals in a glass phase. Rnk8-2 has spherical tin drops, relict quartz grains and tiny opaque crystals in a glass with schlieren of varying colour and composition. Rnk5-2 shows different shades of opaque crystals and cubes and tin droplets in a glass matrix with voids.

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In microstructure, some of the pale grey type had acicular structures of opaque crystials that are rich in titanium [probably rutile (TiO_2) or ilmenite ($FeTiO_3$)] and zirconium, which is in keeping with tin slags worked from alluvial placer ores (Figure 8.5). Zircon is a mineral found in the host rock associated with the tin mineralisation at Rooiberg and was most likely retained together with cassiterite during panning of alluvial deposits because of its specific gravity (Miller and Hall, 2008; Chirikure et al. 2010). Ilmenorutile spinels have also been reported in glassy tin slags from alluvial placer deposits in Europe (Farthing, 2002; Veblen et al. 2004).

The conspicuous absence of iron rich phases such as fayalite and wüstite (FeO) in the microstructure of the tin slags is also noteworthy. These phases are associated with highly reducing conditions and as such their absence may insinuate that less reducing conditions were attained. Tin slags tend to be non-fayalitic but glassy with both silicon and tin as glass-formers (Heimann et al. 2010). Despite the fact that tin has a low melting point (231.9 ˚C), it was usually smelted at relatively high temperatures of around (1000º C), making it difficult to avoid the reduction of some iron oxide to iron and its subsequent reaction with tin to form the undesirable hardhead (FeSn and $FeSn_2$) (Tylecote, 1987: 106; Killick, 1991; Grand, 1994; Adriens et al. 1998; Miller and Hall, 2008). It is possible to smelt tin at lower temperatures of about 600º C (Babu, 2003: 178, Hobbs et al. 2002: 13), but this means that about 15 to 30 % of the tin will be retained in the slag, even after metal prills have been removed (R. Smith; 1996: 91). Tin producers at the sites under study appear to have opted for the second choice in which less reducing conditions were maintained, resulting in some tin losses to the slag (Table 8.4).

Table 8.4: SEM-EDS readings for tin slags

SampleID	Na2O	MgO	Al2O3	SiO2	K2O	CaO	TiO	MnO	Fe2O3	NiO	CuO	ZrO2	SnO2	Total
Rnk2-3	0.0	1.8	8.8	37.0	0.0	4.8	1.3	1.9	25.5	0.0	0.0	0.0	19.0	100
Rnk2-18	1.1	2.4	7.8	34.6	2.2	7.7	2.0	1.5	24.3	0.0	0.0	0.0	16.0	100
Rnk3-4	0.0	0.0	9.1	32.9	2.4	4.9	2.8	2.2	20.9	0.0	0.0	0.0	24.3	100
Rnk3-15	0.0	2.9	10.9	35.7	2.2	5.7	2.0	3.7	22.3	0.0	0.0	2.6	12.6	100
Rnk3-17	0.0	0.0	7.2	28.0	3.4	7.2	3.1	2.9	12.9	0.0	0.0	0.0	35.2	100
Rnk3-18	1.9	2.5	5.2	34.7	1.9	6.2	4.3	2.3	26.2	0.0	0.0	2.9	12.1	100
Rnk4-2	0.5	2.4	8.6	32.1	0.4	5.3	2.4	0.8	29.2	0.0	0.0	2.0	16.3	100
Rnk4-3	0.0	1.0	6.0	29.1	2.9	4.9	3.6	1.9	18.9	0.0	0.0	0.0	31.3	100
Rnk5-2	0.0	2.0	3.8	27.9	2.5	6.6	2.5	4.0	33.2	0.0	0.0	0.0	17.7	100
Rnk6-3	0.0	0.0	4.0	29.2	2.8	7.7	1.2	1.9	19.9	0.0	0.0	6.6	26.3	100
Rnk8-2	0.0	0.7	5.1	38.1	2.7	7.5	0.4	3.4	28.6	0.0	0.0	1.8	12.1	100
T1-16	1.2	1.3	8.5	36.8	1.6	5.2	2.1	2.0	13.1	0.0	0.0	0.0	28.5	100
T1-17	0.0	1.1	5.2	37.0	1.5	6.2	1.5	2.4	19.7	0.0	0.0	2.1	23.0	100
T1-24	1.5	1.7	10.7	35.5	2.4	5.1	1.6	2.8	18.4	0.0	0.0	0.0	19.8	100

However, such losses are not a major concern when smelting rich tin ore (pure cassiterite contains up to 78.8 % tin) (Tylecote et al. 1989), and when such ores were acquired at low costs. Both the glassy slags and the slagged portions of glassy tuyeres and furnace walls had moderate iron SEM-EDS readings (Table 8.3 and 8.4). The origin of the moderate to high iron readings in tin slags from the Southern Waterberg has recently been mooted by Chirikure et al. (2010) who suggest that iron readings between 15 and 30 % could not have come from reactions

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between cassiterite and furnace refractories but may suggest the use of an iron flux. Perhaps this should come as a warning against treating all slags with relatively high iron content and low tin content as products of iron and not tin production (see Friede and Steel, 1976; King, 1989). In terms of the chronology of tin production, the presence of tin slags at Rhenosterkloof 3 is also important because it supports the earlier suggestion that crucibles from the same site were used in bronze production. As for the rest of the sites, the confirmation of tin production is not chronologically surprising because contemporary sites in the Rooiberg and Boschoffsberg valleys are known to have worked tin (Miller and Hall, 2008; Chirikure et al. 2010; Heimann et al. 2010).

8.5: IRON PRODUCTION

Iron production was well represented at most sites (Rhenosterkloof 1, 2, 3, 4, 5 and 7, and Tembi 1) with different production remains (ores, technical ceramics, slags and blooms) and finished objects (arrowheads, bangles, among others).

8.5.1: IRON PRODUCTION REMAINS

Three types of possible iron ores; haematite, specularite and laterite were found at the sites under study. These are all locally available on Koppieskraal ridge (Geological Map 1: 1000 000 series of the Republic of South Africa and the Kingdoms of Lesotho and Swaziland, Northern Sheet 1970). No underground mine was discovered around this ridge but it was apparent that the ores did not require substantial sub-surface collection methods. Several subtle rubble mounds were identified on the northern side of this ridge, about 1 km away from the sites under study. These mounds run parallel to the depression, giving the appearance of a "cut-and-fill" action and suggest quarrying for iron ore.

Hematite specimens were selected for analyses and these were red-brown in colour with fresh breaks producing a red streak (Figure 8.6). In microstructure, the specimens were dominated by iron oxide with a few siliceous inclusions. These microstructural observations corroborate the chemical data (Table 8.5).

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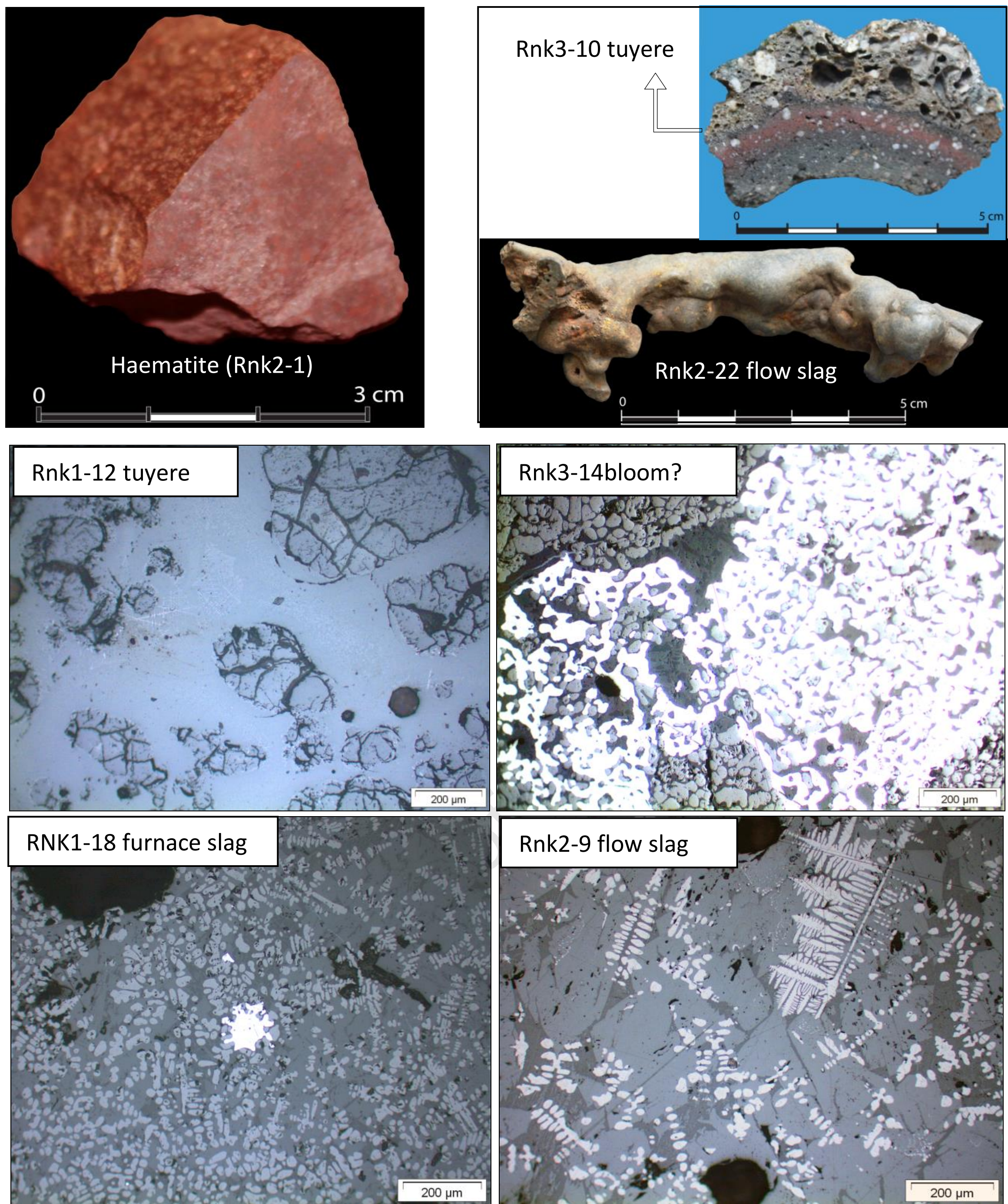

Figure 8.6: Photograph and micrographs of iron production remains. Rnk1-12 shows fractured quartz grains in a matrix of clay minerals and gas bubbles. Rnk3-14 is showing labyrinths of metallic iron surrounded by dendritic wüstite, fayalite, a glass matrix and voids. Rnk1-18 shows iron drops (bright white) surrounded by dendritic wüstite (white) that is resting in fayalite (light grey) and a glass matrix (grey). Dark areas are voids. Rnk1-9 shows dendritic wüstite in angular fayalite and a glass matrix, with gas bubbles.

Table 8.5: WD-XRF readings for iron production remains. M* stands for mean values, refer to Appendix 8.1B for full analyses

Sample ID	Na2O	MgO	Al2O3	SiO2	P2O5	K2O	CaO	SO3	TiO2	Cr2O3	MnO	FeO	NiO	Total
Rnk1-M*	0.09	0.34	10.97	19.51	0.32	0.77	0.17	0.05	0.85	0.07	0.04	66.81	0.01	100
Rnk2-M*	0.04	0.42	5.16	18.70	0.06	0.22	0.08	0.04	0.27	0.05	0.07	74.87	0.01	100
Rnk3-1	0.02	0.33	2.11	18.85	0.01	0.01	0.02	0.02	0.18	0.02	0.06	78.31	0.06	100
Tuyeres														
Rnk1-M*	0.07	1.09	9.50	65.25	0.22	1.91	4.38	0.03	0.44	0.03	0.93	16.14	0.01	100
Rnk-2-21	0.20	0.57	13.97	65.93	0.16	2.77	5.50	0.00	0.45	0.03	0.13	10.26	0.01	100
Rnk3-M*	0.48	0.92	16.57	65.14	0.16	2.24	1.25	0.01	0.71	0.03	0.12	12.35	0.01	100
Furnace wall fragments														
Rnk1-M*	0.73	2.68	11.56	65.13	0.17	1.22	6.67	0.05	0.50	0.02	0.33	10.92	0.01	100
Rnk-2-25	0.24	1.24	15.29	67.55	0.19	2.56	2.21	0.00	0.56	0.02	0.28	9.88	0.01	100
Flow slag														
Rnk1-M*	0.06	0.82	3.69	22.32	0.16	0.66	5.22	0.06	0.19	0.02	2.99	63.81	0.00	100
Rnk2-M*	0.13	0.65	3.21	23.98	0.15	0.59	2.30	0.08	0.16	0.01	1.70	67.01	0.00	100
Rnk3-M*	0.20	0.32	3.93	22.28	0.13	0.45	2.55	0.03	0.14	0.01	0.30	69.64	0.01	100
T1-M*	0.16	1.16	4.49	23.86	0.20	0.83	5.49	0.02	0.20	0.01	1.51	62.06	0.01	100
Furnace slag														
Rnk1-M*	0.03	1.18	3.75	20.87	0.14	0.37	3.49	0.05	0.19	0.02	1.63	68.27	0.00	100
Rnk2-M*	0.02	0.88	4.11	19.52	0.16	0.50	4.08	0.05	0.19	0.03	1.63	68.81	0.00	100
Rnk3-3	0.24	1.33	1.94	15.23	0.14	0.30	0.82	0.00	0.09	0.00	4.15	75.76	0.00	100
T1-M*	0.22	1.05	2.85	18.53	0.24	0.67	4.80	0.54	0.19	0.01	1.25	69.65	0.01	100
Bloom/crown material														
Rnk1-M*	0.05	0.54	2.08	21.34	0.14	0.42	2.11	0.12	0.14	0.02	1.31	71.72	0.01	100
Rnk2-M*	0.09	0.99	1.88	11.51	0.11	0.40	2.96	0.05	0.12	0.02	1.21	80.63	0.01	100
Rnk3-14	0.26	0.20	1.63	15.00	0.09	0.33	0.73	0.01	0.07	0.00	0.50	81.17	0.01	100
Smithing slag														
Rnk1-M*	0.02	0.77	2.78	14.74	0.12	0.32	2.21	0.04	0.14	0.02	1.05	77.79	0.00	100
T1-14	0.22	0.63	2.15	10.33	0.13	0.26	0.89	0.02	0.08	0.00	1.39	83.88	0.01	100

Iron oxide (67 to 78 %) dominates, followed by silica (18-20 %) and alumina (2-11 %), and the rest of the elements are below 1 % (Table 8.5). However, the presence of high iron oxide readings in ore specimens does not automatically translate to good ores for pre-industrial metal production (Rostoker and Bronson 1990: 44), because very rich ores usually have low permeability and low silica content (Tylecote et al. 1971; Prendergast, 1974; Friede, 1980). Nonetheless, pre-industrial iron producers in southern Africa and beyond are known to have engineered solutions that enabled them to work both very rich ores (Cooke, 1966/7; van der Merwe and Scully, 1971; Miller et al. 2001) and lean ores (Killick, 1990; Chirikure, 2006; Lyaya, 2013). The amount of gangue material in the ore also determined the ease with which it could be smelted. For instance, the 20 % Al_2O_3 value for sample Rnk 1-35 (Appendix 8.1B) is high enough to have rendered the specimen undesirable because this element increases the melting temperature and the viscosity of the slag, thereby hindering the separation between liquid slag and solid metal (Schmidt, 1997: 115; MacDonald et al. 2009: 37). Minimal viscosities in slags occur only in a narrow range of temperatures and compositions, which in pre-colonial times may have been controlled by choosing particular ores, varying the proportion of ore to fuel and varying the force of the blast (Rostoker and Bronson, 1990). Some of the gangue materials may have been physically removed during beneficiation. Mortars with visible indentations from hammering were recovered next to metal working Middens 3 and 4 at Rhenosterkloof 1. The raw material for these stone implements (dolerite) is not found in the immediate vicinity of the site (Geological Survey, 1959: 234, Geological Maps 1: 250 000 series of 2426 Thabazimbi 1974), which means that the mortars were purposefully carried to the metal working area for tasks such as beneficiation. Beneficiation was a widespread practice in pre-industrial societies and in India, quartz was separated from magnetite-haematite quartzites by washing them in running water or by winnowing and letting the quartz fall to the ground (Bhardwaj, 1982).

Intact furnaces were very scarce in the area under study but furnace wall fragments were identified amongst other metallurgical debris. The presence of slag on the inner walls of furnace walls separates this group from other burnt clay fragments associated with residential structures. Macroscopically, intense slagging and vitrification was also visible in the tuyeres (Figure 8.6). Notwithstanding the fact that they were broken, some tuyeres still had slag (some of which clogged the tuyeres) and vitrification for up to 25 cm of their longitudinal section, suggesting that they were placed deep into the furnaces. Previously such deep tuyere protrusions were linked with the "preheating hypothesis", in which air passing through the

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tuyere was preheated before it entered the furnace, thereby ensuring that temperature in excess of 1800˚C were reached and high carbon blooms were produced (Schmidt and Avery, 1978; 1983; Avery and Schmidt, 1979; Schmidt, 1997). This hypothesis has since been challenged based on physical grounds (Rehder, 1986; Killick, 1988) but it is acceptable that deep insertion of tuyeres may also have been a deliberate move aimed at gradually sacrificing the tuyeres to facilitate slag formation (Veldhuijzen, 2005). David et al. (1989) demonstrated that the Mafa iron smelters of northern Cameroon used one tuyere that was directed vertically downwards and lost one third of its original length during the smelting process to contribute about 15 % of the silica found in the slag. Other studies have also concluded that the partial melting of tuyeres can contribute significantly to slagging (Veldhuijzen and Rehren, 2006).

Microscopically the ceramic fabrics of the tuyeres and furnace wall fragments were dominated by quartz inclusions (Figure 8.6) that appear to be natural to the clay because they were rounded, unlike intentionally added temper which is irregular (Chirikure and Rehren, 2004). The quartz grains reveal thermal stress in the form of cracks, which when combined with the intense slagging and vitrification, unequivocally demonstrate that they were used in smelting as opposed to smithing (van Schalkwyk, 1987; Crew, 1996; Friede and Steel, 1986). Elsewhere, the shattering of quartz grains has been explained as evidence of intermittent heating and cooling and or chemical attack by the melt (Ige and Rehren, 2003). Despite the occasional presence of bigger fragments (1 mm diameter), most of the quartz inclusions appear to be well sorted and fine with diameters averaging 150 µm (Figure 8.6). This phenomenon is usually associated with the use of quartz-rich slurry from termite mounds (MacDonald et al. 2009: 40). Throughout sub-Saharan Africa, technical ceramics are known to have quartz inclusions, even in cases where deliberate tempering was not practiced (van der Merwe, 1980: 490; David et al. 1989; Gordon and Killick, 1993; Jensen, 1997; MacDonald et al. 2009).

Chemically, the influence of quartz was also evident through elevated silica readings for the technical ceramics (Table 8.5). The average SiO_2–Al_2O_3 ratio was 7: 1 for the tuyeres and the furnace wall fragments from Rhenosterkloof 1, 4:1 (tuyeres) and 5: 1 (furnace walls) for Rhenosterkloof 2 and 4: 1 for tuyeres from Rhenosterkloof 3. For Rhenosterkloof 1, this ratio is significantly higher than that of ores (2:1) and technical ceramics must have contributed significantly to slagging. Charlton et al. (2010) reiterate that SiO_2 and Al_2O_3 are expected to maintain a constant ratio between ore and slag and would be sensitive to any changes in the

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utilisation of ore. Quartz is fairly refractory and its presence in these technical ceramics gave the clay more structural stability, while progressively dissolving to facilitate slag formation during smelting (Rostoker and Bronson, 1990). Paynter (2006: 285) argues that the clay used for furnace structure plays an important role in the formation of slag, particularly when high grade iron ores were smelted. Other researchers such as Fulford and Allen (1992) and Thomas and Young (1999) were able to demonstrate that the furnace lining constituted about 30 % of the smelting slag formed through their analysis of smelting waste from archaeological sites where relatively high grade ores were smelted. Thus, the studied sites show that technical ceramics contributed significantly to the slag formation and as such no flux may have been necessary (Prendergast, 1974).

Magnetite (Fe_3O_4) and hercynite ($FeAl_2O_4$) spinels were also visible in the slagged regions of the furnace walls and tuyeres. These spinels were limited to the regions in contact with the ceramic walls only, which suggest that insufficient reducing conditions were limited to these regions and not the whole furnace. The chemistry of the rest of the major elements for technical ceramics was also comparable, which insinuate that similar clays may have been used to construct tuyeres and furnaces.

With regard to iron slags, four types (furnace, flow, smithing and unidentifiable) were identified (Appendix 6.1). Furnace slags and flow slags are products of iron smelting, typically produced in a bloomery process (Killick and Gordon, 1988). The bloomery process involved the solid state reduction of iron ore into a sponge bloom of impure metal (Schmidt, 1997). On the other hand smithing slags, as the name implies, relate to the refining and shaping of the smelted bloom into a usable tool. The separation of smelting from smithing slags is not easy and must involve both field observations and science-based analysis (Bachmann, 1982; Miller and Whitelaw, 1994; Crew, 1995; Miller, 2002; Serneels and Perret, 2003; Miller and Killick, 2004).

Furnace slag had obvious charcoal impressions that separate this slag type from flow slag, which had an apparent flow structure, but these slags were microscopically indistinguishable (Figure 8.6). However, flow slags tend to be slightly leaner than furnace slags. Wüstite was the dominant phase but metal droplets were also visible (Figure 8.6). The presence of wüstite and iron droplets, over and above the iron used to slag the total silica, suggests that the iron smelting process at these site was inefficient (Morton and Wingrove, 1972). However,

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Kiriama (1987: 127) argues that iron smelting efficiency should not necessarily be judged by the presence or absence of wüstite in a slag, because iron-rich ores may produce more wüstite than leaner ores.

The current suite of furnace and flow slags has blocky fayalite, which suggests that they solidified within the furnace (Chirikure, 2006). No lines of magnetite skins were detected in the microstructure of flow slags but in hand specimen, the flow-like structure was visible (Figure 8.6). Magnetite lines are usually indicative of slag-tapping, in which case individual slag flows from the furnace, forms elongated fayalite crystals perpendicular to the magnetite skin, resulting in the spinifex structure similar to geological lava flows (Park and Rehren, 2011: 1183). In general, furnace and flow slags from all the sites investigated retain the inhomogeneity that is in keeping with other bloomery slags known from elsewhere (Gordon and Killick, 1988; Miller, 2001).

Unidentifiable slags were another category of smelting debris from Rhenosterkloof 1 and 5, which was analysed. Their microstructure was different from furnace and flow slags. They were very heterogeneous with portions that were dominated by dendritic wüstite in angular fayalite and areas with unreacted minerals. Angular fayalite is associated with slow cooling that happens within the smelting furnaces (Chirikure, 2006), suggesting that the smelt may have been stopped before these materials had completely reacted. In some instances partially reduced haematite particles were also visible (Rnk5-1), confirming the earlier proposition that haematite ores were probably smelted.

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Smithing slags were microstructurally similar to furnace and flow slags but with subtle differences (Figure 8.6). They revealed considerable inhomogeneity when compared to smelting slags. Wüstite and iron drops were predominant but in some areas kalsilite was also visible. Other scholars have also noted that smithing slags are generally more inhomogeneous than smelting slags (Tylecote, 1982: 262; Miller et al. 1995). However, inhomogeneity in itself is not a very useful criterion for distinguishing between smelting and smithing slags because it is a characteristic of most bloomery slags in general (Killick and Gordon, 1988; Killick, 1988; Tholander, 1989; Crew, 1991; Pryce et al. 2007, Humphris et al. 2009). Chemically, smithing slags had a slightly lower SiO_2–Al_2O_3 ratio (and lower values) than smelting slags, which points to the fact that the former promoted less reducing conditions that are necessary to facilitate the slow melting of technical ceramics. In addition, smithing slags

have higher iron content than smelting slags (Table 8.5). This is unsurprising because the former comes out of iron rich blooms (Crew, 1995).

