

RWANDA

Iron production in southern Rwanda: A summary of recent research

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Introduction

This paper is an interim progress report of the first archaeometallurgical project carried out in Rwanda since the groundbreaking work of Van Grunderbeek (1983, 1988) and Van Noten (1979, 1983). Over the course of six months in 2006-2007, investigations were conducted into the long-term metallurgical history of the Butare region, with two major aims: to reveal and investigate further Early Iron Age furnaces associated with the infamous decorated clay "brick" tradition, and to illuminate the extent of later iron production connected with the Nyiginya Kingdom. The availability of in-depth analytical and dating techniques, and the implementation of specific sampling strategies by the author, allow for an extensive understanding of both early and later sites, providing detailed insight into technological practices. Combining this information with the growing corpus of archaeological, ethnographic, linguistic and historical information provides an opportunity to better understand the role and significance of iron during certain key periods in Rwanda's past.

The fieldwork was conducted in collaboration with the Institute of National Museums of Rwanda and alongside the Ph.D. research of John Giblin (UCL Institute of Archaeology), to provide archaeological material for the Ph.D. thesis of the author. This preliminary report documents the iron production sites selected for detailed investigation, the fieldwork methodologies employed and the analytical techniques that are currently being applied to the archaeometallurgical and archaeological record. Some initial interpretations are offered, although it should be noted that the analyses are ongoing.

Background to the project

Iron has been an integral part of the every day life of many African societies for millennia, as can be

seen in the often complicated relationship between iron workers and society, and the importance of iron objects as utilitarian and symbolic items (for example Childs 1991; Reid and MacLean 1994; Schmidt 1996; Akinjogbin 2004; Childs and Herbert 2005). In Rwanda, people were producing iron in furnaces partly constructed from decorated clay rolls from around the mid first millennium BC to approximately the mid first millennium AD, although lack of associated archaeological evidence limits our understanding of the significance of iron during these early periods (Van Grunderbeek 1983, 1993, 2007; Van Noten 1983; Schmidt 1996). In addition to this data, there is also evidence from a relatively well-known period in Rwanda's history: the Nyiginya Kingdom. This polity seems to have emerged from around the sixteenth to seventeenth century AD, eventually covering the area now known as Rwanda (Chrétien 2003; Vansina 2004). The demand for iron during this period intensified, not least from the ever-busy armies who required a continual supply of weapons: 'Armies existed to wage war ... from the time of Rujugira onward (1770), the country was almost continually in a state of war' (Vansina 2004; 75). Finally, ethnographic work has demonstrated that at least four physically distinct furnace types were in operation in Rwanda by the time of colonial contact, sometimes associated with various secret and ritual practices (Celis 1987), and that there was a diversity of smelting techniques practiced throughout the country.

This brief overview highlights southern Rwanda's two-and-a-half-thousand years of metallurgical history, and the manner in which it is embedded into the complex economic, political and social systems. However, until now the archaeometallurgical potential of this area has not been fully explored, due to the earlier research focus on the Early Iron Age (Van Grunderbeek 1983, 2001; Van Noten 1983) and also due to the recent civil war and genocide, which created a situation inappropriate for archaeological studies to be conducted.

Field approaches

It was not possible to conduct systematic transect surveys in southern Rwanda, owing to the hilly nature of the landscape, dense habitation/cultivation and a general suspicion of strangers. Therefore a pragmatic survey strategy, led by John Giblin, was implemented within a 15km by 15km area,

whereby every passable road and track was explored, and people consulted along the way. Translation was provided by an employee of the National Museums of Rwanda and/or a University of Rwanda history student, and permission was obtained at every level of local administration. Thus, besides locating and re-assessing known sites, more than 50 previously unrecorded archaeological sites were located within one month.

