Metallurgy in Tanzania

Introduction

Compared to professional research on Stone Age technology, which started in the mid-1910s, professional archaeometallurgical research in Tanzania started relatively late, in the 1970s, with the works of P. Schmidt, D. Avery, and T. Childs in the western Lake Victoria region (Childs, 1986; Schmidt & Avery, 1978). Observations and reporting on the iron production process by travelers, explorers, and missionaries started long before the 1970s (Brock & Brock, 1963; Greig, 1937; Lechaptois, 1913; Wise, 1958; Wychaert, 1914). Some of these early writers witnessed the process of producing iron especially in Ufipa, southwestern Tanzania, before the ore smelting process was halted in the 1950s mainly because of external factors (cf. Mapunda, 2010). The delayed start of professional research in archaeometallurgy in Tanzania as well as other East African countries can be attributed to the dearth of trained experts from this part of the continent.

The 1960s witnessed the emergence of anthropologists and ethnographers interested in and who wrote on iron production (Wembah-Rashid, 1969; Willis, 1966, 1968). Foreign nationals dominated the early period of professional archaeometallurgical research (1970s to mid-1990s). Interests in training national archaeologists matured with the establishment of the Archaeology Unit (now the Department of Archaeology and Heritage) at the University of Dar es Salaam in 1985. Today, along with foreign archaeometallurgists, there are two local archaeometallurgists in Tanzania, the authors of this entry. Archaeometallurgical research in Tanzania has concentrated mainly on iron. This is because iron production dominated indigenous technologies in the country. Although copper deposits have been noted in some areas west of the country, no record of exploitation of the same scale is known so far.

Professional research into iron production in Tanzania has focused on various themes including origin and chronology, technology (e.g., furnaces, tuyère ports, and tuyères), and culture (rituals, symbolism, and taboos) of producing iron and steel.

Origin and Chronology

One of the key questions for early archaeometallurgical research has been finding out whether iron production was introduced or independently invented in sub-Saharan Africa. Tanzania is no exception. On the basis of the available research evidence in Tanzania, it is extremely difficult to declare that iron production in Tanzania was introduced from elsewhere outside Africa. The technology of Early Iron Age (EIA) Tanzania is so different from the known European and Asian evidence, which makes it reasonable to suggest that the technology of iron production in Tanzania has an independent origin in sub-Saharan Africa (cf. Schmidt & Avery, 1983, p. 432). The absence of a three-stage process of iron production in Eurasia also strengthens the proposition of independent invention of iron technology in sub-Saharan Africa. In terms of chronology, the metallurgy of Tanzania is conveniently divided into two phases, namely, EIA and Later Iron Age (LIA). For the purpose of this entry, the first phase approximately covers the period between 500 BC and 1500 AD (Chami, 1994; Haaland, 1993, 1994/1995; Mapunda & Burg, 1991; Schmidt & Childs, 1985; Schmidt, 1988), while the LIA covers ca. the period between 1500 AD and 1950 (cf. De Rosemond, 1943; Lyaya, 2011). From the oldest to the youngest, the archaeological sites with EIA iron technology in Tanzania include (i) Rugomora Mahe, KM2 and KM3 in the Kagera Region; (ii) Limbo in the Coast Region; (iii) Dakawa in the Morogoro Region; (iv) Ntuha in the Mbinga, Ruvuma Region; (v) Usambara mountains; and (vi) Magubike in the Iringa Region. There are many LIA archaeological sites in Tanzania in almost every region, although more research is needed to declare this position. The technology of iron production spread widely during this period possibly because it was vital for socioeconomic and cultural activities than in any other time before (Mapunda, 1995; Lyaya, 2013).

Process of Iron Production

Generally speaking, the process of iron and steel production in sub-Saharan Africa either followed a two-stage or three-stage process. The process of iron production especially in the southern highlands of Tanzania followed a three-stage process including ore smelting, iron refining, and iron smithing (primary and secondary smithing) stages. It

© Springer-Verlag Berlin Heidelberg 2014

means that not all iron-producing societies followed the three-stage process; most of the iron-producing societies in Tanzania and elsewhere in sub-Saharan Africa followed a two-stage (ore smelting and smithing) process. So far the three-stage process has been verified ethno-archaeologically and archaeometallurgically in Unyiha (Brock & Brock, 1965) and Ufipa (Greig, 1937) in the southern highlands of Tanzania. The two-stage process is popular in much of Tanzania and in many other places across the globe. In extension, the three-stage process was practiced in Zambia, Malawi, Democratic Republic of Congo (DRC), NW Mozambique, and Tanzania (Chaplin, 1961; Davison & Mosley, 1988; Killick, 1990; Mapunda, 2010; van der Merwe & Avery, 1987).

