TANZANIA

Re-visiting African Bloom Refining Technology in Tanzania

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Introduction

This paper reports the results of archaeological field research conducted in Pito division in Sumbawanga district, southwest Tanzania (Figure 1). The main objective of the research was to survey and record traditional iron bloom refining sites with an aim to establish field identification criteria for such sites based on their material properties. The need to examine refining materials is related to the fact that published ethnoarchaeological works affirm the presence of traditional bloom refining technology in central and east Africa. However, little is known on how to identify refining sites in the field. This study took place between August and September 2009, as part of summer field school training that was organised by the Archaeology Unit, University of Dar es Salaam. It is interesting that fieldwork walkover surveys conducted with the aid of informants led to the discovery of many refining sites in nine areas and included ore sources, smelting and smithing sites. Smithing sites are different from smelting sites based on their material composition, slag morphology, location in relation to primary smelting sites, and other physical attributes. Smithing sites have grey-coloured slags, with almost all the refinery slags possessing flow or tape textures, and smelting sites are composed of blocky and rough slags with colours ranging from reddish-brown to grey. This paper argues that it is possible to distinguish refinery slag from smelting and smithing slags in the field because these processes are technologically and functionally different. It is important to give due weight to the role of matrix, provenience, and time while ascertaining these slag categories. The following section reviews literature related to refining technology.

Ethnoarchaeological Background Information

Traditional African ironworking varies greatly in both cultural and technological facets. While some societies may have practised a two-staged ironworking process namely smelting and smithing (Childs 1996; Sutton 1985), others practised a three-staged process, which included a refining process between smelting and smithing (Barndon 1996). Although it appears that the former technological style was practised across sub-Saharan Africa, the latter is uniquely encountered in central and eastern African countries including Tanzania, Democratic Republic of Congo (DRC), Malawi, and Zambia. The following section discusses information published on bloom refining technology in these countries.

One of the earliest colonial ethnographic reports mentioning the presence of a three staged ironworking process was written by Greig (1937) on Fipa iron smelting. This report was later complimented with supplementary notes by Wise (1958). They both report that Fipa ironworking involved three separate stages: smelting the ore in tall induced furnaces, refining the bloom in small forced-furnaces, and smithing the iron into implements (Greig 1937:79; Wise 1958:110). For example, while Greig (1937:79) writes, "at the end of another day the kiln (the tall furnace) has burnt out, and after it has cooled the iron is sorted out from among the ashes. This iron still contains a great deal of impurity and has to be treated further in a miniature blast furnace", Wembah-Rashid confirms "exactly there are three stages: the kiln stage (or smelting stage, own translation), the blast furnace (or refining stage, own translation) and the smithing stage (1969:66). Post independence, Fipa ironworking technology continued to receive attention from both ethnographers and archaeologists in publications including those by Wembah-Rashid (1969:66), Mapunda (1995a, 1995b:50), and Barndon (1992, 1996, 2004). These studies affirm that Fipa ironworking was a three-staged technology and that it was an inherited technology whereby experts teach others, especially their children. Also, no one will presume to try his hand at the technology unless he is an accredited craftsman (Greig 1937:1). Similar tradition to Fipa technology was practised by the Nyiha of Mbozi in Mbeya Region (Brock 1963:98) in southern Tanzania. Outside Tanzania there are ethnographic examples of this technology among the Tabwa in east DRC

Figure 1: Ufipa Research Area (adapted from Barndon 2004).



(Mapunda 1995a), the Lungu and Kaonde in northern Zambia (Chaplin 1961:54, 58), and the Phoka and Chewa of northern Malawi (Davison and Mosley 1988:77; Phillipson 1968:102).

This second stage in the ironworking *chaîne opératoire* was usually situated next to tall smelting furnaces, also called *Malungu* (or *Ilungu*, sing.) for convenience reasons because the material to be refined in miniature furnaces was the bloom from smelting furnaces (Mapunda 1995b). Nevertheless, it is vital to note that early travellers and missionaries in Tanzania claim "miniature furnaces were built near or in a village" (Greig 1937:79). Unlike the primary furnaces, refining furnaces were bellows-operated using three draught holes (Barndon 1996; Greig 1937; Phillipson 1968), almost cylindrical in shape with height ranging from 30 to 45.72 cm (Greig 1937; Wise 1958). They were always built on a sloping area: a small funnel-shaped channel was dug in front of the furnace that allowed the slag to flow away down the slope (Greig 1937; Wise 1958).

