# Iron Age metal working in the Magaliesberg area

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**SYNOPSIS**

Evidence of smelting and metal working in the Magaliesberg comes mainly from three sites: Broederstroom (Pretoria District), Uitkomst Cave (Krugersdorp District), and Olifantspoort/Olifantshoek (Rustenburg District).

The analyses of copper ores found at or near these sites are reported, as are the analyses of twenty-six samples of slag from the Magaliesberg area and other sites in the Transvaal.

Iron implements and copper ornaments found at the Magaliesberg sites are described, and the analyses of some of these specimens are reported and discussed. A metallographic report on two iron objects from Broederstroom points to similarities in the smelting and forging techniques that were practised in the Transvaal and Nigeria during the Early Iron Age.

**SAMEVATTING**

Bewyse van smeltery en metaalbewerking in die Magaliesberge is hoofsaaklik afkomstig van drie plekke: Broederstroom (Pretoriase distrik), die Uitkomstgrot (Krugersdorpse distrik) en Olifantspoort/Olifantshoek (Rustenburgse distrik).

Die ontledings van kopererts wat by of naby hierdie plekke gevind is, word aangegee asook die ontledings van ses en twintig slakmonsters afkomstig uit die Magaliesberggebied en ander plekke in Transvaal.

Ysterimplemente en koperornamente wat by die plekke in die Magaliesberge gevind is, word beskryf en die ontledings van sommige van hierdie toetsstukke word aangegee en bespreek. 'n Metallografiese verslag oor twee ystervoorwerpe afkomstig van Broederstroom dui op ooreenkomste tussen die smelt- en smeetegnieke wat gedurende die Vroeë Ystertydperk in Transvaal en in Nigerië toegepas is.

## Introduction

The Magaliesberg area, which extends from the west of Rustenburg to the east of Pretoria in the Transvaal, is well endowed with the two main raw materials that are needed in the production of metal: ore and wood. Iron ores, especially banded ironstone, sufficient for the needs of the Iron Age metalworkers occur at many places in this area, particularly in the Timeball Hills and the Daspoort Ridges; and many of the hills and valleys are (or were) densely wooded and could have supplied all the wood that was required for charcoal by the early smelters.

## Ore Deposits

Wagner[1] describes several such deposits. Near Pretoria are the well-known deposits of clayband ironstone and magnetite that were mined and smelted successfully in the early days of Iscor. (Analyses of this ore are given in Table I.) West of Pretoria, ironstone beds, 1,2 m thick with an iron content of 55 to 58 per cent, have been found on the farm Welgegund 481, about 5 km south-east of Hartebeespoort Dam, fairly near the Early Iron Age site of Broederstroom[1]. Several outcrops of iron ore occur in the Koster District near Boons (a railway siding on the line between Krugersdorp and Swartruggens), particularly on the farm Syferfontein 963, where there are remains of extensive ancient workings along the outcrops of the ore-bed[1]. The ore-bed there was 3,65 m deep, with an iron content of 44 to 53 per cent (Table I). The deepest layer of the deposit consisted of specularite ore, which has been partly worked away, and it is likely that the ancient miners looked there originally for *Sibilo*, an iron oxide used as a cosmetic powder. The Syferfontein ore deposits are situated about 30 km to the south of the Olifantspoort Iron Age settlement (Fig. 1). It is not impossible that the metal workers of Olifantspoort brought iron ore or crude iron from such distant deposits. It is known that the BaVenda of the Soutpansberg carried loads of iron ore in leather bags from a faraway iron mountain to the furnaces of their villages[2].

No large deposits of copper ore have been found in the Magaliesberg area itself, but, at Vlakfontein, 50 km north-west of Rustenburg, is an old copper–nickel mine, about which Wagner[3] reports:

> [On the Farm Vlakfontein] . . . there occur peculiar gossans, iron rich weathered surface ores . . . . The presence of a fairly considerable [ancient] working on the site of which the No. 3 shaft on Vlakfontein has been sunk, proved that [these ore-bodies] had attracted the notice of native miners long before the advent of the white man in this part of the Transvaal. Copper was clearly the metal sought and worked, as pieces of copper ore are to be seen among the debris occupying the upper part of the working. At a depth of about 40 feet, there was [found] a copper armlet presumably made from copper smelted from the ore. The latter consisted of veins and patches of chrysocolla and malachite in a gangue of limonite and opal.

An analysis of Vlakfontein ore is given in Table I. According to Schwellnus[4], similar gossan outcrops have been found on the farm Klipfontein 482 (20 km north-west of Pretoria), 'where old shallow and fallen-in workings on gossans occur'.