In terms of the end products, the second stage of the three-stage process, locally referred to as the vintengwe process, aimed at producing carbon-rich steel through carburization of the end product (soft iron) of the ore smelting stage (locally referred to as the malungu process). The end products of the first stage of the two-stage process were either soft iron (bloom) or steel, while the end product of the three-stage process was the soft iron from the ore smelting stage and carbon-rich steel from the second vintengwe stage. The ore smelting and iron refining stages used furnaces, and the smithing stage used smithing hearths. The difference between the two processes can be discussed in relation to the nature of the iron ore, because the malungu furnaces utilized low-grade iron ore, but the relatively small and short ore smelting furnaces utilized iron-rich ores (Mapunda, 2010; van der Merwe & Avery, 1987).

Furnaces

The ore smelting and iron refining furnaces can be described in relation to variable criteria such as (i) building material, (ii) height, (iii) presence or absence of slag-pit provision, (iv) furnace morphology, (v) decoration, and (vi) presence or absence of a peep hole. The majority of EIA furnaces were built using bricks or clay rolls, but with the exception of the Barongo furnaces that were termite slab-made, almost every LIA furnace was built using wet clay. The general change of the building material can be associated with efficiency of the furnaces in terms of the effect of air in smelting the metal, possibly because expansion and contraction due to heating and cooling loosens the fireclay cement between the bricks and clay rolls, which in turn allows air to be drawn in and gas to escape at low levels (cf. Tylecote et al. 1971). The furnaces in the EIA period were completely bowl furnaces, although it is difficult to completely verify this position on account of the fragmentary nature of the furnace remains (Sutton, 1985). Some of the EIA furnaces have been referred to as shaft-bowl furnaces (Schmidt & Avery, 1983). Generally speaking, the bowl and shaft-bowl furnaces had slag-pit provision wherein liquid slag accumulated at the bottom of the furnace.

There is a group of furnaces especially during the LIA period that were clearly shaft furnaces: short shaft furnaces about 1 m and tall shaft furnaces about 1.5-3 m. Most of the shaft furnaces had no slag-pit provision; the liquid slag was tapped out of the furnace through tuyères [a nozzle through which an air blast is delivered to a forge or blast furnace] or through special holes dug below the tuyère level. The shaft furnaces are greatly variable in terms of morphology, which includes truncated and globular, almost cylindrical, conical, and olpe-shaped furnaces (Figs. 1, 2, 3, and 4).