While Davison and Mosley (1988) suggested that no taboos were attached to the secondary refining process, Fipa refining furnaces had anthropomorphic attributes of a woman and they incorporated the ritual use of medicinal barks from different tree species, animal bones, and white juice (Barndon 1996). Because the culture of traditional ironworking is rapidly disappearing or has completely gone in some societies, we may need to rely on metallurgical remains analysis to support or to refute the validity of the existing ethnographic information. However, this should remain one of the future tasks in archaeometallurgy.

Figure 2: A group photo of students with villagers in Sumbawanga.



The linguistic terminology for refining furnaces is more or less similar throughout the *malungu* zone (Davison and Mosley 1988; Mapunda 1995b). For example, they are called *vintengwe* in the Fipa language or *shitengwi* in the Nyiha language in Tanzania, *vitengwa* in the Chewa language (Phillipson 1968:102) or *kathegu* or *vintengwe* in the Phoka language (Davison and Mosley 1988). Yet in English they are referred to as secondary smelting furnaces (Davison and Mosley 1988; Phillipson 1968; Wembah-Rashid 1969) or miniature furnaces (e.g. Greig 1937). Because the tall smelting furnaces in this part of Africa are generally called *malungu*, I suggest that this refining technology be referred to as *vintengwe* technology *(or kintengwe*, sing.) and probably not a "Tanganyika-Nyasa Corridor tradition" (e.g. Barndon 1992, 1996; Davison and Mosley 1988) because the former nomenclature refers to both *malungu* and *vintengwe* technologies.

Based on the above reviewed literature, it is worth pointing out that extensive published information on refining technology is basically ethnographic information. With the exception of Mapunda (1995b), who points out that the presence of refining sites in Nkansi district, very little has been done in terms of field surveying with the view to locate, document and comprehend refinery sites and slags. This field research focused on this academic knowledge gap, and aimed at discovering refining sites with the view to verify the available ethnographic data based on remains of the technology.

Field Methods

The field research was essentially part of field school training in archaeology. I worked and supervised 34 undergraduate students (Figure 2) from the Archaeology and History Department of the College of Arts and Social Sciences. As part of fieldschool training this research aimed at introducing students in archaeology to survey methods. After a three week survey orientation exercise, it was possible to survey methodically nine villages (see results section) in rural Sumbawanga with the view to discover ironworking sites with an emphasis on refining sites.

Identification and sampling of the areas to survey was assisted by local village governments and key informants, such as Mzee Meneja, who participated in traditional ironworking in Fipaland and who continue to practice modern iron smithing activities. Some of the informants took us to areas where the smelting and refining technologies took place. Physical observation of the materials was conducted in these areas. We continued with walkover survey on a non-random basis because all smelting and refining sites were located on ant-hills.

Table 1: Mkumbi sites.