Many of the newly recorded sites were identified by the presence of iron slag (the waste product of iron smelting), which often occurred as blocks representing complete smelting episodes. These smelts undertaken in pit furnaces, with or without some form of superstructure, during which the gangue material and iron oxides from the ore would melt and run into the pit and solidify, leaving an iron bloom to be processed, and furnace-pit-shaped slag blocks to be discarded into the archaeometallurgical record. Of these sites, 57% were found alongside knotted strip roulette decorated ceramics, making it likely that at least some, if not most of these sites relate to the Nyiginya Kingdom. This very loose dating structure will be substantiated as absolute dates become available. A number of sites also contained other archaeometallurgical remains such as furnace bases, some with slag blocks still in situ, and fragments of tuyeres (the pipes through which air is supplied to the furnace). All furnace bases were recognisable as faint circles in the ground. No superstructures were located across the study area, and most of the sites had experienced some level of erosion over time. Thus, no reconstructions of the size and shape of the original furnace walls are possible.

Six of the sites containing an array of archaeometallurgical evidence (and therefore presumably the most detailed archaeometallurgical information) were selected for excavation (Figure 1). Four of these sites contained large slag blocks, and at these sites a sampling methodology developed previously by the author in Uganda was applied (Humphris *et al* 2008): five of the most visually representative blocks were selected for systematic sampling and each slag was drawn and photographed. Each block was then sectioned, and the section recorded. Samples were then taken from the top of the section (sample A: slag produced at the end period of the smelt), the middle (sample B: slag representing the middle time period of the smelt), and the bottom (sample C: slag produced at the beginning of the

smelt) as seen in Figure 2. By analysing each of these samples, it is possible to create a reconstruction of the smelting episodes that produced the slag. In this way, technological practices such as preheating, the addition of any flux to increase the efficiency of the process, and overall operating parameters throughout the smelt can be investigated. Furnaces and other features were excavated at each site, and samples of furnace pit lining and other technical ceramics taken for further analysis. To increase the potential of the analyses, samples of domestic pottery were also taken from each site, to provide comparative material to reveal whether the smelters were selecting specific clays for the ceramics needed for the iron production processes. Finally, a number of units were excavated across each site in order to reveal any existing stratigraphic relationship within the sites and to test for associated features such as habitation remains. Where possible, the soil removed from these units was sieved and most of the units were excavated until bed rock was reached. In most cases this was only around 30cm in depth, as the sites tend to lie on heavily-eroded hill ridges or slopes. Apart from the site of Kamana (see below), no finds of interest were recorded from these test pits, meaning that either the smelts were conducted away from habitation sites, or that associated evidence has been eroded away.

Analytical approaches

Standard archaeometallurgical analytical approaches were applied to the iron production remains. The analyses included (P)ED-XRF analysis of homogenous powder pellets, providing an indication of the bulk chemical composition of the samples; optical microscopy, providing an insight into the internal microstructure of the sample, and so an indication of different phases present; SEM-EDS analysis, to understand the chemical composition of various phases of the samples to be specifically analysed. Samples of furnace wall, tuyere fragments, slag and charcoal have been submitted for dating. Some preliminary results are presented below.

The sites

In the area of Gahondo in the Gisagara district (to the east of Butare town) an archaeological iron production site was identified due to the presence of the remains of two smelting furnaces in a house compound, halfway down the side of a gently sloping

Figure 1. Archaeometallurgical sites chosen for detailed investigation.