© Springer-Verlag Berlin Heidelberg 2014

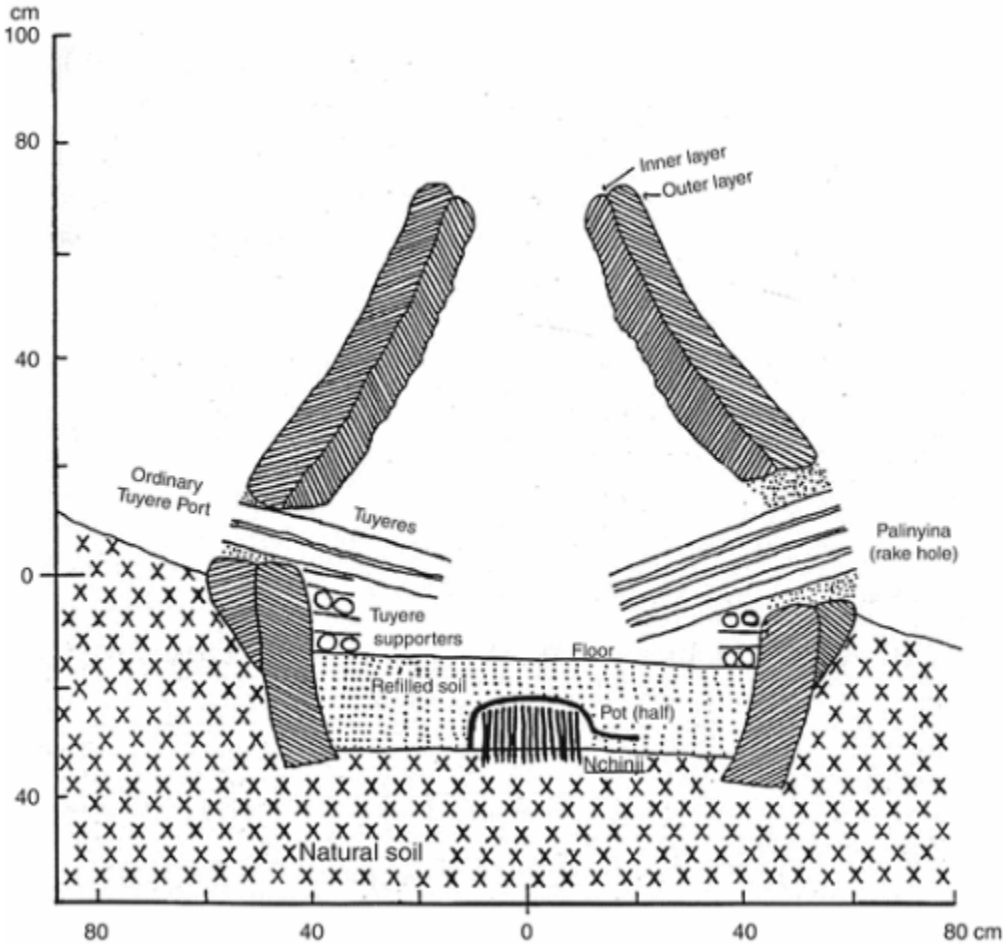


Fig. 1
Globular ore smelting furnace (Adopted from Mapunda, 2010, p. 131)

© Springer-Verlag Berlin Heidelberg 2014

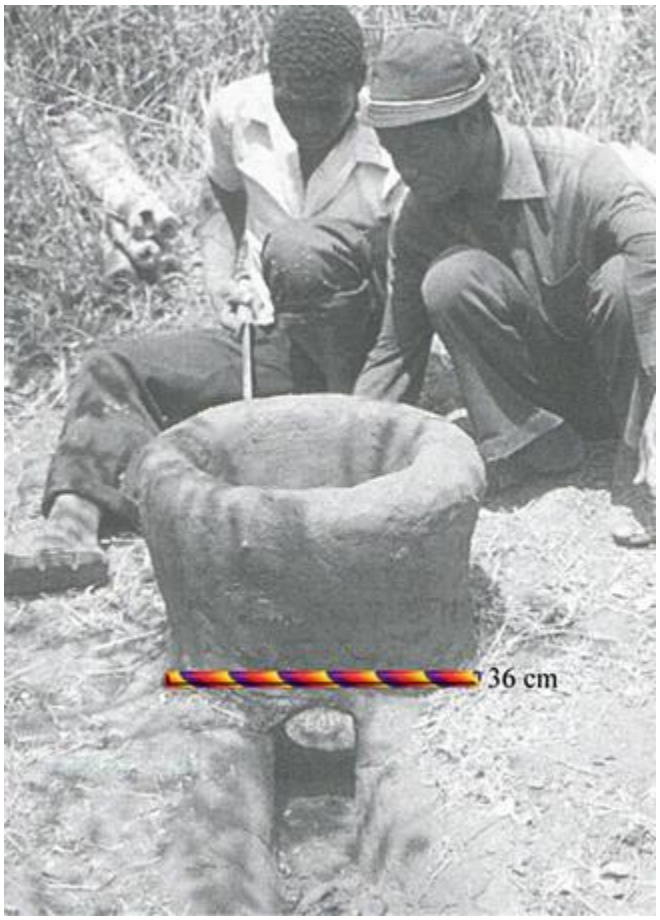


Fig. 2
Cylindrical Kitengwe iron refining furnace (Adopted from Barndon, 2004b)



Fig. 3
Conical ore smelting furnace from Ufipa (Adopted from Lyaya, 2013)