Site Name	Site Type	Site Location	Area (m^2)	Materials	Discovered by
Mkumbi 1	Smelting	S (8^0 04.325'), E (31^0 40.8')	452.16	smelting slags, tuyere pieces, furnace walls	Ismail Khasimu
Mkumbi 2	Smelting	S (8^0 04.326'), E (31^0 40.884')	803.84	smelting slags, tuyere pieces, furnace walls	George Samweli
Mkumbi 3	Refining	S (8^0 04.302'), E (31^0 40.879')	78.5	flow slags, furnace walls	Faraja Mgimba
Mkumbi 4	Smelting	S (8^0 04.305'), E (31^0 40.826')	408.0744	smelting slags, tuyere pieces, furnace walls	Pamela Felix
Mkumbi 5	Refining	S (8^0 04.313'), E (31^0 40.834')	55.3896	flow slags, furnace walls	Anita Msaki
Mkumbi 6	Refining	S (8^0 04.319'), E (31^0 40.795')	50.24	flow slags	Pamela Felix
Mkumbi 7	Smelting	S (8^0 04.286'), E (31^0 40.808')	314	smelting slags, tuyere pieces, furnace walls	Amne Kassam
Mkumbi 8	Refining	S (8^0 04.259'), E (31^0 40.826')	200.96	flow slags	Emmanuel Josiah
Mkumbi 9	Refining	S (8^0 04.257'), E (31^0 40.827')	254.34	refining flow slags	Furgency John
Mkumbi 10	Smelting	S (8^0 04.455'), E (31^0 40.786')	200.96	smelting slags, tuyere pieces, furnace walls	George Samweli
Mkumbi 11	Smelting	S (8^0 04.048'), E (31^0 41.021')	254.34	smelting slags, tuyere pieces, furnace walls	Mzee Meneja
Mkumbi 12	Smelting	S (8^0 04.071'), E (31^0 41.068')	200.96	smelting slags, tuyere pieces, furnace walls	Reuben Tembo

Table 2: Chulu River sites.

Site Name	Site Type	Site Location	Area (m^2)	Materials	Discovered by
Chulu 1	Smelting	S (8^0 04.105'), E (31^0 41.433')	200.96	smelting slags, tuyere pieces, furnace walls	Gabriel Kaminyoge
Chulu 2	Smelting	S (8^0 04.061'), E (31^0 41.422')	153.86	smelting slags, tuyere pieces, furnace walls	Furgency John
Chulu 3	Smelting	S (8^0 04.062'), E (31^0 41.399')	346.185	smelting slags, tuyere pieces, furnace walls	Abdu Slim
Chulu 4	Smelting	S (8^0 04.084'), E (31^0 41.468')	346.185	smelting slags, tuyere pieces, furnace walls	Emmanuel Josiah
Chulu 5	Smelting	S (8^0 04.124'), E (31^0 41.621')	200.96	smelting slags, tuyere pieces, furnace walls	George Samweli
Chulu 6	Smelting	S (8^0 04.211'), E (31^0 41.544')	45.3416	smelting slags, tuyere pieces, furnace walls	Emmanuel Josiah
Chulu 7	Smelting	S (8^0 04.207'), E (31^0 41.570')	140.9546	smelting slags, tuyere pieces, furnace walls	Noel Ng'itu
Chulu 8	Smelting	S (8^0 04.099'), E (31^0 41.654')	314	remaining part of ilungu furnace (height 70cm, base diameter=2.3m, wall thickness=30cm, tuyere ports=11), smelting slags, tuyeres with intact slags	Mzee Meneja
Malimbo 1	Refining	S (8^0 04.690'), E (31^0 41.230')	359.4986	flow slags	Mzee Meneja
Malimbo 2	Smithing	S (8^0 04.684'), E (31^0 41.128')	78.5	anvil, scales, droplets, and few conglomerated slags	Mzee Meneja

Table 3: Kamafupa sites.