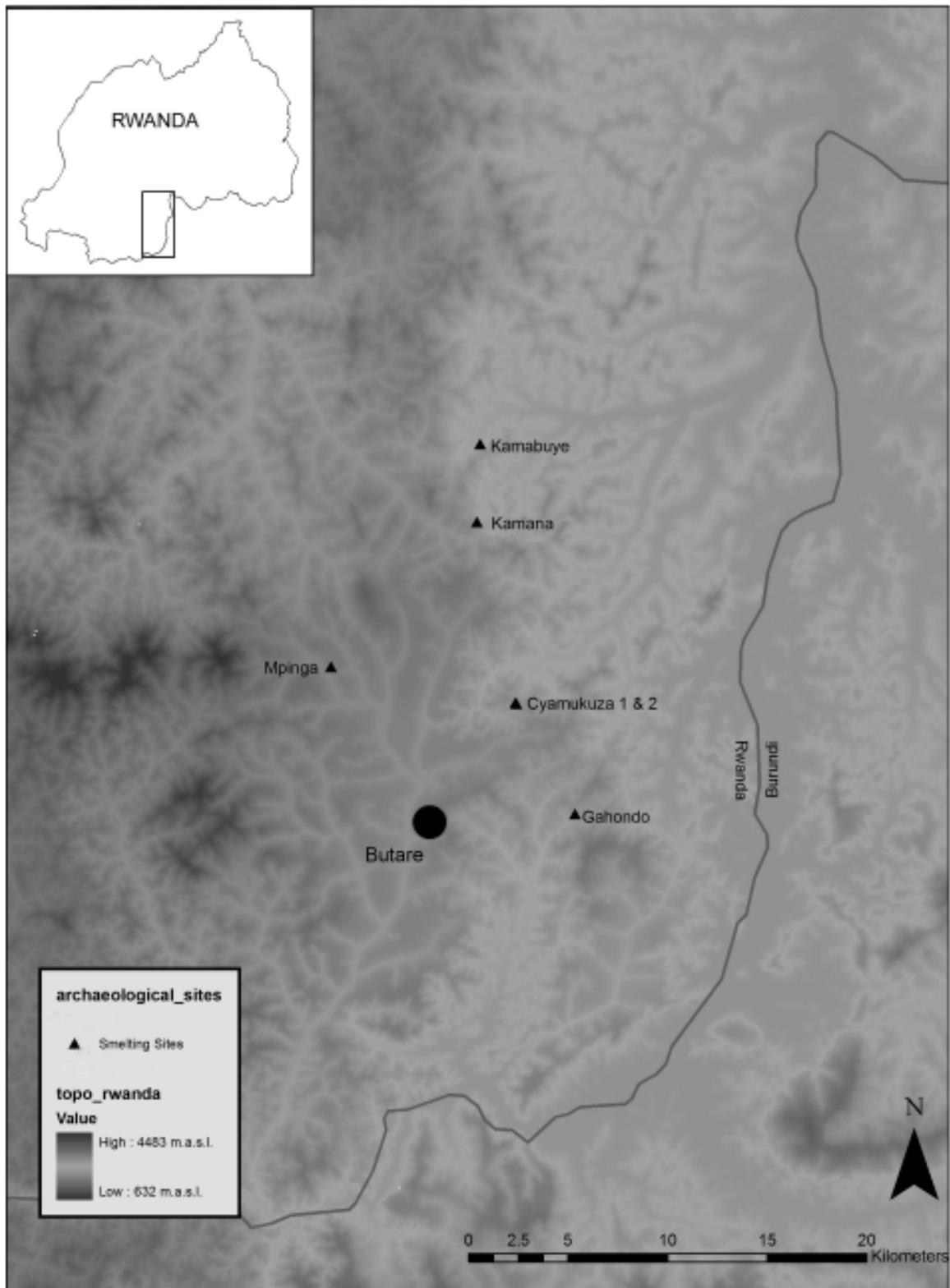
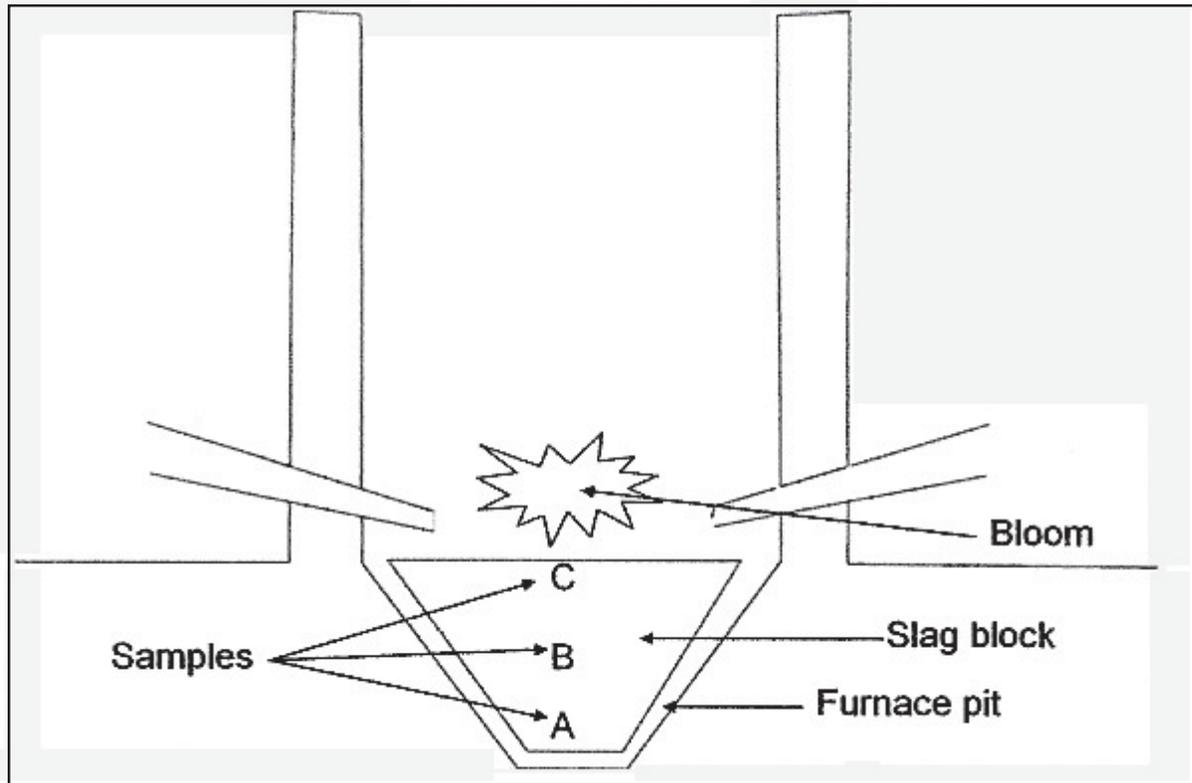