According to Killick (1990: 234), polished sections in which more than 50 % by area is metallic iron are defined as blooms. Specimens from Rhenosterkloof 1, 2 and 3 do not satisfy this definition because they consist of iron laden slags that are known as gromp or crown material (Crew, 2000). In hand specimen, these materials were irregular with iron corrosion precipitating on the outside but in cross section they revealed skeletal labyrinths of iron metal with charcoal impressions (Figure 8.6). The same corrosion products were also visible microstructurally but in the less corroded sections, wüstite was the predominant phase. The predominance of iron was repeated in the WD-XRF chemistry of the crown materials (Table 8.5). As products of the smelting process, they also had high SiO_2 content which was comparable to smelting slags.

Two consolidated blooms (T1-22 and T1-23) from Metal Working Area 1 at Tembi 1 were analysed. Consolidated blooms rarely occur in archaeological contexts (Killick, 1990; Crew, 1995). Both specimens exhibit corrosion products on the outside and were evidently consolidated under a forge, as shown by their flattened faces (Figure 8.7).

The occurrence of deformation lines in T1-23 points towards vigorous hammering, probably aimed at consolidating the blooms by flattening projections and tacking together separate fragments of metal (Rostoker and Bronson, 1990: 86). However, such blooms had to be hot worked again to drive out occluded slags and weld the metal particles, before they could be forged into usable tools (Cleere, 1981). An alternative way of removing the slag stringers from the bloom involved allowing slag to drain away on its own while the bloom was resting on the hearth (Atkinson, 1890: 270) but this method has not been reported in Sub-Saharan Africa.

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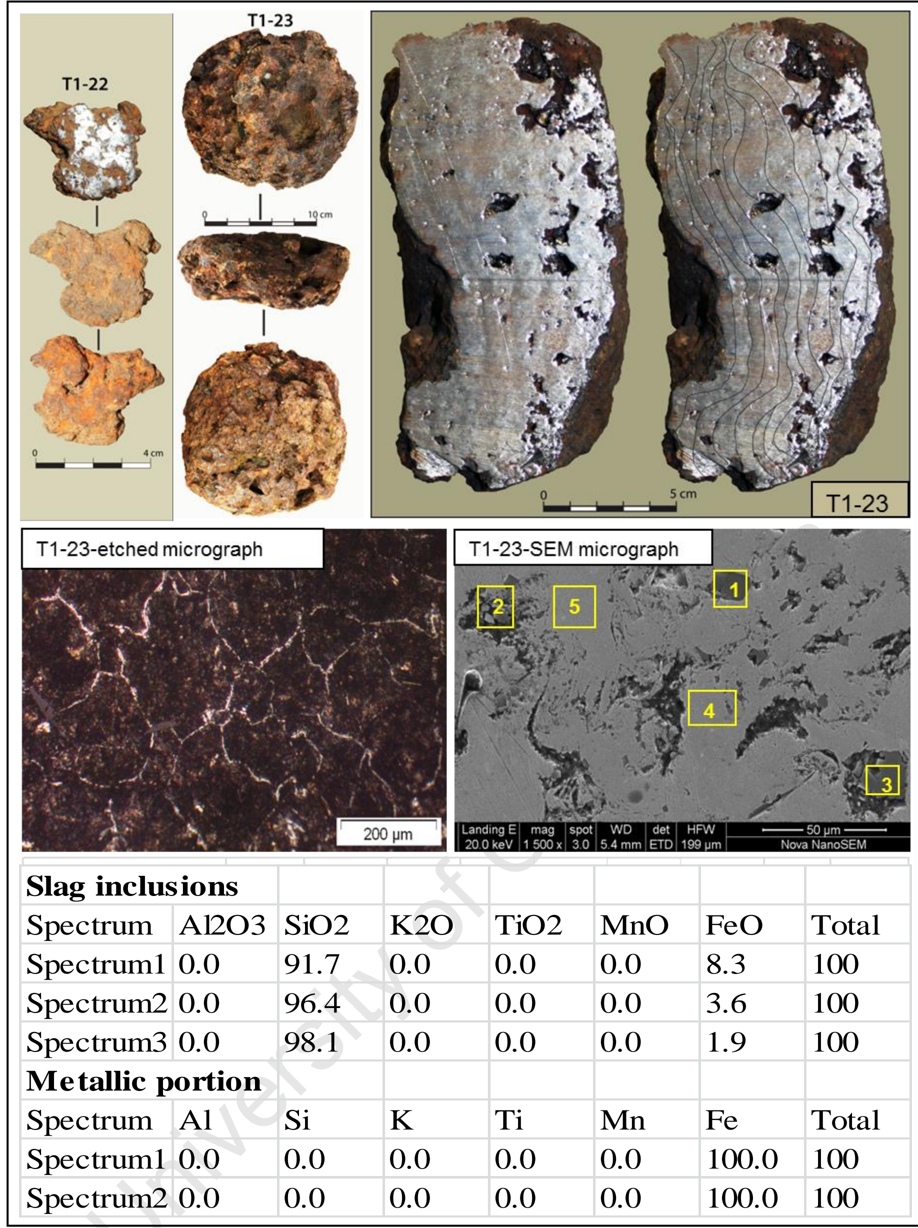

Slag inclusions							
Spectrum	Al2O3	SiO2	K2O	TiO2	MnO	FeO	Total
Spectrum1	0.0	91.7	0.0	0.0	0.0	8.3	100
Spectrum2	0.0	96.4	0.0	0.0	0.0	3.6	100
Spectrum3	0.0	98.1	0.0	0.0	0.0	1.9	100
Metallic portion							
Spectrum	Al	Si	K	Ti	Mn	Fe	Total
Spectrum1	0.0	0.0	0.0	0.0	0.0	100.0	100
Spectrum2	0.0	0.0	0.0	0.0	0.0	100.0	100

Figure 8.7: Photographs and micrographs of blooms from Tembi 1. A photograph of T1-23 was reproduced and digitised to enhance deformation lines (top right). The etched micrograph shows a white network of cementite enclosing grains of pearlite, with isolated slag stringers (grey) crossing the grain boundaries. The SEM micrograph shows siliceous inclusions in consolidated masses of iron, and the chemistry for selected spectra is shown in the table.

The results from qualitative wavelength scans show that the specimens are relatively free from impurities such as sulphur and phosphorous (Appendix 8.2). The two elements are notorious for causing hot or cold shortness of blooms, even though they were rarely a problem in most pre-industrial blooms (Rostoker and Bronson, 1990: 11). Only silica was detected in significant quantities but alumina and calcium were also present in low levels

(Appendix 8.2). Silica does not affect the physical properties of the blooms in any way when it is less than 1 % but the readings in these two specimens suggests that further hot working of the blooms may have been required. The element was higher in T1-23 than in T1-22, probably because the latter enabled the hammering blows to effectively squeeze out the slag because of its smaller size. The carbon content of these specimens was variable but they suggest that smelters were capable of producing hypereutectoid steel.

Optically, the specimens are consistent with the pre-industrial bloomery metal and opposed to the modern industrial one because the latter is generally free of slag inclusions (Rostoker and Bronson, 1990). This microstructure is paralleled by several examples from ethnographic and archaeological contexts (Cleere, 1981; Killick, 1990; Rostoker and Bronson, 1990; Schmidt, 1997; Ackerman et al. 1999).

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WORKING PARAMETERS & REDOX CONDITIONS FOR IRON PRODUCTION

To extrapolate on the working parameters and redox conditions in archaeometallurgical projects, phase diagrams may be used (Bachmann, 1982: 13, Tylecote, 1962: 193). Ternary plots are an example of phase diagrams or equilibrium plots in which three variables, normalised to 100 %, are plotted (Tylecote and Boydell, 1979: 41). There are some reservations regarding the use of phase diagrams to estimate temperature and predict solidification processes in archaeometallurgical remains because they create a "false" sense of equilibrium (Killick, 2001). It has also been argued that common minor oxides like CaO and MgO (that do not always feature in some plots) can in fact increase liquidus and viscosity at intermediate partial pressures (Kongoli and Yazawa, 2001: 585). On the other hand, liquidus calculations assume that the slag was fully fused and homogeneous when in fact most pre-industrial processes produced heterogeneous slags (Bachmann, 1982; Gordon and Killick, 1988; Burger et al. 2007). This is especially true when dealing with slags from non-slag-tapping furnaces (Friede et al. 1982, Miller and Killick, 2004). Moreover the bulk chemical analyses cannot, for instance, independently distinguish between Fe, as in iron or ferrite, $Fe_{2}+$, as in fayalite or wüstite, $Fe_{3}+$, as in haematite and limonite, or $Fe_{2}+/_{3}+$, as in magnetite (Pryce, 2008). This means one needs to be careful when interpreting phase diagrams. Nevertheless, the current suite of remains under study were not chemically complex, when compared for instance with those from Phalaborwa, where TiO_2 is one of the major elements. Friede et al. (1984: 292) posit that FeO-SiO_2-Al_2O_3 work well only under certain conditions such as low CaO and Al_2O_3 contents, fairly high FeO content, medium

SiO_2 content without a higher percentage of other elements. Since the samples under study satisfy the above conditions, a FeO-SiO_2-Al_2O_3 plot was consulted based on some WD-XRF analyses of the iron working remains (Figure 8.8). An overview of this phase diagram reveals a systematic and somewhat repetitive pattern in slag composition and microstructure (Morton and Wingrove, 1969; Tylecote, 1975; Bachmann, 1982; Schmidt, 1997; Miller et al. 2001). Most furnace and flow slags plot in the fayalite-wüstite region of the FeO-SiO_2-Al_2O_3 plot, closer to what Rehren et al. (2007) call Optimum 2. Optimum 1 and Optimum 2 are temperature minima associated with maximisation of slag fluidity relative to energy inputs (Rehren et al. 2007). The former is theoretically associated with less reducing conditions than the latter. In practice the two reflect the configurational parameters of the furnace and charge, all of which are a direct consequence of human decisions regarding furnace design, raw material selection and charge recipe (Rehren et al. 2007: 214). Thus the clustering of these slags around Optima 1 may reflect, as suggested by Kiriama (1987), the use of iron rich ores. In any case, Rehren et al. (2007) reiterate that Optima 1 and 2 do not have fundamentally different melting temperatures and the system would not favour one over the other when a liquid slag is forming at around 1200 °C.

Technical ceramics plot in the cristobalite region because of their high SiO_2 content (Figure 8.8). Smithing slags and crown materials also plot beyond Optimum 2 towards the iron rich regions. For the ores, two samples (Rnk 1-33 and Rnk 1-35) are exceptions because they had significantly higher SiO_2 and Al_2O_3 content and as such plot in the cordierite and hercynite regions. To extrapolate further on the reductive skills of the communities at the different sites, the Reducible Iron Index (RII) was calculated.

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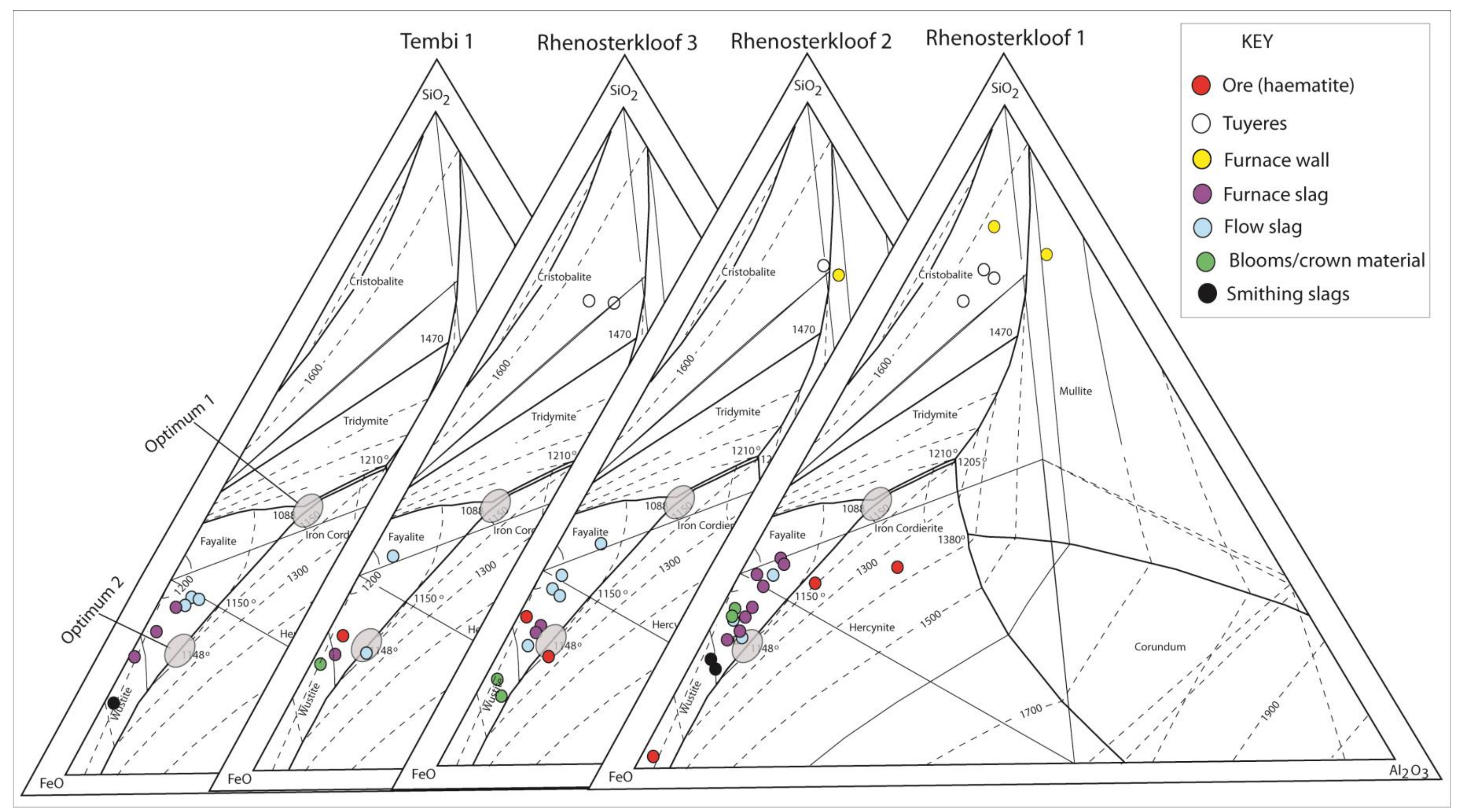

Figure 8.8: FeO-SiO_2-Al_2O_3ternary plot of iron production remains. Based on WD-XRF readings in Appendix 8.1B.

Charlton (2007) and Charlton et al. (2010) suggested that changes in the way the furnace is operated can be assessed better by calculating the RII. The RII can quantitatively be calculated by multiplying SiO_2 by the molar ratio of FeO to SiO_2 in fayalite (2.39) and dividing this product by the sum of FeO and MnO (Charlton et al. 2010). The result is a value of the index which is positively correlated to reduction efficiency. Thus an RII value of 1.0 implies that all of the SiO2 in a slag specimen has been fluxed by FeO (corrected by MnO), while those with values greater than 1.0 retain SiO_2 that has not been fluxed and those with values less than 1.0 retain excess FeO (Charlton et al. 2010). There amount of MnO in the analysed ores are too to have replaced significant amounts of FeO during reduction but the slightly elevated amount of the MnO in the slag suggest that this process took place. Based on WD-XRF values in Appendix 8.1B, the RII for iron slags was 0.77 for Rhenosterkloof 1, 0.73 for Rhenosterkloof 2, 0.70 for Rhenosterkloof 3 and 0.75 for Tembi 1. These values mean that for all the four sites, excess FeO was retained in the slag but one can also suggest that iron producers at Rhenosterkloof 1 were more skilled than those from Rhenosterkloof 3. Nonetheless, the retention of excess FeO in the slag may not have been a major concern, especially when high grade ores were smelted (Kiriama, 1987).

8.5.2: IRON OBJECTS

Seventeen iron objects (fourteen from Rhenosterkloof 1, one from Rhenosterkloof 2 and two from Tembi 1) were analysed (Figure 8.9A and B). These small objects (generally average weight of 50 g and average length of 9 cm) were limited in number when compared to the volume of the production remains (Figure 8.9A and B). The paucity of large metallic objects at these sites is not unique, but has also been reported, even at sites linked to renowned metal workers (Fagan, 1964; van der Merwe and Killick, 1979; Maggs, 1982; 1991; Holl, 2000; Miller et al. 2001). In the archaeological record, metallic objects appear to be more ubiquitous as grave goods, and as such their absence in settlement contexts does not necessarily mean that less metal was produced (Holl, 2000: 45).

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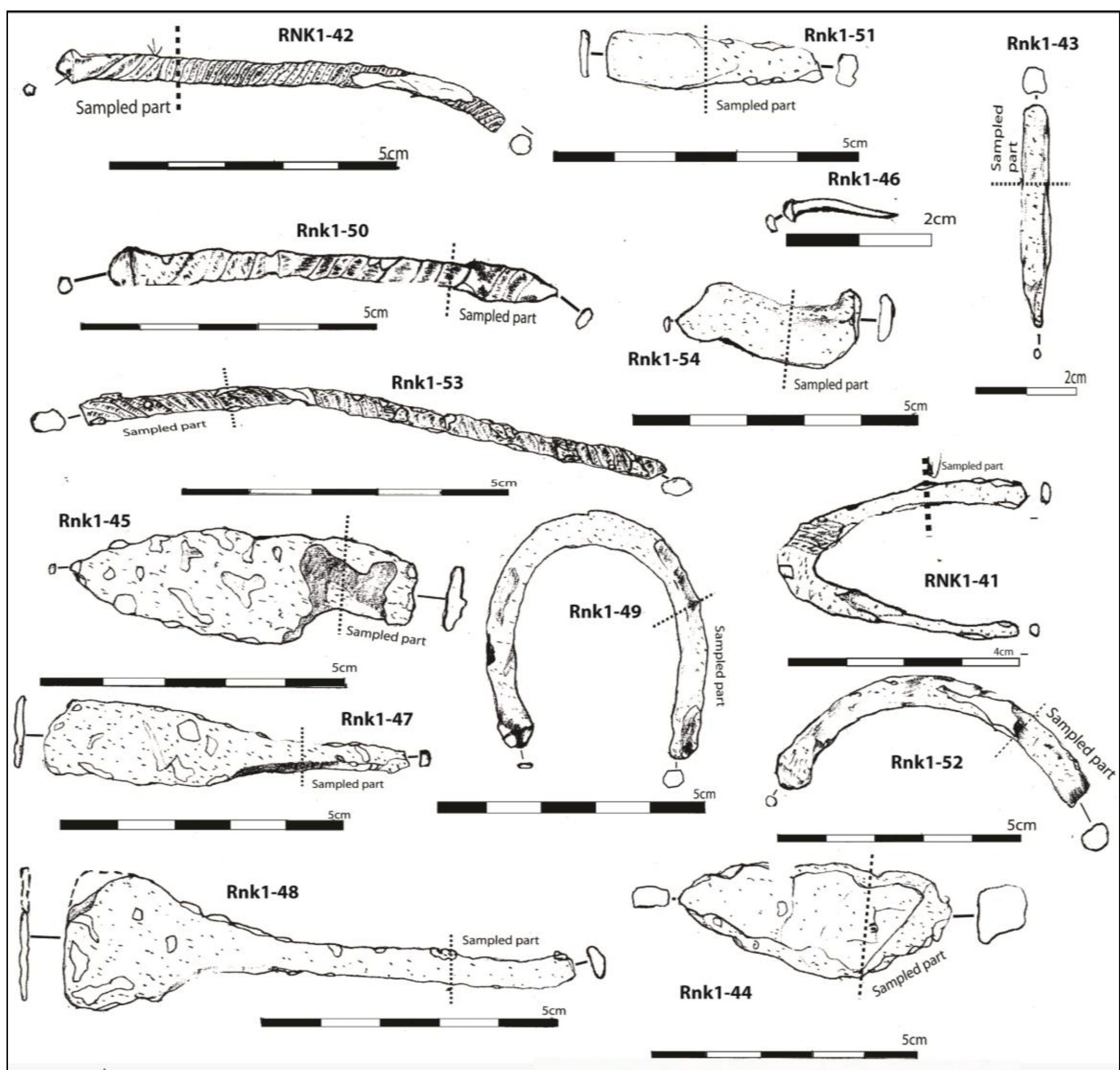

Figure 8.9A: Iron objects from Rhenosterkloof 1. Rnk1-42, Rnk1-49, Rnk1-50, Rnk1-52 & Rnk1-53= bangles; Rnk1-41= pendant?; Rnk1-47, Rnk1-48, Rnk1-51, Rnk1-45= blade, Rnk1-46= pit/nail; Rnk1-43, Rnk1-44 =small bars; Rnk1-54=unfinished object.

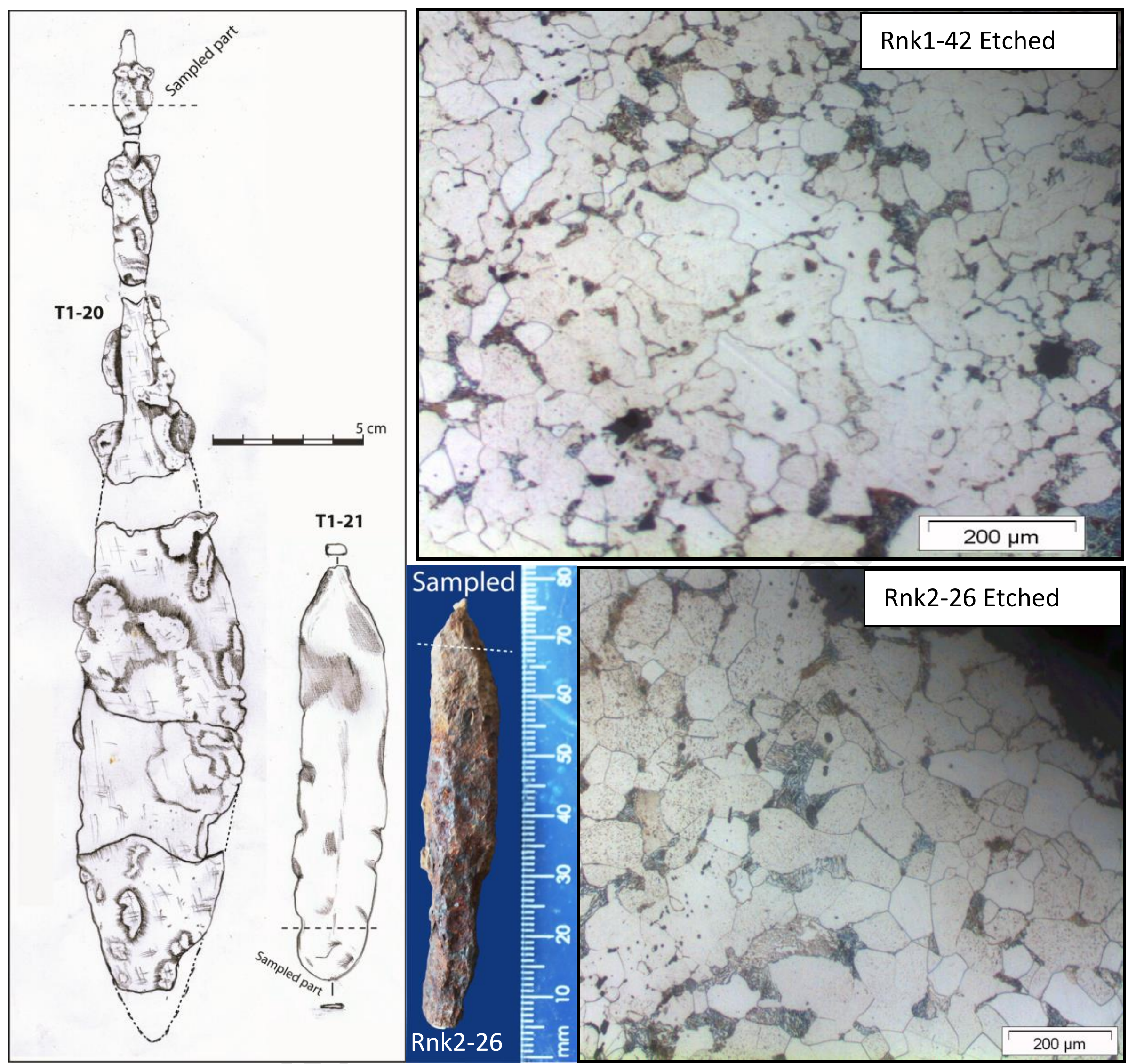

Figure 8.9B: Illustrations of spearheads from Tembi 1, a photograph and micrographs of iron objects from Rhenosterkloof 1 and 2. Micrograph Rnk1-42 shows a transverse section in which round slag dots are embedded in course ferrite and course pearlite islands. Micrograph Rnk2-26 shows course pearlite islands that grade to pearlite with grain boundary and ferrite. Elongated slag stringers also appear as dark areas.

