

The conservation of the Mapungubwe gold collection, South Africa

Sian Tiley-Nel and Hazel Botha

Contact addresses:

Sian Tiley-Nel

Department of Anthropology and Archaeology, University of Pretoria, Private Bag x 20, Hatfield 0028, Gauteng, South Africa

Email: sian.tiley@up.ac.za

Hazel Botha

The South African Institute for Objects Conservation, PO Box 1, Twee Riviere 6411, Eastern Cape, South Africa

Email: conservation@sainst.org

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The basic objective of this article is to elucidate the conservation of the African Iron Age Mapungubwe gold collection from South Africa which is curated by the University of Pretoria. This nationally significant collection of gold artefacts has been researched since the 1930s, but active conservation began only in 1999 to ensure its long-term preservation. The focus of this article is mainly on the stabilization of the entire gold collection, which involved efforts to arrest fragmentation, re-unite dissociated fragments and bring about considerable improvements to the collection. Work included creating sufficient support to enable the safe handling and packaging of objects in order to ensure research could be undertaken without further damage to the objects. The gold collection has been consistently researched for many decades, during which time significant amounts of materials analyses and other research data have accumulated. During a preliminary study of the collection in 1999 by conservators from the British Museum, suggestions were made for future conservation and since then, efforts by the Mapungubwe Museum have resulted in the formation of strategic partnerships, garnered support and funding to initiate a gold conservation programme. With funding secured in 2007, conservation was undertaken at the South African Institute for Objects Conservation in the Eastern Cape of South Africa. The conservation programme concluded with public lectures, media interest and an exhibition *The Gold Treasures of Mapungubwe* in November 2009, which attracted interest world-wide. This article will focus on the conservation programme.

Background to Mapungubwe

In the early 1930s, the discovery of a southern African Iron Age site on Mapungubwe Hill and its associated royal burials on the northern borders of South Africa, brought to light one of the most significant early second millennium (AD1220–1290) archaeological gold collections.¹ Excavations were conducted by the University of Pretoria from 1933 to 1940 and yielded a vast quantity of gold jewellery and ornamentation in the form of gold anklets, bracelets, necklaces, beads, globules, tacks, foil and gold animal figurines, recovered from three elite burials.² From this point onwards Mapungubwe received international media coverage. Research excavations, continued by the University of Pretoria, led to the declaration of a representative portion of the Mapungubwe gold as a national heritage collection in October 1997. This declaration required that the University of Pretoria serve as official custodians of the collection and take responsibility for its curation and long-term preservation.³

In 2007, the University officially re-interred the human remains associated with the burials, in response to calls from several claimant communities for repatriation. Over the decades, the archaeological site has been the subject of much political controversy and, as such, the University of Pretoria as

¹ Stephan Woodbourne, Mark Pienaar, and Sian Tiley-Nel, 'The Dating of the Gold Graves from Mapungubwe Hill', *Journal of African Archaeology* 7, no.1 (2009): 95–101.

² Maryna Steyn, 'Mapungubwe Gold Graves Revisited', *South African Archaeological Bulletin* 62, no.186 (2007): 140–6.

³ National Heritage Resources Act No 25 of 1999, section 32; *South African Government Gazette*, 10 October 1997.

custodians of a 'contested' collection have to delicately balance many challenges. Decisions and consultations on the gold collection in particular had to be made against the background of guiding conservation principles, short- and long-term curation practices, future scientific and analytical research and, at the same time, consideration of the accumulated multiple layers of meaning and history. The gold conservation programme was devised over years of detailed planning in respect to specialist consultation, projected time frames, treatment proposals and permission from state authorities. The treatment of the collection also had to conform to various legislative requirements. Ultimately, all imperatives were met. New research programmes and re-inventorying the gold collection are currently proceeding.

History of technical examinations

The Mapungubwe gold finds were first examined in 1933 by the Royal Mint in Pretoria. Metallurgical specialists Dr M. Weber, Mr R. Pearson and Professor G. H. Stanley were the first to make official observations on the gold collection. They provided general descriptions of the gold, and proposed methods of original manufacture of the gold objects.⁴ Due to natural degradation of shallow burials and the disturbed context by early excavators, the gold was in a less than ideal condition and in a bad state of preservation. Fortunately, however, some of the foil and sheet gold were still shaped sufficiently to be identified as animal torsos, heads and ears, while the remainder of the gold foil fragments or loose gold beads did not give any indication of their relation to each other or of the forms they originally held, having no vital contextual data. Analytical results were basic, including the identification of purity content, which averaged between 92% and 98% fine gold. Cleaning was mentioned as 'slight washing', while any further interventions were regrettably not recorded or photographed. Other than general correspondence, any previous actions went undocumented with no associated information available for review.