Figure 2. Schematic diagram of slag block sampling methodology.



hill. Furnace 1 appeared to be a typical bloomery furnace pit, filled with a number of tuyere and slag fragments, and fragments of burnt clay. The pit lining of this structure was approximately 2-3 cm thick throughout and the pit was approximately 40 cm deep. Furnace 2, at the other side of the compound, appeared very different from furnace 1 even before excavation, and yielded decorated and undecorated orange clay rolls, not bigger than 15 cm long and 10 by 10 cm in cross-section. These are reminiscent of those found in furnaces dating to the early/mid first millennium AD in the area by Van Grunderbeek (1992). Further decorated and undecorated clay rolls were also found next to this furnace. The furnace itself was badly preserved, but contained numerous flows of what appeared to be iron slag, tuyere fragments, undecorated burnt clay fragments and some pieces of unreduced ore (Figure 3). The furnace pit was approximately 27 cm deep, and the lining, where intact, was 2 cm at its thickest.

Based on the analytical work carried out so far, it appears that the smelters operating furnace 2 were using a very high grade ore, and utilising strongly

refractory ceramics – as seen in the high alumina content in the furnace wall, clay rolls and tuyere fragments – to ensure the longevity of smelting episodes. At present the relationship between furnace 1 and furnace 2 is unclear, although the fragments of burnt clay found in both features are macroscopically and chemically similar. Of additional importance will be the metallurgical analyses of two fragments of iron excavated by John Giblin from an Early Iron Age burial near to Gahondo, which contained Urewe decorated ceramics. The iron objects are adornments, comprising a necklet and a bracelet. Following cleaning and conservation at the UCL Institute of Archaeology, it is clear that different techniques of smithing were employed to make these objects: while the bracelet is distinctly square in section, the necklet is circular. The results of the analyses on this metal will go some way to understanding further these early metal working traditions. Metallographic analyses of the fragments taken from these objects are currently being carried out by the author.