The majority of these iron objects still retain sound metal below the oxidised surface. Standard microscopic procedure for analysing metallic objects was followed as outlined in standard texts (Brick et al. 1965; Samuels, 1980). It was clear that the specimens were made from indigenous bloomery metal because they have slag stringers that are generally not expected from modern industrial metal (Rostoker and Bronson, 1990). The objects are plain carbon steels, whose microstructure is varied in keeping with their composition and mechanical and thermal history

(Greaves and Wrighton 1957; Brick et al. 1965; B. Scott, 1975; van der Merwe, 1977; Samuels, 1980; D. Scott, 1991; Miller, 1992b).

Three different forms of iron in combination with carbon (ferrite, cementite and pearlite) were detected (Figure 8.8B). Ferrite is a soft and ductile low carbon phase of iron capable of containing up to 0.02 % carbon in solution (Miller, 1992b). On slow cooling it typically forms large polyhedral grains but relatively rapid cooling, such as cooling after normalisation, results in crystallisation into the characteristic laths that give rise to the Widmanstätten structure and appears white under a microscope, when etched (van der Merwe 1977). Normalisation refers to reheating steel to a temperature exceeding the upper limit of the critical range but unlike annealing where the steel is then cooled slowly, it is allowed to cool in air at a relatively faster rate than the latter (Greaves and Wright 1957: 88).

Cementite, on the other hand, is a hard and brittle iron carbide (Fe_3C) which forms in small quantities at grain boundaries in very low carbon steels (B. Scott, 1975; Denbow and Miller, 2007). Its hardness makes it easier to identify microscopically because if a scratch is made on the specimen, it broadens in passing through ferrite and pearlite but becomes narrow or disappears when passing across cementite (Greaves and Wrighton, 1957: 91). In higher carbon steels cementite crystallises in a typically lamellar intergrowth with ferrite to form a eutectoid called pearlite (Figure 8.9B) whose carbon is about 0.8 % (Denbow and Miller, 2007: 284).

Both hot and cold working of iron objects appear to have been practiced. According to Miller (1996) hot working between 700˚C and 1000˚C allows the metal to be shaped plastically and results in elongated slag inclusions. Dark slag stringers arranged longitudinally in the microstructure of ferrite grains as a result of hot working, were a common feature in the iron artefacts, suggesting that this method was employed unselectively on both decorative and utilitarian objects. The hot worked objects appear to have been normalised and air cooled relatively slowly as evidenced by the presence of the typical Widmanstätten structure. With small objects such as the current suite, welding was unsurprisingly not evident (Childs, 1991). On the other hand cold-working (at temperatures lower than the critical range or near ambient temperature) may leave traces of grain deformation and fractured glassy inclusions or strain lines

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(Figure 8.9B). Cold working tends to leave the object more susceptible to corrosion attack because of the fractures (Miller, 1996). Forging the objects in oxidizing environments decarburised the high carbon smelting products (blooms) and there were no signs of intentional hardening processes such as quenching or carburization, neither was there evidence of iron wire drawing. The isolated occurrence of high carbon areas in the samples is a telltale sign of uneven and "unintentional" carburisation of the bloom during smelting (B. Scott 1975). Similar patterns are reported by several scholars in the region (Frobenius, 1931; Stanley, 1931; Schultz, 1950; Henger, 1970; Friede, 1975; 1977; 1979; van der Merwe 1977; Friede and Steel, 1986; Miller, 1992a; 1992b; 1996; 2001; 2002).

8.6: SCALE OF PRODUCTION

It is difficult to calculate the relative quantities of remains represented by different metals because at most sites, the production remains of different metals are mixed up in the dumps. Additionally, there only thin smears of metallurgical remains at majority of the sites and consequently volume calculation per unit could were not possible. The subsequent estimates of the scale of production are only based on three sites of Rhenosterkloof 1 and 2 and Tembi 1 where there is significant metal production remains. To estimate the scale of production at these sites, I used slag (volume), because this requires fewer assumed constraints (Killick, 1990: 164) and I followed the suggestions provided in Acta Archaeologica (2009) for iron production sites in West Africa.

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For Midden 3 (Rhenosterkloof 1), 27 buckets of slag were counted from a 2 m X 2 m trench and the average weight for each bucket was 15 kg. The maximum depth of this trench was 0.6 m but a 1 m X 1 m test pit sunk five meters away revealed that the midden was only 0.4 cm in that area. This gives an average depth of 0.5 m. The area of the midden was 15 m X 10 m and its shape was fairly rectangular (Figure 5.8). The calculations were done as follows.

The **volume of the midden** was 15 m X 10 m X 0.5 m = **75m^3**.
The **volume of deposition from the trench** was 2 m X 2 m X 0.6 m = **2.4 m^3**
The **volume of the slag from the trench** was 27 (buckets of slag) X 15 (average bucket weight) = **405 kg**
The **volume of slag for the whole midden** was (**75m^3 /2.4 m^3**) X **405** = **12 656.25 kg**.

Slag volume from Midden 2 at Rhenosterkloof 2 was calculated based on two trenches sunk on this midden (Trench 2 and Trench 3), following the formula adopted for Rhenosterkloof 1. Trench 2 produced 13 buckets of slag from a 2 m X 2 m excavation that went to a depth of 0.4 m. Trench 3 on the other hand produced 17 buckets of slag from a 2 m X 2 m excavation with a depth of 0.3 m. Both trenches were sunk on the outer edges (about 20 m away from each other) of this 20 m X 22 m midden that lay on generally flat ground (Figure 5.10). The average weight of each bucket was also 15 kg. The disparities in trench depth and buckets of slag between the two trenches do not only show that the depth of the midden was variable, but also that the slag densities were not uniform throughout. Based on figures from Trench 2, the volume of slag is estimated at 42 900 kg but Trench 3 gave a much higher figure of 56 100 kg. The average reading was 49 500 kg.

Excavations at Metal Working Area 1 (Tembi 1) only produced 5 buckets from a 7 m X 7 m trench that was only excavated to 0.05 m. However, metallurgical remains were spread over an area which is about 30 m in diameter. Using the same formula and average weight of each bucket as the one used for the Rhenosterkloof sites, the estimate volume of slag at Metal Working Area 1 is 1081.53 kg.

The above figures support the macro observations made during the fieldwork. At Rhenosterkloof 1, it is difficult to be certain about whether the large metal dumps are associated with the excavated middens or with the stone walling component, but the contrast between Rhenosterkloof 2 and Tembi 1 is more informative on the scale of metal production. Rhenosterkloof 2 represents a small homestead, in terms of spatial extent, number of structures and cultural material from domestic middens, but it has a large quantity of metallurgical debris. On the other hand, Tembi 1 has a large homestead with some metal production remains. Clearly, metal production was the main economic activity at Rhenosterkloof 2 and the output outstripped the metallurgical needs of this small homestead. The same cannot be said for Tembi 1, where metal production must have been geared towards satisfying homestead demand. It is also clear that in the area under study, there is no correlation between political scale and the scale of metal production.

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8.7: SUMMARY

This chapter began by presenting the analyses of the crucible sherds discussed in the previous chapter. It has been shown that all crucibles analysed were used in bronze production. This suggests that the inferred chronology of bronze production that is commensurate with evidence from elite sites in southern Africa can be assumed, pending further investigations on a bigger sample. Tin, copper and iron were also produced at Rhenosterkloof 3 which is associated with the Eiland phase. The identification of tin and bronze at this site may be significant because of the possible association with the Eiland phase. Evidence for tin and bronze production was also identified at Rhenosterkloof 5, 6 and 8 that are all associated with the Madikwe phase. The association of this metallurgy with the Madikwe phase is not new in the Southern Waterberg (Grant, 1994; Miller and Hall, 2008; Chirikure et al. 2010). For the Rooiberg phase, Rhenosterkloof 1 produced evidence of iron, tin and bronze production, but Rhenosterkloof 2, 4 and 7, and Tembi 1 only produced iron and tin production remains.

Iron ores are abounding around Koppieskraal ridge, but no copper or tin ores were located. The inability to distinguish copper slags from iron or even tin may have led to the rather conspicuous absence of copper slags in the archaeometallurgical record of the sites under study. Most of the technical ceramics (tuyeres and furnace wall fragments only), irrespective of the metal or alloy, appear to have been made from quartz rich slurry, probably collected from ant hills. Blooms and metallic objects were scarce at most sites, probably because they were traded or recycled (Charlton, 2009). The two sites of Rhenosterkloof 1 and 2 represent significantly high scales of metal production when compared to several sites in the area under study but this scale is not less than that which is typically found in west Africa. These issues and several others that have been raised in previous chapters are discussed in detail in Chapter 9.

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CHAPTER NINE: DISCUSSING THE ARCHAEOLOGY&METALLURGY OF THE SOUTHERN WATERBERG

"But the fact is that the archaeological data available to us are inadequate to answer these questions and will always be so. Clearly we need to think outside the box of pure economic analysis, we should instead consider the whole range of available evidence" (Killick 2009b: 195)

9.1: INTRODUCTION

Most of the previous chapters were inescapably focused on local observations as a way of increasing the resolution required in different analytical approaches. This chapter attempts to generate greater correspondence between different analytical methods and theoretical strands as well as the wider discussion on developments within the southern African region and beyond. While, relevant information has been drawn from desktop surveys, field work, laboratory analyses and broader theoretical frameworks, the inherent inadequacy of the data is also appreciated. However, as argued by Killick (2009b: 195) this limitation will always be there in most archaeological projects and researchers must come up with ways of transcending them, while remaining true to the available data. Often, this means going beyond the traditional interpretive framework and tapping into the less obvious patterns, some of which are not necessarily depicted in the site specific data.

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This thesis is focused on exploring the innovation of tin and bronze production and its associated metallurgy in the Southern Waterberg, using the analytical strengths of both archaeological and archaeometallurgical approaches (see Chapter 1). Several key issues have since arisen from these seemingly straight forward aims. The chronology and reconstruction of the metal technologies are some of the obvious substrates that are explored in this discussion. Issues of interaction, trade, organisation and scale of metal production are discussed. Conclusions are summarised at the end of the chapter as a way of consolidating and reflecting on the successes and challenges encountered in this study, as well as pointing out areas for future study.

9.2: SORTING OUT THE CULTURE HISTORY

"It is no longer acceptable to simply equate ceramics with ethnicity or to use them as chronological tools and little else; ceramics are a key resource in the region, and archaeology needs to draw as much data and insight from them as possible" (Ashley, 2010:158)

Ceramic and settlement data from the sites under study intimated the occurrence of the Eiland facies, Ntsuanatsatsi/Uitkomst facies, Madikwe facies and Rooiberg facies. A Previous study by S. Hall (1981) also confirmed the presence of the Diamant facies. The latter marks the earliest Iron Age expression in the Southern Waterberg, but as suggested by S. Hall (1981), sites with this facies are small and occur in arable lands. The same also holds for the Eiland facies that succeeded the Diamant facies. No significant centralised polity is associated with both of these EIA ceramic communities, which is also the case with the first Moloko ceramics to appear in this area (Madikwe facies). The traditional time brackets for the Madikwe facies (1500-1700 AD) and the Eiland facies (1000-1300 AD) insinuate that the former appeared on the landscape, well after the latter had faded (Huffman, 2007: 199, 231). However, existing ceramic data suggest interaction between vestiges of Eiland communities and Madikwe communities because characteristic Eiland traits such as herringbone do occur in the Madikwe facies, not only in the Southern Waterberg (S. Hall, 1981) but also in the Marico district to the south (Boeyens, 2003).

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The separation between the Eiland facies and the Madikwe facies cannot be gainsaid. Evers (1983) has demonstrated that there is a discontinuity between the Eiland facies and the early Moloko sequence. Indeed, besides the isolated herringbone motifs, the Eiland facies is clearly different from the Madikwe facies (Figure 7.12 and 7. 14). Herringbone is a characteristic feature of the former (it also occurs in its precursor, the Diamant facies) and that its presence in the Madikwe facies and its absence in the Icon facies (the precursor to the Madikwe facies), suggests contact with the EIA communities. No Eiland or even Broadhurst facies (1300-1430 AD) has been found in the Marico district, which means that the implied interaction between these EIA and LIA communities must have taken place in the adjacent Waterberg region. A later expression of the Eiland facies (dating to the 15th century) has been reported in the Northern Waterberg (van der Ryst, 1998).

The continuity of some motifs across the Eiland and Moloko divide is also underpinned by the presence of Eiland stylistic features in Rooiberg assemblages. For instance, one vessel from S. Hall's (1981: 128) original excavations in Midden 1 at Rhenosterkloof 1 has Eiland herringbone motifs and an Eiland layout (Figure 9.1).

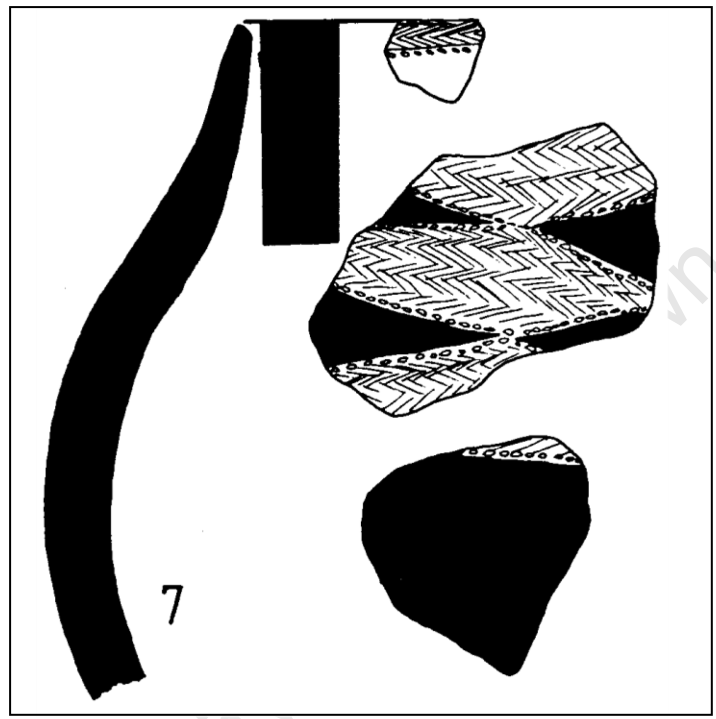

Figure 9.1: A Rooiberg potsherd with Eiland features from Rhenosterkloof 1 (after S. Hall, 1981: 128).

While this vessel may be an intrusion, its relative completeness indicates that it is contemporary with other Rooiberg ceramics. These include some vessels that could be placed in the Madikwe phase (S. Hall, 1981), which supports further the contemporary and overlapping chronology between Madikwe and Eiland. This is an important point to remember, because, as will be shown later, it has implications on the introduction of tin and bronze working to Madikwe communities. If the two communities were in contact and Eiland people were working tin (as is cautiously suggested here), there is no reason to assume the Madikwe people had to re-discover for themselves the exploitation of this metal.

During the Madikwe period, other groups, related to Nguni-speaking communities also start appearing in the Southern Waterberg (Huffman, 2007). The isolated stone walled sites such as those documented at Rhenosterkloof, Tembi and Onverwacht farms may be Type-N sites related to Ntsuanatsatsi/Uitkomst ceramic groups from the Free State Province (Maggs, 1976). The settlement layout of Tembi 1 (and Smelterskop) conforms to another group of Nguni-speakers related to the Moor Park phase. These Moor park settlements are located on hilltops and are more aggregated than the Ntsuanatsatsi/Uitkomst settlements. Unfortunately, ceramic evidence from these Nguni-related sites is insufficient for extensive classification.

The convergence of Ntsuanatsatsi/Uitkomst and Moor Park communities on the Southern Waterberg may have been attractive because of the opportunities to exploit tin and add it to their economic production. But the scale of tin production seen at Tembi 1 and Smelterskop (Moor Park phase), as well as the smears of slag debris from the various Ntsuanatsatsi/Uitkomst sites in Tembi farm, suggests that tin production was not a major part of the economy. Whatever the case, Ntsuanatsatsi/Uitkomst communities must have been on the landscape at the same time with the Madikwe communities, because that is the only way to explain the development of the Rooiberg facies (characterised by a combination of comb stamping and incisions). The earliest incidence of comb stamp design with horizontal lines in the neck date to the 15th century at Ntsuanatsatsi in north eastern Free State (Maggs, 1976: 140) and indeed this technique is unknown in the Madikwe facies, which reinforces the suggestion that Ntsuanatsatsi/Uitkomst communities must have been in the Southern Waterberg, perhaps from early 16th century AD, because this technique is represented in the Rooiberg facies (Huffman, 2007).

The nature of the Rooiberg facies in the Southern Waterberg deserves some commentary. The current study, as well as a reappraisal of previous studies (S. Hall, 1981 and Fichardt, 1957), has revealed that hardly any Rooiberg vessels are decorated with both incisions and comb-stamping. It is highly likely that this dichotomy is speaking of the separate origins of the two techniques because in the Madikwe facies, incisions appear together with other techniques such as impressions. Thus, it can be suggested that women, although living within the same communities, they retained a stylistic inheritance of quite different origins and consequently, incisions (from Madikwe) were not merged with comb-stamping (from

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Ntsuanatsatsi/Uitkomst) on the same vessels. What other expressions might indicate the continuity or change in the technology of metal production? Unfortunately, attempts to expose other developments that resulted from this merger are limited by the fact that most of the metallurgical evidence, especially the style and morphology of furnaces is scarce. Elsewhere, a similar ceramic merger between the Khami facies (related to Shona people) and the Icon facies (related to Sotho-Tswana people) is associated with the emergence of a new type of furnace (the cylindrical-shaped furnace with a wide chimney and three openings for tuyeres at equidistant intervals) and even a new language (Venda) (Küsel, 1974; Friede, 1979; 1980; Loubser, 1991; Huffman, 2007). It remains to be seen if the merger between the Ntsuanatsatsi/Uitkomst phases with the Madikwe phase in the Southern Waterberg, produced other visually discernible evidence such as furnaces, besides the ceramics and settlement organisation. Nonetheless, metal technological practices, to which I now turn, seem to be suggesting continuity.

9.3: METALLURGICAL TECHNOLOGIES: PROCESSES & PRACTICE

"The following do not represent universal practice by any means: local variations, anachronistic methods etc existed" (R. Smith, 1996: 96)

So far I have discussed the general archaeology of the Southern Waterberg and have emphasised ceramic typology and settlement layouts. The archaeology at this stage cannot be more specific about how this data relate to the introduction of tin and bronze production into this area. What can be said is that the Southern Waterberg ceramic sequence indicates that phases overlapped, people intermarried and that the appearance of Madikwe and Ntsuanatsatsi/Uitkomst phases implicates people arriving from some distance away. In the case of Madikwe, this appearance was from the north, where the earlier phase (Icon) is evident on the Shashe-Limpopo landscape, soon after the decline of Mapungubwe. What these connections and overlaps imply is that intermarriage and social and kin connections between agriculturalist communities in the Southern Waterberg could have been networked with the wider region. Whatever the case, the continuity in the Waterberg sequence implies that tin and bronze was a metallurgical innovation that possibly occurred in the context of the rise of state systems in the Shashe-Limpopo region and beyond. Once "learnt", it became embedded within the metallurgical sequence. In order to explore continuity in tin and bronze production, it was important to study the metallurgical processes for these metals. The

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analyses of metallurgical debris and artefacts analysed in the present study are congruent with previously noted examples from sub-Saharan Africa and beyond. I outline the salient features of the major stages in the production cycle of these materials. There are obviously gaps in the data that render the reconstruction of the whole *chaîne opératoire* of the metals impossible. The processes important in the production of the metals are summarised in Figures 9.2.A to D. Mining for iron ores was rarely sub-surface when compared to copper, gold or even tin (Summers, 1969). The occurrence of subtle and shallow quarries for haematite on the north eastern end of Koppieskraal ridge is in keeping with this observation. The same method together with alluvial panning and subsurface digging were carried out for tin ores in the Rooiberg and Boschoffsberg valleys (Figure 2.3 and 2.4). Perhaps the mineralisation of tin in the Southern Waterberg, which allowed for relatively easy mining compared, for instance, to that of the Zaaiplaats tin field, probably explains why there was large scale tin mining in the former, despite the wide spread occurrence of tin in the region (Caton-Thompson, 1931, Killick, 1991).

The smelting of iron, copper and tin was done in forced draught furnaces, as noted elsewhere (Grant et al. 1994; Craddock, 1995; Heimann et al. 2010). It is not possible to tell which furnace type was used for which metal but two paired bowl furnaces were recovered from the Rhino Andalusite Mine site (Huffman, 2006; Figure 2.5) and two other twinned bowl furnaces (but morphologically different) from Rhenosterkloof 1 (Figure 5.9). The former are associated with the Madikwe facies but the latter are associated with the Rooiberg facies and are reminiscent of the "butterfly type" discussed by Maggs (1982) for the KwaZulu-Natal region. It appears the pairing of furnaces was an innovation aimed at maximising on labour because one person could pump the bellows for the two furnaces simultaneously from one end, while the other person was doing the same on the other end. It also appears as if the bloom was recovered by breaking down portions of the furnace, which explains the paucity of superstructures in most furnaces recovered in the Southern Waterberg. The two apertures on the bowl furnaces from Rhenosterkloof 1 appear to be well suited for this practice, which then meant that the rest of the furnace walls will be preserved. In the present study, it was not possible to determine which metal was produced in these paired bowl furnaces but elsewhere, it has been shown that copper was worked in smaller bowl furnaces (comparable to the Rhenosterkloof 1) than those of iron (Anderson, 2009).

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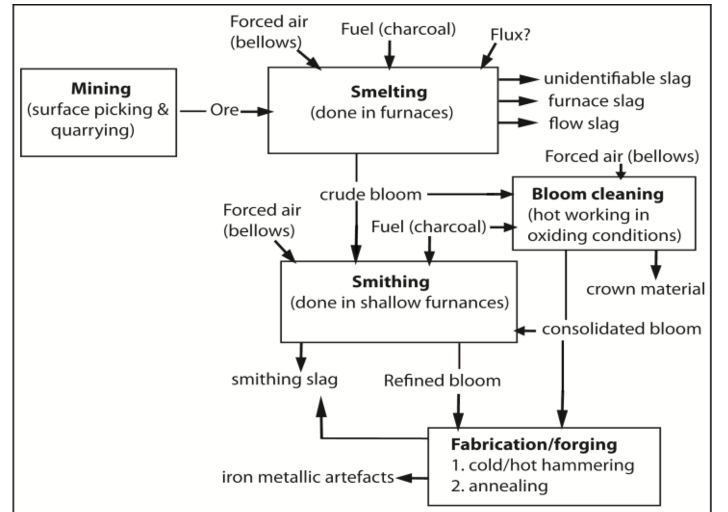

Figure 9.2.A: The chaîne opératoire for iron production.

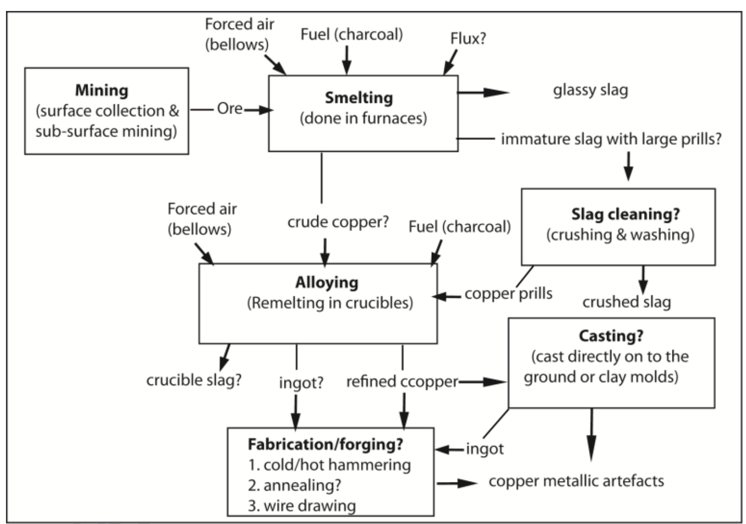

Figure 9.2.B: The chaîne opératoire for copper production.