Several decades later, in the early 1980s, Dr W. A. Oddy of the British Museum (Fig. 1) conducted further technological observations in South Africa on the manufacturing techniques of the gold foil, the strip and alloy wire around a fibre core, and compared the Mapungubwe gold collection to other archaeological gold finds in the region of southern Africa.⁵ Oddy did not undertake any conservation treatments on the gold collection himself. His published research remains accessible and provides a valuable basis for further metallurgical analyses.

Previous conservation interventions

The first published photographs available of the gold objects and of the excavations appeared in *The Illustrated London News*, 8 April 1933. These images clearly showed that some of the gold had been cleaned; apparently the objects were washed shortly after excavation. Some of the fragments, particularly those that were inexpertly lead soldered (Fig. 2), had been cleaned at some stage, but no documentation or treatment reports exist on these earlier damaging interventions.⁶ However, recent evidence of previous interventions was discovered during the current treatments. Most of the foil fragments would conform to corrective shaping without resistance. In contrast, two particular fragments were hard, shiny, lustrous, flattened and springy, and appeared to be burnished, which suggested that they had been work-hardened previously. Such interventions are assumed to have been performed undocumented in the 1930s by the Royal Mint during initial examinations.

⁴ Roger Pearson, 'Gold from Mapungubwe', in *Mapungubwe: Ancient Bantu Civilization on the Limpopo: Reports on Excavations at Mapungubwe (Northern Transvaal) from February 1933 to June 1935*, Vol. 1., ed. Leo. Fouché (Cambridge: Cambridge University Press, 1937), 116–17; M. Weber, 'Notes on Some Ancient Gold Ornaments', in Fouché, *Mapungubwe*, 114–16; G.H. Stanley, 'Mapungubwe Metallurgical Material', in Fouché, *Mapungubwe*, 117–18; L. Fouché, ed. *Mapungubwe*.

⁵ Andrew Oddy, 'Gold in the Southern African Iron Age: A Technological Investigation of the Mapungubwe and other finds', *Gold Bulletin* 17, no. 2 (1984): 70–8; Andrew Oddy, 'On the Trail of Iron Age Gold', *Transvaal Museum Bulletin* 19 (1983): 24–6; Andrew Oddy, 'Ancient and Historic Metals Conservation and Scientific Research: Gold Foil, Strip and Wire in the Iron Age of Southern Africa', in *Getty Conservation Institute & J. Paul Getty Museum Symposium*, ed. B.B. Conisidine, J. Podany, and D.A. Scott (Getty Conservation Institute, November 1991), 192.

⁶ Marilyn Hockey and Andrew Oddy, 'Short Report on the Conservation and Restoration of the Gold Bowl from Mapungubwe, Northern Province, South Africa', Department of Metals Conservation, British Museum unpublished report no. 2001/31/M/5 (2001).



Fig. 1 Dr Andrew W. Oddy examining the Mapungubwe gold collection in Pretoria, South Africa, 1983. © University of Pretoria.



Fig. 2 Evidence of previous interventions in the 1980s of soft lead solder attempts for joins of the gold foil. © The South African Institute for Objects Conservation.

The physical stability and condition of the gold collection received little attention for several decades until a conservation programme initiated in 1999 by the University of Pretoria contracted the British Museum for assistance and advice. The greater portion of the foil and sheet fragments were cleaned by the British Museum at this time. This initial cleaning to remove surface dirt and slight tarnish was performed with Detarol 120 (trisodium salt of N-hydroxyl ethylene diamine tri-acetic acid) 10% v/v in distilled water followed by rinsing. In March 1999, Marilyn Hockey, Head of Ceramics,

7 Marilyn Hockey, 'Report on the Conservation of Gold Artefacts from Mapungubwe', Department of Metals Conservation, British Museum unpublished report no. 99/19/M6 (1999), 1-7; Hockey and Oddy, 'Short Report'.