Such ores may have been used by the early smelters of the Magaliesberg. It is possible, as already mentioned, that the ores were carried over long distances from the mines to the smelters, perhaps even from far-away places such as the fairly rich deposits of the Bronkhorstspruit–Groblersdal area. However, it is more likely that the Magaliesberg metal workers mined or 'grubbed' small deposits situated near their settlements. Such a small copper mine has been discovered by Steel[5] near the Olifantspoort Iron Age sites. Pieces of copper ore have also been found by Berry[6] in the hills about 1 km to the south of the Broederstroom site. There is also a vague report[7] 'that a very small copper working existed near the Hennops River' — a location not far from the Uitkomst Cave.

It is likely that a number of such small, shallow copper deposits, mostly weathered and leached-out outcrops,

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existed in the Magaliesberg area. Some of them may be re-discovered, but most of them were probably worked out soon and then filled in again, as was the custom of the ancient miners. These small copper mines probably yielded only very small amounts of usable ore. However, relatively small quantities, perhaps 10 kg, of malachite (enriched by the picking out of gangue and poor pieces) were needed for the production of sufficient refined copper for the trinkets and ornaments required by a small group of people. Occasionally a few ingots for barter may also have been cast. There is no evidence that any large-scale production of copper, such as existed at Messina and Phalaborwa, was ever conducted by the Magaliesberg copper workers.

## Metal Workings

The main evidence for metal working in the Magaliesberg area — furnace remains, tuyères, crucible sherds, and slag — comes from three excavated sites: Broederstroom[8], Uitkomst Cave[9], and the Olifantspoort settlement complex[8]. All these sites were excavated by Professor Mason and his staff from the Archaeological Research Unit of the University of the Witwatersrand.

### Broederstroom

The Broederstroom site (24/73), on the south bank of Hartebeespoort Dam, is one of the oldest Iron Age sites in Southern Africa, dating from the 5th to the 6th century A.D.

Besides much other archaeological material, no fewer than five iron slag floors, much furnace debris, and a number of tuyère fragments have been excavated there. Few well-preserved iron artifacts have been found at Broederstroom, and it seems that nearly all the iron metal that must have been buried there has corroded away long ago. However, the pieces of iron slag lying in

TABLE I

ANALYSIS OF IRON AND COPPER ORES FOUND IN THE MAGALIESBERG AREA

| Site | | Pretoria Townlands | Syferfontein near Boons railway site, W. Tvl | Vlakfontein 902, Swartruggens Dist. | Olifantspoort Iron Age copper mine 47/73, Rustenburg Dist. | Uitkomst Cave A.R.U. 5/67, Krugersdorp Dist. |
|---|---|---|---|---|---|---|
| | | Mean of 43 analyses | Mean of 4 analyses | | | |
| Constituents | Expressed as | % | % | % | % | % |
| Silicon | $SiO_2$ | 21 | 11,71 | 20,50 | 63,37 | 79,95 |
| Aluminium | $Al_2O_3$ | 5,6 | | 2,66 | 11,18 | 0,69 |
| Iron (ferric) | $Fe_2O_3$ | 65 | (Fe) 44-53 | 49,45 (total) | 4,82 | 10,57 |
| Iron (ferrous) | FeO | 3,2 | | | 4,32 | 1,71 |
| Magnesium | MgO | 0,17 | | 8,02 | 5,97 | 0,35 |
| Calcium | CaO | Traces | | 2,08 | 0,09 | 0,10 |
| Sodium | $Na_2O$ | | | | 0,01 | 0,01 |
| Potassium | $K_2O$ | | | | 0,78 | 0,06 |
| Titanium | $TiO_2$ | Nil | | | 0,28 | $<0,05$ |
| Chromium | $Cr_2O_3$ | | | 0,23 | 0,05 | $<0,05$ |
| Manganese | $Mn_3O_4$ | (MnO) 0,26 | | | 0,07 | 0,04 |
| Copper | Cu | Nil | | 0,78 | 2,00 | 3,74 |
| Nickel | Ni | Nil | | 4,25 | 0,014 | |
| Arsenic | | Traces | | 0,12 | | |
| Sulphur | | 0,03 | 0,04 | 23,35 | | |
| Phosphorus | $P_2O_5$ | 0,55 | 0,012 | | 0,11 | 0,12 |
| Water, $CO_2$, etc. (loss on ignition) | | | | | 6,53 | 2,38 |
| Analyst | | | | S.A. Minerals Ltd | National Institute for Metallurgy | |
| Reference | | 1 p. 86 | 1 p. 97 | 4 p. 18 | Report AA991/10 | Report AA991/11 |