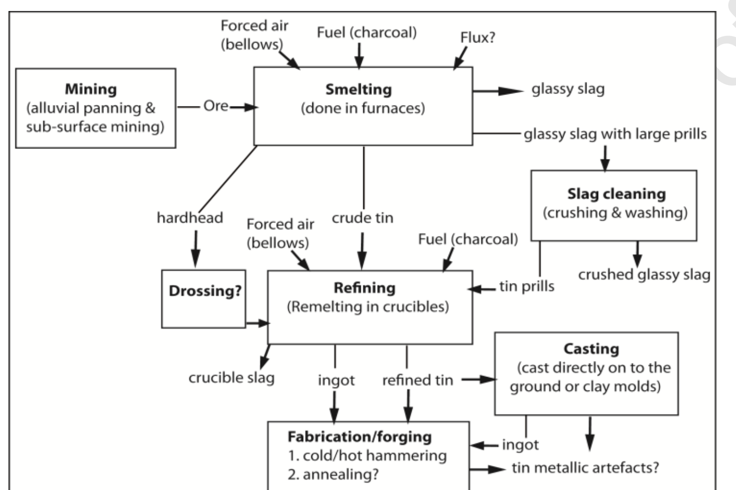

Figure 9.2.C: The chaîne opératoire for tin production.

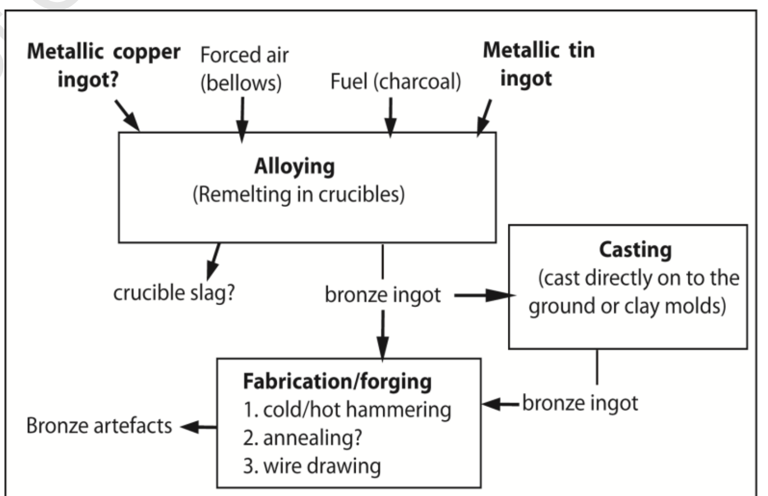

Figure 9.2.D: The chaîne opératoire for bronze production.

Iron, copper, tin and bronze production techniques are similar for the different ceramic phases. The smelting slags are mostly inhomogeneous, which is in keeping with the indigenous smelting practices. No slag tapping or addition of fluxes appears to have been practiced for all the metals. Nonetheless, the possible mixing of different grades of iron ores during iron smelting suggests that the function of a flux was understood but was unnecessary in most cases. No major technological differences were evident in the tin production evidence from different time periods and this is logical, given that the ceramic sequence shows that later groups, such as Madikwe may have derived their tin production knowledge from Eiland communities. Whichever way, this suggests that tin production, once started was simply embedded within existing technology with little technological change, such as keeping the reducing conditions low in order to avoid the simultaneous reduction of iron and tin to form hardhead (Miller and Hall, 2008).

Evidence of copper smelting is meagre but this may be a result of sampling or indeed that the amount of copper ore in the region is not high. One needs to remember that efficient copper smelting can remove almost all the copper, leaving a lean slag with very low quantities of copper and visible metallic iron (Killick, 1986; Miller et al. 1995), all of which makes it difficult to separate them from iron slags. The recovery of copper smelting slag at Rhenosterkloof 3 indicates that more copper working remains maybe found.

The recovery of tin and copper prills from immature slags through crushing must have been practiced. R. Smith (1996) posits that this practice was a common exercise for tin smelting operations in Eurasian prehistory. After crushing the slags, the flattened prills were then collected by hand-picking or sieving, before being re-melted to purify them and for casting (R. Smith, 1996). Where bowl furnaces were employed, it was possible, as demonstrated in experimental work by Tylecote (1990: 44) to produce plano-convex ingots (Figure 2.6) as primary products without having to re-melt prills and cast them in a mould. In Eurasia, very pure tin was sometimes obtained by smelting in a furnace using charcoal, and carrying out drossing (oxidising impurities when molten and skimming off surface) (Tylecote, 1990: 46; Loughman, 2007). While it is possible that this practice may have been practiced in the Southern Waterberg and relatively pure tin ingots have been documented (Killick, 1991), this area still needs further work.

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Smaller and shallower furnaces must have been used in iron smithing because of the very limited furnace wall fragments recovered at contexts related to this activity at Tembi 1. Blooms (between 50g and 5kg) recovered from smelting furnaces, were fired in these furnaces and hammered, starting with light blows to consolidate and tack together small pieces, before vigorously hammering them to drive out occluded slag (Rostoker and Bronson, 1990). This evidence is very ephemeral in the archaeological record but was better represented at the site of Tembi 1 where two blooms were recovered (Figure 8.7). Blooms earmarked for sale or distribution, were shaped flattened balls (T1-23) but those for forging into usable tools (T1-22) were hot worked further to drain away excess slag. The forging of iron objects was fairly simple and limited to hot and cold working, with occasional annealing (Figure 8.7) without quenching or tempering which are wide spread in Eurasia (Miller, 2001; Killick, 2009b). Harder surfaces would have been obtained by cold working even though this partially weakened the objects and made them susceptible to corrosion (Rostoker and Bronson, 1990). It is also interesting to note that iron objects were also used in the expressive sphere despite the fact that tin and bronze were also worked at these sites (Figure 8.9A). However, iron artefacts were generally scarce when contrasted with the large amounts of slag produced at Rhenosterkloof 1 and 2. The implication is that blooms were recycled and traded out even used as funerary goods, as was the case elsewhere (Crew, 1996; Holl, 2000). The context of metal production at Rhenosterkloof 2 (and to some extent Rhenosterkloof 1) was clearly suggests that the scale of production is completely out of proportion to the extremely small homestead it is associated with.

A bronze casting spill from Rhenosterkloof 1 is consistent with bronze artefacts from the region that have about 10 % tin content. Slagged crucibles also intimate the production of bronze at Rhenosterkloof 1, 3, 5, 8, 9. Notwithstanding the small samples, it appears that alloying was achieved by mixing already smelted tin and copper, a technique which enabled some control over the ratios of the two metals (Rovira, 2007). Nonetheless, this did not produce homogeneous bronzes, as evidenced by the different EDS-SEM readings taken from different parts of the prills and artefact. This alloying was done in ceramic crucibles that were further insulated in a cluster of large rocks to allow for the pumping of bellows, necessary for melting of these metals (Wagner and Gordon, 1929: 564). The presence of heavy slag attack on the inside of the

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crucibles contrasts with the unaltered outside surfaces and suggests that the source of heat was inside (Calabrese, 2000).

Copper, tin and bronze must have been cast into ingots. Several ingots of these metals and alloy are known from elsewhere in southern Africa (Appendix 2.1 to 2.3). The relatively average tin content in the bronze prills analysed must have resulted in average castability (due to slightly lower liquidus and solidus temperatures (Valério, 2012). The presence of precipitated tin in some areas of the casting prill (Rnk1-56) is an indication that this process was not practised in a systematic way. Lack of control over the cooling rate after pouring is understandably problematic especially for small artefacts that will naturally cool faster to form cored microstructures and form alpha and delta eutectoids (D. Scott, 1991). Generally, alloys of copper and tin (bronze) and copper and zinc (brass) are much easier to cast than copper alone because they melt at much lower temperatures than copper and generate fewer gasses to cause blowholes and porosity in the finished products. However, the heterogeneity in some of the prills shows that temperatures may not have been sufficient to homogenise the melt (Rovira, 2004).

It is important to remember that while ingots in Eurasia were primarily temporary artefacts made with the intention of melting down at a later date (Loughman, 2007), in southern Africa some of these ingots such as the ceremonial *MuTsuku* were end products in themselves (Thompson, 1949). Ethnographic and archaeological examples of tin, copper and bronze ingots from southern Africa show that their size and shape varied according to purpose and the style required in different areas. For instance, the *MuTsuku* (singular) copper ingot of the Lemba and Venda people fell into two types, one of which was commercial while the other one was ceremonial. The former varied in size according to their respective value, while the latter was generally larger but hollow (Thompson, 1949: 16). In Europe, simpler shapes such as plano-convex, square, rectangular slabs and H-shaped tin ingots have been reported at sites like Erme Estuary Ingot site (Loughman, 2007). These simple shapes would have been achieved by casting directly on to the ground or in stone moulds as was the case in some parts of Indian (Babu, 2003). It appears most tin was made into ingots and traded out of the Southern Waterberg.

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The lost wax technique, applied for casting more complex and sometimes finely decorated artefacts was never used in the southern Africa (Miller, 2001; Denbow and Miller, 2007). The closest but debatable example of this technique is that of a bronze spearhead found at Khami and examined by several experts who have concluded that it may have been cast by the lost wax method but was not well enough preserved to demonstrate this unequivocally (Robinson, 1959; Herbert, 1984: 87). In the lost wax method moulds were made of bees-wax which burnt out after casting (Coghlan, 1975).

Another curious method that was practiced in the Southern Waterberg is wire drawing. The precise start date of this technique is debatable but has been attested at a 10th century cemetery in the DRC and became more visible in the second millennium AD century throughout southern Africa (Herbert 1984). Further south, other examples of this technique come from Great Zimbabwe, Danangombe and Ingombe Ilede (Fagan, 1969; Lagercrantz, 1989). This technique was executed by a simple pincer and draw plate with different sizes of holes (Steel, 1975). One end is hammered to a point small enough to be fed into the drawplate hole and held fast by pincers or a vice, before a drawplate is pulled against the remaining rod while the pincer is fastened to a tree or a pole (Herbert, 1984: 78). Alternatively, it was the pincers that was used to pull the metal while the drawplate is fastened. The piece of coiled wire from Rhenosterkloof 1 (Figure 8.2) appears to have been drawn and annealed. S. Hall (1981: 99) also found a wire with evidence of wire drawing from this site. An experiment conducted by Steel (1975), based on ethnographic accounts, is consistent with these observations. Steel (1975) noted the slow efficiency that comes with annealing after each pull, as well as the significance of lubricating the plate hole with fat to reduce shearing, which results in less striation marks.

9.4: THE SOCIOLOGY & SPATIALITY OF METAL PRODUCTION

"In a study of traditional industries the ritualistic features cannot be divorced from the mechanical descriptions of processes" (McCosh, 1979: 155).

While, the present study emphasises the technical analyses of metallurgical debris and artefact, an emphasis was also placed on the social contexts in which the artefacts were produced. The patterns from the sites in the present study are complex and not clear. Rhenosterkloof 1 produced production debris related to smelting (iron and tin), smithing (iron) and melting/casting (bronze),

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from the same dump (Middens 3/4). Two *in situ* furnaces were also recovered next to this dump but no slag was found inside them, making it difficult to relate them to either iron or tin smelting. Midden 1 and 2, as well as Hut Collapse 1, all produced iron and tin smelting slags. Rhenosterkloof 2 on the other hand had iron and tin smelting debris in one midden but no furnace was recovered. Rhenosterkloof 3 produced copper, iron and tin smelting debris as well as bronze melting debris, from the same locality. However, here the midden had eroded away, leaving the site in a compromised state. No furnace was retrieved from Tembi 1 but all the analysed debris came from two localities adjacent to each other. Metal Working Area 1 produced iron smithing slags and blooms but West Midden 2 produced iron and tin smelting waste. No obvious contextual data was available for the surface collected sites.

The findings from the sites under study cannot just be ignored because of lack of identifiable *in situ* furnaces as suggested by Huffman (2007). Analytical results produced on the sampled specimens suggest that iron and tin were smelted in the same locality as the one used for bronze production at Rhenosterkloof 1. The same is true for Rhenosterkloof 2 and Tembi 1 although bronze was not recovered at these sites. For all these sites, the locality also appears to be within domestic space where ordinary pottery, bones, and beads were also recovered. However, at Tembi 1 a half-circle of stone walling at Metal Working Area 1 appears to have shielded the activity from view by at least one half of the site, perhaps suggesting symbolic exclusion. These results mean that iron, tin and bronze (and probably copper) may not have been engendered and ritualised (at least not by seclusion) during the LIA of the area under study. Probably the need to capitalise on labour (from both women and children) may have encouraged the need to locate smelting precincts within settlement space (see Chirikure, 2007). These are certainly not the first examples of iron smelting being carried out within villages, nor are they the only cases involving women in the smelting processes. Other examples include the Ndondondwane and Magogo of South Africa, Njanja and HlambaMlonga of Zimbabwe, Busanga of Ghana, Barongo of Tanzania (Schimmin, 1893; Maggs and Ward, 1984; Loubser, 1993; Herbert, 1993; Schmidt, 1996; Chirikure, 2007; Swan, 2007; 2008).

The social boundaries of metal working are difficult to define because there so much diversity in Sub-Saharan Africa (Collett, 1993). Even when one is dealing with a single metal, attempts to

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generalise about the role and social status of the smith have been unsuccessful because of the seemingly unmanageable archaeological and ethnographic diversity (Herbert, 1993: 12). On technical grounds, all iron workers were capable of working copper, tin and bronze (Herbert, 1984; Killick, 2001). Nonetheless, socio-cultural factors do intervene. For instance, the casting of cult brass images by Ogboni smiths among the Yoruba was a preserve for men past child bearing age because the process was surrounded by libations, sacrifices and other rites (Herbert, 1984: 40). Another problem associated with attempts to explore socio-cultural patterning and behaviour in the archaeological record, emanate from the inherent limitations in the evidence. Blakely (2006: 104) argue that the most dominant means of incorporating gender into African smelting was through explicit sexual songs and dances. McCosh (1979: 163) argues that in some instances ritual "medicines" were administered orally to the smelters or though placing of organic materials such a pieces of human afterbirth into the furnace, which do not leave recognisable traces in the archaeological record. Nonetheless, in other examples "small medicine holes" usually sunk in to the floor of iron smelting furnaces can be encountered (Küsel, 1974; Schmidt and Childs, 1985; van der Merwe and Avery, 1987; Rowlands and Warnier, 1993) but sometimes these holes are destroyed by fusion with liquid slag (Schmidt and Mapunda, 1997). Additionally, Herbert (1993: 14) argues that gender concepts are so fundamental in many societies that they are rarely articulated as such.

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Without ethnographic data, the sociology of metal production is usually discernible through the combination of field studies that indicate patterns in the spatiality of metal production and scientific analysis. The challenge lies in establishing contemporaneity of the metallurgical processes and settlements related to it. Huffman (2007: 84) argues that "only *in situ* remains of the furnace designate the actual smelting spot". Unfortunately, encountering *in situ* furnace remains is not always possible, because most furnaces were destroyed upon completion of the smelt and their remains were dumped together with the slag and tuyeres. However, from an archaeometallurgical point of view, it is also possible to establish a metallurgical activity based on careful scientific analysis and field observations of the production debris (Crew, 1996; Bayley et al. 2001).

Notwithstanding the inherent diversity, iron (smelting) in Sub-Saharan Africa is invariably associated with restrictions and taboos and, as such, was conducted outside the settlement (de Maret, 1980; van der Merwe and Avery, 1987; Killick, 1990; Collett, 1993; Kiriama, 1993; Schmidt, 1997; Schmidt and Mapunda, 1997; de Barros, 2000; Haaland, 2004). To this generalisation, there are exceptions. For instance, in some societies women were allowed in the smelting area and even participated in ore procurement and furnace construction, even though the actual smiths and smelters were almost always male (Killick, 1990; Herbert, 1993; Kiriama, 1993, Schmidt, 1997). With alluvial deposits such as gold and tin ores, more women may have taken part because as once suggested by Park (1799: 217-18) in the case of gold mining in Mandingo, women participated in the washing of alluvial ores because the act resembled cereal winnowing, which they were used to.

Additionally, looser rules around taboos and proscriptions against women applied in situations of large-scale metal production, which meant greater participation of women and children (Blakely, 2006: 105). For instance, the Kwanyama of southern Angola are known to have included the whole family in the iron smelting process in which females also took turns with the pumping of bellows because of the need to meet increased demand (Angebauer, 1927: 111). The scale of metal production at Rhenosterkloof 1 and 2 may be consistent with the loosening of restrictions but for the rest of the sites, the scales of production are very small and consequently there was no need to mobilise extensive labour. However, it is also interesting to note that rituals were not only restricted to smelting but were also sometimes associated with forging but with less restrictions than during smelting. The Mafa (Cameroon) invited the whole family to witness rituals associated with the establishment of a new forge (Labouret, 1931: 68). In Kenya, forges tended to be located in private places on the edge of villages, towns, and individual homesteads, with the location being dictated by the availability of fuel, labour, space, security of homesteads and spiritual guardians of a forge (Kusimba, 1996: 390). Some smiths in this area even performed their duty naked, which also confirms that smithing was also ritualised (Jeffreys, 1952: 152). Even with the normally less ritualised copper, some communities in Burundi forbade the presence of women or strangers during either forging or wiredrawing and the smiths were also supposed to refrain from sexual relations the night before work is undertaken (Herbert, 1984: 41).

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The case studies of the Bassar (Togo) and Babungo (Cameroon) iron industries are reminders that large-scale production need not always lead to the relaxation of the application of magic and rituals. In both cases, there was maximum utilisation of labour through the mobilisation of women, children and slaves in work (such as mining, charcoal preparation, as well as haulage of these materials to the furnace). Restrictions, such as sexual abstinence and associated rituals were adapted or adopted only by a few individuals supervising the smelting operations (Herbert, 1993: 122-125; de Barros, 2000: 173). All this provides a rich pool of socio-cultural diversity in metallurgy, which requires critical application.

In southern Africa, scholars such as Huffman (2007: 84-85) have suggested that throughout the Iron Age, Bantu-speaking groups shared a common worldview reflected in the gendering of metals, for example, copper (and probably bronze and tin) was "female" and "iron" was male (Herbert, 1984; Huffman, 2007: 84-85). This also meant that the primary production of these metals was done in spatially distinct areas. Copper is associated with the homestead (female) while iron was done outside the homestead. Ethnohistoric examples have been put forward to support this. For instance, Ellenberger (1937:44) collected information on the Lete, a "Tswana-ised" chiefdom of Ndebele (Nguni) indicating that their iron smelting furnaces were situated outside villages and the only women allowed to approach the furnaces were old women, and girls under the age of puberty. Campbell (1822: 275-276) reports the occurrence of iron smelting furnaces outside the village and copper furnaces within the settlement at Kaditshwene. An archaeological example of this pattern is also described by Anderson (2009) at the 19th century site of Marothodi. On the contrary, researchers such as Maggs (1992) have observed the occasional appearance of iron smelting within the settlement context at a number of EIA sites in KwaZulu-Natal, while the LIA sites appeared to emphasise the seclusion of smelting precincts.

The overall there is no evidence to suggest that the exploitation of tin resources in the Southern Waterberg transformed the communities into pure tin workers but rather that this metallurgy was simply embedded within the on-going iron and copper production. To explore this issue further, I now turn to a discussion on specialization and the scale of production and trade.

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9.5: SPECIALIST METAL PRODUCTION & ISSUES OF SCALE & TRADE

"Such specialisation was not just confined to large-scale producers, such as the Bassar and the Babungo chiefdoms of the Cameroon Grassfields; it also included smaller-scale producers" (de Barros, 2000: 152)

The question of specialisation is intrinsically linked to the issue of production scale, and by extension trade. By default, specialists are forced to produce a surplus because specialisation is typically a risky approach in which one produces a single or narrow range of products in order to supply a lucrative market niche or meet the "quota" demanded of him by the master (Thurstan and Fisher, 2007b). In the archaeological record, specialisation can be inferred when there is evidence of intensive production that must have produced surplus (which could be either large-scale or small-scale). Consequently, one needs to consider not just the quantity produced, but also the period in which the products were produced, as well as the size of the producing community. While the last two factors are difficult to measure, one can still make an informed guess based on the size of the settlement, middens and number of huts, among other things.

The greatest challenge with regards to estimating the scale of metal production at most sites under study is the fact that the debris representing different metals and different metallurgical processes is mixed. This is exacerbated by our inability to positively separate, for instance, tin slag from iron slag using basic macro observations. What is certain, however, is that in terms of slag debris, Rhenosterkloof 1 and 2 represented the largest quantity of metallurgical debris recorded to date in the Southern Waterberg. These sites clearly do not necessarily represent the largest sites in terms of spatial extent, and the number and size of middens or features. Even before quantifying the volume of slag from the excavation trenches, it was clear that domestic middens were outstripped by metallurgical middens at these two sites. This was then confirmed through excavations. The estimates indicate that Rhenosterkloof 1 yielded 12.7 tons, and Rhenosterkloof 2 produced 49.5 tons while Metal Working Area 1 at Tembi 1 produced 1.1 tons of slag and most of the analysed debris from these sites relates to iron production.

The large slag quantities from Rhenosterkloof 1 and 2, suggest that these communities were specialist metal workers. This can be inferred simply on the basis that the scale of production seems to be far in excess of the needs of the relatively small sites within which the metal was

produced. What is also intriguing about the slag volumes from these sites is that the demand for these metals does not appear to be situated in the Southern Waterberg because almost every site has metallurgical evidence. Even in the Rooiberg and Boschoffsberg valley, where iron ores are scarce, scholars have reported the occurrence of haematite specimens as part of the furnace feed (Friede and Steel, 1976; S. Hall, 1981; Grant, 1994; Chirikure et al. 2010). Likewise, tin was worked in areas such as the Sand River valley where there are no known deposits. This suggests that areas outside the Southern Waterberg were the likely destination for most of surplus metal produced in this area. Certainly, the evidence cited above indicates this was so for the 18th and early 19th centuries.

From the early second millennium AD, different polities and small groups from all directions appear to have tapped into the Southern Waterberg from time to time, probably until the early 19th century AD. This meant that metal production in this area never exceeded and perhaps never met demand, a situation replicated in the even larger scale West Africa iron industries such as the Bassar, Babungo and Yatenga regions (de Barros, 2000: 152-155). From the time of Mapungubwe up to the demise of Thulamela, elite sites to the north such as Bosutswe, Khami, and Great Zimbabwe were in indirect contact with the Southern Waterberg (Molofsky, 2009). The large Sotho-Tswana towns of the 19th century, to the south were also in contact with this area (Campbell, 1822; Hall et al. 2008; Anderson, 2009). A little earlier, some Tsonga groups from the Venda areas also acquired tin and bronze objects from Rooiberg for trade with the Dutch at Delagoa Bay (Theal, 1902; Paver, 1933). All this appears to represent possible pulses of demand for these metals, to which specialists, such as those at Rhenosterkloof 2 and Smelterskop would have responded by increasing production. At Smelterskop, about 4 tons of tin production debris was recovered (Chirikure et al. 2010). The rise of different specialist metal producers who such as those at the above sites would partly account for the large quantities of tin which early geologists calculated had been mined from the Rooiberg tin mines in pre-colonial times (Baumann, 1919a), as well as the immeasurable alluvial deposits exploited from this area and possibly from other areas in the region as well.

If communities in the Southern Waterberg were trading with outsiders, what did they receive in return? To date, only small amounts of exotica, in the form of glass beads, have been recovered

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from the Southern Waterberg. In the current study, for instance, only produced 14 glass beads, came from Rhenosterkloof 1. A few more glass beads were recovered at Smelterskop but one should also remember that this low representation of glass beads may have been exacerbated by researchers using large sieve meshes. For instance, excavations at one of S. Hall's (1981) trenches did produce some glass beads and the earlier absence must relate to the size of the sieve used. Whatever the case, there is no doubt that glass beads are generally scarce in the Southern Waterberg. Other occasional trade goods include isolated seashells such as cowrie (*Cypraea annulus*) from Rooikrans (S. Hall, 1981) and *Insulare vidal, 1997* or *flavum (Linnaeus, 1758)* from Rhenosterkloof 1. The isolated occurrence of the exotica in the area under study is consistent with the suggestion that these materials may have been received as gifts rather than as trading merchandise. Indeed gifts are important in fostering and nurturing relations between producers and traders. For instance, Kusimba (2009: 171) noted that in the Tsavo interaction sphere of Kenya, negotiated social relations (involving exchange of gifts) played an important role in regional interaction and trade. Nonetheless this analogy does not address the fact that so little evidence of exotica was recovered from these sites, to suggest long-distance exchanges.

