Extractive metallurgy in Iron Age South Africa

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SYNOPSIS

The finds relating to the metal-working of Iron Age Bantu tribes are reviewed, the following metals or alloys being considered: gold, tin, copper, bronze, brass, and iron. Most is known about copper- and iron-working, but even this is very little, and no one has successfully been able to demonstrate how iron was smelted in the primitive furnaces that have been found.

SAMEVATTING

Daar word 'n oorsig gegee oor die vondse in verband met die metaalbewerking deur die Bantoestamme van die Ystertydperk en die volgende metale of legerings word behandel: goud, tin, koper, brons, geelkoper en yster. Die beskikbare inligting het veral te make met die bewerking van koper en yster, maar hierdie inligting is uiters beperk en niemand kon nog daarin slaag om die smeltproses wat in die primitiewe oonde gebruik is, na te maak nie.

INTRODUCTION

Several early travellers who came into contact with the Iron Age Bantu tribes in South Africa mention the techniques they used in smelting and working metals. However, their descriptions are mostly vague and in many cases totally incorrect. It is clear that most writers only heard of these processes and never saw them.

In 1936 a Venda smelting demonstration was organized as part of the Empire Exhibition in Johannesburg[1]. A number of the old Venda smelters were asked to demonstrate the process, but, even during this last demonstration of an almost extinct technique, no efforts were made to record the process as carefully as possible. J. B. Bullock, who made the arrangements for the demonstration, said that the demonstration was held as a curiosity rather than a scientific experiment.

It also appears that this effort resulted in the production of only one piece of iron, from which two assegai blades were made. Mr J. F. Giesekke had to persuade the Venda to do the demonstration. According to him, a rumour was circulating among them that their bones were to be used in Iscor. He had to convince them that this was not the case, and they then informed him that the Venda in the early days had used bones in the smelting process and that human bones were especially good for this purpose[2].

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This information is very interesting: bones have a very high calcium content, and calcium is a fine flux.

Some of the most valuable work in the field of chemical and microscopic examination has been done by Professor G. H. Stanley. He mentions a piece of cast iron from South West Africa that was probably produced by accident—he doubted the possibility of cast iron ever having been produced in the type of furnace in general use in South Africa. He conducted numerous microscopic examinations of primitive iron, and, as early as 1929, he asked museums to permit more of their objects to be examined[3]. Very little work has since been done in this field, probably because archaeologists do not have slag and other metallurgical finds analysed. One cannot expect the metallurgist himself to hunt for these in the veld.

GOLD

The only gold objects so far found in South Africa are those discovered at Mapungubwe. Where this gold was obtained is still uncertain. J. G. S. Brokhurst, who travelled to the Limpopo in 1836, is the only early traveller who states that the natives were mining gold in the Zoutpansberg and making rings of it[4]. No crucibles or other objects that could give an indication that gold-melting was practised in the Transvaal have so far been found. It is more likely that the concentrated gold ore was exported without being melted.

TIN

Extensive ancient tin mines occur at Rooiberg, the estimated[5] production of the mines being 2000 tons. In addition, numerous smelting sites have been found on the farm Blaauwbank No. 435.

The ancient miners were evidently very well acquainted with the different types of tin ore. Thus, the feed included the following: alluvial cassiterite, ore from the outcrops of the lodges, fine cassiterite in quartzite, and fine-grained chloritic ore of the type known as ruby tin. The ore smelted was fairly rich, having evidently been carefully sorted and cobbed. A representative sample taken near a tin furnace assayed 43,3 per cent tin. Slag analysis showed that large amounts of metals were left in all the slags, and proves that the smelting operations were crude and wasteful[6].

An examination of the smelting sites showed that two distinct types of furnaces were used.

The Hearth Furnace

Only the bottoms of these hearth furnaces remain, so that it is not possible to reconstruct them accurately. It is clear that they were built up with clay, were circular in shape, and were a form of blast furnace—a portion of a clay tuyère was found sticking into the side of one of the hearth bottoms. Prills of tin were found in the bottom of one of these furnaces[7].

The Crucible Furnace

These furnaces were built of stones set in a rough circle that had apparently been excavated out of the ground. A gap of 4 inches was left in the circle, possibly for the insertion of the tuyère. The most perfect furnace found had an external diameter of approximately 22 inches, with an internal diameter of 16 or 17 inches. The stones forming the sides were about 8 inches deep, of which about half were above the ground. Pieces of pot, containing slag on the inside, which were found close to this furnace, show that circular pots were used as crucibles[8].

COPPER

Although thousands of tons of copper ore have been mined in the Transvaal, relatively few copper-smelting sites have been found and very little is known about the furnaces used. Judging from the size of the ancient mines at Messina, T. G. Trevor[9] estimated that at least 5000 tons of pure copper had been extracted, but, even in the aggregate, he doubted whether the slag heaps would total 1000 tons. The same anomaly occurs at Phalaborwa.