Site Name	Site Type	Site Location	Area (m^2)	Materials	Discovered by
Kamafupa 1	smelting	S (8^0 04.462'), E (31^0 38.827')	803.84	three tuyeres held together, smelting slag, furnace walls	Mzee Meneja
Kamafupa 2	smelting	S (8^0 04.499'), E (31^0 38.795')	907.46	remaining part of ilungu furnace (height=1m, base diameter=1.9m, wall thickness=31cm, tuyere ports=9), smelting slags, tuyere pieces	Edwinus Lyaya
Kamafupa 3	refining	S (8^0 04.533'), E (31^0 38.596')	63.585	flow slags	Mzee Meneja
Kamafupa 4	refining	S (8^0 04.566'), E (31^0 38.549')	153.86	flow slags	Noel Ng'itu
Kamafupa 5	refining	S (8^0 04.576'), E (31^0 38.512')	216.3146	flow slags	Salum Muya
Kamafupa 6	refining	S (8^0 04.600'), E (31^0 38.490')	113.04	flow slags	Lioba Justine
Kamafupa 7	refining	S (8^0 04.582'), E (31^0 38.462')	113.04	flow slags, tuyere pieces	Sigfrid Kikoti
Kamafupa 8	refining	S (8^0 04.681'), E (31^0 38.447')	200.96	flow slags	Abdu Slim
Kamafupa 9	refining	S (8^0 04.745'), E (31^0 38.475')	145.1936	flow slags	Faraja Mgimba
Kamafupa 10	smelting	S (8^0 04.803'), E (31^0 38.526')	1256	complete ilungu furnace (height=2.75m, base diameter =1.9m, wall thickness=10cm, tuyere ports=10, huge smelting slags heap.	Mzee Meneja
Kamafupa 11	smelting	S (8^0 04.715'), E (31^0 38.869')	200.96	slags tuyere-tapping, smelting slags, tuyeres	Edwinus Lyaya
Kamafupa 12	smelting	S (8^0 04.676'), E (31^0 38.852')	191.0576	smelting slags, furnace walls, tuyeres	Reuben Tembo
Kamafupa 13	smelting	S (8^0 04.672'), E (31^0 38.745')	226.865	almost complete pot-rituals?, furnace walls, smelting slags, tuyeres	Edwinus Lyaya
Kamafupa 14	smelting	S (8^0 04.667'), E (31^0 38.666')	200.96	smelting slags, furnace walls, tuyeres	Anita Mealsi
Kamafupa 15	smelting	S (8^0 04.699'), E (31^0 38.638')	176.625	standing ilungu furnace (height=2.7m, base diameter =1.55m, wall thickness=14cm, tuyere ports=10), smelting slags, tuyeres	Mzee Meneja
Kamafupa 16	smelting	S (8^0 04.777'), E (31^0 38.582')	530.66	smelting slags, furnace walls, tuyeres	Aldah Barghash
Kamafupa 17	smelting	S (8^0 04.783'), E (31^0 38.541')	171.9464	part of standing ilungu furnace, smelting slags, tuyeres	Abdu Slim

The surface survey was coupled with sites location readings via GPS with approximately accuracy of three metres. All readings will be processed soon to produce contour maps of the sites showing the position of refining sites in relation to smelting sites. Surprisingly, the three week survey led to discovery or documentation of many refining and smelting sites including smithing and iron ore source sites. Based on the discoveries of several still standing smelting furnaces, we thought that it was critical to conduct a public talk with villages for the protection of such historical heritage. There is a need to increase public awareness of cultural resources in the region. The following section presents the field results of this study.

Results

This section describes the major findings of the field research. The results are summarized in Tables 1 to 8, and if the Wanzale ore site is added to this list then there are a total of nine surveyed areas. Each of the tables has six columns: site name (or number), site type (or process), site location in latitudes and

Table 4: Nangesu sites.

Site Name	Site Type	Site Location	Area (m^2)	Materials	Discovered by
Nangesu 1	refining	S (8^0 04.942'), E (31^0 38.815')	660.185	flow slags, tuyere, cake-like slags	David Samwel
Nangesu 2	refining	S (8^0 04.981'), E (31^0 38.810')	660.185	flow slags	Noel Ng'itu
Nangesu 3	refining	S (8^0 04.886'), E (31^0 38.826')	113.04	flow slags	Edwinus Lyaya
Nangesu 4	refining	S (8^0 04.883'), E (31^0 38.781')	221.5584	flow slags	Edwinus Lyaya
Nangesu 5	smelting	S (8^0 04.988'), E (31^0 38.006')	400.9466	smelting slags, furnace walls, tuyeres	Noel Ng'itu
Nangesu 6	smelting	S (8^0 05.019'), E (31^0 38.948')	206.0154	smelting slags, furnace walls, tuyeres	Mzee Meneja
Nangesu 7	refining	S (8^0 04.998'), E (31^0 38.929')	271.5786	flow slags	Tumsifu Usiri
Nangesu 8	smelting	S (8^0 05.000'), E (31^0 38.895')	400.9466	smelting slags, furnace walls, tuyeres	Abdu Slim
Nangesu 9	refining	S (8^0 05.006'), E (31^0 38.868')	221.5584	flow slags	Vincent Charles
Nangesu 10	refining	S (8^0 04.960'), E (31^0 38.909')	437.2136	flow slags	Mzee Meneja
Nangesu 11	refining	S (8^0 04.909'), E (31^0 38.699')	237.6666	flow slags	Furgency John
Nangesu 12	smelting	S (8^0 04.981'), E (31^0 38.737')	232.2344	smelting slags, furnace walls, tuyeres	Noel Ng'itu
Nangesu 13	refining	S (8^0 04.963'), E (31^0 38.763')	186.1706	flow slags	Furgency John

