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METALLURGICAL ANALYSIS OF TWO ARTEFACTS FROM A BURIAL AT DE HOOP, KIMBERLEY DISTRICT*

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ABSTRACT

Two earrings associated with a burial on the farm De Hoop, Kimberley District, were analysed metallurgically. Both consisted of relatively pure copper wire, one with an additional ornamental cone of iron. Their similarity to copper ornaments from the dated Riet River burials is discussed.

INTRODUCTION

In June 1991 a donga-eroded burial on the farm De Hoop, on the Vaal River, Kimberley District, was reported to Kimberley's McGregor Museum. It had been found by farmer Mr Gerhard le Roux, who recovered a copper earring from slumped material. A salvage disinterment of what remained of the burial was conducted by the museum, in the course of which a second, more complete, right earring was found *in situ*.

The burial was that of a juvenile, probably Khoisan, on the basis of the burial pattern (Morris, Kiberd, Fourshé, Miller & Evans in prep.). What little of the skeleton was left, after erosion and damage by a termite nest in the middle of the burial, was highly fragmented and friable. But the positions of limb bones and the cranium indicated horizontally flexed interment. Specularite was found on the cranium, while traces of ochre occurred on grave goods including beadwork. Erosion had exposed and truncated the back left portion of the cranium, and the earring picked up by Mr le Roux came from the slumped material here. Copper staining was observed on the right mandibular and ear regions, immediately adjacent to the second earring (De Hoop 1A right), which is consistent with findings by Morris (1981) on copper discolouration of bone in burial contexts. Corresponding bones from the left side of the cranium had slumped away and disintegrated so that, had any copper staining been present, the original placement of the first earring could not be verified similarly. A detailed account and assessment of the burial as a whole is in preparation (Morris *et al.* in prep.).

The present report concerns the metallurgical analysis of the two earrings, submitted to the Archaeology Materials Laboratory at the University of Cape Town. The analysis was performed to identify the metal from which they were made and to provide an analysis of their major element chemistry for comparison with similar artefacts.

ANALYTICAL METHODS

The specimens were photographed, weighed, sketched, measured, and their visual appearance described. Small sections were cut from the ends of the wire hooks. These samples were mounted in acrylic resin under vacuum to remove air bubbles and ground and polished on rotary laps using standard metallographic techniques.

The polished sections were studied with a Reichert-Jung Polyvar dual metallographic/petrographic microscope, using plane polarised light and Nomarski differential interference contrast where appropriate. Grain size was established by visual comparison with standard charts (ASTM 1981). Microhardness measurements were done on a Shimadzu microhardness tester, with a load of 200 grams and a 10 second dwell

time. A Cambridge S200 scanning electron microscope with a KEVEX energy dispersive X-ray fluorescence micro-analysis system (EDS) was used for the chemical analysis of the metal and selected inclusions. Analyses were done in spot mode with an analytical volume approximately 1 micron in diameter. Software ZAF corrections were applied to the analytical results to produce semi-quantitative analyses expressed as atomic percent normalised automatically to 100 percent. This system has a precision of about 1 percent for the detectable elements, in this case those with atomic weights greater than sodium. The lower limit of detection is about 0,1 percent under optimal conditions.

DESCRIPTIONS AND ANALYTICAL RESULTS

De Hoop 1A right

This was a compound earring, found *in situ* in the burial, consisting of a hollow cone of iron sheet suspended from a curved copper hook (Fig. 1). The copper wire was about 1,5 mm in diameter, lightly corroded, and covered in a bright green corrosion product. The iron cone was severely corroded and cracked, and was dark brown. The total length of the earring was 20 mm and the diameter of the cone at the base 10 mm. The total mass was 0,649 g. The corroded iron cone was weakly magnetic. The connection between the copper and iron appeared to be mechanical rather than a soldered joint, but the geometry of the connection was obscured within the corrosion product.

Fig. 1. The right earring.

The iron was too corroded to be sectioned profitably but a short length of copper wire was removed from the end of the hook. Two types of inclusions were visible in the polished section (Fig. 2 & 3). Trapped surface oxides formed elongated and contorted blue strings along which further corrosion had taken place. There were also numerous bands of tiny rounded globules arranged in strings parallel to the length of the wire except near the tip where they formed contorted swirls recording the former deformation in shaping the rounded end. These globules were blue in reflected light with characteristic red internal reflections identifying them as cuprite (Cu_2O) (Craig & Vaughan 1981). They were completely rounded which was a result of hot-working of the metal. They

Fig. 2. Polished section of the right earring (12x).

Fig. 3. Polished section of the right earring showing trapped oxide bands and rounded cuprite inclusions (375x).

originated as cuprite droplets in a typical Cu-O cast alloy which was wrought and then annealed (cf. Brooks 1982, Fig. 8-4). The EDS analysis of selected copper grains and of several cuprite inclusions revealed no detectable elements other than copper.

The polished longitudinal section was etched in alcoholic ferric chloride ($FeCl_3$) solution to reveal the microstructure (Fig. 4). It consisted of very fine, equiaxed, recrystallised copper grains with annealing twins, and a grain size of about ASTM 9. The annealing twins were evidence of cold work followed by heating to above about 300 °C (Maddin, Wheeler & Muhly 1980). The very fine grain size was an indication that the artefact had not been held at high temperature for very long. The Vickers microhardness was HV 116 (200 g, 15 s, n = 5, range 107-139) which is high for annealed copper (cf. HV 53 for fully annealed tough pitch copper strip (Smithells 1967:801)) and was due probably to the fine grain size and residual strain of cold-work.

The copper wire in this earring was made of very pure copper with only oxygen as an appreciable additional element. The metal had been hot- and cold-worked, and annealed briefly above about 300 °C.