The only South African furnaces described[10] as copper furnaces are the small ones found at Phalaborwa. An analysis of slag attached to the walls of one of these furnaces showed no traces of copper but indicated iron. The author believes that these were iron-smelting furnaces that were also used for copper smelting. Similarly, at Rooiberg the author found a Buispoort-type of iron-smelting furnace with copper slag on its walls.

According to Stanley[11], it is reasonable to suppose that the ore smelted consisted chiefly of carbonate, which is an easily smelted mineral, and not of sulphides. Against this, however, must be set the fact that, since the minerals occur mixed, anything considered untreatable could have been sorted out and cast aside (though, of course, some could have been smelted along with the carbonate, and the copper would have been reduced by mutual reaction), but such waste is not found.

At Messina, the smelting was not done close to the workings but on the slopes of neighbouring hills. On examining these smelting sites, the author found, in addition to slag and broken tuyères, hundreds of pieces of burnt clay and stones bearing pieces of slag on one side. No complete furnace could be found.

It thus seems that the furnaces were broken down after each smelting. This corresponds with the information obtained by Hugh Stayt from an old Balemba copper-worker who lived near Messina. The following is Stayt's description.

> The copper-ore was first cobbled into small pieces. The kiln for smelting was prepared by making a small circular impression in the ground, about 1½ feet in diameter, and lining it with clay and ashes; on this base a circular clay wall was built up to a height of 1½ feet and reinforced on the outside with stones. A layer of dry leaves of the mukwiliri or mulamvhira trees was put into the bottom of this kiln to a depth of about 2 inches to help in the kindling, over this was put a thick layer of charcoal and then more leaves. A small hole was made at the base of the kiln to give entrance to the nozzles of the bellows, and the charcoal was fired; as soon as it was red-hot another layer of copper was added and then a final layer of charcoal until all the copper was melted, when the worker proceeded to break down the wall of the kiln. All the debris of dirt, charcoal and ashes was brushed away, leaving the copper in the clay-lined impression in the ground. The copper was left to cool and then again hammered into small cobbles and re-smelted in a potsherd about 7 inches in diameter, which was put over the impression in the ground, so that the molten copper could be manipulated easily and poured out into moulds prepared for it.[12]

According to oral tradition, the Messina people appeared from the east and came to Phalaborwa. However, not finding copper at Phalaborwa but only iron, they left again and moved towards Venda country, where they found copper at Zwikol hill near Messina and settled in that area[13].

The Messina people consisted of only two inter-married tribes, their totem being the lion and the hearthstone. They were distinguished from their neighbours by being uncircumcized and wearing black cloth around their hips, rather than the loin-skin between the legs as was the Sotho custom[14]. In Zambia, at Solwegi to the west of the main copperbelt, live the Kaonde tribe, who have been traditional copper-smelters. In 1961, a group of old men were asked to demonstrate the traditional methods of copper production. All but one were over 70 years of age, and their conservatism was illustrated in their persistent wearing of an ankle-length dark-blue waist-cloth, rather than the more general shorts or trousers. Three were of the lion totem, one of the goat, and one of the ant.

The furnace was built by digging a hole 20 centimetres wide and 5 centimetres deep, which was then thickly spread with ashes. Small ant hills had been cut in half, and these were set round the excavated hole to form a wall in which all the gaps were filled with puddled clay. The resulting furnace was 40 centimetres high and of approximately the same diameter. Charcoal was added until it was above the opening of the tuyère, firebrands were added, and the bellows were worked. When the charcoal began to glow, a few handfuls of the ore were placed on them and further charcoal was added to cover it. After three hours, there was a careful turning over of fragments of copper amid the charcoal, and a stick inserted into the ventilation hole came out with a globule of molten copper at its end. The kiln was then broken down with a long pole and the charcoal scattered. Below the vent was a glowing pool of liquid copper, which rapidly ran into streams and solidified.

The copper was refined by the building of a similar kiln, except that a clay pot was fixed into place in the hole in the ground. The furnace was heated as before, and the crude copper was placed carefully in the centre of the glowing pile. After two hours, when the kiln was broken down, the pot had a pool of molten copper, which could be cast into ingots[15]. A similar method of copper-smelting is used by the Bayeke of Katanga.

It thus seems that there might be some connection between the Messina copper-smelters and the Zambian copper-smelters, but this has yet to be proved.

BRONZE

Bronze is an alloy of tin and copper in the standard one-to-nine ratio. Alloys of tin and copper have been made by several groups in West and South East Africa. Of these, the Benin Bronzes are the best known, but they are far from true bronze and should be referred to as copper, rather than as bronze.

The best examples of bronze in Africa are found in Rhodesia and the Transvaal, but only a small number are true bronze. Of these, the Blaauwbank ingot, which had apparently leaked out of a fissure in a furnace wall or overflowed from a crucible, represents the nearest approach to serviceable bronze. This analysed: copper 80 per cent, tin 7 per cent, iron and aluminium 5 per cent, nickel 3 per cent, arsenic 2 per cent, and gangue 3 per cent[16].