© Springer-Verlag Berlin Heidelberg 2014

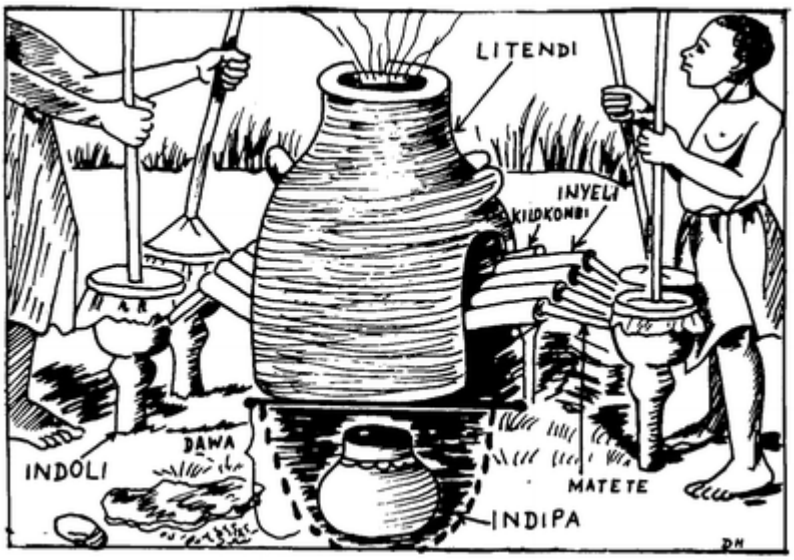


Fig. 4
Olpe-shaped ore smelting furnace (Adopted from Kapinga, 1990)

It should be noted that for the sake of stability and maintenance of the reduction temperature in the furnace, almost all the shapes were designed such that the furnaces were wider at the base diameter and tapered toward the top (see Fig. 1). Some furnaces were decorated, for example, with breasts and wood punches, while others were undecorated (e.g., Kapinga, 1990; Mapunda, 2010, p. 114; Sutton, 1985). Most of the smelting furnaces had peep holes for monitoring progress in them, but some smelters used short tuyères (kikolombi) for this purpose.

Tuyères and Tuyère Ports

Generally, the iron production furnaces had about two to ten tuyère ports, where the smelting furnaces of Umatengo, southern Tanzania, had the minimum number of two tuyère ports (Kapinga, 1990) and the malungu furnaces of Ufipa and Unyiha represent the maximum number of tuyère ports, 10 (Mapunda, 2010). Generally speaking, the number of tuyère ports relates to the mode of draft a particular iron production process employed. Low numbers, say 2-5, were associated with forced draft whereas high numbers with natural draft. Often, tuyère ports of the former mode housed a single tuyère each, although cases of twin tuyères have also been reported, for example, among the Matengo of southern Tanzania (cf. Kapinga, 1990; Lyaya, 2013). The smelting furnaces with eight (katukutu) to ten tuyère ports (malungu) housed multiple tuyères and were natural-draft furnaces. The mode of draft bears some relationship to the height and size of the furnaces. For example, the internal base diameter (IBD) of a furnace with two or three tuyère ports is ca. 40-60 cm, while the internal base diameter (IBD) for the malungu is ca. 130-160 cm.

The individual or multiple tuyères were placed horizontally, one beside another or one on top of another. While the main function of tuyères was to supply air into the furnace (for examples, see Childs, 1996; Schmidt, 2006), in Ufipa, tuyères were also used for slag tapping (cf. Mapunda, 1995, 2010). Tuyères used for such a purpose would be placed in such a way that they were sloping downwards outwardly, while those used for air supply alone were inwardly inclined (Mapunda, 2010, p. 154). In terms of length, the longest tuyères from Ufipa (Fig. 5) measure ca. 40-50 cm, and the shortest tuyères from Iringa (Fig. 6) measure ca. 10-15 cm.

© Springer-Verlag Berlin Heidelberg 2014

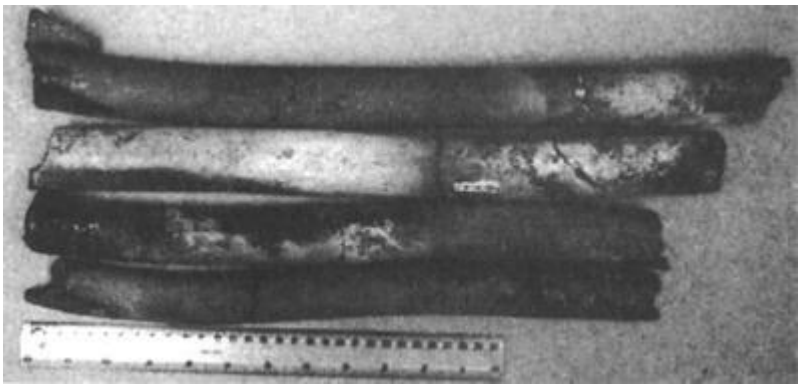


Fig. 5
Longest tuyères from Ufipa (see Mapunda, 2010, p. 126)