The meagre evidence of exotica in the Southern Waterberg evident through the second millennium AD is at the time when there was intensified long-distance trade between southern Africa and the wider world. Indeed settlements in gold producing areas such as the Shashe-Limpopo basin and the Zimbabwe plateau are endowed with rich exotic goods, mainly in the form of porcelain ceramics, glass beads and cloth (Bisson, 1982; Herbert, 1984; Swan, 1994, Plug and Pistorius, 1999; Manyanga, 2007). This might suggest that tin and bronze were also not geared towards feeding overseas market. Alternatively, the lack of exotica in the Southern Waterberg sites may not necessarily mean that metal was not traded into the international, but may reflect on the immediately local nature of trade. Such a scenario may suggest that trade of metal was of a down the line type, in which first and second intermediaries traded in local forms of production (see Chapter three). Thus, the answer to the earlier question on what the Southern Waterberg received for their merchandise lies in the domain of food.

Cattle are indeed one of the most probable "imports" into the Southern Waterberg because our surveys documented that nearly every site had a sizeable cattle kraal (Appendix 5.1). At the

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relatively larger sites such as Tembi 1, the number of kraals as well as the depth of dung increased. Thus it is highly likely that cattle (and probably grain) were the major imports in to the Southern Waterberg. Future work could perhaps measure strontium levels in the cattle bone from the Southern Waterberg in order to see whether it the cattle were local or from elsewhere. The fact that the area is not very favourable to crop farming may suggest that some communities had to resort to metallurgy as a way of compensation against grain shortage. It may also suggest that they were in no position to acquire other "luxuries" such as beads. A similar situation occurred in the 19th century where ethnographic accounts show that the Venda used food (maize) to exchange for iron ores with the Tsonga groups in north eastern Limpopo (Stayt, 1931: 60). Another case of specialist metal workers who were paid in grain relate to the attached Ndwandwe smiths who were forbidden from receiving cattle in exchange of their metal because Shaka did not want them to amass wealth that could potentially make them powerful (Maggs, 1992: 69). The same coercive pattern of trade cannot be assumed for the Southern Waterberg because there is no evidence of large polities capable of strangling access to metal resources. This issue brings us to the dynamics of exploiting tin resources in the area under study.

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9.6: AVENUES FOR THE MINING OF TIN AS A POINT RESOURCE

"As a basic principle, mines were not regarded as private property, but belonged to the tribe like any piece of land. A mining site belonged for the duration to whoever worked it" (Sundström, 1974: 218)

One of the puzzling things about the Rooiberg tin mines relates to their control and exploitation. It is not clear whether there was any group or groups of people through the sequence who had direct control of over these mines. Certainly some of the deeper mines may have belonged to individuals (Figure 2.4) but without direct oral histories on this subject, one can only use parallel analogies from other point resources such as iron, copper or salt, to think about the political management of the tin mines.

The comparison with salt extraction in Makgadikgadi salt pans of Botswana may provide closer analogy. At places such as Tswantsha, salt was owned by Basarwa (Khoesan) who loosely controlled access to this surface resource (Matshetshe, 1998). Several groups from the immediate vicinity and places further afield, had to seek permission to collect the salt at Tswantsha from

Basarwa but no one was ever denied (Matshetshe, 1998). The above case meant that the Basarwa did not tax salt collecting groups, which were dipping into their salt resources and consequently "lost" on the opportunity to enrich themselves by taxing salt collectors. In cases were salt collectors were taxed, such as at the Ivuna salt springs in Tanzania (Sutton and Robert, 1968), considerable profits were accrued leading to the modification of issues of territoriality and resource (salt) control (Antonites, 2005). The Basarwa case appears to be closer to the Southern Waterberg tin mining situation, where loose control may also have reflected confidence in the abundance of this resource. However, occurrence of relatively large sites such as Smelterskop (for the more recent period), which at one time was described as "a sort of an acropolis overlooking the Rooiberg valley" may indicate that access to some of the deeper mines was restricted (de Vaal, 1984: 10).

Ethnohistorical accounts of the acquisition of iron ores in Venda may also be informative. In the Iron Mountains of Tshimbupfe, the Venda had to bring maize and other exchange goods to barter for ores with the Tsonga groups that worked and owned the mines (de Vaal, 1985; Miller et al. 2002). Other ethnohistorical accounts of copper mining in Zambia and the DRC also appear to support the vesting of direct usufructuary rights in the hands of local people who had direct access to the mines and people from areas further afield only coming in as traders. In the Lushia area of DRC, the Koyo and Akwa people emphasised that only those with special ritual knowledge could perform the ceremonies that neutralised the malefic forces of the earth and made it render up its treasures (Herbert, 1984: 39). It was only after this ceremony was held that others could then enter. The copper mines of the Bembe area (DRC), as well as those of Zambia and Ovambo in Namibia, also belonged to several surrounding towns but other people from other towns were also allowed to extract malachite on payment of a percentage of the ore to the locals (Sundström, 1974; Herbert, 1984). If these analogies are valid for the area under study, it may help in explaining why communities in the Southern Waterberg did not develop in to large polities. This is comparable to several other areas in which intensive mining and metallurgy took place without producing large polities, such as the Phalaborwa and Messina areas in southern Africa and the Middle Senegal valley (Robert-Chaleix and Sognane, 1983; Miller et al. 2002).

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9.7: THE BIG QUESTION OF THE ANTIQUITY OF TIN PRODUCTION

"In January 1914, during clean-up operations after heavy rains and floods in the Leeuwport area, adjoining Rooiberg, two bodies described as 'Arab mummies' were discovered by the mine compound manager and a team of labourers, after they had been washed up against a donga on the farm, Knoppies Kraal. This added to the speculation about the early miners but the bodies disappeared during the night, before proper investigations could be made, and findings about the first period of tin mining at Rooiberg have remained inconclusive" (Nattrass 1987: 8)[24]

The above quotation is an apt example of the "fantasies and fever" that gripped early writers about the identity of pre-colonial gold, copper and tin miners. These writers were not convinced that indigenous black populations were capable of working these metals without guidance from "superior foreign" peoples such as Phoenicians, Arabs and Indians, but without any solid scientific evidence (Baumann, 1919a; Friede, 1980, Hammel et al. 2000). One of the key problems related to the above issue is the uncertainty surrounding the age of the mines and for a long time the Rooiberg tin mines remained undated and in a historical enigma (Herbert, 1984: 16). Until now, no site in the Southern Waterberg had produced evidence of tin or bronze production that is earlier than the 15th century (Grant et al. 1994). On this issue, the two sites of Rhenosterkloof 3 and 5 are relevant because they both have Eiland ceramics and I have suggested may indicate tin exploitation in the 13th century. Eiland ceramics at Rhenosterkloof 5 were mixed with Madikwe ceramics that postdate the 15th century and as such, only the evidence from Rhenosterkloof 3 can be used to argue for an earlier date for tin production.

This discussion is emphasising ceramics because, as highlighted earlier, a possible earlier date for tin production in this study can only be inferred through an association with Eiland ceramics and not by direct dating methods. Despite the small amount of identifiable tin and bronze remains recovered in association with the Eiland site of Rhenosterkloof 3, analytical results show that there is no doubt that these remains do actually represent tin and bronze production. As indicated above, the association of the bronze production crucibles with the Eiland phase has been made using similarities in the technological style between the crucible sherd and decorated Eiland sherds. As a control for comparison, it has been shown that Madikwe pottery from Rhenosterkloof 5 is different. It is therefore possible, on the basis of this evidence that Eiland

[24] It is also interesting to note that the written reports about this incident are also missing from the Leeuwpoort (African Farms) Limited and that Campbell Impey (son of the compound manager) who is purported to have made the find, only remembered the incident (or talked about it) but could not confirm the date (Nattrass, 1987: 8).

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communities in the Southern Waterberg exploited tin resources. In the wider context, it makes sense that Eiland communities in the Southern Waterberg worked tin because of the presence of bronze at the 13th century capitals such as Mapungubwe, where the tin component of the bronze appears to be Rooiberg tin (Molofsky, 2009). Also as noted, the presence of Eiland pottery at Mapungubwe unequivocally shows that there was interaction between the two. This is not to say, however, that this interaction was direct with Eiland communities in the Southern Waterberg, but as shown in Chapter three, nodes and networks of trade and exchange may have connected these areas.

9.8: THEORISING THE INNOVATION OF TIN & BRONZE IN THE SOUTHERN WATERBERG

"Cultural innovation, like cultural evolution in general, can be profitably studied experimentally in the psychology laboratory" (Mesoudi, 2010: 177).

In contrast to the Eurasian case, the demand for the novelty of bronze in southern Africa lies outside of its mechanical hardness which is higher than either tin or copper, because iron already fulfilled this function (Herbert, 1984). The innovation of tin, and especially bronze, may consequently be sought in its value in the expressive sphere. This is an important suggestion because the implication is that, there was already an appreciation of the role bronze was to play in the expressive sphere and if so, why then did copper not satisfy this role? The answer possibly lies in the slightly earlier innovation of gold[25], whose colour is similar to polished bronze (Miller, 2003, Valério, 2012) and consequently, the same symbolic value of gold may be inferred for the bronze. The evidence from Rhenosterkloof 3 suggests that both tin and bronze were produced at the same time, which means that one cannot hypothesise random discovery of bronze production through the unintentional exploitation of mixed copper-tin ores. While a number of studies on modern and pre-historic data have demonstrated that most material culture variations can be explained simply by cumulative copying error (Eerkens and Lipo, 2005), this does not seem to be the case in the Southern Waterberg. In other words, the innovation of tin and bronze production in this area was not a progression of tin to bronze, but the innovation was a

[25] Gold was used by elites to make decorative objects such as bangles and beads, but it was also hammered into sheets that were used to cover special objects such as the famous golden rhino and bowl from Mapungubwe (Miller et al. 2000).

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complete metallurgical "package" that cannot be treated in isolation but as part of a broader regional framework and demand.

The logical node of the demand for tin production may have been sought in the elite centres in the region. Chronologically, when considering the appearance of broader regional novelties and innovations in southern Africa, one can note that these cluster around the terminal EIA, the MIA and the beginning of the LIA. The MIA is especially replete with innovations that include the re-melting of glass beads, an intensification in ivory working, weaving of cotton, working of gold, intensive regional and long-distance trade, as well as the rise of state systems (Voigt, 1983; Davies and Harries, 1983; M. Hall, 1987; Miller et al. 2000; Wood, 2005). This provides us with a rich context of innovation and change, from which to discuss the innovation of bronze production. For instance, the innovation of gold production has been linked with a growing demand for the Indian Ocean export economy (Miller et al. 2000).

If the idea of bronze production was demand driven, there are several options that come to mind. Firstly, because bronze production was already in full swing in Eurasia (Craddock, 1995; 2001), south east African coastal traders may have learnt about bronze from the Eurasians and diffused the ideas into the region (Miller, 2002) but their intention may not have been to develop an export economy .With the increasingly complex pattern of trade networks that may have existed in southern Africa from the beginning of the second millennium AD (see Chapter three) this is possible. However, as shown in Chapter three, very little tin and bronze was exported to Eurasian markets, making it highly unlikely that the innovation of tin and bronze was driven by Eurasians as a demand-driven enquiry for export.

The key to understanding the beginning of innovations in the interior also lie in understanding the flow of information (Killick, 2009b). By the beginning of the second millennium AD, some of the innovations noted in southern Africa were produced in the Shashe-Limpopo basin and other areas further afield, such as the Zimbabwe Plateau. Elites in these areas were probably the most powerful in the region at this time and as such they had greater power to attract people and therefore would have been more exposed to information about and from the wider world compared to areas such as the Southern Waterberg where there was no comparable political

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centralisation (Huffman, 2007). The elites also had higher levels of administration and organisation to monitor procurement, production and movement of exchange goods in their areas of influence (Manyanga, 2007: 139). Consequently, as is well-known in other contexts, it was probably the elites in the Shashe-Limpopo and the Zimbabwean plateau, who had power to have the artisans and the "financial" means to develop innovation projects (e.g. Kristiansen, 2005). Being experimental, no commoner would have preferred undertaking the innovation in tin production on their own (Grant et al. 1994: 89), except through chance discovery, which does not appear very likely in the present case.

The occurrence of garden roller beads at other Eiland sites adjacent to the Southern Waterberg, such as Moritsane near Gaborone (Denbow, 1981) and in the Lephalala drainage basin in the Northern Waterberg, indicates that contact between the Shashe-Limpopo basin and the south existed from the 12th century (Huffman, 2007: 391). This assumes that the origin of the garden Roller bead innovation was within the Shashe-Limpopo region. The trade links would have acted as conduits through which the innovation of tin production was channelled. Unfortunately, the possibility of tin and bronze production at Rhenosterkloof 3 does not encourage a view that production was aimed at fully satisfying the demand that must have been coming from the larger polities to the north. This is partially an archaeological problem given the weak contextual evidence for metal production at Rhenosterkloof 3. Additionally, a more intensive search for Eiland phase sites in the wider region may throw up more and better evidence for tin and bronze production. Such a search however, also requires an equivalent refining of metallurgical data from larger polities in the Shashe-Limpopo area and the adjacent Zimbabwean Plateau in order to assess just how great that demand actually was.

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In Eurasia, the introduction of bronze technology was associated with complex social, political and economic developments that mark the rise of the state (Muhly, 1988: 16; Pare, 2000: 32). For instance, in the vast area between the British Isles, southern Scandinavia, the Carpathian Basin, and Tuscany, the desire for bronze during the thirteenth century BC, created a demand for tin, which was satisfied through intensive trade that was controlled by an emerging network of elites (Kristiansen, 1987; Pare, 2000). Exceptions to this pattern, however, have been noted, for instance in the Khao Wong Prachan valley of central Thailand, tin and bronze production did

develop in the context of complex state systems (Pryce, 2008). The latter may be a closer parallel to the Southern Waterberg because the archaeological evidence shows that no large-centralised polity developed from the exploitation of tin resources in this region. The notion that larger polities could not develop in the Southern Waterberg because of Tsetse fly does not hold, because this insect also occurs in the Shashe-Limpopo basin (Fuller, 1923). It clearly cannot be argued that tin or bronze trade alone led to the growth of the Shashe-Limpopo polities because these were already on course to transformation when the date for tin production in the Southern Waterberg started (Hanisch, 1980; Huffman, 2000; Pwiti, 2005; Manyanga, 2007).

The demand for bronze in pre-colonial Africa obviously requires access to the major component in the alloy, which is copper. Herbert (1973) classified the African uses for copper and its alloys into four general categories: (1) as a medium of exchange, (2) as objects of personal adornment, (3) as emblems of status and kingship, and (4) as objects of cult in a narrower sense. All these uses clearly reside within the expressive sphere, in the most explicit use of the term. Some gold was probably used for similar purposes but mostly amongst elites, with the rest being fed into overseas markets (Summers, 1969; Herbert, 1984; Hammel et al. 2000; Miller et al. 2000). In this context, Herbert (1984) describes copper as the "red gold" of Africa. She cites that early Arab writers such as al-Idrisi (1100-1166 AD), Abu al-Fida (1273-1331 AD) and later on al-Wardi (mid-fourteenth century) were puzzled that southern African indigenous peoples valued copper more than gold. The same observation was made by one of the earliest Portuguese writers Figueroa (1505 AD) (Herbert, 1984: 106). While the elites valued gold, a value that must have been communicated by Eurasian traders, gold never replaced copper and bronze, even at well-known trade centres such as Great Zimbabwe and Ingombe Ilede (Herbert, 1984). Furthermore, the ubiquity of gold meant that value was created as elites artificially strangled, tightened and restricted access to it (Killick, 2009b). With regards to bronze, the question is whether the value of bronze was imported or locally developed? With respect to this question, I explore its use and presence in relationship to that of gold.

The innovation of bronze production potentially increased the options of elites to materialise and enhance their status and make this visible to commoners (Table 9.1)

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Table 9.1: Bronze artefacts from southern Africa. (Red= elite sites; Blue= lower ranked sites)

Site	Date AD	Axe	Bangle	Bead	Earring	Helix	Handle	Spoon	Armlet	Ring	Sheet	Spearhead	Tack
Monk's kopje	12-14th C			☑									
Mapungubwe	13th C					☑	☑						
Great Zimbabwe	13-16th C?	☑	☑	☑		☑					☑	☑	
MatandayaChiwaya	13-15th C			☑									
Baranda	13-15th C			☑									
Ruangwa	13-15th C			☑									
Arlington	13-15th C			☑									
Bosutswe	14-15th C			☑		☑							
Matendere	14-16th C?		☑	☑	☑	☑							
Hubvumi	14-16th C?					☑							
Beril Rose	14-16th C			☑									
Matsheumhlope	14-16th C				☑								
Ingombe Ilede	15-16th C					☑							
Rydings	15-16th C			☑									
Muyove	15-16th C									☑			
Khami	15-18th C		☑	☑		☑		☑		☑		☑	
Thulamela	15-18th C					☑					☑	☑	☑
Danangombe	16-18th C		☑		☑	☑					☑	☑	
Kuruman	1805								☑				
Marothodi	19th C				☑								
Kaditshwene	19th C				☑								
Agatha	?		☑										
Broederstroom	?		☑		☑								
Little Over	2-7th C?			☑									
Mabveni	2-7th C?			☑									
Goergap	15-16th C			☑	☑								
Rhenosterkloof 1	15-18th C					☑							
Magozastad	15-18th C		☑										
Muringare Bay	16th C				☑								
Krugerskraal	16-18th C									☑			

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The excavation contexts for beads from Mabveni and Little Over need to be carefully examined because 19th century glassbeads were also recovered from these sites but Table 9.1 seem to suggest that as the second millennium progressed, bronze became more widely used, irrespective of political status. Elite sites clearly have a much wider variety of bronze artefacts that include sheets, tacks and ceremonial objects among others, but lower ranked sites also have bronzes in the form of bangles, beads, earrings, helices and rings (Table 9.1). With very few exceptions such as handles, spoons and armlets, these artefacts were also made of gold at some of these elite

sites (Miller, 2002: 1085). Bronze artefacts may have been produced in order to emulate those made from gold because polished bronze looks like gold (Miller, 2003). In contrast to gold, which is virtually "immutable" in its unalloyed form, copper and its alloys are changeable in colour and texture, when they are hammered, heated, polished or exposed to natural oxidation (Herbert, 1973). Thus indigenous African communities may have favoured copper and its alloys over gold because of the former produced various colour contrasts (including the gold colour) whereas the latter only produced one colour (Herbert, 1973). Thus, the initial demand for bronze may have come from the elites but later on, lower ranked communities also produced it and access was less restricted when compared to gold (Table 9.1). There are clear exceptions to the restrictions of access to gold, as shown by Mudenge, (1974: 386), but no lower ranked site has produced evidence of gold production in southern Africa. This contrasts with access to bronze that seem to have been produced by non-elites, as suggested in the present study.

The inventory of bronzes from southern Africa (Table 9.1) falls short of the much wider paraphernalia of copper-based artefacts from West and East Africa. These include plain unadorned rings, bracelets, ear rings, and necklaces but specifically the cast heads or bells attached, links, chains, spirals, disks, beads, hairpins, swords (both hilt and blade) and caskets (Herbert, 1984). This range attests to a diversity of meaning and use which includes invoking power, protection, aesthetics, comfort, weapon balance and initiations (Herbert, 1984). In contrast, the majority of southern African bronze artefacts are small objects such as earrings and bangles that fall within the role of exchange medium in which they are accompanied by other objects of value such as cloth, cowries, cattle, copper and iron bars (Herbert, 1984).

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In southern Africa, most tin was alloyed with copper to make bronze, other than ingots that were probably used as trading currency (Thompson, 1949; 1954; Miller, 2002). Only in rare instances, was it used to make hilts for daggers and tongs, and earrings (Goodwin, 1956; Herbert, 1984). Within this decorative sphere, copper and its alloys took the centre stage. Nonetheless there are also exceptions. For instance, amongst the Chokwe, Lunda and Ovimbundu, nearly all prestige objects were made of iron (Herbert, 1993: 135), while the Wa Chagga women of Tanzania wore spiral iron rings around their necks or arms to ensure fertility and cure sick children (Blakely, 2006: 104). Even the current study where tin and bronze were produced, decorative iron artefacts

such as bangles were also recovered from Rhenosterkloof 1, confirming that iron continued to be used in the expressive sphere. However, when copper and its alloys were used to emulate utilitarian objects such as axes and spears, these were mainly ceremonial in function and as such remained in the realm of expressive metals (Caton-Thompson, 1931).

9.9: METALLURGICAL INNOVATIONS IN SOUTHERN AFRICA

So far I have discussed the general process by which the innovation in tin production could have been brought into the Southern Waterberg. This has emphasised trade routes and trade networks as the "medium" along which information was passed. However, it is also important to explore, just how innovative where agriculturalist communities in southern Africa, throughout the second millennium AD. Here emphasis is placed on metallurgical novelties as a way of highlighting their relevance in thinking about the innovation in tin production in the region. The systematic search for innovative elements in societies is important because innovations are generally part of an on-going process that gradually adds new elements to existing pattern and thereby refining routines and efficiency (Kristiansen 2005: 151).

Throughout the second millennium AD, researchers have identified several metallurgical innovations, which when critically approached, provides a perspective with which to comprehend the advent of tin production in the southern African. These include the use of fire setting to break the rocks and narrow adits to provide lighting and ventilation in underground mines related to copper, tin and golf mines (Baumann, 1919a; Summers, 1969; van der Merwe and Scully 1971: 181-182). The pairing of furnaces in order to maximise on labour during periods of intensive metal productions are other examples of metallurgical innovations that have been reported from the 15th Century AD onwards (Maggs, 1982; Huffman, 2006). Related to furnaces, is the innovative use of sandstone crucibles (as opposed to the widely used ceramic crucibles) in brass processing (Maggs and Miller, 1995) and the tempering of copper production crucibles with crushed iron slag (Thondhlana, 2012: 146-147). The rise of a well organised of iron production Njanja industry in the 19th century (discussed in Chapter three) is also an example of novel approaches to metal production (Chirikure, 2007). Outside metallurgy, the organisational and entrepreneurial skills of the Tsonga and other itinerant traders also marks innovation (see Chapter three). As already highlighted above, the re-melting of glass beads, use

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of ceramic spindle whorls in cotton weaving and other intensive crafts also clearly highlight that from the terminal first millennium, through the second millennium AD, society at large was on the course of innovation and researcher should, as attempted here, actively search for innovative elements in southern African Iron Age

9.10: SUMMARY

This chapter has discussed the archaeology and metallurgy of the area under study and how these relate to southern Africa and beyond. The culture history is anchored by the ceramic sequence and settlement layouts that show that there were significant overlaps, underpinned by interaction between contemporary groups, starting with the Eiland phase (early in the second millennium AD) up to the Rooiberg phase (late in the same millennium). The sequence provides a context for tin and bronze production and the associated iron and copper metallurgy. The advent of tin production is view within a regional perspective in which complex networks and nodes of trade may have been crucial conduits.

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CHAPTER TEN: CONCLUSIONS & DIRECTIONS FOR FUTURE STUDIES

" The consciousness growing upon me that even now we are only in the beginning of our knowledge, and that for years to come new facts will be revealed, solving some old problems, and presenting new ones instead, has prompted me to collect my data and present them to the Society at the present moment" (Recknagel, 1908: 83)

10.1: INTRODUCTION

Some of the questions about tin metallurgy, acknowledged over a century ago, are still with us and more research is still needed to address them (Recknagel, 1908). The main issues that the current study sought to address relate to the innovation of tin and bronze production, its timing and culture historical contexts, as well as how it was embedded in the production of other metals and their culture-historical contexts. These aims were addressed through desktop surveys, ethnohistorical, field and laboratory methods. Comparative case studies from the region and beyond have enabled this thesis to contribute data that pushes back the boundaries around our comprehension of the innovation of tin and bronze production and its subsequent history in the Southern Waterberg region and southern Africa at large.

Some of the challenges encountered in this study include, the lack of undisturbed sites and consequently, some doubt over the provenance of critical samples (especially for the earlier Eiland period), the lack of complete pots for culture historical work and intact furnaces. Other challenges are methodological and relate, for example, to the longstanding difficulties in separating cuprous from ferrous slags in the field (Miller and Killick, 2004). With these deficiencies, this work makes a contribution to our knowledge of the subject matter but is clearly not a final statement. It makes a significant step towards comprehending the complexity of the innovation of tin and bronze, and its relationship to the other metals in the Iron Age of the area.