The bronze at Rooiberg was probably melted in a crucible that was put into a crucible furnace.

BRASS

Brass is an alloy of copper and zinc. As yet there is no evidence that the zinc used by the early inhabitants of South Africa for making brass was of local origin, while several facts suggest that all the zinc was imported from the East. A zinc ingot of fourteen pounds was found at Tjuenie's Poort, and several zinc ingots have been found at Pilandsberg, near Rustenburg[17]. No ancient zinc mines have been found in Southern Africa, and it is therefore likely that the inhabitants imported zinc for the casting of their brass.

IRON

Of all the metals used by the early inhabitants of South Africa, iron was used the most. Iron ore is abundant in most areas, and furnaces are found in almost all parts of the Transvaal and Natal, although no furnaces have yet been found in the Orange Free State or the Cape Province. In the Transvaal, four different types of furnaces are found, and in Natal one type is known.

Buispoort Type

The furnaces are oval in shape, with two openings for tuyères (one on each end of the oval). They have a third opening on top, which served as a chimney and for charging the furnace[18].

Melvillekoppies Type

The furnace resembles a wide-mouthed, globular pot, and is nearly 3 feet in maximum external diameter and slightly over 2 feet in depth. The furnace has two tuyère apertures about 6 inches wide and 1 foot deep[19].

Venda Type

The furnaces are cylindrical in shape, with three parallel oblong openings or slots for the tuyères. These run from the floor to about 10 centimetres below the upper edge of the furnace. The openings for the tuyères are roughly at an angle of 120° from each other. Between the openings for the tuyères are three supporting walls on the outside of the furnace. The middle of the floor of the furnace has a cylindrical hole, which, according to the old Vendas, was used for medicine.

Loole Type

The furnace is bowl-shaped, with only one tuyère opening. The walls gradually converge towards the top to form a hole or chimney through which the furnace was probably charged. As in the Venda type, this has a concave floor with a hole in the centre[20].

Natal Type

The furnaces are mostly found in groups of two or three, and consist of a hole in the ground more or less 50 centimetres long, 25 centimetres broad, and 30 centimetres deep, which is lined with clay. There is no opening for a tuyère, which was probably inserted against the inside of the furnace with its one opening pointing towards the bottom of the furnace.

Some early authors state that the molten iron produced in these furnaces was cast into crude forms. However, this is not true; if this had happened, the smelters would not have known what to do with the iron, as cast iron is brittle and cannot be forged into different types of tools.

The following is a brief, over-simplified description of the process involved. The so-called bag bellows were used to blow air into the furnaces, and charcoal was used as fuel. The burning of charcoal in the furnace releases heat, and carbon monoxide is formed because of a shortage of oxygen. The carbon monoxide withdraws oxygen from the ore, thus causing the formation of carbon dioxide and the release of iron:

$Fe_2 O_3 + 3Co \rightarrow 2 Fe + 3CO_2$.

The iron that was formed at a temperature below its melting point was not liquid when it separated, but in the form of tiny crystals. These tiny particles grew and gradually built up a sponge, which contained entrapped slag. This iron sponge or bloom was withdrawn and forged.

When the author first heard of an old Venda who claimed that he had helped to smelt iron in his youth, he asked the old man to demonstrate the whole process, and thought that, within a month or two, he would know exactly how these furnaces functioned. Since then almost two years have passed, and the problem has not yet been solved. Traditional iron-smelting attempts have been made in Vendaland with the help of two old Vendas, and in Rhodesia near Enkeldoorn with the help of Headman Ranga of the Njanja tribe. In both cases, the whole process of iron smelting has been recorded as accurately as possible, including the mining of the ore; the making of the bellows, tuyères, and charcoal; and the building of the furnaces. Though neither attempt succeeded in producing iron, very valuable ethnographic information that would otherwise have been lost has been recorded.

The furnace used during the demonstration in Vendaland was taken to Pretoria, where further smelting experiments were carried out. Some iron was produced at least once in the furnace before it collapsed. A new furnace, but of the Buispoort type, has been built at the University of the Witwatersrand, where Mr Dingle, a final-year student in metallurgy, will try to solve this very interesting problem.

Slag analyses and investigations on slag from old smelting sites have been done by Dr J. C. D. Steyn of Iscor. The investigations give very interesting information on the metallurgical knowledge of these early smelters.

CONCLUSION

From the information at our disposal, it is clear that thousands of tons of different metals were mined and smelted in Southern Africa before the arrival of the Europeans. Far too little work has been done in this field to lead to definite conclusions about where these people came from, how they mined and smelted the different ores, and what happened to all the thousands of tons of metals extracted.

Urgent archaeological work is needed at various sites where valuable data are being destroyed daily because of modern mining and industrial expansion. This very interesting aspect of Southern Africa's pre-history cannot be solved by archaeologists alone, but will have to be investigated with the help of mining experts, metallurgists, geologists, and ethnologists, to mention but a few of the people concerned.

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