Fig. 6
Shortest tuyères from Kalenga (see Lyaya, 2013)

Morphologically, tuyères are either flared proximally or having the same diameter tip to tip. The former shape is associated with forced air supply and hence could be used for smelting, refining, or smithing, while the latter is associated with natural-draft combustion system and is therefore not associated with the post-smelting process of smithing.

Rituals, Symbolism, and Taboos

The process of iron production in Africa was fully associated with ritualistic symbolism and taboos, and Tanzania is no exception (cf. Lyaya, 2011; Mapunda, 2013; Schmidt & Mapunda, 1997; Schmidt, 1997). Metaphorically, the ore smelting process was equated to the human (re)production system. The furnace was regarded as a pregnant woman, and that is why some smelting furnaces in the southern highlands of Tanzania were decorated with breasts (Kapinga, 1990; Sutton, 1985). The furnace "rake hole" was considered as the "mother door" in Ufipa (Mapunda, 2010), and for this reason, the metal produced was regarded as the child. Because of the importance attached to a childbirth event and the risks involved, no wonder that the process was accompanied with ritualistic medicines and symbolism to guarantee a safe child delivery. Similarly, the process of iron production used ritualistic medicines to symbolically ensure successful production of the metal. Most of the plant and animal species used for the ritualistic medicines in the iron production process had similar sociocultural uses in societies including curing or protection against witchcraft, diseases caused by witchcraft and spirit possession, epidemics threatening the community, venereal diseases that reduce fertility, and symbols of fertility (Mapunda, 2010, 2013; van der Merwe & Avery, 1987). It therefore follows that the use of such medicines in iron production was related to the belief of the smelters that because these medicines worked efficiently in child conception, pregnancy, and delivery, they could have worked effectively to ensure successful bloom production (Lyaya, 2012, 2013; Mapunda, 2011, 2013).

Most of the iron production ritualistic medicines have been found buried at the bottom of smelting furnace floors. Some of the medicines were covered with ritual pots, which were sometimes perforated to supply breathing throughout the furnace

© Springer-Verlag Berlin Heidelberg 2014

(Kapinga, 1990). The use of smelting medicine was critical for the smelters; smelting could not be conducted without it (Barndon, 2004a; van der Merwe & Avery, 1987). The smelting magic functioned to increase the seriousness of the performers (rewards or punishment) and to increase confidence to cope with the unknown. The legacy of iron production medicine is evident in some iron-producing societies for they use the smelting sites for ritualistic healing, because people believe that the smelting medicines were strong and eternal (Mapunda, 2010, p. 160). Others in the southern highlands of Tanzania collect and keep smelting memorabilia in their houses.

The process of ore smelting in Tanzania was governed by serious taboos, including the following. First, among most communities, smelters were not allowed to take showers for the entire smelting season! Second, they were required to maintain celibacy during the entire period. Third, in most iron-producing societies, women especially those menstruating were not allowed to come close to the smelting site or any smelting raw materials. For the same reason, in some cases, women already in menopause were allowed to come close to the smelting sites. Fourth, the smelting activities were isolated from the general public eye and especially from the strangers. Lastly, smelters were required to stay peacefully at the smelting camp. If one of these taboos was violated, then there was a big chance that the smelt would fail. Anyone who was identified to have violated the taboos was punished including chasing them from the smelting exercise (for details, see Bandon 2001, 2004b); Mapunda, 2002, 2011, 2013; Schmidt & Mapunda, 1997)!

Conclusion

We have noted that archaeometallurgical research in Tanzania started relatively late when compared with other archaeological themes such as Stone Age technologies, human evolution, pottery ware and traditions, and coastal archaeology. Nonetheless, expansion of research in this subject both spatially and thematically has been comparatively impressive. Almost 50 % of the country is sufficiently surveyed through staff and postgraduate research or undergraduate field schools program and its archeometallurgical information is confidently known. Efforts continue to cover the remaining area so as to gain a comprehensive understanding of the metallurgical history of the entire country within the next 10 years. Thematically, research interests have covered issues related to technological variations (both stylistic and spatial), origins, composition, symbolism, bio-metallurgy, metallography, and elemental analysis.