longitudes, site area in m^2, materials recovered, and names of the discoverer of the site. However, noteworthy is the fact that general observation in the field shows that smelting slags include blocky slags, cake slags, rough and oxidized slags, and these are quite different from refining slags that are clearly flow or tape slags that include very few cake slags.

Table 1 presents a total of seven smelting and five refining sites from Mkumbi historical village. While smelting site areas range from 200 m^2 to 803 m^2, area of refining sites range from 50 m^2 to 200 m^2. Table 2 presents a total of eight smelting, one refining and one smithing site from the Chulu River area. The smelting area ranges from 45 m^2 to 346 m^2. Refining site areas of 359 m^2 is relatively bigger than smithing site areas of 78 m^2. Table 3 presents a total of ten smelting and seven refining sites from Kamafupa sub-village. While smelting site areas range from 171 m^2 to 1256 m^2, areas of refining sites range from 63 m^2 to 216 m^2. We discovered a total of four smelting and nine refining sites from Nangesu sub-village (Table 4). The smelting site areas range from 206 m^2 to 400 m^2 and the area of refining sites range from 113 m^2 to 660 m^2.

Tupa is named after a zebra (*Equus burchellii*) which was found dead in that particular area. We were able to discover a total of 33 smelting and 16 refining sites respectively in this area as well as one ore quarrying site depression with an area of 907 m^2 (Table 5a and 5b). While smelting site areas range from 63 m^2 to 1133 m^2, the area of refining sites range from 60 m^2 to 1074 m^2. Table 6 presents a total of ten smelting, three refining, and one smithing site recovered from Nantula sub-village. We measured smelting site areas and found these to range from 84 m^2 to 530 m^2. The area of refining sites ranged from 78 m^2 to 314 m^2 and the smithing site has an area of 78 m^2.

While Malonje is an iron ore site as well as a refining site (Table 7), Namatanda is an iron ore site as well as a smelting site (Table 8). The two sites of Malonje measure 1256 m^2 and 153 m^2 respectively whereas the sites of Namatanda measure 1017 m^2 and 78 m^2 respectively. Initially these two areas were known to be solely iron ores sites. Lastly, Wanzale ore site was mentioned by informants, in particular Mzee Meneja. We visited it and verified that it was an iron ore site. It is located at latitude S (8^0 06.540') and longitude E (31^0 40.081') and measured an area of 1808 m^2. The following section interprets these results in relation to the research problem.

Discussion

There are several points to learn from this study. First, GPS locations can be used to suggest that *vintengwe* furnaces were situated next to *malungu* furnaces. Based on Mkumbi site mapping, which was

Table 5a: Tupa sites.