TABLE II

ANALYSES* OF SLAG SAMPLES

| | | 13 | 14 | 15 | 16 | 17 | 32 | 33 | 18 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ref. Archaeological Research Unit Wits University | | 24/73 | 24/73 | 24/73 | 24/73L | 24/73L | 24/73K | 24/73G | 56/73 | 19/67 |
| Site | | Broederstroom | Broederstroom | Broederstroom | Broederstroom | Broederstroom | Broederstroom | Broederstroom | Olifantshoek | Olifantspoort |
| District | | Pretoria | Pretoria | Pretoria | Pretoria | Pretoria | Pretoria | Pretoria | Rustenburg | Rustenburg |
| Position | | 16 | 17 | 7 | Type I | Type II | | | Lower furnace site | Encl. 1, 1 m north of furnace |
| Constituent | Expressed as | % | % | % | % | % | % | % | % | % |
| Silicon | $SiO_2$ | 23,60 | 25,47 | 22,78 | 29,24 | 24,69 | 19,97 | 75,46 | 22,43 | 63,48 |
| Aluminium | $Al_2O_3$ | 3,23 | 3,60 | 4,31 | 4,00 | 4,99 | 4,17 | 5,23 | 4,53 | 15,36 |
| Ferric iron | $Fe_2O_3$ | 16,61 | 33,53 | 26,81 | 25,30 | 19,14 | 11,19 | 3,06 | 16,11 | 3,68 |
| Ferrous iron | FeO | 53,69 | 29,65 | 41,47 | 39,09 | 47,57 | 57,30 | 7,31 | 51,65 | 5,55 |
| Magnesium | MgO | 0,50 | 0,63 | 0,09 | 0,12 | 0,10 | 1,48 | 2,19 | 1,43 | 3,75 |
| Calcium | CaO | 1,41 | 1,21 | 0,72 | 0,62 | 0,87 | 0,71 | 3,49 | 1,78 | 1,64 |
| Sodium | $Na_2O$ | 0,10 | 0,14 | 0,03 | 0,08 | 0,14 | 0,12 | 0,47 | 0,11 | 0,25 |
| Potassium | $K_2O$ | 0,15 | 0,53 | 0,17 | 0,08 | 0,16 | 0,11 | 0,89 | 0,61 | 2,52 |
| Titanium | $TiO_2$ | 0,20 | 0,31 | 0,18 | 0,22 | 0,22 | 0,24 | 0,40 | 0,49 | 0,77 |
| Phosphorus | $P_2O_5$ | 0,09 | 0,14 | 0,31 | 0,10 | 0,22 | 0,08 | 0,16 | 0,20 | 0,35 |
| Chromium | $Cr_2O_3$ | <0,05 | <0,05 | <0,05 | <0,05 | <0,05 | 0,03 | 0,04 | <0,05 | 0,29 |
| Manganese | $Mn_3O_4$ | 0,06 | 0,07 | 1,56 | 0,29 | 1,04 | 0,09 | 0,14 | 0,28 | 0,17 |
| Loss on ignition | $H_2O$, $CO_2$ | 0,33 | 5,06 | 1,62 | 1,00 | 0,78 | — | — | 0,10 | 1,43 |
| Total copper | | — | — | — | — | — | 0,011 | 0,059 | — | <0,01 |
| Total iron | | 53,35 | 46,50 | 50,98 | 48,08 | 50,37 | 52,37 | 7,82 | 51,42 | 6,89 |

*Done by the National Institute for Metallurgy

TABLE II (Continued)

| | | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
|---|---|---|---|---|---|---|---|---|---|---|
| Ref. Archaeological Research Unit Wits University | | 20/71 | 20/71 | 20/71 | 21/71 | 20/71 | 47/73 | 67/72 | | 49/73 |
| Site | | Olifantspoort | Olifantspoort | Olifantspoort | Olifantspoort | Olifantspoort | Olifantspoort | Kleinfontein | Rooiberg | Rooiberg |
| District | | Rustenburg | Rustenburg | Rustenburg | Rustenburg | Rustenburg | Rustenburg | Brits | Waterberg | Waterberg |
| Position | | Probably from furnace A, surface slag | Hut A6 | Hut G | Hut A | Hut Aj, furnace | Trench D | Furnace bottom | Smelters Koppie | Smelters Koppie, furnace 1 |
| Constituent | Expressed as | % | % | % | % | % | % | % | % | % |
| Silicon | $SiO_2$ | 64,43 | 64,92 | 62,66 | 69,26 | 63,23 | 65,77 | 72,59 | 62,81 | 68,90 |
| Aluminium | $Al_2O_3$ | 14,72 | 12,86 | 15,92 | 10,37 | 16,96 | 15,75 | 14,06 | 10,61 | 13,83 |
| Ferric iron | $Fe_2O_3$ | 3,60 | 4,67 | 4,26 | 1,47 | 3,86 | 3,52 | 3,23 | 1,78 | 1,98 |
| Ferrous iron | FeO | 5,60 | 2,61 | 5,51 | 5,46 | 4,53 | 7,16 | 2,91 | 5,27 | 6,40 |
| Magnesium | MgO | 4,08 | 4,40 | 3,62 | 3,11 | 2,49 | 1,26 | 0,11 | 0,85 | 1,83 |
| Calcium | CaO | 1,78 | 2,29 | 1,50 | 2,41 | 1,30 | 2,16 | 0,84 | 4,08 | 2,73 |
| Sodium | $Na_2O$ | 0,24 | 0,18 | 0,22 | 0,34 | 0,21 | 0,08 | 1,60 | 0,25 | 0,16 |
| Potassium | $K_2O$ | 2,36 | 3,36 | 3,09 | 3,53 | 3,38 | 3,14 | 3,76 | 2,32 | 2,20 |
| Titanium | $TiO_2$ | 0,68 | 0,65 | 0,74 | 0,68 | 0,95 | 0,73 | 0,49 | 0,48 | 0,66 |
| Phosphorus | $P_2O_5$ | 0,42 | 0,57 | 0,28 | 0,62 | 0,47 | 0,10 | 0,29 | 0,14 | 0,23 |
| Chromium | $Cr_2O_3$ | 0,27 | 0,27 | 0,28 | 0,25 | 0,25 | 0,08 | 0,01 | 0,01 | 0,08 |
| Manganese | $Mn_3O_4$ | 0,17 | 0,16 | 0,12 | 0,18 | 0,12 | 0,22 | 0,05 | 0,14 | 0,05 |
| Loss on ignition | $H_2O$, $CO_2$ | 0,84 | 1,23 | 1,03 | 0,67 | 1,45 | 0,10 | 0,22 | 10,52 | 0,05 |
| Total copper | | <0,01 | <0,01 | 0,013 | <0,01 | <0,01 | — | <0,01 | <0,01 | — |
| Total iron | | 6,87 | 5,30 | 7,29 | 5,27 | 6,22 | 8,03 | 4,52 | 5,34 | 6,36 |

*Done by the National Institute for Metallurgy

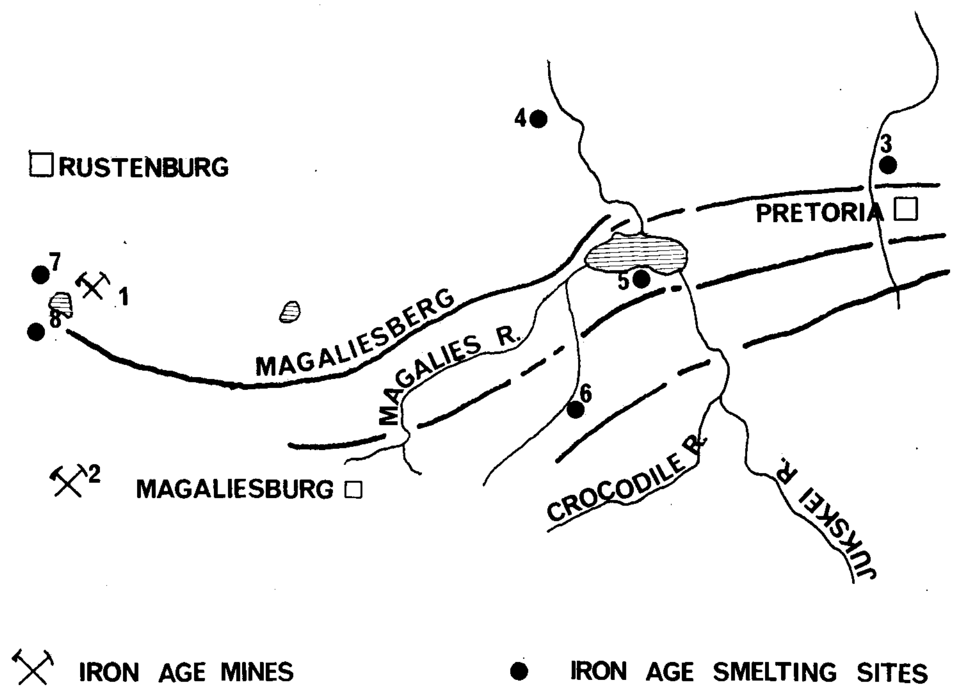


**Fig. 1—Iron Age smelting sites and mines in the Magaliesberg area**

| | |
|---|---|
| 1 Olifantsfontein (copper) | 5 Broederstroom |
| 2 Syferfontein (iron) | 6 Uitkomst |
| 3 Wonderboom | 7 Olifantspoort |
| 4 Kleinfontein | 8 Olifantshoek |

large quantities on the furnace floors are well preserved.