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10.2: THE POSSIBLE EARLY DATE FOR THE START OF TIN PRODUCTION

One of the central issues that this thesis aimed to establish was the visibility of tin and bronze production in the archaeological record of the period prior to the 15th century in the Southern Waterberg. The method here was to use the culture history sequence to identify earlier Iron Age sites and then to examine the nature of the metal debris that is associated. The recovery of tin smelting slag and bronze mixing crucibles at the site of Rhenosterkloof 3 is a step towards addressing this question because the site produced Eiland ceramics which are dated elsewhere to the period between 1000 and 1300 AD. Thin section petrography of the crucible, Eiland ceramics from Rhenosterkloof 3 and the Madikwe ceramics from Rhenosterkloof suggests that the bronze production crucible may be related to the former making the "possible" pre 15th century advent of production of tin in the Southern Waterberg, "probable". This brings the possible chronology of the advent of tin production in the southern Waterberg into line with the evidence from the Shashe-Limpopo region, where bronze (with a Rooiberg tin signature) is present at the site in the 13th century AD. Nonetheless, the current evidence should be treated as tentative because the integrity of the site of Rhenosterkloof 3 was compromised by the erosion and only a few samples were analysed.

Future studies should be dedicated to exploring more Eiland sites and probably Diamant site in the Southern Waterberg for more securely provenance evidence of tin and bronze production. The search for better preserved sites should be given priority because they would allow a better and clearer reconstruction of the contextual archaeology and to provide more secure interpretations (one way or another). What I mean here is better data in order to test the probable 13th Century date for tin production; that is to either provide secure confirmation or to possibly reject the notion. More thin section petrography should also be actively pursued, even if, for example, decorated Eiland crucibles are encountered, in order to test the relevance and extend the interesting distinctions in applicability of both ceramic decorative style and technological style and issues of identity.

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In areas further afield, museum collections of metal artefacts classified as "copper" from sites such as K2 in the Shashe-Limpopo basin should also be analysed to see if there are bronze even earlier in the local sequence. Following the recommendations of early researchers such as Robinson (1961), most copper objects should be treated as possible bronzes until this has been confirmed by scientific analyses. Moreover, the analysis of museum collections of "copper" artefacts from elite and commoner sites dating throughout the second millennium AD, and from various parts of southern Africa may also shed more on the status of bronze through the period. It is unfortunate that most researchers in southern Africa tend to disregard and ignore metal production debris such as slag (Miller, 2001), which would have been equally informative in identifying the metal or alloy being worked (Rehren and Pernicka, 2008). The significance of production debris is that, unlike finished artefacts and ingots, that may have been imported or traded, they help in pinning down production to a particular site and to a particular date.

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10.3: THE ASSOCIATED IRON & COPPER METALLURGY

Investigating the metallurgy associated with tin and bronze working in the Southern Waterberg was also critical. Iron production remains were found to be ubiquitous even though one must admit that separating them from copper materials is not always possible (Miller and Killick, 2004). This separation cannot always be done in the field unless large copper prills (appearing as oxidised green granules), are visible in the slags or tuyeres (Rostoker and Bronson, 1990). However, this thesis has underscored the fact that similar prills may in fact point to bronze melting but more scientific analyses are needed in order to confirm which metals were worked. This echoes previous calls by several scholars against superficial field classification of metallurgical materials without further laboratory analyses (Miller and Killick, 2004). Additionally, one should not rely on one form of analysis but should combine chemical with micro-structural analyses in order to come up with the fine resolution required for these characterisation (Bachmann, 1982).

The ability to properly identify the metals represented by the production remains is fundamental in the area under study because of the mixing of metallurgical remains from different metals, as

noted at several sites. This pattern includes the large metal dumps from Rhenosterkloof 1 and 2, suggestive of specialist production. However, the Southern Waterberg is not unique in exhibiting production remains from different metals in one metal dump (Miller, 2001; 2002). With such mixtures, postulating how metals may have been gendered can be challenging. In addition, dumps only mark the end point of the metal producing process and consequently, as noted above, the spatial location of different metal production needs to be more securely identified with the location of more evidence for primary smelting areas. Thus it is sincerely hoped that this thesis will remind researchers to refrain from assigning metal dumps to the production of a single metal, based on little or no scientific analyses.

The recovery of consolidated blooms at the site of Tembi 1 is also expected to revitalise smithing as a topic of study. This topic has received little more than incidental concern in the archaeometallurgical study of the region, probably owing to the scanty evidence of true blooms in the archaeological record (Miller, 2001). Lessons from the current study are that careful field observations by archaeometallurgists are necessary if hopes of finding and identifying the limited blooms are to be refined. It has been noted that blooms come in various sizes but may not be easily distinguishable from slag, which is why archaeometallurgists must also engage in field work.

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10.4: THE CULTURE HISTORY SEQUENCE THROUGH CERAMIC & SETTLEMENT LAYOUT ANALYSES

All of the metallurgical studies highlighted above need to be anchored within a dated culture history framework. From a culture historical perspective, the archaeology the Southern Waterberg is challenging because there is clearly overlap between phases and the juxtaposition of contemporary identities, especially from the 15th Century AD. Some of the occupations have very little and fragmentary ceramics, with which to characterise them. Moreover, the fragmentary nature of the ceramics means that a full scale multi-variant analysis is not possible (Huffman, 2007) even though meaningful reconstructions can still be constructed (Evers and van der Merwe, 1987, Sadr and Sampson, 2006). Despite these differences, sufficient stylistic

resolution provides a perspective that, from the 15th Century AD, several groups converged on the Rooiberg area and it is possible that tin production was one of the draw cards in the convergence. A complementary technique to ceramic typology is ceramic technological style (Gosselain, 2000). Recently, this technique was successfully applied on a few case studies in southern Africa (Rosenstein, 2008; S. Hall, 2012). Future studies in this area must seriously consider this technique, which works well even with fragmentary assemblages. As noted above, technological style has suggested that Eiland and Madikwe fabrics were put together in different ways, and this has been pivotal in suggesting that crucibles at Rhenosterkloof 3 were recupled Eiland vessels. The sensitivity of settlement pattern data to issues of group identity is another avenue that can be explored and complements ceramic typology in terms of different scales of identity. In the Mpumalanga area, it is clear that settlement pattern relates to specific identifies and historical backgrounds while the wider homogeneity of ceramic style underpins regional networks of intermarriage (Delius et al. 2012).

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10.5: SUMMARY

This thesis has explored several questions raised at the beginning of the thesis. A synergy of culture-historical and science-based approaches has enabled the production of a credible result. Ceramic and settlement data, as well as a the limited exotica, have been used to explore the culture historical patterns and chronologies, while field and science-based techniques were employed in identifying and characterising metallurgical materials (both production debris and metallic artefacts). From the terminal first millennium AD, different cultural groups trickled in to the Southern Waterberg. Metallurgy, especially the unique exploitation of tin resources, could have been an attraction in this agricultural unattractive area. Nonetheless, this new innovation did not usurp on-going iron and copper production nor did it significantly alter the scale of the socio-political economy of the producing communities. A few exceptions exist though, in relationship to isolated cases of specialist metal production. By exploring the metallurgy in this area and relating it to contemporary developments in the region, the present study provides a number of primary clues regarding to the innovation of tin and bronze production in southern Africa. Throughout the second millennium AD, this small scale but relatively widespread production could have been the norm. This needs further investigation, and the possibility that

most tin and bronze production was coordinated at the homestead level with a politically “flat” regional system.

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APPENDIX 2.1: INVENTORY OF TIN & BRONZE OBJECTS FROM SOUTH AFRICA

Site & Provenance	Date	Description	Chemistry	Source
Rooiberg-camp working	435±45 BP 395±55 BP (GrN5138, ETH5127)	1 Plano-convex bun tin ingot. 150mm long, 95mm wide, 58mm high, 2100g weight	99.4 Sn, 0.008 Cu, 0.16 Fe	Grant (1990a) Friede & Steel (1976)
Rooiberg-camp working	435±45 BP 395±55 BP (GrN5138, ETH5127)	1 Plano-convex bun tin ingot. 95mm long, 75mm wide, 35mm high, 800g weight	99.16 Sn, 0.41 Cu, 0.40 Fe	Friede & Steel (1976)
Mabotse (Buffelshoek)	?	Bun tin ingot		Recknagel (1908) Grant (1999)
Smelterskop-surface	?	1 Plano convex bun-shaped tin ingot. 156mm long, 100mm wide, 51mm high, approx. weight 2000g	95.4Sn,	Thompson (1949)
All days (unknown provenance)	?	Horned tin bar		Grant (1999)
Sterkrivier Waterberg Mt TvI	?	Rod tin ingot, triangular in section. 450mm long, equilateral sides of section approx. 7mm	99.61 Sn, 0.3 Cu, 0.06 Fe	
Agatha near Polokwane	?	small fragments of bronze and tin bangles		Trevor (1919)
Polokwane (unknown provenance	?	1 horned bar tin ingot		Grant (1999)
Blouberg Mts near Polokwane, obtained by Mason	?	3 tin rod ingots (two thin, 1 heavier), several		Mason (1986: 421)
Levubu-Sibasa, (2 feet under the ground, found uprooting tree)	?	Bar tin ingot. Original dimensions; 305mm long, 31mm wide, 57mm high, approx. weight 2300g	98.41Sn, 0.06Cu, 1.40 Fe	Friede & Steel (1976)
Musina (Unknown provenance)	?	Rod tin ingot		Grant (1999)
Mokopane Public library	?	9 tin rod ingots (20 Inc long, triangular in section, base & sides of triangles each measure 9 mm, weigh 6 oz)		Thompson (1949)
Mokopane Public library	?	2 tin bar ingots (on top of the ingots are minute studs)	One had 99.25 Sn, 0.20 Fe, 0.30 Cu	Thompson (1949)
Blaauwbank	?	Bronze bun shaped ingot & a complete pot containing bronze ingot		Thompson (1949)
Mashishimale, Lillie farm	?	Bronze nodule	5.5 Sn	Miller (2003)
Near Gravelotte, Murchinson Range	?	Large tin ingot with a keyhole cross section shown to Killick and Van Der Merwe in 1978		Miller (2003)
Kuruman-taken from Ba-Thlaping by Dr Litchenstein in 1805	1805 AD	Bronze armlets said to be obtained from the Bakwena	93 Cu, 7 Sn	Thompson (1949)
Marothodi-settlement unit 1 (senior kgosing) hut excavation	Early 19th century AD	Bronze earrings		Anderson (2009: 322)
Krugerskraal	AD 1500-1700	Bronze rings-no chemistry was given but they were confirmed to be true bronzes		Laidler (1936)
Goergap B3 Layer 1	250±50 BP (Pta-5653)	Barrel shaped bronze bead, 6.6 mm diameter, 5.6 mm long, central hole approx. 3.9 mm	1.7 Sn	Van der Ryst (1998)
Goergap H3 layer 2 Q3	540±50 BP (Pta-5510), 380±50 BP (Pta-5511)	Teardrop shaped bronze earring, 28.8 mm long, a bent sheet of metal about 1mm thick formed a hollow pendant cone 17.9 mm long & 5 mm in diameter.	3.5 Sn	Van der Ryst (1998), Miller, et al. (1995)
Magozastad 248 JP	400±50 BP,	Semi-circular bronze bangle. Diameter	92.7 Cu, 6.8 Sn	Miller, et al.

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farm (site 2556, hut floor)	230± 45 BP, 210± 40 BP (Pta5416, Pta5784, Pta5650)	61 mm, 3 mm thick		(1995).
Umgeni River, 56 feet deep		Bronze bowl	77.5 Cu, 22.0 Sn	Stanley (1929a)
Umgeni River, 56 feet deep		Bronze Slug	91.9 Cu, 5.0 Sn,	Stanley (1929a)
Mapungubwe				
Southern Terrace, 34.5.C. [JS2a]	1250-1300 AD	Bucket handle-shaped bronze bar, roughly square cross section (128.4 g weight)	6.0 Sn in Cu	Miller (2001)
Grave area	1250-1300 AD	4 pieces of a bronze helix, trapezium cross section with cut edges on inside, fibre core	All had 6.0 Sn in Cu	Miller (2001)
Skeleton #23-304	1250-1300 AD	Bronze helix, trapezium cross section with cut edges on inside, fibre core	6.0 Sn in CU	Miller (2001)
Thulamela				
Midden B surface	1450-1650 AD	Bronze sheet-12.82 g	95.0 Cu, 5.0 Sn	Miller (2003)
Surface near baobab	1450-1650 AD	Bronze wire-1mm thick, 2mm broad, 58.661 g	92.6 Cu, 6.0 Sn, 1.4 Ni	Miller (2003)
TS2C layers 1 and 2	1450-1650 AD	Bronze helices	three with 3.8, 3.0 & 2.1 Sn	Miller (2003)
TS2C layers 5	1450-1650 AD	Bronze helices	Two with 3.3 & 8.6 Sn	Miller (2003)
TS2C layers 6	1450-1650 AD	Compound bronze helix	2.8 Sn	Miller (2003)
TS2C layers 7	1450-1650 AD	Bronze wire/bar	91.5 Cu, 8.5 Sn	Miller (2003)
TS2C layers 7	1450-1650 AD	Bronze wire/ bar	95.7 Cu, 4.3 Sn	Miller (2003)
TS2C layers 7	1450-1650 AD	Bronze wire/ bar	94.1 Cu, 5.9 Sn	Miller (2003)
TS2C layers 7	1450-1650 AD	Bronze helix	98.0 Cu, 1.5 Sn, 0.5 S	Miller (2003)
2231AC2 Square E14 hut floor	1450-1650 AD	Bronze sheet with tacks	92.5 Cu, 7.5 Sn	Miller (2003)
2231AC2 Square E14 hut floor	1450-1650 AD	3 bronze tacks	All had 96.7 Cu, 3.3 Sn	Miller (2003)
2231AC2 Square E14 hut floor	1450-1650 AD	Bronze sheet with tacks	One had 91.8 Cu, 8.2 Sn, another 92.5 Cu, 7.5 Sn	Miller (2003)
Broederstroom				
24/73 U surface	15th c?	Bronze earring	87.3 Cu, 12.7 Sn,	Miller (2003)
24/73? Azd surface	15th c?	Bronze bangle	91.2 Cu, 8.8 Sn	Miller (2003)

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Tin and bronze objects have been observed by early European travelers amongst some South African tribes. One of the expeditions sent out by Jan van Riebeeck, under the leadership of Surgeon-Barber Pieter van Meerhoff, on 18 March 1661 met Namaqua hunter-gatherers and observed that:

> "*all women wore necklaces of small sea- shells, glass beads or pierced bronze pellets in imitation of beads, the latter being rather more fashionable and only suited to the rich...I have also seen some tribes using thongs, interlaced in regular patterns with flattened copper and tin wire*" (Goodwin, 1956: 48).

The copper, tin and bronze used by these Namaqua communities was probably acquired through trade with Iron Age communities to the north and east.

The Machicosjes (people of chief Mashakatsi/Mashakadze) a Tsonga group, which lived in the area adjoining the Limpopo and Levubu rivers are known to have traded bars of tin to the Dutch at Delagoa Bay early 1700s (Paver, 1933). In 1723, Van de Capelle reports that the Mashakadze people brought copper and tin to sell as they had previously done when the crew of the Dutch ship *Naarstigheid* was at Delagoa Bay (Paver, 1933: 606).Van de Capelle also states that they bought copper from the Dutch, to mix with their tin for making bronze neck and arm rings (Paver, 1933; Theal, 1902). About ten years later, Van de Capelle also reported another transaction between him and the Mashakadze people, in which 56 bars of large flattened rounds of tin and another 56 small rounds of tin were acquired from the later (Friede and Steel, 1976). In a bid to establish the economic prospects and geographical state of the area of their trade partners, the Dutch at Delagoa Bay commissioned an informant called Mahumane (a Tsonga from chief Mpfumo) to accompany the Mashakadze, Venda, Phalaborwa people groups in 1727 to their home areas. On his return with the same people the following year, Mahumane then reported that the Mashakadzes and Phalaborwas got the tin from mountains which he did not see because they were far away from Inthovelle's (Vele chief of Venda) settlement (Liesegang, 1977). Dzata is the most likely place referred to as Intowelle's palace, but the most probable candidate for the tin mountains is Rooiberg, to the southwest (Liesegang, 1977).

Bronze objects were also reported amongst the Thlaping at Kuruman in the early 1800s. In 1805, Dr L. Lichtenstein also observed that the Thlaping at Kuruman had bronze armlets supplied by the Kwena to the north east, whom they credit as metal suppliers to other tribes (Thompson, 1949). Further to the north east of Kuruman, John Campbellobserved the Hurutse at Kurrechane (Kaditshwene) wearing a metal resembling gold and silver (Paver, 1933). One of them, headman Sinosi had about forty copper rings on his arms and about thirty earrings made of what he calls a metal resembling gold, obtained from countries to the

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north (Paver, 1933: 609). The metal which Campbell says resembled gold is most likley bronze made from tin which would have been obtained from Rooiberg to the north of Kaditshwene. A few years later, Robert Moffat also remarked that the Kwena country had tin, the mines of which he also did not see but had an opportunity to buy some of the tin. He also observed a smith making bronze by mixing copper with tin, although Moffat called it brass (Theal, 1902). In 1836, Bronkhorst J.G.S., the scribe of the reconnoitring party which travelled to the Limpopo River recorded that the "natives in the Ransberg had good tin, which they called "white iron" and made rings from it (Paver, 1933: 610).

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APPENDIX 2.2: INVENTORY OF TIN & BRONZE OBJECTS FROM ZIMBABWE

Site & Provenance	Date	Description	Chemistry	Reference
Great Zimbabwe: Maund Ruins				
M. 12.-Strat. 2 (Area 1-29 below cement flow)	13-15th C AD	11 fragments bronze wire bangles. Coiled over fibre, wire being flat		Caton-Thompson (1931)
M. 27 a-Strat. 2 (area 21-23)	13-15th C AD	Fragments bronze wire bangles. Coiled over fibre or hair. Length 7.5 shows a green patina		Caton-Thompson (1931)
M. 38 Strat. 2 (area 26-28 beneath cement)	13-15th C AD	2 fragments bronze-wire bangles. Coiled over fibre		Caton-Thompson (1931)
M. 19 Strat. 3-4 (on platform 26)	13-15th C AD	Bronze bangle-solid corroded wire of oval section, approx. 2 X 1½ mm.	87.43 Cu, 12.3 Sn, 0.08 Fe	Caton-Thompson (1931)
M. 22-Strat. 3-4 (on platform 26)	13-15th C AD	Bronze ball/pellet-1.4 cm diameter, hammered to shape and annealed	98.7 Cu, 0.8 Sn, 0.08 Fe	Caton-Thompson (1931)
Below the stone wall	13-15th C AD	Bronze wire-relatively few compared to upper layers		Garlake 1973 (115)
Great Zimbabwe: Hill complex: Acropolis				
A. 1 No. 5-Daga 9”	13-15th C AD	2 fragments bronze wire bangles- Coiled flat wire over fibre, highly patinated a smooth green		Caton-Thompson (1931)
A. 2 No. 12-Daga 3’ 0”	13-15th C AD	Bronze sheathing with rivet-holes-Approx. 2X 2½ cm. Thickness 0.008-0.01 in. Probably hammered, not rolled. Corroded and exhibits a blue-green patina	89.43 Cu, (10.5 Sn by difference)	Caton-Thompson (1931)
Midden to rock bottom	13-15th C AD	Coil of copper or bronze wire- Neatly twisted. These twists of wire are noticeable feature in the ruins. Seem to have been wound over a finger, and the loose ends are usually tacked in..		Caton-Thompson (1931)
A. 3, No. 18-Daga 1’ 0”	13-15th C AD	Bronze wire bangle- Flat wire coiled over fibre. Length approx 16.0		Caton-Thompson (1931)
A. 3, No. 26a-Daga 6’ 0”	13-15th C AD	2 fragments bronze-wire bangle- Coiled flat wire over fibre		Caton-Thompson (1931)
A. 3, No. 35-Red soil 11’ 6”	13-15th C AD	Fragment bronze wire bangle- Coiled flat wire over fibre, exhibits green patina		Caton-Thompson (1931)
A. 3, No. 36-Red soil 13’ 6”	13-15th C AD	Fragment bronze wire bangle- Much corroded exhibits green patina		Caton-Thompson (1931)
A. 3, No. 45-Red soil 17’ 3”	13-15th C AD	Fragment bronze wire bangle-Coiled flat wire over fibre		Caton-Thompson (1931)
A. 3, No. 50-Midden beneath pavement	13-15th C AD	White porcelain bead threaded on wire- Copper wire with trace of tin		Caton-Thompson (1931)
A. 4, No. 41-Cave dust strat. 4	13-15th C AD	Coiled bronze wire bangle fragments		Caton-Thompson (1931)
West Temple acropolis- Unknown provenance	13-15th C AD	Bronze hoe or axe From Bulawayo museum, exhibited in British museum 1929	8.58 tin	Caton-Thompson (1931)
Basal deposits on the Hill complex	? but older than the walls	Wire used to thread beads-not coiled like that found in later phases		Garlake (1973: 115)
West Temple acropolis- Unknown provenance	13-15th C AD	Bronze axe		Hall and Neal (1902)

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Great Zimbabwe: Great Enclosure				
Midden below walls-	? but older than the walls	Bronze/ copper wire		Garlake (1973: 115)
Under conical tower- In hill-wash beneath foundations	13-15th C AD	Fragments bronze wire bangle- Disintegrated traces in nodule. Very fine coiled wire, circular but not flat, too eroded but definitely bronze		Caton-Thompson (1931)
Great Zimbabwe: unknown provenance				
Unknown	?	Bronze spearhead- From Bulawayo museum, exhibited in British museum 1929		Caton-Thompson (1931)
unknown	?	Bronze spearhead barbed type-From Bulawayo museum, exhibited in British museum 1929	9.75 Sn	Caton-Thompson (1931)
Unknown	?	Lump of smelted tin-found by Hall		Caton-Thompson (1931)
Unknown	?	Bicone bronze bead	98.7 Cu, 1.3 Sn	Thondhlana and Martinon (2009)
Intermediate floor?	?	A small piece of a bar of tin		Hall and Neal (1902: 116)
Unknown	?	Bronze spearhead		Hall and Neal (1902: 116)
Great Zimbabwe: Renders Ruins				
Unknown	?	2 small bronze crotals- Sometimes identified as hawk bells		Caton-Thompson (1931)
R.R. 1 No. 3-Humus	13-15th C AD	Copper or bronze bangle- Solid wire		Caton-Thompson (1931)
R.R. 3 No. 47-Grey clay strat. 1	13-15th C AD	14 Fragments bronze wire bangles- Coiled over fibre		Caton-Thompson (1931)
Great Zimbabwe: Mauch Ruins				
Mauch 3 No. 2-Humus strat, 5	13-15th C AD	2 dozen small fragments bronze wire- Remains of coiled wire bangle over fibre		Caton-Thompson (1931)
Mauch 4 No. 7a Midden strat. 3	13-15th C AD	Length plain copper or bronze About 24.0 in length		Caton-Thompson (1931)
Mauch 4 No. 8a- Midden strat. 3	13-15th C AD	4 fragments bronze wire- Coiled over fibre		Caton-Thompson (1931)
Mauch 4 No. 10- Midden strat. 3	13-15th C AD	Length fine bronze wire-Very fine, coiled over fibre, circular section similar to one from beneath the conical tower		Caton-Thompson (1931)
Mauch4 No. 10 a-Grey ash bed strat. 2	13-15th C AD	Various fragments bronze wire- Coiled over fibre		Caton-Thompson (1931)
Mauch 4 No. 6 Basal deposit strat. 1	13-15th C AD	Bronze wire, coiled over fibre-diameter 0.075; width 0.030-0.020; thickness 0.010		Caton-Thompson (1931)
		Bronze wire, coiled over fibre-diameter 0.170, width 0.045-0.035; thickness 0.020		Caton-Thompson (1931)
Mauch 4. No. 6a-Basal deposit strat. 1	13-15th C AD	Fragment bronze sheathing- High tin bronze		Caton-Thompson (1931)
Mauch 5 No. 11-Basal deposit strat. 1	13-15th C AD	Bronze wire fragment-Core missing. Diameter 0.140; width 0.030; thickness 0.010		Caton-Thompson (1931)
Mauch E No. 12- Humus	13-15th C AD	2 fragments of bronze-wire bangle- Coiled over fibre		Caton-Thompson (1931)
Great Zimbabwe: valley excavations				
Great Zimbabwe valley excavations	16th C AD?	Long tin bar weighing 1545g		Huffman (2006)
Z1 E: 7: 2	13-15th C	Bronze bangle fragment	90.5 Cu, 9.5 Sn	Miller (2003)