8 Hockey and Oddy, 'Short Report', 2001.

Metals and Glass Conservation, Department of Conservation at the British Museum, visited the University of Pretoria to address some of the deterioration issues.⁷ This involved the treatment of seven iconic objects, among them a gold figurine of a rhinoceros, a gold sceptre and a gold vessel (treatment for this object was undertaken in 2001 at the British Museum), as well as several other gold foils. The remainder of the gold collection (mainly foils and plate, comprising approximately 256 fragments, gold beads, tacks, anklets, necklaces and bracelets) remained untreated due to a shortage of time and funding. In the final assessment of the collection, Hockey and Oddy recommended that the sheet gold fragments, helix bangles and gold bead strings 'needed to be treated to ensure their long term preservation'.⁸ It was with these international recommendations in mind, that a programme to conserve the remainder of the gold, as well as implement a long-term conservation strategy for the collection was set up.

Initial examinations

Phase one of the conservation programme involved preliminary investigations which included collating accession numbers, inventories and gathering all research data, records (archival documents and photographic information) and publications relating to the gold collection, its history and context. This was followed by preliminary condition assessments, sorting through all the fragments, weighing, measuring, sampling and compiling systematic documentation records in order to determine the extent of damage and condition of the gold for the purpose of keeping a permanent museum record. This phase was critical in the decision-making process and determined a way forward for the remedial treatment. A 40× magnification microscope and optivisor were used for the visual inspections. Further examination revealed that an estimate of over 98% of the foil and sheet gold had been previously cleaned. The gold anklets were amongst those that had been cleaned, whereas the bracelets and necklaces were in loose groups still with soil deposits. Decades of repeated handling by researchers investigating various aspects of the gold collection had taken their toll, as post-depositional damage was clearly visible. Fragile edges had been lost on thin gold foils, as indicated by the presence of small flecks of gold fragments which were found in the packaging. Dissociation of previously intact sections, coupled with the lack of accurate records from the early 1930s excavation and of any subsequent treatments were all impacting on the coherence of the gold collection and its preservation. This examination and exploratory phase took several months to conclude and determined the work schedules for the conservation programme as well as anticipated needs for further funding and revision of projected time frames.

The conservation approach

With the results of the preliminary assessment and examinations in mind, the focus of the gold conservation programme was essentially to arrest the further deterioration of the gold collection and to ensure its long-term preservation for exhibition and future research access. The programme was divided into timed work packages with regular interim reports for evaluation and assessment purposes. Notwithstanding time frames and funding challenges, there was a continual committee consultation system and, at the same time, the project had to stay within the confines of permit regulations issued by the South African Heritage Resources Agency, which is the national governing authority. The first consideration

was the sheer volume of fragments of gold foil, minute gold tacks, thousands of beads and several hundred coiled or canular forms, such as the anklets. The second consideration was the lack of information from early excavations, unsound recording methods and post-excavation damage from handling and storage of the collection. These early preservation efforts, however, were characteristic of the methodology of the time.

The final consideration was to ensure that all objects were treated equally and irrespective of their value and quality, in accordance with section 1.5 of the VeRes Code of Ethics to which members of the South African Guild of Conservators and Restorers are signatories.⁹ All the treatments utilized were first tested on small areas of single items to ensure the preservation of physical and historical integrity of the collection and its associated information. The treatment was, as with all conservation considerations, a careful balance between that which is desirable and that which is achievable, and also with due consideration of time frames, legislative permit parameters and the realities of funding to ensure the appropriate long-term outcome for future research and preservation of the gold collection. The conservation treatment which followed was to superficially clean the gold (where necessary) and remove surface dirt, stabilize the collection and reinstate fragmentary remains, so as to not incur further damage and ensure that all treatment, where possible, was reversible.

The gold conservation programme centred on the museum collection comprising 9kg of gold that consisted of about 460 objects, including 117 beaded bracelets, 139 necklaces, 133 coiled anklets, 26,000 gold beads, 1428 gold tacks, 40 gold foil forms and several gold animal figurines. Conservation treatment was divided into four main categories: anklets, bracelets and necklaces of coiled gold; beads; tacks; foil and plate.

Conservation treatments

1 Anklets

Treatment of the gold anklets comprised 133 individual coiled anklets. These coiled forms fell into three main categories, namely thicker strip (approximately 2.6mm thick), thinner strip (approximately 2.36mm thick) and fine strip (approximately 1.74mm thick), which almost resembled wound wire. The anklets being coiled from the widest strip foil were the most resistant to damage and deterioration. Their outer surfaces were smoother (non-pitted) and more lustrous. Although there were sections that had become stretched or broken, the majority of these anklets were in good condition. Iron corrosion crusts were found in small patches, but were not numerous.¹⁰ These crusts were formed over more than one coil and immobilized these sections. This increased the risk of fracture in the adjacent areas when the coils were handled. Since loose burial material had been previously removed from the anklets, attention was focused on the fragmentation that resulted from handling and the adhered iron corrosion crusts.