De Hoop 1B left

This specimen was the one recovered by Mr le Roux

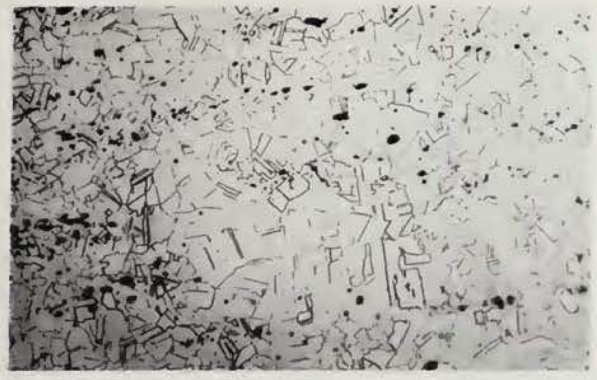

Fig. 4. Etched section of right earring showing recrystallised copper grains (375x).

Fig. 5. The left earring.

Fig. 6. Polished section of left earring (12x).

from material eroded out of the burial, and appears to have been another compound earring. It consisted of a copper wire, about 2 mm in diameter bent around into nearly a full circle, with a shaft terminating in a small hook (Fig. 5). It was lightly corroded, and covered in a bright green corrosion product. If this earring originally had an iron cone it probably was corroded completely after being exposed by erosion. The total preserved length of the earring was 15 mm. The mass was 0,247 g and it was non-magnetic.

A sample was removed from the end of the curved wire and a longitudinal section was polished and etched to study the microstructure (Fig. 6). There was some intergranular corrosion at the margins of the section but otherwise the appearance was the same as De Hoop 1A right. There were elongated and contorted stringers of surface oxides trapped during hot-working and numerous bands of tiny cuprite globules (Figs. 6 & 7). The EDS analysis of metal grains and cuprite inclusions in this specime n also failed to reveal any detectable elements other than copper. The metal consisted of angular recrystallised copper grains with annealing twins and a grain size of ASTM 7 - 9 (Fig. 8). The Vickers microhardness was HV 92 (200 g, 15 s, n = 5, range 66-108). This metal was not significantly different from the material used for the hook of the other earring. The difference in Vickers microhardness was probably due to slightly different intensity of cold-work and annealing.

Fig. 7. Polished section of the left earring showing trapped surface oxides and rounded cuprite inclusions (375x).

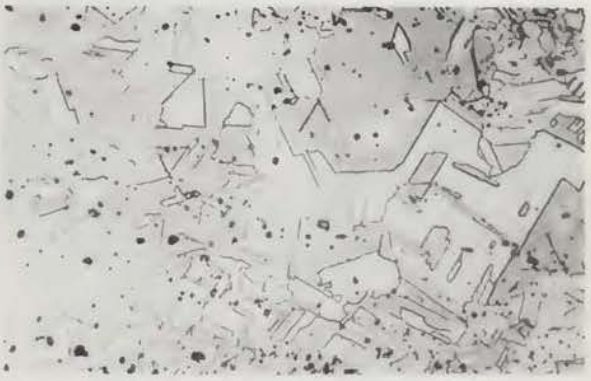

Fig. 8. Etched section of left earring showing recrystallised copper grains (375x).

DISCUSSION AND CONCLUDING REMARKS

These earrings probably originally formed a matching pair. The conical iron pendant on the left earring had corroded away entirely while the right earring still retained some highly corroded remnants. The

microstructure of the copper wire used for the suspensory loops was similar to material excavated elsewhere in southern Africa, although it could not be distinguished from tough pitch copper wire of European manufacture on the basis of its chemical composition. The fabrication techniques were also consistent with those seen in other indigenous copper jewellery but these are not necessarily exclusively characteristic of indigenous production.

Nevertheless, comparative material from the region (Morris 1981), both historically described (Burchell 1822) and recovered archaeologically (Humphreys 1970), permits some comment on the possible affinities of the earrings from De Hoop. Their basic "ear-drop" form, a decorative shank hanging from a wire hook piercing the ear lobe, was widely noted in the interior of southern Africa in both Khoisan and Sotho-Tswana contexts (Morris 1981). Known sources of smelted copper in the interior were all within areas of Iron Age control, from which the material was traded as ingots and finished ornaments on a wide front in the late eighteenth and early nineteenth centuries. In the northern Cape, metal artefacts at Later Stone Age sites provide some of the evidence for burgeoning interaction between Khoisan and Sotho-Tswana communities in the region, during the preceding centuries (Humphreys 1988; Morris 1992). The De Hoop burial augments this evidence.

The burial has not as yet been dated, but some idea of the age range into which it could fall is provided by radiocarbon readings on two comparable Riet River burials which contained copper ornaments (Morris 1992:33). These are MMK 329 with a date of 110 $\pm$ 50 BP (Pta-247) [AD 1840], and MMK 277 dated to 890 $\pm$ 50 BP (Pta-2898) [AD 1060] which is surprisingly early. An interesting aspect of the De Hoop earrings is the degree of resemblance of De Hoop 1A right to the two larger earrings found with the burial MMK 277, from Weltevrede near Koffiefontein (Humphreys 1970; Morris 1981). The burial and grave goods recovered by W. Fowler in the late 1930s were described by Humphreys (1970). Fowler dubbed the conical ear-rings "snuffers", and the word "extinguisher" was used in the McGregor Museum Accession Catalogue (Humphreys 1981) to describe the hollow cones attached to them, like De Hoop 1A right. Unlike the De Hoop example, the Weltevrede cones were crafted from copper sheet, and were about twice as big. While these and other metal items from this region await closer definition, the De Hoop analysis reported here adds to a growing metallographic data base on southern African metal artefacts.

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