Samples of slag were taken from seven different places at the site and analysed (Table II). Six of the seven samples show total iron values ranging from 46,5 to 53,3 per cent. These high-iron slags correspond in composition to the slags found in Iron Age smelting furnaces at numerous sites in Southern Africa. Some of these sites are listed below.

| | |
|---|---|
| Chibote[10] (Zambia) | 49,2 % iron |
| Mbabane[11] (Swaziland) | 42,2 % iron |
| Melville Koppies[11] (Johannesburg) 7/63, 28/64 (four samples) | 44 to 53 % iron |
| Panorama[11] (Roodepoort) 20/72, 80/72, 81/72 (four samples) | 40,4 to 50,5 % iron |
| Phalaborwa [12] (E. Tvl) | 53,4 % iron |
| Sibasa[12] (N. Tvl) | 42,2 % iron |
| Thabazimbi[13] (Central Tvl) | 55,4 % iron. |

Interesting is the proportion of ferric to ferrous iron in the six slag samples from Broederstroom (Table II). The values fluctuate considerably — from 29,6 to 57,3 per cent for ferrous iron and from 11,2 to 33,5 per cent for unreduced ferric iron. The ratio of ferric to ferrous iron is apparently a measure of the efficiency of the reduction process, but Tylecote[14], who has investigated this subject, points out that little significance can be attached to such calculations since the sampling pattern is, of necessity, erratic. Of the Broederstroom slag samples analysed, only one has a ferric iron content higher than its ferrous iron content, so that the reducing conditions in the furnaces appear to have been satisfactory.

The values for alkaline and alkaline earth metals in the slags analysed are all relatively low, an indication that the use of flux in the smelting of ores at these sites is unlikely.

The values for titanium, chromium, manganese, and phosphorus vary, but all the values are relatively low. These constituents in the smelting slag are apparently derived from the ore.

Whereas the values for total iron content in these six samples from Broederstroom are fairly uniform (49,5 ± 4 per cent), a seventh sample shows a very much lower iron content. This odd result could be ascribed to some vagaries in the sampling procedure if it were not for a number of similar slags of low iron content from other smelting sites, e.g., Olifantspoort, Rooiberg, and Kleinfontein.

### Olifantspoort

The extensive Olifantspoort Iron Age settlement is rich in remains from the Middle and Later Iron Age (*ca* 1000 A.D. to 1800 A.D.), and it is somewhat disappointing that these sites yielded little evidence of metal working[8]. In enclosure No. 1 of site 20/71, there is a curved segment of walling that could be the remains of a smelting furnace, but none of the usual associated material such as tuyères and crucible sherds was found. Some slag-like material was recovered there, as well as in a nearby hut, but the samples from these places look more like light cinder than like a typical 'lava flow' smelting slag.

The total iron content of each of seven samples taken at various places at the Olifantspoort settlement complex is low (less than 8 per cent), while the total iron content of most true smelting slags found in Southern Africa is much higher, ranging from 40 to 55 per cent. The general composition of these seven samples from Olifantspoort agrees much more closely than can be accounted for by coincidence ($SiO_2$ 62,6 to 69,3 per cent, Fe 5,3 to 8 per cent, $Mn_3O_4$ 0,12 to 0,22 per cent, $TiO_2$ 0,65 to 0,95 per cent, etc.).

It is therefore necessary to look for an explanation for the low iron content of this type of slag (or cinder), which has also been found at some other Iron Age sites in the Transvaal (Kleinfontein, Rooiberg).

A hypothesis might be based on the fact that slags from copper smelting sometimes show iron contents of from 4 to 10 per cent, the iron being derived from copper-iron pyrites, but they do not always show more than traces of copper[15]. One might also speculate that the ancient copper smelters might occasionally have used green iron-containing ores, which they incorrectly thought would yield workable copper.

Another explanation could be that the low-iron slags are the product of iron-forging operations in smithy furnaces in which were re-smelted either the 'bloom' from primary smelting furnaces or rusted iron implements unsuitable for further use, together with charcoal and some siliceous material. So far the techniques of Iron Age forges in South Africa have not been investigated, but it is intended to reconstruct and to work a bellows-operated smithy furnace at the Archaeological Research Unit of the University of the Witwatersrand, and to analyse the resulting slag and iron.

As can be seen from Table II, the low-iron slags contain more silica and combined alkaline/earth alkaline compounds than do the high-iron slags. Variations in the composition of the raw materials used (ore and charcoal) and possibly the addition of flux can, of course, influence the composition of slag. The ratio of fuel to ore and other conditions existing during a smelting operation also have a bearing on the iron content of the slag produced.