Two major ironworking production sites were located in the Gisagara district, to the north east of

Butare town in the area of Cyamukuza (CMZ). These sites, and the following sites mentioned, were found in association with knotted strip roulette decorated ceramics, and therefore thought to date to the later kingdom period. It should be noted that the CMZ sites mentioned in this paper are not the same sites investigated in the Cyamukuza area in previous studies.

CMZ 1 is located on the ridge of a hill, in front of a primary school and between two houses. One furnace base was identified with a slag block still *in situ*. Seventeen further slag blocks were visible in an 8 m by 8 m area around the furnace base. A further pit - of uncertain function - was found 3.5 m to the west of the furnace base. Between these two pits was an unusual ceramic deposit consisting of a large pot with knotted strip roulette decoration around the rim, further embossed with 1 cm tall triangles around the bottom of the roulette band. The slag blocks at this site were macroscopically very similar and more complete than blocks found at any other site, with an average diameter of 57 cm, an average depth of 35 cm and an average weight of 77 kg (Figure 4). The slag was generally very dense with very few visible plant impressions. The furnace pit was approximately 65 cm in diameter and 40 cm deep, the lining being 2-7 cm thick. The second pit was approximately 30 cm wide and 25 cm deep. The lining of this feature was not well preserved, although it appears to have been re-lined at some point. It was a maximum of 2-3 cm thick. The pit was filled with burnt residue, fragments of slag and ceramics, and possible ore pieces. Test pits excavated at CMZ 1 contained no archaeological finds, probably because the site has been laid bare by human traffic over the years, leaving the surface prone to erosion by rainfall and slope wash.