Some of the intact anklets still contained their original fibre cores (an unidentified plant species) whereas those that were fractured or in the process of unravelling had lost some, if not all, of the fibrous material they contained. The loose fibres lying in the recesses of the packaging material were collected and stored for future analysis; further research will hopefully provide definitive identification of these fibres (Fig. 3).

The anklets were cleaned under a 40× magnification microscope to assess the level of dirt removal. The iron oxide crusts proved very

⁹ 2010 VeRes Code of Ethics, <http://cool.conservation-us.org/byorg/veres/vereseth.html> (accessed 26 October 2012); The South African Guild of Conservators and Restorers, http://www.sainst.org/index.php?option=com_content&view=article&id=91&Itemid=6 (accessed 26 October 2012).

¹⁰ The gold was buried in association with many iron objects. The random deposition of these corrosion patches suggested that the source was associated with iron objects. No depletion of the gold surface was observed after cleaning. One would expect pitting of the gold surface if the iron that was corroding was alloyed with the gold.



Fig. 3 Plant fibres retained from gold anklets for future analysis and identification. © University of Pretoria.

resilient and hard to remove with wooden picks or similar softer tools. An adjustable glass bristle brush proved to be the least damaging option and was found to be better than chemical cleaning or air ablation which could further damage the surface. Since the powdery corrosion crusts formed mounds on the otherwise smooth surface of the anklets, the small corroded areas were mechanically brushed off with the glass fibre brush, carefully removing the damaging material; the area was then swabbed with distilled water to collect any remaining fine dust and fibres. This method was effective for superficial cleaning and particular care was taken to not scratch the original surface or alter the surrounding gold surface. The length of the bristles was constantly adjusted to allow satisfactory removal of the corrosive crusts only. No evidence of damage or erosion of the gold surface was microscopically observed under $\times 40$ magnification.

¹¹ E. Aura-Castro and M.T. Doménech Carbó, 'Evaluation of the Phase Inversion Process as an Application Method for Synthetic Polymers in Conservation', *Studies in Conservation* 44, no. 1 (1999): 9–28.

¹² The laboratory had close temperature control and active ventilation and extraction but no humidity control.

The fractured ends were adhered by means of custom-made tapes.¹¹ This tape consisted of Japanese tissue cut into small squares and immersed in a solvent blend of Paraloid B72[®] in 50:50 acetone: butanol. The Paraloid (approximately 50% w/v) was added until the viscosity was sufficient to facilitate adhesion. The exact concentration of the adhesive was dependent on the prevailing ambient conditions in the laboratory.¹² The hotter, drier days required the addition of solvents from time to time, whilst cooler days required higher viscosity solutions to obtain faster tack times. For adhesion of the anklets, the two ends were brought together and the tape square wrapped around the anklet with the juncture in the centre (Fig. 4). The anklet was supported in the correct position with a dental tool on either side of the tape to prevent the join from springing open while the adhesive tacked. The unravelled sections were minimal and could be corrected quite readily by gently pressing very small lengths of the coils back together with the finger tips. Such corrective measures involved no modifications or re-shaping of the original form as these sections had become unravelled or stretched over time. In this poor state, the anklets were very prone to becoming tangled and further fragmented, as the stresses on the juncture between the coiled portion and the stretched portion led to repeated bending and finally fracturing at the junctures. It also proved to be quite impossible to handle these partially wound fragments without snagging and tangling. Therefore, given the extreme vulnerability of these sections, the minor corrections of



Fig. 4 Securing of the coil anklet sections with Japanese tissue cut into small squares and immersed into a solution of Paraloid B72[®] solubilized in an acetone and butanol solvent blend to stabilize broken joins. © The South African Institute for Objects Conservation.

the coils provided the necessary protection and preservation. The cleaned and stabilized anklets were then grouped into sets of ten. More groupings would be too heavy, causing the wound wire to stretch further. It was found that sets of ten enabled easier lifting of the anklets and better curation to ensure no further damage to them.