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	AD			
Z1 H/6/1	13-15th C AD	Bronze bangle fragment	90.2 Cu, 9.8 Sn	Miller (2003)
Z4 6?/D/ISH 2	13-15th C AD	Bronze bangle fragment	90.3 Cu, 9.7 Sn	Miller (2003)
Z1 1/D2/F	13-15th C AD	Compound helix on fibre (bronze clip around double copper wire and iron wire helix, wound around fibre core)	96.1 Cu, 2.3 Sn, 1.6 Fe, 96.8 Cu, 2.2 Sn, 1.0 Fe, 88.9 Cu, 3.7 Sn, 3.9 Fe, 3.1 Ni	Miller (2003)
Danangombe ruins				
Unknown	16-18th C AD	Bronze spearhead-Bulawayo museum	7. 45 Sn	Caton-Thompson (1931)
D.*m.*-Main trench strat. 5	16-18th C AD	Bronze wire-bangles- Partly fused masses of coiled metal anklets and bangles, some spaced with glass beads found on fragmentary arms and legs of skeletons		Caton-Thompson (1931)
D.*m.No2*-Main trench, strat.2	16-18th C AD	Bronze bangle-Solid metal, bright green patina	96.8 Cu, 3.22 Sn	Caton-Thompson (1931)
D.*m.*-Test pits Nos 1 and 2 base of strat. 3	16-18th C AD	Bronze bangles 2 complete, 1 imperfect made of strands of wire, overcast with closely spaced metal beads	8.40 Sn	Caton-Thompson (1931)
Danangombe	16-18th C AD	Specimen 1: Corroded bronze wire-6cm diameter	87.43 Cu, 12.3 Sn, 0.8 Fe	Stanley (1929a)
Danangombe	16-18th C AD	Specimen 2: Spherical bronze pellet about 1.4 cm in diameter	98.82 Cu, 0.8 Sn, 0.08 Fe	Stanley (1929a)
Danangombe- 11-14 feet	16-18th C AD	Specimen 3 & 4: 2 portions of bronze bangles-highly corroded		Stanley (1929a)
Danangombe- 12̓ 6̋ depth	16-18th C AD	Specimen 5: portion of bronze bangle	89.57 Cu, 10.45 Sn, 0.03 Fe	Stanley (1929a)
Danangombe	16-18th C AD	Specimen 6: small piece of thin bronze plating with tack holes	89: 43 Cu, 10.5 Sn	Stanley (1929a)
Hubvumi ruins				
Hubvumi No. 21- Central area terrace Strat. 1	?	Fragment bronze wire- Diameter Of coil 0.07 width of wire 0.017, thickness of wire 0.010		Caton-Thompson (1939)
Hubvumi No. 6- Rock passage B	?	Coil of bronze wire- Wound over a finger. End twisted in.		Caton-Thompson (1939)
Matendere Ruins				
Matendere No. 1b Midden inside building	?	Bronze beads- Out of 19, 11 were analysed and some were copper but some were bronze	One had 97.25 Cu, 2.27 Sn	Stanley (1929a)
Matendere No. 2- Midden	?	Bronze bangle- Solid wire, cold worked, round cross section	89.93 Cu, 9.99 Sn	Stanley (1929a)
Matendere No. 3- Midden	?	Bronze wire fragment-Flat wire coiled over fibre. Similar in all respects to the others of this class. Exhibits a smooth green patina		Stanley (1929a)
Matendere No. 4- Midden	?	Semicircular bronze fragment- Outer surface incised with cross-hatched lines. Similar but larger than Dhlodhlo. Ear ring?	97.04 Cu, 2.70 Sn 0.02 Fe	Stanley (1929a)
Chiwona Ruins				
Chiwona No. 4- Midden	?	Bronze wire fragment- Flat wire over fibre		Caton-Thompson (1931)
Khami Ruins: Site 11 E176				
Site II E176-layer 7	15-18th C AD	Bangle of flat copper or bronze wire wound over fibre, with biconnical copper spacer beads		Robinson (1959)
Hill ruin-Below Platform Ba	15-18th C AD	Bronze snuff spoon		Robinson (1959)
Hill ruin-floor of upper passage	15-18th C AD	Bronze objects		Robinson (1959)

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Hut Cbi-outside west wall-floor-	15-18th C AD	Museum No: 4310-21 bronze spearhead-blade has a midrib		Robinson (1959)
Hut Cbi-outside west wall-floor-	15-18th C AD	Museum No: 4310-bronze blade, leaf shaped		Robinson (1959)
Hut Cbi-outside west wall-floor-	15-18th C AD	Museum No: 4312 bronze blade		Robinson (1959)
Hut Cbi-outside west wall-floor-	15-18th C AD	Museum No: 4311-broanze blade, broad leaf shaped		Robinson (1959)
Hut Cbi-outside west wall-floor-	15-18th C AD	Museum No: 1150 bronze blade tapering, leaf shaped-a remnant wire binding remain		Robinson (1959)
Hut Cbi-outside west wall-floor-	15-18th C AD	Museum No: 4313 bronze blade tapering, leaf shaped		Robinson (1959)
Hut Cbi-outside west wall-floor-	15-18th C AD	Museum No: 4314 bronze blade narrow, leaf shaped		Robinson (1959)
Hut Cbi-outside west wall-floor-	15-18th C AD	Museum No: 4315 bronze blade, much twisted and bent	82.2 Cu, 16.6 Sn	Robinson (1959)
Hut Cbi-stone lined hole	15-18th C AD	Museum No 1130 Bronze finger ring-coiled and twisted		Robinson (1959)
Hut Cbi-stone lined hole	15-18th C AD	Museum No: 1127 Bronze bangle wound over fibre core		Robinson (1959)
Hut Cbi and passage	15-18th C AD	Museum No: 1129 bronze wire wound over fibre core		Robinson (1959)
Hut Cbi	15-18th C AD	Museum No: 3940 fragments of wound wire bangles		Robinson (1959)
Hut Cbi-northern entrance	15-18th C AD	Museum No: 1137-Copper/ bronze bead-very corroded/ oblate		Robinson (1959)
Upper passage	15-18th C AD	Museum No: 1138- copper/ bronze bead strip bent into tube		Robinson (1959)
Upper passage	15-18th C AD	Museum No: 1139-two copper/ bronze beads		Robinson (1959)
Khami Ruins: Site 1e Hill ruin-Hut Cb7				
Excavation 14-surface to floor V	15-18th C AD	Museum No: 1778 bronze beads and bangles		Robinson (1959: 16)
Beneath hut Ba1 on stone filling	15-18th C AD	Bronze bangle- coarse wire, core missing		Robinson (1959: 16)
Khami Ruins: Site 111a (excavation 19)				
Layer 3 and 4	15-18th C AD	Museum No: 5736 copper or bronze beads, small rings and disks		Robinson (1958)
Matsheumhlope				
Various levels	?	Copper/ bronze wire wound over fibre core,		Robinson (1958)
Various levels	?	Copper/ bronze bangle, oval section, pointed one end		Robinson (1958)
Little Over				
Little Over-Gokomere tradition level	2nd -7th Century AD	Cylinder bronze bead	64.7 Cu, 8.2 Sn	Thondhlana and Martinon (2009)
Monk'skopje				
Monk's kopje-Musengezi tradition level	12th-14th C AD	Cylinder bronze bead	93.1 Cu, 6.2 Sn	Thondhlana and Martinon (2009)
Monk's kopje-Musengezi tradition level	12th-14th C AD	Cylinder bronze bead	93.1 Cu, 6.2 Sn	Thondhlana and Martinon (2009)
Monk's kopje-Musengezi tradition level	12th-14th C AD	Cylinder bronze bead	94.1 Cu, 5.3 Sn	Thondhlana and Martinon (2009)
Monk's kopje-Musengezi tradition level	12th-14th C AD	Cylinder bronze bead	94.9 Cu, 5.1 Sn	Thondhlana and Martinon (2009)
Monk's kopje-Musengezi tradition level	12th-14th C AD	Cylinder bronze bead	90.0 Cu, 9.2 Sn	Thondhlana and Martinon (2009)
Monk's kopje-Musengezi tradition level	12th-14th C AD	Cylinder bronze bead	98.2 Cu, 1.8 Sn	Thondhlana and Martinon (2009)

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Monk's kopje-Musengezi tradition level	12th-14th C AD	Bicone bronze bead	90.7 Cu, 8.7 Sn	Thondhlana and Martinon (2009)
Matanda ya chiwawa				
Matanda ya Chiwawa-Zimbabwe tradition level	13th-15th C AD	Barrel bronze bead	51.8 Cu, 8.4 Sn	Thondhlana and Martinon (2009)
Beril Rose Claims				
Beril Rose Claims-zimbabwe tradition level	16th-17th C AD	4 cylinder bronze beads	One had 88.3 Cu, 11.7 Sn	Thondhlana and Martinon (2009)
Beril Rose Claims-zimbabwe tradition level	16th-17th C AD	1 octahedral bronze bead	77.9 Cu, 20.7 Sn	Thondhlana and Martinon (2009)
Beril Rose Claims-zimbabwe tradition level	16th-17th C AD	1 barrel bronze beads		Thondhlana and Martinon (2009)
Baranda				
Baranda-zimbabwe tradition level	13th-15th C AD	Bronze pendant	54.7 Cu, 22.7 Sn	Thondhlana and Martinon (2009)
Baranda-zimbabwe tradition level	13th-15th C AD	Cylinder bronze bead	77.4 Cu, 7.1 Sn	Thondhlana and Martinon (2009)
Mabveni				
Mabveni-Gokomere level	2nd -7th C AD?	Barrel bronze bead	88.2 Cu, 11.8 Sn	Thondhlana and Martinon (2009)
Ruangwa Ruin				
Ruangwa Ruin-zimbabwe tradition level	13th-15th C AD	3 cylinder bronze beads		Thondhlana and Martinon (2009)
Rydings				
Rydings-Ingombe Ilede tradition level	15th-16th C AD	Cylinder bronze bead	98.5 Cu, 1.5 Sn	Thondhlana and Martinon (2009)
Muyove				
Muyove-Ingombe Ilede tradition level	15th-16th CAD	Bronze ring	97.5 Cu, 2.5 Sn	Thondhlana and Martinon (2009)
Arlington				
Arlington-zimbabwe tradition level	13th-15th C AD	Bicone bronze bead	81.0 Cu, 8.0 Sn	Thondhlana and Martinon (2009)
Arlington-zimbabwe tradition level	13th-15th C AD	Cylinder bronze bead	92.7 Cu, 7.3 Sn	Thondhlana and Martinon (2009)

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APPENDIX 2.3: INVENTORY OF TIN & BRONZE OBJECTS FROM BOTSWANA, MOZAMBIQUE & ZAMBIA

Site and provenance	Dates	Description	Chemistry	Reference
Botswana				
Bosutswe-central precinct, 4e5s level 10	1300-1420 AD	Wrapped bronze bead	97.8 Cu, 2.2 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 1e5s level 11	1300-1420 AD	Wrapped bronze bead	85.3 Cu, 14.7 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 1e4s level 5	1300-1420 AD	Bronze nodule/ prill	91.8 Cu, 8.2 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 1e1s level 9a	1300-1420 AD	Wrapped bronze bead	93. Cu, 6.2 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 2e3s level 9	1300-1420 AD	Wrapped bronze bead	90.7 Cu, 9.3 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 3e4s level 8	1300-1420 AD	Wrapped bronze bead	94.1 Cu, 5.9 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 3e4s level 11	1300-1420 AD	Wrapped bronze bead	68 Cu, 32 Sn	Denbow et al. (2008)

Bosutswe-central precinct, 3e4s level 11	1300-1420 AD	Wrapped bronze bead	94.7 Cu, 5.3 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 4e2s level 5	1300-1420 AD	Wrapped bronze bead	96.1 Cu, 3.9 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 4e3s level 1	1300-1420 AD	Wrapped bronze bead	70-85 Cu, 15-30 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 4e4s level 11	1300-1420 AD	Wrapped bronze bead	96.7 Cu, 3.3 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 1e6s level 2	1300-1420 AD	Wrapped bronze bead	95.2 Cu, 4.8 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 1e6s level 8	1300-1420 AD	Bronze/bronze/iron helix	95.1 & 87. 1 Cu, 4.9 & 12.9 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 2e4s level 10	1300-1420 AD	Wrapped bronze bead	84.4 Cu, 15.6 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 2e4s level 10	1300-1420 AD	Wrapped bronze bead	91.8 Cu, 8.2 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 2e4s level 11	1300-1420 AD	Wrapped bronze bead	93.1 Cu, 6.9 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 3e6s level 9	1300-1420 AD	Wrapped bronze bead	97.0 Cu, 3.0 Sn	Denbow et al. (2008)
Bosutswe-central precinct, 3e4s level 10	1300-1420 AD	Wrapped bronze bead	86.6 Cu, 13.4 Sn	Denbow et al. (2008)
Bosutswe-eastern precinct, 60e29s level 7	1300-1420 AD	Wrapped bronze bead	90.9 Cu, 9.1 Sn	Denbow et al. (2008)
Bosutswe-eastern precinct, 60e28s level 1	1300-1420 AD	Bronze helix	94.6 Cu, 5.4 Sn	Denbow et al. (2008)
Bosutswe-western precinct, 101w,0 level 1	1300-1420 AD	Bronze helix	94.8 Cu, 5.2 Sn	Denbow et al. (2008)
Bosutswe-western precinct, 101w,0 level 1	1300-1420 AD	Bronze helix	95.0 Cu, 5.0 Sn	Denbow et al. (2008)
Bosutswe-western precinct, 104w, 6n level 1	1300-1420 AD	Bronze prill		Denbow et al. (2008)
Mozambique				
Muringare Bay (Mouth of Sabi River)	Around AD 1500	3 bronze beads	One had 88.5 Cu, 11.5 Sn	Dickson (1975)
Zambia				
Ingombe Ilede	15th -16th C AD	2 bronze wires, hammered into roughly rectangular cross sections. One measured 16.2 cm and another measured 32 cm	One had enough tin to classified as bronze	Fagan et al. (1969: 256-7)

There are also a few cases of tin being reported amongst African groups in Mozambique and Zambia, by early travelers. In 1498, Vasco da Gama met some African groups at the mouth of Limpopo River/ Sabi River, who were trading copper, and probably tin. The Roteiro notes "that weapons of the Bantu were long bows and arrows, iron-bladed assegais, and daggers which had ivory sheaths and hilts decorated with tin. The people wore copper ornaments, and for this reason Vasco da Gama named the Limpopo, Rio do Cobre (Copper River) (Northrup, 1998). A few years later when the Portuguese occupied Sofala (AD 1505), they reported that the inhabitants at Sofala wore tin bracelets on their legs (Axelson, 1973). By AD 1600, Joâo dos Santos also reports that the "currency" at Sena and Tete consisted of small copper bars,

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small ingots of tin, coloured beads on strings and various kinds of cloth and gold (Axelson, 1960). Around the same time, the Portuguese also observed that the people of Maravi state wore copper and tin spangles in their hair (Hall and Neal, 1902). With very little scientific analyses, it highly likely that there are several bronze objects that are misclassified as copper objects. Future research will definitely expand on the current inventory of tin and bronze objects from southern Africa.

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APPENDIX 5.1: LIST OF SITES DOCUMENTED IN THE PRESENT STUDY. Rnk=Rhenosterkloof, Tmb=Tembi.

Site#	Coordinates	location	Period	Features & materials
Rnk1	24 29. 333S, 27 42.860E	Base of ridge	LIA	Subtle crescent-shaped stone features & stonewalled kraals, pottery, metal remains
Rnk2	24 39. 567S, 27 42.916E	valley	LIA?	Two subtle stone features, one big metal midden and a kraal without stone walling
Rnk3	24 39.191S, 27 42.874E	valley	EIA	Clusters of pottery, no in situ feature, one kraal without stone walling. On eroded patch
Rnk4	24 39.233S, 27 43 435E	Base of ridge	LIA	Slag scatters, furnace bottom, pottery. On eroded patch
Rnk5	24.65245S, 27.71399E	valley	EIA/LIA	Pottery, slag and furnace base. Also on eroded patch
Rnk6	24.65201S, 27.70651E	Base of ridge	LIA	Pottery, one stone kraal, slag scatter. Less eroded
Rnk7	24.66401S, 27.70661E	valley	LIA	Pottery, slag, grinding stones. Less eroded.
Rnk8	24.66312S, 27.70740E	valley	LIA	At the western end of a dyke running parallel to the ridge. Furnace rubble, tuyeres , slag and pottery
Rnk9	24.65812S, 27.70730E	valley	LIA?	Slag, crucibles, pottery and tuyeres
Rnk10	24.64822S, 27.7074 E	valley	LIA?	Pottery on eroded patch
Rnk11	24.65281S, 27.71332E	valley	?	Burnt clay mound? On eroded patch
Rnk12	?	Base of ridge	LIA?	Stone walling that has been robbed and is now part of modern farm homestead.
Rnk13	24.66503S, 27.66966E	valley	LIA	Large stone kraal (14 m diameter), upper and lower grinding stones, pottery and slag.
Rnk14	24.65273S, 27.71156E	valley	LIA	Pottery, stone platforms, lower grinding stone and slag
Rnk15	24.65311S, 27.72331E	Base of hill	LIA	Located northeast of farm house. Several crescent walling. Pottery, slag, grinding stones
Rnk16	24.65211S, 27.66986E	Valley	LIA	Pottery, slag, tuyres
Rnk17	24.66023S, 27.70814E	valley	EIA?	Clusters of potsherds and slag
Rnk18	24 39.193S, 27 42.649E	hillslope	?	Mounds of rubble running up the lower slopes of Koppieskraal ridge. Iron ore quarries?

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Rnk19	24.66026S, 27.70910E	valley	LIA	Scatters of pottery and a kraal (not stone walled).
Tmb1	24. 39.926S, 27. 40.190E	hilltop	LIA	Several stone kraals and enclosures and a continuous back wall joining some of these features on the upslope side. Pottery, slag, tuyeres, grinding stones etc
Tmb2	24. 66517S, 27. 66782E	valley	LIA	Large (14 m diameter) stone kraal associated with slag, pottery and grinding stones
Tmb3	24. 39.730S, 27. 42.300E	Base of ridge	LIA	Just pottery but difficult to see anything off the road due to thick vegetation
Tmb4	24 39.949S, 27 40.994E	Base of ridge	LIA	Shallow rock crescent features
Tmb5	24 39.993S, 27 41.942E	Base of ridge	LIA	One large (12 m diameter) and one small (6 m diameter) stone walled kraals, pottery
Tmb6	24. 39.927S, 27 40.876E	Base of cliff edge of ridge	LIA	Small crescent and circular enclosures. The latter are kraals
Tmb7	24 39.964S, 27 41.833E	Base of cliff edge of ridge	LIA	A 9 m diameter, joined to a 6 m diameter stone kraal by a 5 m long wall. pottery
Tmb8	24 39.975S, 27. 40.733E	Base of ridge	LIA	Very small stone kraal 5m in diameter, pottery
Tmb9	24 39.983S, 27 40712E	Base of ridge	LIA	Large stone kraal (13 m diameter) between a small (11 m) semi-crescent wall upslope and a long (45 m) wall downslope. Concentration of pottery and slag further downslope
Tmb10	24 39.947S, 27 40.210E	Base of ridge	LIA	Large stone kraal (14 m diameter) and small stone platform, pottery. May be related to Tmb11
Tmb11	24 39.961S, 27 40.203E	Base of ridge	LIA	12 m below Tmb10. Two small stone kraals. Few pieces of slag
Tmb12	24 40.056S, 27 39. 940E	slope of ridge	LIA	Small stone kraal at the boundary of the farm and a large one (Tmb13) can be seen to the west
Mts1	24 39.002S, 27 43.840E	valley	LIA?	Anvil (shifted by the construction of road) upper forge rock (probably in situ) and slag.
Mts2	24 38.125S, 27 43.975E	valley	LIA	North of Sand River but on the poort (Rookpoort). Pottery and slag

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Mts3	24 64773S, 27 73119E	Base of ridge	LIA	South side of poort but above river. Large base of cave kraal. Pottery but no stone wall
Mts4	24 38.971S, 27 43.853E	Base of ridge	LIA	200m from Mts3. Pottery, grinding stones and slag
Mts5	24 38.557S, 27 51.496E	slope of ridge	LIA	Large stone kraals (largest is 15 m diameter) but all have been robbed using heavy machinery
Mts6	24 38.347S, 27 51.594E	slope of ridge	LIA	Part of kraal complex related to Mts5. Several kraals also robbed and slag found
Mts7	24 38.918S, 27 57.682E	valley	LIA	Slag and pottery scatter on the road above the northern bank of the river
Mts8	24 38.716S, 27 51.511E	slope of ridge	LIA	Two stone kraals and some mounds around them, west of robbed stone complex (Mts6) and another complex (not recorded) can be seen west of this site. May be related and if so, this will form one of the largest grouping of settlements in the Southern Waterberg.
Mts9	24 38.537S, 27.51.514E	slope of ridge	historical	Graves, two with headstones and decorated but others are just mounds of stones outside fence
Mts10	24 38.362S, 27 51.593E	slope of ridge	historical	Collapse mound of farm house. rectangular
Mts12	24 39.290S, 27 44.004E	valley	LIA	Pottery and slag, close to Mts 4
Mts13	24 39.153S, 27 44.316E	valley	LIA	Pottery and a flake upper forge stone, most likely brought from the nearby Sand River
Mts14	24 3700.50S, 27 4417.16E	slope of ridge	LIA	Stone walled site with pottery.

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APPENDIX 6.1: CLASSIFICATION OF ARCHAEOMETALLURGICAL REMAINS

The first task in my macro analysis was to separate out bona fide metal remains (both production remains and metallic objects). The guiding principle was to ensure that all metals and production stages were sampled. Metallurgical remains were then classified in to classes based on established typologies (Bachmann, 1982; Martinon-Torres and Rehren, 2002; 2009; Greenfield and Miller, 2004; Miller and Killick, 2004; Chirikure and Rehren, 2006; Miller and Hall; 2008; Chirikure et al. 2010). With only a few exceptions, both European and Africa schemes were useful in the classification of the materials in the present study.

ORES

The modern standard definition of an ore is that ores are rocks or minerals that can be mined, processed and delivered to the marketplace or to technology at a profit (Guilbert and Park, 1986:1). In pre-colonial societies, however, rocks or alluvial sediment was classified as “ore” if the technological, social and economic conditions enabled people to extract the metal by smelting (Bayley et al. 2001). For instance, the Chewa people of Malawi are known to have worked low grade laterite ores, which are not considered economical today (Killick and Gordon, 1988; Killick, 1990). No copper or tin ores were recovered but different types of iron ores such as haematite, speculatire and laterite were reported. In hand specimen, haematite ores had a red-brown colour and a red streak on the fresh breaks but unlike specularite, they do not have the bright shining sparkles. The latter was so hard and could be scratched with difficulty while the former was quite soft and usually soiled the fingers. However, they all have the same chemical composition (Fe_2O_3) and crystalline structure under the microscope in the case of the massive variety and the only significant difference is in the aggregation of minute crystals, which forms a single crystal in specularite compared to aggregates in haematite (Encyclopedia Britannica, 1911, http://www.theodora.com/encyclopedia/m2/mineralogy.html, accessed 20 July 2012). Laterites on the other hand were generally soft and friable, but with hard masses in them. They were dull brown to earthy in colour, with an equally dull and weak staining streak on their fresh breaks, thereby making them easily distinguishable from haematite or specularite, to the trained eye. Haematite was considered to be the most likely smelted ore because of a longstanding observation that specularite was of minor significance as an ore but significant as an ochre for decorative purposes (Rostoker and Bronson, 1990; Miller, 2001).

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TECHNICAL CERAMICS

The term technical ceramics refers to all the ceramic refractories that include tuyeres, furnace walls and crucibles.

FURNACE WALL FRAGMENTS

Furnace wall fragments are lumps of combustion chambers (Bayley et al. 2001). Like other technical ceramics, they may be vitrified and slagged on the inner surface, which was exposed to high temperatures, while the outer surface may not. Clay used to line the inside of the furnace can facilitate slag formation if it is high in silica. Moreover, the relative quantity, thickness and degree of vitrification of the wall fragments can be useful in separating combustion chambers from smithing forges (Crew, 1995: 2).