The fact that no true iron-smelting slag was found at the large-scale excavations of the Olifantspoort sites is surprising, but perhaps, as is known from other Iron Age sites, the smelting furnaces were some distance away from the living sites or their requirements of crude iron or iron implements were obtained by barter. In this connection, it is interesting to note that remains of smelting furnaces and iron-smelting slags have been found on the farm Olifantshoek, which is adjacent to the Olifantspoort sites. Slag lying there in two small furnace

TABLE III

ANALYSES OF COPPER ORNAMENTS[17]

| Site | Broederstroom, Pretoria District | | Uitkomst Cave, Krugersdorp District | Olifantspoort, Rustenburg District |
|---|---|---|---|---|
| Catalogue no. | A.R.U. 24/73D | | A.R.U. 5/67 | A.R.U. 20/71 |
| Description of object | Chain formed by eleven links<br>Mass 10,8 g<br>Length of link 14 mm<br>Width of band 3 mm | | Wire coil<br>Mass 0,11 g<br>Length 7 mm<br>Diam. of coil 3,5 mm<br>Diam. of wire 1,1 mm | Earring<br>Mass 1,54 g<br>Length 26 mm<br>Diam. of wire 1,6 mm<br>(round shank 0,4 mm) |
| Treatment | 1<br>Unpickled | 2<br>Pickled | Untreated | Untreated |
| Constituents | % | % | % | % |
| Copper | Balance | Balance | Balance | Balance |
| Tin | 0,0018 | 0,0029 | 8,39 | 0,20 |
| Lead | 0,0025 | 0,0035 | | |
| Iron | 0,40 | 0,05 | 3,15 | 0,73 |
| Aluminium | Present | Trace | | |
| Nickel | 0,040 | 0,042 | | |
| Antimony | 0,0011 | <0,0009 | 0,005 | 0,04 |
| Arsenic | <0,0009 | <0,0009 | 0,113 | 0,123 |
| Silicon | Present | 0,005 | | |
| Zinc | <0,001 | <0,001 | | |
| Bismuth | <0,0009 | <0,0009 | | |
| Analytical method | Spectrographic | Spectrographic | Neutron-activation analysis | |
| Analyst | McKechnie Brothers S.A. (Pty) Ltd, Germiston | | Nuclear Physics Research Institute, University of the Witwatersrand | |

circles on the lower slope of a hill showed the usual composition of high-iron slag (Table II).

### Uitkomst Cave

Like Broederstroom, Olifantspoort was a fairly large settlement with a population of hundreds of people. On the other hand, probably only a few families lived at Uitkomst Cave. However, this cave is, in several respects, a unique and important archaeological site. Professor Mason, who discovered this site, has discussed[9] its archaeological features, especially the smelting furnaces found there. More details of the structure of the Uitkomst furnaces and the composition of the slag samples found there have been given in a recent publication[16]. The results of the analyses of some additional material recovered at Uitkomst Cave (ore and a fragment of a copper ornament) are reported here (Tables I and III). All the materials analysed contained copper in smaller or larger amounts, thus giving definite evidence of copper smelting at Uitkomst Cave.

## Iron Artifacts

The excavations at Olifantspoort yielded a large number of iron objects including many well-preserved implements (hoes, knives, adzes, etc.), weapons (assegai heads), and ornaments (bangles, rings, and pins). No iron artifacts were found at Uitkomst Cave, and, although fragments of iron were found at the Broederstroom site, only one (larger) 'formed' piece of iron was recovered. This is a cylindrical block (about 95 mm high, 56 mm in longest diameter, and 960 g in mass) that was strongly attracted by a magnet (Fig. 2). For convenience, this specimen was marked 'Broederstroom iron ingot' (the word *ingot* being used in a wide sense to mean a formed mass of metal).