2 Necklaces and bracelets

Several decades of handling (repeated flexing and stretching) of the necklaces and bracelets had caused fracturing of the coiled ornament and loss of the fibrous core. Weak and vulnerable portions were identified for support, after which the necklaces and bracelets were manually untangled to reduce stress and strain on their structure. The bracelets and necklaces were made from thin strip foil (approximately 2.36mm thick) and were much softer and more malleable than the thinner anklets. The necklaces were particularly vulnerable to unwinding and flattening. Although the bracelets were slightly more resistant, they too were more vulnerable than the anklets. The same manufacturing method had been used as for the anklets—that of strips of foil coiled around an organic fibre core. The bracelets and necklaces were largely in their ‘excavated’ condition, covered with a thin layer of burial soil and lying tangled together. The first process involved the careful extraction of all the intact pieces. The remaining broken strands were then separated into groupings of pieces that respectively had one fracture only, those that had more than one fracture and those that were unravelled. The intact and partially fragmented groups comprised approximately 70% of the necklaces and coiled bracelets. The remainder of the fragments had unravelled completely or could not be assembled into sizes consistent with the rest of the intact pieces. The intact and nearly intact items were initially cleaned with a soft artist’s brush and non-ionic detergent (Synperonic[®] NPIO); however, the dirt did not dislodge readily enough to respond to a soft cleaning action.

It was therefore decided that, with the propensity of the coils to flatten and unravel due to their inherent malleability, controlled trial cleaning of a small

dissociated fragment in an ultrasonic bath containing water would serve as an alternative treatment option. The few dissociated loose fibres found were also placed in the bath prior to the treatment to check whether the ultrasonic action was deleterious to them. As no damage was observed, it was deemed safe to expose the coils for the brief periods needed to dislodge the dirt. The gold fragments were then subjected to the bath for a few seconds, removed and the surface gently brushed. The exposure times were increased incrementally to approximately two minutes until the dirt could be brushed off without damaging either the shape or surface texture of the sample. This method proved the most successful and efficient. The surfaces still contained residual dirt in the lacunae. However, it was decided that complete removal of all contaminants could potentially harm the surface finishes through over-cleaning, and would not measurably improve the visual result attained by the current level of cleaning. Many fragments of gold necklaces, anklets and organic fibres remained untreated and were saved for future research purposes.

Instances of physical damage required two types of intervention. The first was the same as for the anklets, where the broken fragments were adhered with Japanese tissue and Paraloid B72[®] in acetone: butanol and slightly unravelled sections were gently pressed together with the finger tips. The second intervention, which was followed by adhesion, was the supporting of the severely unravelled sections. This was successfully achieved for a large portion of these items by employing a modified pair of jeweller's pliers and a wooden pick.¹³ The pick was made to match the inside diameter of the intact sections. The custom-made pliers were improvised by cutting two grooves in the mouth of the pliers so that, in the closed position, the two grooves aligned to form a tunnel with the same diameter as the outside diameter of the corresponding sample bracelet or necklace. The unravelled strips were then gently wound around the wooden pick and the outsides contained with the custom-made pliers. All the sections that could not be re-assembled were sorted by approximate length and category, namely necklaces or bracelets, and loosely bound in bundles with custom-made melinex tabs for easier handling and to reduce weight on the groupings.

3 Gold beads

The examination of the gold beads utilized a 40× magnification microscope and 7× magnification optivisor to scrutinize the minute beads prior to treatment, confirming previous fabrication research that they were made either from gold globules with deliberately smoothed holes (a casting process) or from small wire which would have been bent round into a loop with butted ends.¹⁴ A microstructural study of the gold beads confirmed that the flattened beads were shaped after an annealing treatment, and were most likely perforated by an iron instrument.¹⁵ All the gold beads examined for conservation were found to be robust, sturdy and distinct in their various shapes. Some were notched on the outside or displayed clear punch marks in the centre, while others were coiled and had a small space where the two ends met. Some were more disc-like, whilst others were more globular. A majority of the gold beads had not been stored in any particular order over decades, having lost their archaeological context (they were excavated individually and filled into small polyprop glass bottles) and there was no direct evidence of how the beads were originally grouped or formed. After consultation, consensus was reached to sort the beads, first by size and then according to specific categories. The sizes were such that they could be readily grouped by diameter. The following types or categories were then used for each bead:

¹³ Jeffrey Maish, 'Interpretation of Ancient Artistry: Conservation of a Gold Wreath from the 4th Century BC', *Journal of the American Institute for Conservation* 34 (1995): 113–27.