Site Name	Site Type	Site Location	Area (m^2)	Materials	Discovered by
Tupa 1	refining	S (8^0 06.466'), E (31^0 41.561')	615.44	flow slags, furnace walls	Edwinus Lyaya
Tupa 2	smelting	S (8^0 06.493'), E (31^0 41.540')	153.86	smelting slags, furnace walls	Tumsifu Usiri
Tupa 3	smelting	S (8^0 06.491'), E (31^0 41.576')	28.26	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 4	smelting	S (8^0 06.576'), E (31^0 41.597')	226.865	furnace walls, smelting slags, tuyeres	Reuben Tembo
Tupa 5	smelting	S (8^0 06.602'), E (31^0 41.649')	834.2666	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 6	smelting	S (8^0 06.628'), E (31^0 41.620')	452.16	furnace walls, smelting slags, tuyeres	Reuben Tembo
Tupa 7	refining	S (8^0 06.547'), E (31^0 41.638')	113.04	flow slags	Reuben Tembo
Tupa 8	refining	S (8^0 06.551'), E (31^0 41.648')	1074.665	flow slags	Reuben Tembo
Tupa 9	refining	S (8^0 06.535'), E (31^0 41.583')	60.7904	flow slags	David Samwel
Tupa 10	refining	S (8^0 06.515'), E (31^0 41.590')	346.185	flow slags	Edwinus Lyaya
Tupa 11	refining	S (8^0 06.585'), E (31^0 41.647')	132.665	flow slags	Aldah Barghash
Tupa 12	smelting	S (8^0 06.595'), E (31^0 41.668')	283.385	furnace walls, smelting slags, tuyeres	Aldah Barghash
Tupa 13	refining	S (8^0 06.649'), E (31^0 41.690')	132.665	flow slags and cake-like slags	Anita Msaki
Tupa 14	refining	S (8^0 06.616'), E (31^0 41.702')	615.44	flow slags and cake-like slags	Anita Msaki
Tupa 15	smelting	S (8^0 06.713'), E (31^0 41.801')	706.5	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 16	smelting	S (8^0 06.687'), E (31^0 41.815')	113.04	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 17	smelting	S (8^0 06.577'), E (31^0 41.528')	176.625	furnace walls, smelting slags, tuyeres	Charles Maganga
Tupa 18	smelting	S (8^0 06.582'), E (31^0 41.509')	113.04	standing ilungu furnace (height=0.9m, base diameter =2.2m, wall thickness=24 cm, tuyere ports=9), smelting slags, tuyeres	Gabriel Kaminyoge
Tupa 19	smelting	S (8^0 06.180'), E (31^0 41.260')	94.985	furnace walls, smelting slags, tuyeres	Furgency John
Tupa 20	refining	S (8^0 06.190'), E (31^0 41.236')	113.04	flow slags	Frida Kombe
				furnace walls, smelting	

done by GPS and a total station, refining sites are located between 15 m and 36 m from smelting sites. This distance can be used to support what Wise (1958:110) reported about fifty years ago that *vintengwe* were built in front of *malungu*. Although there is no evidence to make a direct association of refining sites to specific smelting sites, it is more likely that the closer the *kintengwe* to *ilungu*, the greater is the possibility that the two furnaces have been used by the same smelters. However, direct association of *vintengwe* and *malungu* may not be necessary because the number of refining sites in the surveyed areas is often less than the number of smelting sites. This may suggest that either two or more *malungu* may have shared a *kitengwe* and smelters may have refined their bloom elsewhere. Here we support the latter because Malimbo 1 refining site was found far from a smelting area and was close to Malimbo 2 smithing site. This affirms the proposition by Greig (1937:79) when he writes "miniature furnaces may have been built near or in a village".

Second, about 99% of refining materials are flow or tape slags and the remaining 1% include cake

Table 5 b: Tupa sites.