TUYERES

These are pipes used to feed air from the bellows to the furnaces (Chirikure, 2002). Soapstone tuyeres are also known in some parts of southern Africa (Sandelowsky, 1974) but specimens here were made of clay. Most clay tuyeres were broken but their distal ends (inside furnaces) were vitrified, slagged and sometimes clogged with slag. No longitudinal impressions (Klapwijk, 1986) or decorations (Bent, 1892; Cline, 1937) were visible. None of the distal tuyere ends were fused together to suggest multiple tuyeres in one furnace port, a practice associated with natural draught furnaces (Prendergast, 1975).

GLASSY FURNACE WALL FRAGMENTS

Just like, glassy tuyeres, glassy furnace walls were also tentatively separated from the furnace wall fragment because of their dark glassy slag. The colours of the slagged portions were similar to those of glassy tuyeres. The only close case study of the analyses of furnace wall fragments that relate to tin production is the one reported in Chirikure et al. (2010). Unfortunately no descriptions of the slagged portions in hand specimen were given in their study.

GLASSY TUYERES

These were morphologically similar but distinguishable from to tuyeres described above by the glassiness of their slagged surfaces. Colour variations of the slagged surfaces ranged from black, dark-brown to green-blue, in keeping with similar examples that relate to tin working (Miller and Hall, 2008). White crystals (probably tin droplets) were also visible in some of

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these specimens, as was the case with previous analysis of glassy tuyeres from the southern Waterberg and beyond (Chirikure et al. 2010). As a project that was also focused on understanding tin, it was necessary to classify these specimens as a separate type pending analysis. Clearly, there were areas of overlap with the other tuyeres described above because iron working tuyeres also tend to be somewhat glassy (Schmidt, 1997). The boundary between these two types of tuyeres was gradational and subjectivity in classifying some specimens was unavoidable.

CRUCIBLES

Crucibles are containers used to hold metals being melted or mixed (Bayley, 1988; 1991; Bayley and Rehren, 2007). They can be made of stone such as sandstone (Maggs and Miller, 1995) but the current specimens were all ceramic. Crucibles can be fashioned as metallurgical vessels from fresh clay but in the current study they were all similar to ordinary clay pots, suggesting that they were not initially fashioned for metallurgical purposes (Calabrese, 2000). The only thing that separated them from ordinary pottery was the vitrification and the presence of slag that adhered on to the ceramic surfaces.

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SLAGS

Slag generally refers to a variety of non metallic, usually oxide waste products formed during smelting, refining, and the hot-working of metals (Morton and Wingrove, 1969). On the basis of the slag morphology alone, it is very difficult to positively identify the metallurgical or even the metal being worked (Hauptmann, 2007). Nonetheless, the morphological analysis is still important as a stepping stone to the exploration of furnace conditions (Bachmann, 1982).

FURNACE SLAG

This type was dense with irregular shapes, varying degrees of porosity and impressions of charcoal or rocks that suggest it solidified in the furnace (Chirikure and Rehren, 2004). It can have a variable surface texture and may be magnetic but it never displays the flow structure (Killick, 1990). Some of the furnace slag samples in this analysis exhibited minimal corrosion and had small charcoal pieces trapped in them.

FLOW SLAG

This type has a smooth or rippled flow structure and some may have flown out of the furnace or into the tuyere holes (Schmidt, 1997). This type of slag must be separated from tap-slag,

which also has a flow structure but typically have flat bottoms that incorporate fresh sand grains from the soils where they were drained on to (Crew, 1995; Miller and Killick, 2004: 24). The southern limit of slag tapping furnaces appears to be central Zimbabwe (Prendergast, 1979; Miller and van der Merwe, 1994; Miller and Killick, 2004). Some of the flow slags were slightly magnetic but they generally will not attract a compass needle.

SMITHING SLAG

Smithing slag was rusty, highly magnetic and exhibited plano-convex shapes conforming to the shape of bases of furnace hearths in which they solidified (Friede et al. 1982; Greenfield and Miller, 2004; Miller and Killick, 2004). In Europe a nuanced type, sometimes called *furnace bottom* has been documented but this is more concave and well developed (Crew, 1995; Pleiner, 2000; Serneels and Perret, 2003) than typical furnace slag from southern Africa (Greenfield and Miller, 2004; Chirikure, 2005). Field and macroscopic observations of this type of slag is important because it is not easy to separate this type from smelting slags based on chemical composition alone. For instance, at Ndondondwane the distinction between this type of slag and smelting slags was made solely on hand specimens because they were chemically indistinguishable (Greenfield and Miller, 2004; Miller and Killick, 2004).

GLASSY SLAGS

This type was separated from furnace slags and flow slags on the basis on their colour and glassiness. Previous studies from Europe and southern Africa have intimated that similar slags relate to tin smelting (Tylecote et al. 1989; Farthing, 2002; Veblen et al. 2004; Miller and Hall, 2008; Chirikure et al. 2010). Both the European and southern African examples proved to be useful in classifying the current suite of glassy slags. Some were denseand others were vesicular and pale. Colour variations of the glass ranged from black to dark brown to green-blue (Wagner and Gordon, 1929; Veblen et al. 2004; Miller and Hall, 2008, Chirikure et al. 2010). Some of them were fractured and appear to have been crushed, probably in an attempt to retrieve metal prill (Franklin et al. 1976, Mascaro et al. 1995; Chirikure et al. 2010,)

UNIDENTIFIABLE SLAG

Some slagged materials could not fit the above classes and these were classified as unidentifiable. Morphologically, they were closer to furnace slag but being heavier and

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exhibiting thin hollow shells and some partially reacted material. It was not possible to tell if these slags had solidified within the furnace or not, but they evidently did not have a flow structure. Crew (1995: 2) classified a similar but less slagged type as partially reduced ores but the suite under study had too much slagged to fit this classification. Other portions of these slags were corroded and magnetic in ways similar to smithing slags.

BLOOMS & CROWN MATERIALS

This group comprised metal rich conglomerates from the furnaces called blooms and their slag and charcoal laden counterparts that are called crown material or gromp in the European context (Killick, 1990; Chirikure and Rehren, 2004). In theory, a bloom consists of semi-congealed, porous or spongy masses of iron still mixed with non-metallic slag but most blooms from archaeological reports are in fact consolidated or semi-consolidated blocks of iron formed by first forging of the bloom (Salter and Gilmour, 2012), while crown material is usually knocked off from the original bloom during smithing or bloom cleaning process (Chirikure, 2005). All the blooms and crown materials in this study were highly magnetic and revealed corrosion on the outer layers.

CASTING SPILLS/ NODULES

Casting spills or nodules are pellets or solid globules of a congealed metal or an alloy that is lost during casting (Figueiredo et al. 2010). Other scholars such as Valério (2012) prefer the broad term metallic nodule which includes small droplets of metal found trapped in slags or crucibles. They are usually dense with either a dull or vitreous outer surface, but fresh breaks have a bright and shiny surfaces deriving from the metal or alloy represented (Crew, 1995).

METALLIC ARTEFACTS

These are metal objects or pieces that were fashioned or were in the process of being fashioned into usable tools, weaponry or decorative objects (Killick, 1990; Valério, 2012). The complete inventory of metallic objects in this study consisted of small items such as bangles, twisted wires, small wound wires, arrowheads, “nail” and some objects whose function could not be easily defined. They had tin layers of corrosion products but some were severely corroded.

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APPENDIX 8.1A: WD-XRF READINGS FOR IRON PRODUCTION REMAINS. Including H2O and LOI.

Sample #	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cr2O3	NiO	Total	H2O-	LOI
Iron ores																
Rnk1-1	1.97	0.18	1.86	92.95	0.03	0.37	0.04	0.04	0.05	0.00	0.03	0.02	0.00	**98**	0.92	1.47
Rnk1-33	27.06	1.55	11.16	60.56	0.05	0.28	0.37	0.02	0.43	0.75	0.08	0.11	0.01	**102**	0.08	-2.54
Rnk1-35	28.45	0.80	18.99	43.45	0.04	0.36	0.10	0.19	1.75	0.21	0.03	0.09	0.01	**94**	0.09	4.81
Rnk2-1	15.23	0.32	7.21	73.16	0.07	0.43	0.12	0.07	0.39	0.10	0.05	0.06	0.01	**97**	0.06	2.23
Rnk2-26	18.70	0.18	2.09	77.67	0.06	0.32	0.02	0.02	0.01	0.01	0.02	0.02	0.00	**99**	0.06	0.60
Rnk3-1	18.85	0.18	2.11	78.31	0.06	0.33	0.02	0.02	0.01	0.01	0.02	0.02	0.06	**100**	0.00	-0.20
Tuyeres																
Rnk1-21	66.02	0.49	11.73	12.20	0.48	1.71	4.63	0.07	2.22	0.27	0.02	0.03	0.01	**100**	0.00	-0.36
Rnk1-12	71.25	0.45	9.34	15.86	0.42	0.56	1.28	0.04	1.40	0.07	0.03	0.04	0.00	**101**	0.05	-0.96
Rnk1-13	58.29	0.38	7.41	20.24	1.89	1.01	7.15	0.11	2.10	0.31	0.05	0.02	0.01	**99**	0.19	0.34
Rnk-2-21	65.20	0.45	13.82	11.27	0.13	0.57	5.43	0.20	2.74	0.16	0.00	0.03	0.01	**100**	0.00	-0.19
Rnk3-10	59.60	0.64	16.75	9.56	0.08	1.09	1.04	0.69	2.14	0.18	0.01	0.02	0.01	**92**	0.00	7.82
Rnk3-21	65.09	0.73	14.83	14.23	0.15	0.65	1.37	0.21	2.15	0.13	0.00	0.02	0.00	**100**	0.00	0.13
Furnace wall fragments																
Rnk1-4	68.95	0.34	6.95	8.80	0.32	1.01	10.29	0.08	1.41	0.27	0.06	0.02	0.01	**99**	0.13	1.21
Rnk1-19	60.17	0.66	16.05	12.88	0.33	4.33	2.89	1.37	1.02	0.05	0.03	0.03	0.02	**100**	0.02	-0.35
Rnk-2-25	67.15	0.55	15.20	10.91	0.28	1.23	2.20	0.23	2.55	0.19	0.00	0.02	0.01	**101**	0.00	-0.47
Flow slag																
Rnk1-7	18.84	0.20	3.90	71.65	7.87	0.87	2.12	0.04	0.50	0.11	0.04	0.02	0.01	**106**	0.02	-6.63
Rnk1-8	26.28	0.18	3.20	68.12	2.66	0.70	2.81	0.01	0.77	0.14	0.06	0.02	0.01	**105**	0.07	-5.39
Rnk1-9	23.17	0.21	4.41	67.29	1.51	0.78	6.42	0.06	0.68	0.15	0.05	0.02	0.00	**105**	0.10	-5.53
Rnk1-10	20.73	0.16	2.84	70.36	2.09	0.90	5.26	0.04	0.63	0.16	0.08	0.02	0.00	**103**	0.44	-4.44
Rnk1-11	17.71	0.15	2.61	72.38	2.57	0.73	4.09	0.16	0.65	0.14	0.06	0.03	0.00	**101**	0.59	-2.52
Rnk1-29	26.59	0.24	5.17	54.71	2.07	1.01	12.27	0.02	0.63	0.23	0.10	0.02	0.00	**103**	0.03	-3.69
Rnk1-22	27.00	0.25	4.38	55.44	2.83	0.91	4.57	0.07	0.89	0.19	0.07	0.02	0.01	**97**	0.42	2.08

Cont'd..flow slag

Sample #	SiO2	TiO2	Al2O3	Fe2O3	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cr2O3	NiO	**Total**	H2O-	LOI
Rnk2-15	14.82	0.14	2.46	71.51	0.69	0.43	1.71	0.05	0.73	0.20	0.18	0.01	0.00	**93**	0.60	6.49
Rnk-2-24	25.14	0.15	3.60	70.59	0.41	0.75	3.27	0.22	0.44	0.11	0.03	0.01	0.00	**105**	0.00	-4.62
Rnk2-2	24.10	0.17	3.76	72.95	2.06	0.77	0.74	0.08	0.56	0.11	0.04	0.02	0.00	**105**	0.00	-5.56
Rnk2-4	27.00	0.25	4.38	55.44	2.83	0.91	4.57	0.07	0.89	0.19	0.07	0.02	0.01	**97**	0.42	2.08
Rnk-2-22	22.27	0.04	0.82	79.81	2.03	0.18	0.37	0.22	0.11	0.10	0.01	0.00	0.00	**106**	0.00	-5.91
Rnk3-9	30.77	0.08	1.92	67.66	0.20	0.22	3.68	0.21	0.61	0.12	0.01	0.00	0.01	**105**	0.00	-5.62
Rnk3-7	15.81	0.21	6.20	77.15	0.43	0.46	1.65	0.21	0.33	0.15	0.05	0.02	0.01	**103**	0.00	-3.45
T1-13	24.11	0.18	4.40	62.11	1.54	1.15	5.31	0.22	0.79	0.17	0.00	0.01	0.01	**100**	0.00	0.20
T1-9	24.93	0.24	4.62	60.14	1.47	1.05	6.52	0.08	0.75	0.16	0.02	0.01	0.01	**100**	0.00	-0.20
T1-10	22.09	0.19	4.37	69.61	1.47	1.26	4.54	0.17	0.93	0.26	0.04	0.01	0.00	**105**	0.00	-5.05
Furnace slag																
Rnk1-18	16.43	0.24	4.93	75.85	0.95	1.16	4.18	0.02	0.37	0.11	0.03	0.02	0.00	**104**	0.01	-5.01
Rnk1-23	28.23	0.13	1.94	68.41	2.75	1.55	1.17	0.03	0.28	0.16	0.06	0.01	0.00	**105**	0.04	-5.31
Rnk1-30	20.74	0.22	4.87	69.53	1.41	0.99	5.58	0.04	0.50	0.15	0.07	0.02	0.01	**104**	0.48	-4.78
Rnk2-16	19.02	0.17	3.98	75.87	1.65	0.86	3.60	0.02	0.41	0.14	0.05	0.02	0.00	**106**	0.13	-5.95
Rnk2-12	19.25	0.19	4.07	73.98	1.55	0.87	4.39	0.03	0.58	0.18	0.06	0.03	0.01	**105**	0.03	-5.85
Rnk3-3	15.42	0.09	1.96	76.73	4.20	1.35	0.83	0.24	0.31	0.15	0.00	0.00	0.00	**101**	0.00	-1.53
T1-15	15.19	0.25	1.57	74.58	0.28	0.99	4.24	0.16	0.78	0.42	1.56	0.01	0.01	**100**	0.00	-0.20
T1-8	18.86	0.16	3.24	69.53	1.71	0.95	4.45	0.32	0.55	0.15	0.04	0.01	0.01	**100**	0.00	-0.20
T1-11	21.08	0.15	3.66	70.51	1.71	1.20	5.59	0.17	0.68	0.16	0.03	0.01	0.00	**105**	**0.00**	-5.16
Bloom/crown material																
Rnk1-32	22.22	0.13	2.04	70.15	0.56	0.42	0.95	0.05	0.28	0.13	0.17	0.01	0.01	**97**	0.27	2.09
Rnk1-36	19.39	0.15	2.02	69.75	2.00	0.64	3.17	0.06	0.53	0.15	0.06	0.02	0.01	**98**	0.62	1.07
Rnk2-20	10.45	0.11	2.28	89.27	1.87	1.20	0.70	0.02	0.24	0.09	0.03	0.03	0.01	**106**	0.02	-6.99
Rnk2-19	11.73	0.13	1.35	83.57	0.48	0.72	4.96	0.15	0.54	0.12	0.07	0.02	0.00	**104**	0.06	-4.53
RNK3-14	15.00	0.07	1.63	81.17	0.50	0.20	0.73	0.26	0.33	0.09	0.01	0.00	0.01	**100**	0.10	-0.20
Smithing slag																
Rnk1-15	14.69	0.15	3.21	81.13	1.67	0.75	2.95	0.02	0.30	0.13	0.05	0.02	0.00	**105**	0.23	-5.27
Rnk1-16	16.52	0.15	2.67	83.54	0.54	0.88	1.72	0.03	0.37	0.12	0.04	0.02	0.00	**107**	0.03	-6.85
T1-14	10.45	0.08	2.18	94.23	1.41	0.64	0.90	0.23	0.26	0.13	0.02	0.00	0.01	**111**	0.00	-10.64

APPENDIX 8.1B: WD-XRF READINGS FOR IRON PRODUCTION REMAINS.

Fe2O3 was converted to FeO by dividing each value by 1.111 (the ratio of the molecular weight of Fe2O2 to 2 x FeO). The difference between the two numbers was then added to the LOI to get the new LOI value. To remove the H2O and the new LOI, and normalize the data, we multiplied each value in a sample by 100 divided by the new total of all elements in that sample.

Sample #	Na2O	MgO	Al2O3	SiO2	P2O5	K2O	CaO	SO3	TiO2	Cr2O3	MnO	FeO	NiO	Total
Iron ores														
Rnk1-1	0.04	0.38	1.91	2.02	0.00	0.05	0.05	0.03	0.18	0.02	0.03	95.29	0.00	100
Rnk1-33	0.02	0.27	10.90	26.42	0.73	0.42	0.36	0.08	1.52	0.10	0.05	59.13	0.01	100
Rnk1-35	0.21	0.38	20.11	30.11	0.22	1.85	0.10	0.03	0.85	0.09	0.04	46.00	0.01	100
Rnk2-1	0.07	0.48	8.02	16.94	0.11	0.43	0.13	0.06	0.35	0.07	0.08	73.25	0.01	100
Rnk2-26	0.02	0.35	2.29	20.46	0.01	0.02	0.03	0.02	0.19	0.02	0.07	76.49	0.00	100
Rnk3-1	0.02	0.33	2.11	18.85	0.01	0.01	0.02	0.02	0.18	0.02	0.06	78.31	0.06	100
Tuyeres														
Rnk1-21	0.07	1.71	11.74	66.10	0.27	2.22	4.63	0.02	0.49	0.03	0.48	12.22	0.01	100
Rnk1-12	0.04	0.55	9.27	70.74	0.07	1.39	1.27	0.03	0.44	0.03	0.41	15.75	0.00	100
Rnk1-13	0.11	1.02	7.49	58.91	0.31	2.12	7.23	0.05	0.38	0.02	1.91	20.46	0.01	100
Rnk2-21	0.20	0.57	13.97	65.93	0.16	2.77	5.50	0.00	0.45	0.03	0.13	10.26	0.01	100
Rnk3-10	0.75	1.19	18.24	64.91	0.20	2.33	1.13	0.01	0.69	0.03	0.08	10.41	0.02	100
Rnk3-21	0.22	0.65	14.89	65.37	0.13	2.15	1.38	0.01	0.74	0.02	0.16	14.29	0.01	100
Furnace wall fragments														
Rnk1-4	0.08	1.02	7.05	69.99	0.28	1.43	10.45	0.06	0.34	0.02	0.33	8.93	0.01	100
Rnk1-19	1.37	4.34	16.08	60.27	0.05	1.02	2.90	0.03	0.66	0.03	0.33	12.91	0.02	100
Rnk2-25	0.24	1.24	15.29	67.55	0.19	2.56	2.21	0.00	0.56	0.02	0.28	9.88	0.01	100
Flow slag														
Rnk1-7	0.04	0.82	3.67	17.75	0.10	0.47	2.00	0.04	0.18	0.02	7.41	67.49	0.01	100
Rnk1-8	0.01	0.66	3.05	25.04	0.14	0.74	2.68	0.06	0.17	0.02	2.54	64.90	0.01	100
Rnk1-9	0.05	0.74	4.21	22.12	0.15	0.65	6.13	0.05	0.20	0.02	1.44	64.24	0.00	100
Rnk1-10	0.04	0.87	2.75	20.07	0.16	0.61	5.09	0.08	0.15	0.02	2.02	68.13	0.00	100
Rnk1-11	0.16	0.72	2.57	17.49	0.14	0.64	4.04	0.06	0.15	0.03	2.54	71.46	0.00	100
Rnk1-29	0.02	0.98	5.02	25.80	0.22	0.61	11.90	0.10	0.23	0.02	2.01	53.08	0.00	100
Rnk1-22	0.08	0.95	4.54	27.94	0.20	0.92	4.73	0.08	0.26	0.02	2.93	57.36	0.01	100
Rnk2-15	0.06	0.50	2.86	17.27	0.23	0.85	1.99	0.21	0.16	0.01	0.80	75.01	0.00	100
Rnk2-24	0.23	0.76	3.68	25.73	0.11	0.45	3.35	0.03	0.16	0.01	0.42	65.03	0.00	100
Rnk2-2	0.08	0.78	3.83	24.56	0.11	0.57	0.75	0.04	0.18	0.02	2.10	66.94	0.00	100
Rnk2-4	0.08	1.00	4.81	29.64	0.21	0.97	5.02	0.08	0.27	0.02	3.11	54.78	0.01	100
Rnk2-22	0.22	0.18	0.84	22.72	0.10	0.11	0.37	0.01	0.04	0.00	2.07	73.30	0.00	100
Rnk3-9	0.20	0.20	1.82	29.17	0.12	0.58	3.49	0.01	0.08	0.00	0.19	64.14	0.01	100
Rnk3-7	0.21	0.44	6.04	15.40	0.14	0.32	1.60	0.05	0.21	0.02	0.42	75.14	0.01	100
T1-13	0.22	1.15	4.40	24.11	0.17	0.79	5.31	0.00	0.18	0.01	1.54	62.11	0.01	100
T1-9	0.08	1.05	4.62	24.93	0.16	0.75	6.52	0.02	0.24	0.01	1.47	60.14	0.01	100
T1-10	0.17	1.29	4.47	22.54	0.26	0.95	4.64	0.04	0.19	0.01	1.50	63.94	0.00	100

...cont'd

Furnace slag

Sample ID	Na2O	MgO	Al2O3	SiO2	P2O5	K2O	CaO	SO3	TiO2	Cr2O3	MnO	FeO	NiO	Total
Rnk1-18	0.02	1.11	4.73	15.75	0.11	0.35	4.01	0.03	0.23	0.02	0.91	72.73	0.00	100
Rnk1-23	0.03	1.48	1.85	26.95	0.16	0.27	1.12	0.06	0.13	0.01	2.63	65.31	0.00	100
Rnk1-30	0.04	0.95	4.68	19.91	0.15	0.48	5.36	0.07	0.21	0.02	1.36	66.76	0.01	100
Rnk2-16	0.02	0.88	4.05	19.37	0.14	0.42	3.66	0.05	0.18	0.02	1.68	69.54	0.00	100
Rnk2-12	0.03	0.89	4.17	19.68	0.18	0.59	4.49	0.06	0.20	0.03	1.58	68.09	0.01	100
Rnk3-3	0.24	1.33	1.94	15.23	0.14	0.30	0.82	0.00	0.09	0.00	4.15	75.76	0.00	100
T1-15	0.16	0.99	1.57	15.19	0.42	0.78	4.24	1.56	0.25	0.01	0.28	74.58	0.01	100
T1-8	0.32	0.95	3.24	18.86	0.15	0.55	4.45	0.04	0.16	0.01	1.71	69.53	0.01	100
T1-11	0.18	1.23	3.74	21.53	0.16	0.69	5.71	0.03	0.16	0.01	1.74	64.83	0.00	100
Bloom/crown material														
Rnk1-32	0.05	0.43	2.10	22.88	0.13	0.29	0.98	0.17	0.14	0.02	0.58	72.22	0.01	100
Rnk1-36	0.06	0.65	2.06	19.79	0.16	0.54	3.24	0.06	0.15	0.02	2.05	71.21	0.01	100
Rnk2-20	0.02	1.23	2.34	10.73	0.09	0.25	0.72	0.03	0.11	0.03	1.92	82.50	0.01	100
Rnk2-19	0.16	0.75	1.41	12.29	0.12	0.56	5.20	0.07	0.14	0.02	0.50	78.77	0.00	100
Rnk3-14	0.26	0.20	1.63	15.00	0.09	0.33	0.73	0.01	0.07	0.00	0.50	81.17	0.01	100
Smithing slag														
Rnk1-15	0.02	0.72	3.05	13.98	0.12	0.28	2.81	0.05	0.14	0.02	1.59	77.22	0.00	100
Rnk1-16	0.03	0.82	2.51	15.50	0.12	0.35	1.61	0.04	0.14	0.02	0.51	78.37	0.00	100
T1-14	0.22	0.63	2.15	10.33	0.13	0.26	0.89	0.02	0.08	0.00	1.39	83.88	0.01	100

APPENDIX 8.2: QUALITATIVE XRF WAVELENGTH SPECTRA FOR BLOOMS FROM TEMBI 1