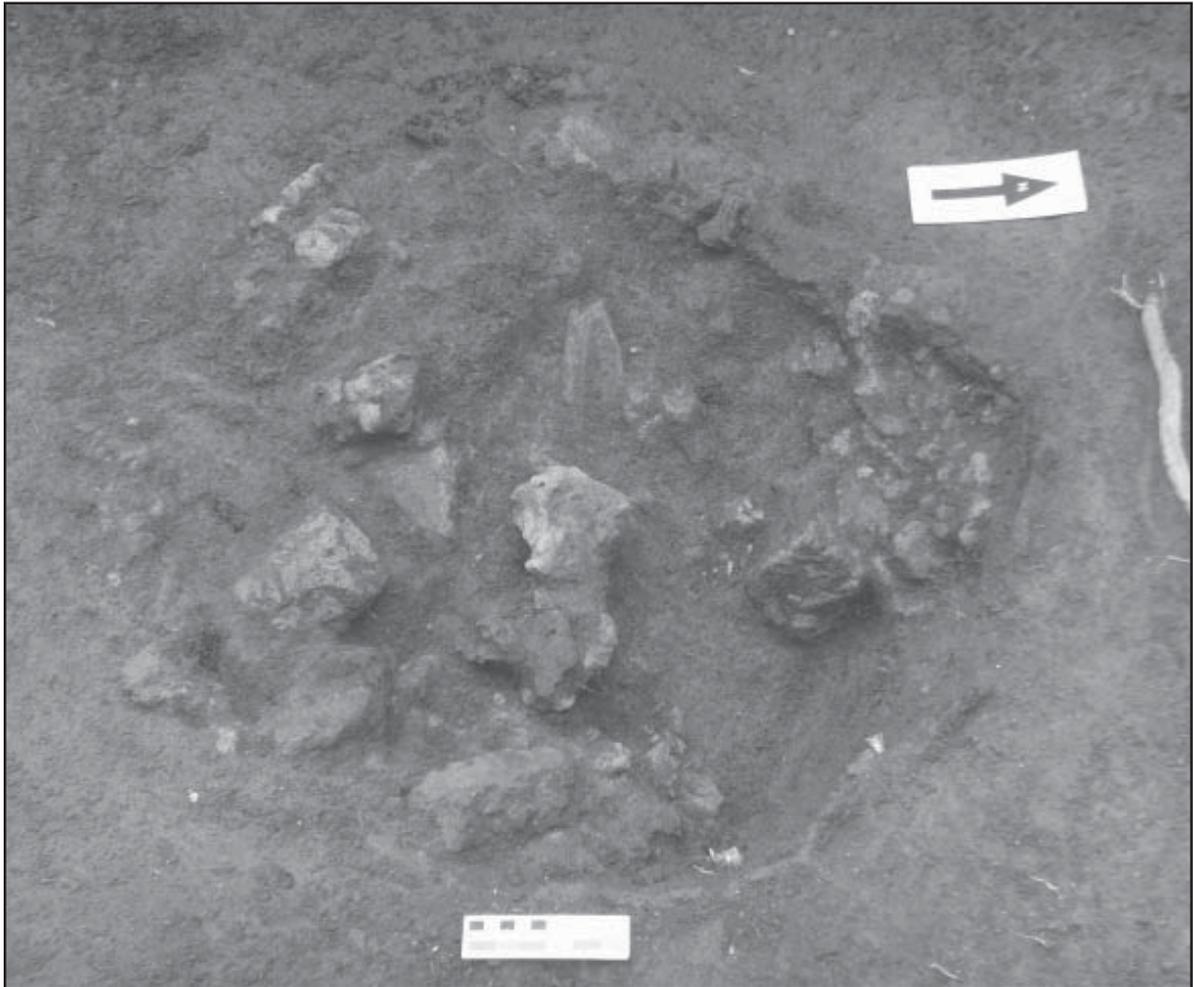
The second site in the area of Cyamukuza (CMZ 2) was on the side of a gently sloping hill, less than one mile from the site of CMZ 1, and contained nearly 50 slag blocks and the remains of two furnace bases. Macroscopically the slag blocks at this site appeared slightly different from those found at CMZ 1, with an average diameter of 66 cm, an average depth of 32.5 cm and an average weight of 71.2 kg. The slag blocks were less dense than those found at CMZ 1 and more easily half-sectioned, with plant impressions visible especially in the base of the blocks (the slag produced during the initial stages of the smelts). The two furnace bases appeared quite dissimilar: the first furnace pit was 85 cm in diameter and 45 cm in

depth, while the second was 70 cm in diameter and 25 cm deep. Both were roughly conical in shape. Furnace 2, located in the middle of a footpath, is probably smaller as a result of erosion suffered from people walking over it; therefore the two furnaces were probably more similar than it seems today. A number of tuyere fragments were found at this site, notably on top of the slag block in furnace 2, perhaps discarded into the furnace after the smelt had finished. Two test pits were excavated at this site with no finds recorded.

(P)ED-XRF analyses of the slag blocks from the two sites in the Cyamukuza area have shown that the smelters at both locations used very uniform smelting methods, which are apparent in both the macroscopic examinations of the slag blocks, but also in the uniformity of the chemical composition of the slag blocks analysed. The operating parameters throughout each smelt, such as temperature and fuel to ore ratio, were maintained at fairly constant rates for the duration of the smelting episodes, demonstrated in minimal chemical and microscopic variation seen throughout slag blocks tested from each site. This indicates that the smelters utilised the furnaces throughout the entirety of the time span of the smelt to their optimum. The smelters at both sites appear to have used very refractory ceramics. The main difference in operating conditions between the sites appears to be the ore source exploited, which at CMZ 2 is more alumina-rich than at CMZ 1.