¹⁴ Nirdev Desai and Duncan Miller, 'Fabrication Technology of Southern African Archaeological Gold', *Annals of the South African Museum* 111 (2004): 83.

¹⁵ Lesley Cornish, P. Ngwenya, M. Mathema and D. Newman, 'A Microstructural Study of Gold Beads from Mapungubwe', *15th International Congress on Electron Microscopy (ICEM)* No. 1 (2002): 811–12.

Category 1: without a joint, punched with square-sided punch.

Category 2: strip wrapped around a form, open join without solder.

Category 3: smaller beads – not clear if they had been wrapped or punched.

Category 4: ornamented by scoring or indenting grooves into the outside edges.¹⁶

Once this had been done, the average lengths of the existing coiled anklets, bracelets and necklaces would be used as a size marker to determine the length of sections to be re-strung as a means of supporting the hundreds of gold beads. The number of beads in each grouping would be used to determine whether they were superficially suited to anklet, necklace or bracelet lengths. A bead sieve was used to sort the beads, after which they were counted and categorized. During this categorization a small group of beads that did not fit easily into the specific categories were identified. These were studied under a 40× magnification microscope and one bead selected for further cleaning. On removal of the red corrosion product from the centre of the bead the black *limitos* of an iron helix was found with the mineralized impression of four organic fibres in the centre (Figs 5 and 6).¹⁷ These strip-wrapped beads, and particularly evidence of manufacture, is unique. They were, therefore, kept separate and have been stored with the research reference material set aside from the rest of the gold collection.

Once the groupings had been made and the string lengths determined, surgical suture thread was chosen as per the inside diameter of the beads. The strings were closed by a custom-made brass crimp, which holds the two loose ends of the thread together.¹⁸ A small amount of Paraloid B72[®] (solubilized in 20% w/v acetone:butanol) was wicked into the overlap to further assist the binding off of the gold beaded string. All the gold beaded strings are easily reversible. A conservative estimate of 26,000 gold beads was sorted and grouped into 117 gold bracelets and 139 gold necklaces, and were safely supported on custom-made perspex mounts for display or storage in acid-free archival containers. Loose beads were also retained for future analysis.

4 Gold tacks or nails

A total of 1428 individual gold tacks or nails was examined. Some had tapered, and either round or rectangular shanks, while many others still remained *in situ* in gold foil (Fig. 7). These minute gold tacks varied in size and shape, but were all on average less than 6mm in length. They appeared to have been cleaned and dispersed over the collection, with many losing their original context. The tacks were assembled and cleaned by placing French chalk on a fine microfibre cloth and with a cotton-gloved hand gently rolled in the chalk. Afterwards they were thoroughly rinsed in methanol, allowed to dry and placed in a glass vial. All *in situ* tacks were left untouched in their original places in the gold foil.

5 Gold foil and plate

All the gold foil and plate fragments (of which there were several hundred) were sorted using the following markers: profile, tool marks, matching tears, overlapping matched by nail holes and edge imprints, creased seams, perforation (tack holes) sizes and, to a certain degree, foil thickness and colour. Distinction was also made between foil and plate (thickness ranging from 0.3 to 0.5mm) when considering the gold from which the animal shapes were made. If the gold was thin enough to yield to manipulation by gentle finger pressure, it was referred to as foil. The thicker gold did not yield to this type of pressure and was referred to as plate.

¹⁶ Duncan Miller, 'Metal Assemblages from Greefswald Areas K2, Mapungubwe Hill and Mapungubwe Southern Terrace', *South African Archaeological Bulletin* 56, no. 173/174 (2001): 83–103.

¹⁷ Valentin Boissonnas, 'An Introduction to the History of Metals', Metals Conservation Workshop presented by the South African Museums Association (July 2007); Janey Cronyn, *Elements of Archaeological Conservation* (London: Routledge, 1990), 172.

¹⁸ Fanie Schoeman, weapons and firearms conservator, South Africa, pers. comm., May 2008, September 2010.