There are efforts to train more practicing local archaeometallugists. Various archaeometallurgical courses have been introduced in both undergraduate and MA levels for students interested in metallurgy. These have proven to be quite interesting to students. For example, since the establishment of an MA (archaeology) degree program in 2003-2004, with an average of six students every year, a total of seven students have conducted their dissertation research on archaeometallurgy. We continue encouraging and supporting colleagues from outside Tanzania to work both collaboratively or independently in this subject matter for the interest of global science. In terms of future research directions, we see it that a purposive employment of archaeometry methods to the study of the archaeometallurgy of Tanzania is vital, in order to improve our understanding of the archaeometallurgy of Tanzania. In line with this there is a need to establish a BSc and MSc in archaeological science programmes at the University of Dar es Salaam.

References

- Barndon, R. (2001). Masters of metallurgy - Masters of metaphors: iron working among the Fipa and the Pangwa of SW-Tanzania. Bergen, Norway: University of Bergen.
- Barndon, R. (2004a). A discussion of magic and medicines in East African iron working: Actors and artefacts in technology. Norwegian Archaeological Review, 37(1), 21-40.
- Barndon, R. (2004b). An ethnoarchaeological study of iron smelting practices among the Pangwa and Fipa in Tanzania. Oxford: Archaeopress.
- Brock, B., & Brock, P. W. G. (1963). Iron-working amongst the Nyiha of Southwestern Tanganyika. South African Archaeological Bulletin, 18, 97-100.
- Brock, B., & Brock, P. W. G. (1965). Ironworking amongst the Nyiha of Southwestern Tanganyika. South Africa Archaeological Bulletin, 20(78), 97-100.
- Chami, F. (1994). The Tanzania coast in the first millennium A.D.: Archaeology of the ironworking, farming communities. Uppsala, Sweden: Societas Archaeological Upsaliensis.
- Chaplin, J. H. (1961). Notes on traditional smelting in northern Rhodesia. South African Archaeological Bulletin, 16 , 53-60.