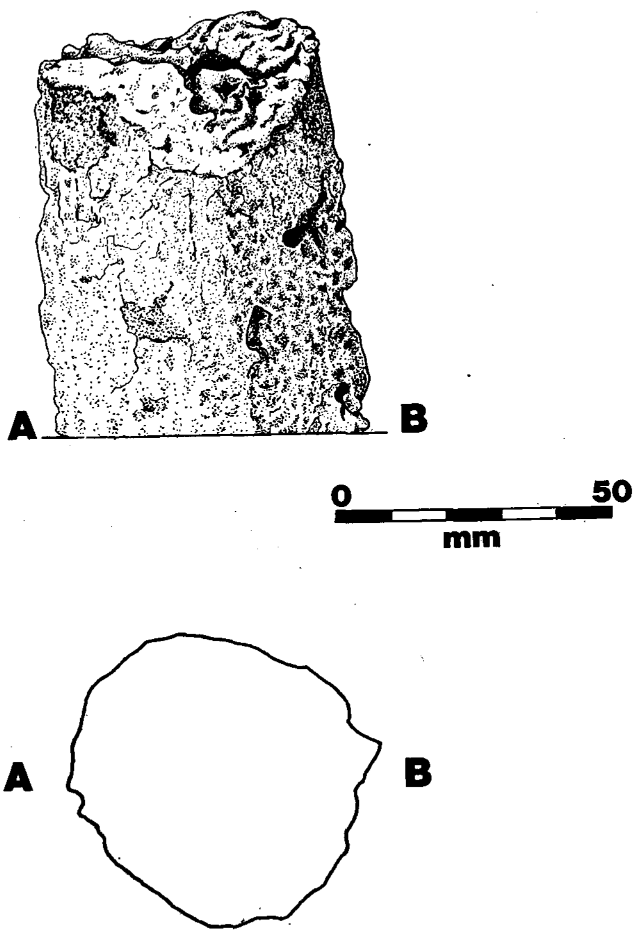


**Fig. 2—Plan and section of iron block from Broederstroom (24/73)**

A closer examination of this specimen was thought desirable, and it was therefore submitted, together with some other iron artifacts excavated at Transvaal sites, to Professor Mavrocordatos of the Department of Metallurgy, University of the Witwatersrand, for investigation.

Two of the artifacts as reported by Professor Mavrocordatos are of special interest. The first is a piece of iron that has been labelled 'Iron bit A.R.U. 24/73—L162 (Broederstroom site)'. A section cut from this specimen consists of three distinct bands of metal forged together, the middle band having a carbon content of 0,4 per cent and the two outer bands having carbon contents of approximately 0,7 per cent. The second, labelled 'Iron block A.R.K. 24/73—L163 (Broederstroom site)', consists of many nuggets or pellets consolidated together, probably achieved by the 'ramming' of the nuggets in a refractory tube and heating to an elevated temperature (probably around 1200 °C).

The techniques used in the production of these two artifacts appear to have been rather sophisticated for a primitive manufacturing process. It is very likely that these methods, together with others used in African iron working, found their way to Southern Africa from far away places by 'diffusion'. This hypothesis is confirmed by recent reports[18] on Early Iron Age smelting (4th and 3rd centuries B.C.) at Taruga, Nigeria.

Iron object (J), a piece from a short blade excavated at the Taruga site, showed metallographic characteristics similar to the Broederstroom specimen L162. An examination of these objects suggests that they were made from three separate pieces of forged metal bands welded together by a 'piling' technique, the microstructure of the outer bands consisting of ferrite and pearlite. Tylecote[18] reports on a 'refining' technique that was probably used at Taruga for the removal of contaminating materials (slag, charcoal) from the crude iron obtained by smelting.

> The particles of metal recovered would be welded up, probably by taking a pile of such pieces, wrapping them up in a fire clay envelope and heating them in a forge fire at 1200 °C. The enveloped iron would then be taken out of the fire and forged, whereupon the iron pieces would be welded together and the envelope fragmented.

The similarities between Tylecote's interpretation of the iron-working process as used in Nigeria and the explanation by Professor Mavrocordatos of the manufacture of ingot L163 from Broederstroom are remarkable, and may fit a general theory of a modified diffusion of Iron Age culture by Bantu-speaking people migrating southwards from a nuclear area in the Congo—a region that in its turn had possibly had contact with Iron Age Nigeria.

## Copper Artifacts

Compared with the large quantity of iron objects recovered from Iron Age sites in the Magaliesberg, the