Tupa 26	smelting	S (8° 06.251'), E (31° 41.285')	803.84	furnace walls, smelting slags, tuyeres	Noel Ngitu
Tupa 27	smelting	S (8° 06.217'), E (31° 41.437')	314	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 28	smelting	S (8° 06.377'), E (31° 41.437')	1017.36	standing ilungu furnace (height=3.25m, base diameter =2.3m, wall thickness=20 cm, tuyere ports=11), smelting slags, tuyeres	Tumsifu Usiri
Tupa 29	smelting	S (8° 06.406'), E (31° 41.310')	314	furnace walls, smelting slags, tuyeres, semi reacted ore?	Winifrida Deo
Tupa 30	smelting	S (8° 06.633'), E (31° 41.824')	452.16	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 31	smelting	S (8° 06.670'), E (31° 41.840')	326.6856	furnace walls, smelting slags, tuyeres	Gabriel Kaminyoge
Tupa 32	smelting	S (8° 06.686'), E (31° 41.865')	63.585	furnace walls, smelting slags, tuyeres	Florentina Bernard
Tupa 33	smelting	S (8° 06.692'), E (31° 41.884')	803.84	furnace walls, smelting slags, tuyeres	Lioba Jastin
Tupa 34	smelting	S (8° 06.632'), E (31° 41.875')	265.7696	furnace walls, smelting slags, tuyeres	Florentina Bernard
Tupa 35	smelting	S (8° 06.660'), E (31° 41.956')	120.7016	furnace walls, smelting slags, tuyeres	Florentina Bernard
Tupa 36	smelting	S (8° 06.620'), E (31° 41.902')	379.94	furnace walls, smelting slags, tuyeres	Gabriel Kaminyoge
Tupa 37	smelting	S (8° 06.598'), E (31° 41.912')	211.1336	furnace walls, smelting slags, tuyeres	Florentina Bernard
Tupa 38	smelting	S (8° 06.602'), E (31° 41.841')	254.34	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 39	smelting	S (8° 06.587'), E (31° 41.818')	314	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 40	smelting	S (8° 06.551'), E (31° 41.801')	333.1226	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 41	smelting	S (8° 06.529'), E (31° 41.797')	379.94	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 42	refining	S (8° 06.540'), E (31° 41.830')	153.86	flow slags	David Samwel
Tupa 43	smelting	S (8° 06.550'), E (31° 41.860')	153.86	furnace walls, smelting slags, tuyeres	David Samwel
Tupa 44	refining	S (8° 06.517'), E (31° 41.835')	78.5	flow slags	Sigfrid Kikoti
Tupa 45	refining	S (8° 06.488'), E (31° 41.880')	379.94	flow slags	Gabriel Kaminyoge

slags, *tuyéres*, and fragmented walls. The flow slag texture, which is greyish in color, is a result of how *vintengwe* were constructed on the slope as Wise (1958) and Brock (1963) have pointed out that the blast furnaces (or vintengwe) were built on a sloping side of the anthill and farther down the slope a large hole was dug to allow the flow out. The cake slags, which are also greyish in color, were part of the bloom and accumulated at the bottom of the furnace during the refining process. While smelting sites are composed of still standing furnaces or walls, refining sites lack this component. This is more or less similar to what happened in an extensive survey of the Kasungu Park where not one secondary furnace (*kintengwe*) was identified, and hence Davison and Mosley (1988:61) suggested that the "interpretation of post-primary stages of ironworking is particularly difficult, since they have considerably less archaeological visibility than primary phase". However, it is important to note that *vintengwe* furnaces were not meant to last. For example, among the Kaonde of northern Rhodesia, the secondary furnaces were broken down after four hours (after refining, own translation) and a secondary lump of iron was collected

Table 6: Nantula River sites.

Site Name	Site Type	Site Location	Area (m^2)	Materials	Discovered by
Nantula 1	smelting	S (8^0 05.836'), E (31^0 40.605')	200.96	furnace walls, smelting slags, tuyeres	Yusta Komba
Nantula 2	refining	S (8^0 05.917'), E (31^0 40.775')	78.5	flow slags	Elieth
Nantula 3	smelting	S (8^0 05.950'), E (31^0 40.783')	84.9056	furnace walls, smelting slags, tuyeres	Imamu Khasimu
Nantula 4	smelting	S (8^0 05.898'), E (31^0 40.827')	216.3146	furnace walls, smelting slags, tuyeres	Diana Mrisho
Nantula 5	smelting	S (8^0 05.911'), E (31^0 40.852')	88.2026	furnace walls, smelting slags, tuyeres	Sakina Mgaya
Nantula 6	smelting	S (8^0 06.008'), E (31^0 40.839')	113.04	furnace walls, smelting slags, tuyeres	Gillan Orenge
Nantula 7	smelting	S (8^0 06.057'), E (31^0 40.646')	314	furnace walls, smelting slags, tuyeres	Catherine Letara
Nantula 8	smelting	S (8^0 06.061'), E (31^0 40.732')	530.66	furnace walls, smelting slags, tuyeres	Amne Kassam
Nantula 9	refining	S (8^0 06.135'), E (31^0 40.929')	78.5	flow slags	Edwinus Lyaya
Nantula 10	smelting	S (8^0 06.140'), E (31^0 40.949')	314	furnace walls, smelting slags, tuyeres	Aldah Barghash
Nantula 11	refining	S (8^0 06.114'), E (31^0 40.943')	314	flow slags	Abdu Slim
Lupofwe 1	smithing	S (8^0 06.184'), E (31^0 41.127')	78.5	droplet slags, scales, anvil, conglomerated slags	Mzee Meneja
Nkale 1	smelting	S (8^0 06.477'), E (31^0 41.176')	132.665	furnace walls, smelting slags, tuyeres	Winifrida Deo
Nkale 2	smelting	S (8^0 06.498'), E (31^0 41.168')	452.16	furnace walls, smelting slags, tuyeres	Abdu Slim