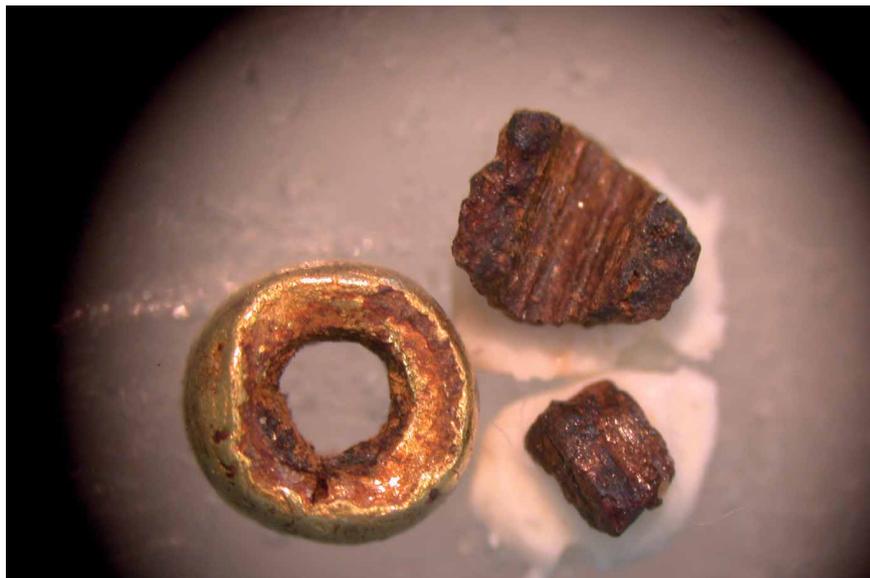


Fig. 5 Red corrosion visible on interior of seam-forged gold bead with pseudomorphic replacement of the organic fibres as retained by the corrosion product. © The South African Institute for Objects Conservation.

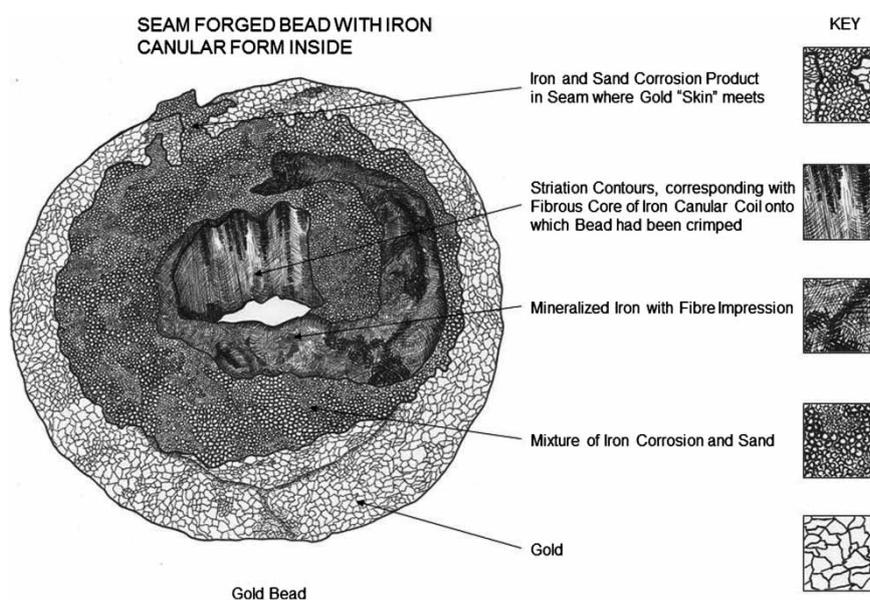


Fig. 6 Diagram of mineralized iron core and impression of organic fibre. © The South African Institute for Objects Conservation.

The foils were additionally sorted into two further groups, by thickness and colour. The thinnest of the foil was very fragile and whiter/paler than the slightly thicker foils. It was consequently found to be creased and wrinkled to a greater extent than the other two types. All the fragments, whether large or small, thick or thin, were showing signs of loss and deterioration. The losses were mostly associated with jagged edges, particularly if a tack hole was situated on the edge and the tack had been torn out. Even the gentlest handling of the fragments put these very small,



Fig. 7 Detail of gold tacks with round, rectangular or tapered shanks *in situ* in the gold foil.
© University of Pretoria.

poorly attached sections at risk as even the slightest pressure would cause flexing. Many of the larger protruding sections were folded over either to the front or back, thus altering the outside profile of the fragment.

The vast majority of these fragments had unfortunately been cleaned previously with no documentation or treatment data available, with less than 1% of all the foil and plate still retaining any original soil remnants or burial deposits.