© Springer-Verlag Berlin Heidelberg 2014

- Childs, S. T. (1986). Style in technology: A view of African Early Iron Age iron smelting through its refractory ceramics. Ph.D. dissertation, Boston University.
- Childs, S. T. (1996). Technological history and culture in western Tanzania. In P. R. Schmidt (Ed.), The culture and technology of African iron production (pp. 277-317). Florida: University Press Florida.
- Davison, S., & Mosley, P. N. (1988). Iron smelting in the upper north Rukuru Basin of northern Malawi. Azania, 23, 57-100.
- De Rosemond, C. C. (1943). Iron smelting in the Kahama district. Tanganyika Notes and Records, 16, 79-84.
- Greig, R. C. H. (1937). Iron smelting in Fipa. Tanganyika Note and Records, 4, 77-80.
- Haaland, R. (1993). Excavations at Dakawa, an Early Iron Age site in east-central Tanzania. Nyame Akuma, 40, 47-57.
- Haaland, R. (1994-1995). Dakawa: An Early Iron Age in the Tanzanian hinterland. Azania, 29-30, 238-247.
- Kapinga, V. (1990). Kuathiriwa kwa Maendeleo ya Mwafrika: Mfano Halisi Tanzania [How an African development were affected: Real example from Tanzania]. Peramiho: Peramiho Priting Press.
- Killick, D. J. (1990). Technology in its social setting: Bloomery iron-smelting at Kasungu, Malawi, 1860-1940. Yale University.
- Lechaptois, A. (1913). Aux Rives du Tanganyika. Algiers, Algeria: Missionaries of Africa.
- Lyaya, E. C. (2011). Bioarchaeometallurgy, technology, and spatial organization of ironworking at Mjimwema, Njombe Tanzania. Papers from the Institute of Archaeology, 21, 66-86.
- Lyaya, E. C. (2012). Archaeology of Hehe iron smelting technology at Kalenga, southern Tanzania. The Journal of African Archaeology Network, 10, 80-106.
- Lyaya, E. C. (2013). Macroscopic and microscopic variation of iron and high carbon steel production in the Southern highlands of Tanzania. London: Institute of Archaeology, University College London.
- Mapunda, B. B. (1995). An archaeological view of the history and variation of ironworking in Southwestern Tanzania. Florida: University of Florida.
- Mapunda, B. B. (2002). Iron metallurgy along the Tanzanian coast. In F. Chami & G. Pwiti (Eds.), Southern Africa and the Swahili World, Studies in the African Past 2 (pp. 76-88). Dar es Salaam. Tanzania: Dar es Salaam University Press.
- Mapunda, B. B. (2010). Contemplating the Fipa ironworking. Kampala: Fountain Publishers.
- Mapunda, B. B. B. (2011). Jack of two trades, master of both: Smelting and healing in Ufipa, Southwestern Tanzania. African Archaeological Review, 28, 161-175.
- Mapunda, B. B. B. (2013). Superstition or ingeniousness: Re-thinking symbolism in indigenous African iron technology. In J. Humphris & T. Rehren (Eds.), The world of iron (pp. 273-280). London: Archetype Publications.
- Mapunda, B. B., & Burg, S. (1991). Preliminary report on archaeological reconnaissance along the Ruhuhu river basin, southern Tanzania. Nyame Akuma, 36, 32-40.
- Schmidt, P. R. (1988). Eastern expression of the Mwitu tradition: Early Iron Age industry of the Usambara Mountain, Tanzania. Nyame Akuma, 30, 36-37.
- Schmidt, P. R. (1997). Iron technology in East Africa: Symbolism, science, and archaeology. Oxford: James Curry.
- Schmidt, P. R. (2006). Historical archaeology in Africa: Representations, social memory, and oral traditions. Lanham, MD: Altamira Press.
- Schmidt, P. R., & Avery, D. H. (1978). Complex iron smelting and prehistoric culture in Tanzania. Science, 201 (4361), 1085-1089.
- Schmidt, P. R., & Avery, D. H. (1983). More evidence for an advanced prehistoric iron technology in Africa. Journal of Field Archaeology, 18(4), 421-434.
- Schmidt, P. R., & Childs, S. T. (1985). Innovation and industry during the Early Iron Age in East Africa: The KM2 and KM3 sites of Northwestern Tanzania. The African Archaeological Review, 3, 53-94.
- Schmidt, P., & Mapunda, B. (1997). Ideology and the archaeological record in Africa: Interpreting symbolism in iron smelting technology. Journal of Anthropological Archaeology, 16, 73-102.
- Sutton, J. E. G. (1985). Temporal and spatial variability in African iron furnaces. In R. Haaland & P. Shinnie (Eds.), African iron working: Ancient and traditional (pp. 164-196). Bergen, Norway: Norwegian University Press.
- Tylecote, R. F., Austin, J. N., & Wraith, A. E. (1971). The mechanism of bloomery process in shaft furnaces. Journal of the Iron and Steel Institute, 209, 342-363.
- van der Merwe, N. J., & Avery, D. H. (1987). Science and magic in African technology: Traditional iron smelting in

© Springer-Verlag Berlin Heidelberg 2014

Malawi. Africa, 57(2), 143-172.
- Wembah-Rashid, J. A. R. (1969). Iron workers of Ufipa. Bulletin of the International Community of Urgent Anthropological Research, 11, 65-72.
- Willis, R. G. (1966). The Fipa and related peoples of Southwest Tanzania and Northeast Zambia. London: International African Institute.
- Willis, R. G. (1968). The Fipa. In A. D. Roberts (Ed.), Tanzania before 1900 (pp. 82-95). Nairobi: East African Publishing House.
- Wise, R. (1958). Iron smelting in Ufipa. Tanganyika Notes and Records, 50, 106-111.
- Wychaert, R. P. (1914). Forgerons paiens et forgerons chretiens au Tanganyika. Anthropos, 9, 371-380.

Metallurgy in Tanzania

Bertram Mapunda	Dar es Salaam, Tanzania
Dr. Edwinus Chrisantus Lyaya	University of Dar es Salaam, Dar es Salaam, Tanzania
DOI:	10.1007/SpringerReference_382758
URL:	http://www.springerreference.com/index/chapterdbid/382758
Part of:	Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures
Editor:	Helaine Selin
PDF created on:	August, 16, 2014 04:20

© Springer-Verlag Berlin Heidelberg 2014