(Chaplin 1961:58). In addition, although the furnaces are not there, we have refinery slags, which are not only ubiquitous but also distinctive materials from primary slags. Thus, we need to give due weight to this second stage in the *chaîne opératoire* for traditional ironworking in this part of Africa.

Third, based on the type of materials encountered during field observation, refining slags are clearly different from smelting sites. This is based on aspects such as slag shape and texture, surface condition, oxidation and color, presence or absence of semi-reacted ore, furnaces and walls, and type of *tuyére* (*tuyére*-mould slag). Noteworthy is the fact that *malungu* technology employed slag tapping, which looks similar to refinery slags. However, in order to make a clear distinction in the field repeated experience is required and the role of provenance is an important factor.

Smithing sites on the other hand are quite different from the other types because they are made of scale and droplet slags (Miller and Killick 2004), conglomerated slags, cake slags, hammers, anvils and hearths, which are clearly different from the former sites. Based on area measurements presented in the previous section, smelting sites are relatively larger than both refining sites. It may be logically correct to suggest that the amount of remains at sites depends on how much material was part and parcel of the process, and hence the more raw materials at smelting areas, the more remains occur at smelting sites.

Conclusion

There are sites from the refining tradition in the field and they are macroscopically different from smelting sites. Although refining technology dates between the 19th and 20th centuries AD (Davison and Mosley 1988; Mapunda 1995b) and probably not prior to the mid-second millennium AD (van der Merwe 1980: 491), there is no good reason to deny the existence of EIA *malungu* or *vintengwe* technology at this stage because little is known about refining sites and their slags. Because of that possibility, endeav-

Table 7: Malonje Village sites.

Site Name	Site Type	Site Location	Area (m^2)	Materials	Discovered by
Malonje 1	ore site	S (8^0 03.561'), E (31^0 44.399')	1256	iron ores	Mzee Meneja
Malonje 2	refining	S (8^0 03.734'), E (31^0 44.373')	153.86	flow slags	Group discovery

Table 8: Nambogo-Namatanda sites.

Site Name	Site Type	Site Location	Area (m^2)	Materials	Discovered by
Namatanda 1	smelting	S (8^0 02.691'), E (31^0 40.878')	78.5	smelting slags, tuyeres	Group discovery
Namatanda 2	ore site	S (8^0 02.461'), E (31^0 40.435')	1017.36	iron ores	Mzee Meneja

ours to investigate the existence of this technology in EIA or elsewhere in Africa should go in concert with efforts to devise appropriate methods to identify refinery materials in the field and in the laboratory. This is important because these materials form part of the archaeometallurgical record. Thus, ignoring them on the basis of their young dates is incomprehensive in the study of human culture, the subject matter of archaeology, and it may foster lack of clarity in the classification of iron slag in Africa.

I end by arguing that if we can accept the presence of this tradition in the field, then there is a further need to study the material properties of refinery slags macroscopically in the field and microscopically in laboratories with the view to define and set out reference materials for smelting and smithing slags in the future. Nevertheless, it is vital to note that not all African traditional ironworking societies practised refining technology as did some societies in central and east Africa as described in this paper.

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