Ten km to the west of Cyamukuza was the site of Mpinga, in the Mbazi district. This site contained the remains of one furnace base with a slag block still *in situ* (Figure 5), and 10 blocks of slag. This site was located on the very wide and long flat ridge of a hill, in the compound of a house. Only one vitrified tuyere fragment was found at the site, being used as part of a flower bed marker. The slags at this site were less complete than those found at the CMZ sites, but much wider than blocks of slag found at any other site. The average diameter was 79.5 cm, the average depth 36 cm and the average weight 125.9 kg. The furnace base was 97 cm in diameter, with the pit lining being 3-10 cm thick. The depth of the furnace pit was 23 cm. The slag blocks were relatively porous, with plant impressions visible throughout. Three test pits were excavated at this site, with sherds of undecorated pottery being the only finds. Analytical results so far indicate that the wider-based furnaces used at this site created smelting conditions that were harder to

Figure 3. Gahondo: furnace 2 during excavation.

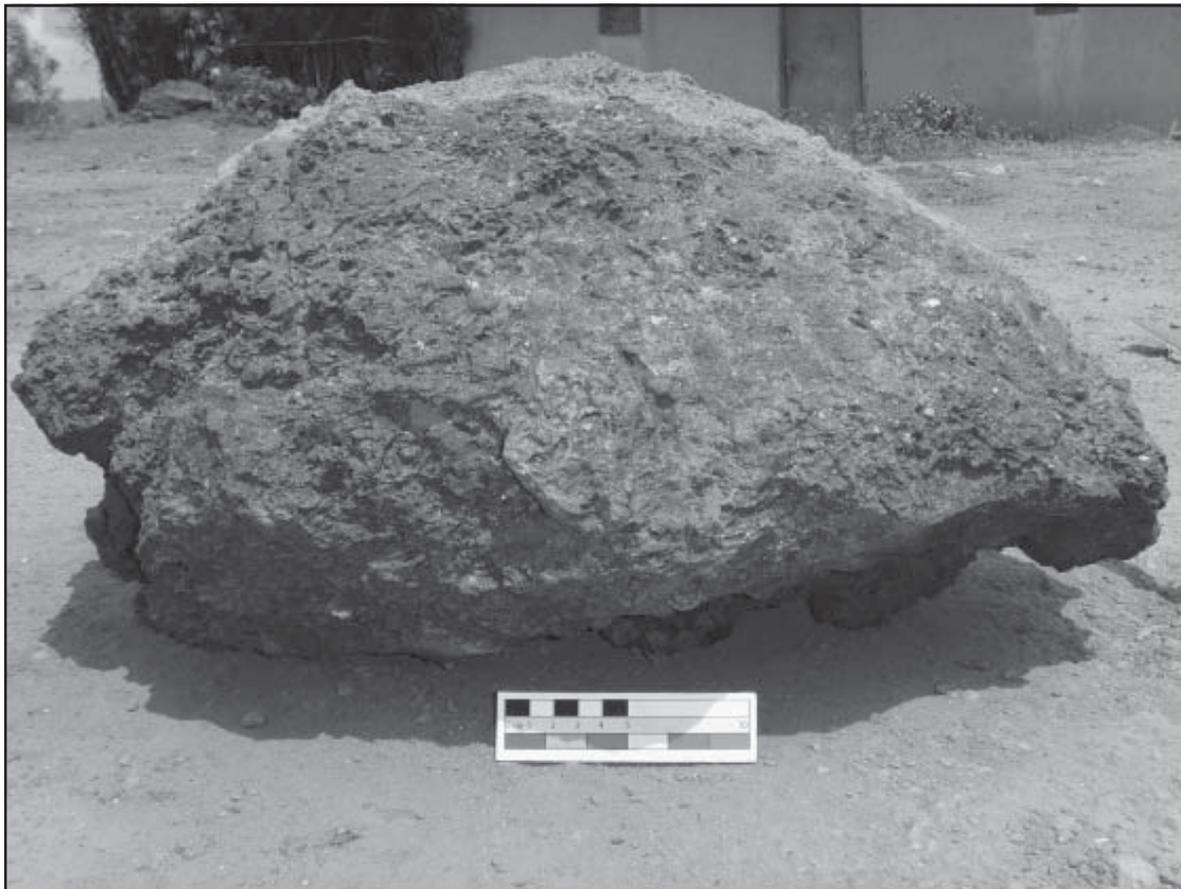


control than at other sites, which seems to have led to a less efficient process. This is apparent in the wider variation in composition within and between the slag blocks from this site, as well as generally higher iron losses in the slag.