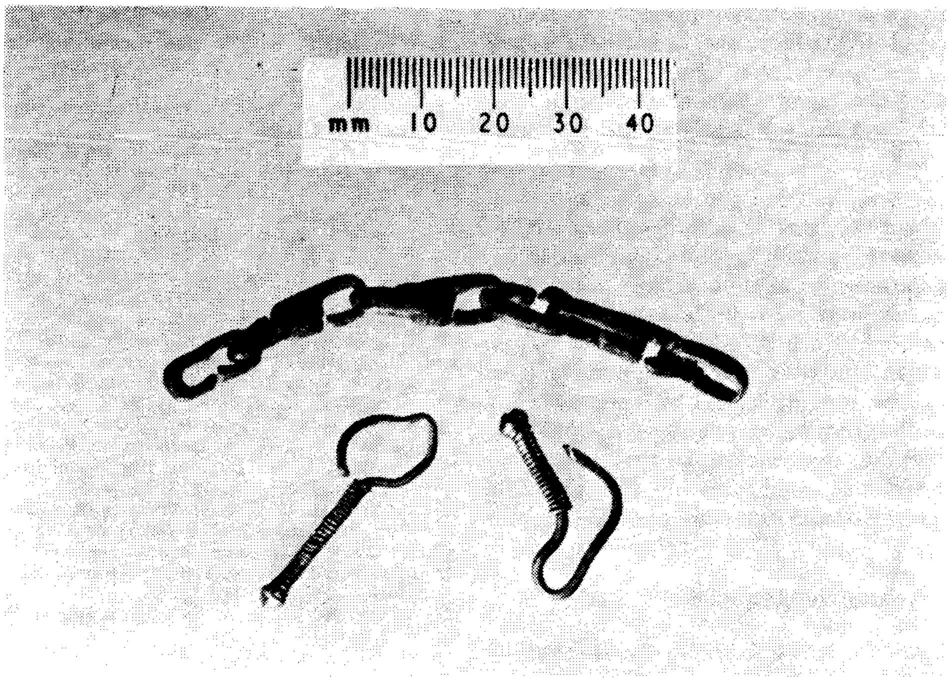


**Fig. 3—Copper chain from Broederstroom (24/73) and copper ear rings from Olifantspoort (20/71)**

number of copper artifacts found there is rather low. However, this is not surprising because copper ornaments, more valuable as personal possessions than common iron implements, were always well looked after and seldom discarded. Small and fragile copper ornaments, when buried in soil, are also easily corroded. Altogether only eleven copper ornaments were recovered at the three larger Iron Age sites in the Magaliesberg area[17].

The most valuable find is a small copper chain, found at the Broederstroom site. The chain is formed by eleven links, apparently shaped by the hammering out of copper rods or copper wire to a narrow band and the bending of cut-off sections of the band to oval links. The width of the copper band is 3 mm, the length of each link being about 14 mm. The chain weighs about 10,8 g. The copper is of great purity, the impurities (mostly iron and nickel) amounting to only 0,1 per cent (Table III and Fig. 3). The analysis of this copper chain gives no indication as to whether it was produced at the site or whether it was an imported trade article.

Some rock fragments excavated near the remains of the Broederstroom furnace have a small copper content, and, as already mentioned, a few pieces of copper ore (malachite) were found in the hills near the Broederstroom site. However, the samples of slag collected at the smelting sites there show only a very low copper content (0,01 to 0,06 per cent), and no remains of smelting crucibles have so far been recovered there. The questions of whether copper was smelted at the Broederstroom site and whether the little chain found there was manufactured locally must remain open.

However, there is no doubt[9] that copper was smelted at the Uitkomst Cave site, but, even there, only a single very small copper object (a minute copper coil weighing 0,1 g) was found. The analysis of the coil (Table III) shows a very high content of tin (8,39 per cent) and iron (3,15 per cent). It appears that the coil was made from a rather impure bronze wire.

Three copper earrings were recovered from the Olifantspoort sites. Two of these are of the same type (Fig. 3) as those described by Burchell[19], who saw them on his journey among the Bechuana people. He stated:

> [The Bachapin] . . . are fond of wearing some ornament in their ears. That which is in most general use is the manjena or eardrop, a small pendant made of copper wire . . . it consists of a thin wire very neatly wound about another of larger dimensions and terminated by a small knob formed by a piece of copper hammered round the end; the upper part being bent into a ring by which it is fastened to the ear.

Maggs[20] found similar earrings at Iron Age sites in the southern Highveld. The analysis of one of the earrings found at Olifantspoort (Table III) shows that the copper wire used in the making of this earring contains a fairly large amount of impurities (iron, tin, arsenic), but the copper content is still over 98,5 per cent.

As far as can be ascertained from the available literature, no cast copper pieces, or ingots, have ever been found at the Magaliesberg sites. The only reference to such objects is by Stow[21], who depicts two copper castings. He notes that 'they were made by the Magaliesberg Bakuena and found near some old copper workings in the Transvaal'. The copper castings as drawn resemble in every detail, the MuTsuku ingots cast by the Iron Age miners of Messina. The information given by Stow is rather vague, and it is likely that these ingots, if they were found in the area now called the Magaliesberg, came there as articles of trade.

## Conclusions

Archaeological and geological evidence indicates that mining was undertaken on a small scale in the Magaliesberg area during the Iron Age, and only a few smelting sites have been discovered there. It is likely that mining and smelting were not prominent features in the economy of the Iron Age people living there but, as in most regions of the Transvaal, were part of the 'village culture'. Iron working seems to have taken place at Broederstroom and Olifantspoort, and copper smelting (to a lesser extent) at Uitkomst.

Analyses of slag samples from the Magaliesberg area and from some other smelting sites in Southern Africa show a fairly constant iron content ranging from 46 to 53 per cent. This consistency points to a basic uniformity of the iron-producing process over a wide territory and over a very long period, which lasted from the 5th to the 19th century A.D. In a number of slag samples the iron content is much lower, ranging from 4 to 8 per cent. No definite reason can be given for this discrepancy, but it is thought that varying raw materials (iron ore and charcoal) and abnormal conditions in the smelting process have a bearing on the iron content of the slag.


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