Numerous small slags and grinding stones were seen in the foundations of a house at the site of Kamana, approximately 20 km north of Butare town, while six clusters of larger slag blocks and the remains of two furnace bases were also located in a 55 m by 30 m area. The average diameter of the blocks (although some had pieces broken off them), was 57 cm, the average depth was 29 cm, and the average weight was 64 kg. One furnace base was identified through a concentration of pit lining fragments. The other, located in a road, was 64 cm in diameter and 11cm in depth. Two one-metre-deep test pits were

excavated at this site. The first contained no finds or stratigraphy, while the second contained a number of slag fragments and what appears to be a smithing cake at 45 cm deep. These finds were isolated: the test pit containing only sterile soil throughout, as its location in the middle of a banana plantation made it subject to cultivation disturbance. The analytical results so far suggest that the smelters here were using a different source of ore (the slags having a generally higher alumina content than at other sites, not reflected in the technical ceramics), and a different source of charcoal than at the other sites (the slags being richer in phosphorus and lime, possibly indicating a different type of tree used as fuel). This probably reflects the distance between this site and the others, Kamana being further north. The presence of a smithing cake suggests that both smelting and

Figure 4. Typical slag block found at CMZ 1 (up=side=down).



smithing were carried out at this production location, although whether or not these technological practices were contemporary is unclear.

The final site excavated was Kamabuye, located 5 km north of Kamana. This site proved the most puzzling and complicated to excavate, consisting of one furnace base with slag *in situ*, positioned in the middle of a relatively busy road. To the side of the furnace pit on a rocky outcrop were over 30 grinding hollows. The furnace pit itself appeared to be set into the rock and built-up with technical ceramic to make the pit for the slag to flow/drip into; the pit was 65 cm in diameter and 27 cm deep. Two test pits were dug to bed rock (maximum depth of 40 cm); there were no associated finds.

Concluding Remarks

Recent survey and excavation has led to the documentation of over fifty iron production sites; six

of these have now been investigated in detail. Ongoing archaeometallurgical analyses show that the smelters at each site were efficiently producing iron, and repeating similar production methods throughout the time period within which the sites were used. The results also highlight a significant degree of variation in production methods in this small study area, which may reflect different ecological or environments adaptations, as well as varying cultural backgrounds of the smelting groups.

Interpretations of the results from each site are ongoing. However, it is already clear that at each smelting site studied, the smelters were making use of both the local resources available and the localised knowledge held within the groups. Each group appears to have consistently used the same methods of iron production throughout the smelting history of each site. Significantly, different technological signatures are visible at macroscopic, microscopic and chemical levels at each site, demonstrating the variety of iron

Figure 5. Mpinga: furnace base with slag block still *in situ*.



production traditions existing in this relatively small study area. The production centers presently associated with the kingdom were producing a large quantity of efficiently smelted iron, which supports the concept of an increased demand being placed on the industries by the growing needs of the polity. The wide degree of variation visible in the archaeo-metallurgical remains of each site could reflect experimentation to produce more iron than competing smelting groups, possibly supported by the secret nature of production at each site. The early site at Gahondo and the unusual site at Kamabuye will offer much deeper insights into the metallurgical history of the region.

These forthcoming results will be considered within the growing corpus of knowledge regarding Rwanda and the broader Great Lakes region in order to shed further light on how these important technologies fitted into diachronic social, economic and political contexts.

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