Since previous elemental analysis indicated that silver was the only major defect element present (the silver content occurs naturally in South African gold and is not a result of alloying), it would be expected that little or no corrosion would be present.¹⁹ In fact, the entire collection features a very high gold purity, with the silver content ranging between 2% and 12%. Only two fragments displayed blackish edges, which could be silver corrosion product.²⁰ This observation was not conclusive, however, and the fragments were left with this discoloration intact. The presence of this residue did not impact on the conservation process and these particular fragments were retained for future research.

The few fragments that still had surface soil deposits (post-depositional) were exposed to a maximum of fifteen seconds in the ultrasonic bath. This was sufficient to loosen the soil deposits to allow for their effective removal with a soft brush after rinsing in distilled water. Considering the brevity of the exposure, this method was considered safe for the removal of damaging deposits or contaminants. The fragments were examined under the microscope prior to immersion to ensure that there was no vulnerable material present. Many of these fragments were small and malleable and, therefore, as little pressure as possible was applied to ensure preservation of the current shape of the foil. Care was also taken to loosen only the dirt superficially rather than removing it fully and thus many remaining gold fragments were not substantially cleaned. According to Scott, it is known that the copper and silver content of a gold alloy is a determining factor in the deterioration of that alloy.²¹ The silver content in the Mapungubwe foils falls below those mentioned and the copper content (which is the most influential) is almost entirely absent.

¹⁹ Miller, 'Metal Assemblages': 89–90; C.S. Erasmus, J.P.F. Sellschop, and J.I.W. Watterson, 'New Evidence on the Composition of Mineral Grains of Native Gold', *Nuclear Geophysics I* (1987): 1–23.

²⁰ L. Selwyn, *Metals and Corrosion: A Handbook for the Conservation Professional* (Canada: Canadian Conservation Institute, 2004).

²¹ David A. Scott, 'The Deterioration of Gold Alloys and Some Aspects of Their Conservation', *Studies in Conservation* 28 (1983): 194–203.



Fig. 8 Senior Conservator Hazel Botha examining all the gold foil and sheet fragments from the Mapungubwe collection. © The South African Institute for Objects Conservation.

The majority of the approximately 6000 hours spent at the treatment bench was expended on the hundreds of gold foils and sheet fragments (Fig. 8). Despite detailed visual and microscopic examination, inspection and comparison, the difference between a tack hole and an archaeological tool hole could not easily be distinguished. Many tears and deformations were stabilized and fragment groupings were gradually identified.

The trial assemblies for all the fragments eventually relied on the following markers or indicators: tool marks, colour, thickness, foil topography and fragment profile. Using these parameters, the trial assembly processes continued over a period of several months until the compiled unit yielded a natural profile and, in some cases, a form or shape (although not always distinguishable).

All adhesions for the final assemblies of the foil fragments were executed with Japanese tissue soaked in Paraloid B72[®] in a 50:50 acetone: butanol solvent blend to allow for easy reversal of joins. Several ornaments, in particular two animal figurines came to light, a gold bovine and gold feline as well as forty other decorative gold foil forms and shapes (Fig. 9).²²

²² University of Pretoria, *Gold Treasures of Mapungubwe: A Companion Guide to the Mapungubwe Museum Gold Exhibition* (Pretoria: Department of UP Arts, 2009), 1–22.

Packaging and storage

On conclusion of the gold conservation programme the immediate need to curate and care for the gold collection within museum preventive standards led to a renewal of all packaging with long-term storage and display purposes in mind as well as handling for future research. This was achieved by sorting of the thousands of beads into a more manageable order which, although not representative of the previous



Fig. 9 Gold foil bovine figurine after reconstruction. © University of Pretoria.

groupings, allowed for the prevention of further losses without loss of context (if any). The coiled anklets which had become fragmented were stabilized whilst the bracelets and necklaces, which had remained untreated since excavation, were cleaned and stabilized. The packaging was renewed to facilitate storage and handling, and all activities were recorded to aid future research and conservation. The gold anklets, necklaces and bracelets, whether coiled or beaded, were placed within custom-made acid-free boxes with high density foam, formed to the required shape to accommodate the embedded groupings. Small melinex lifters were hinged to the foam under the gold, with a clearly projecting tab. These tabs, when pulled, gently lift the gold from the recess so that they may be picked up without incurring any further risk or damage. The loosely bound bundles were not placed in recessed foam but were pinned on to the top of the foam by means of melinex tabs through which the pins were pressed into the foam below. The foil shapes and fragments were similarly packaged in recessed support foam, with additional areas cut out alongside the custom-made shapes so that the person handling the material is able insert enough fingers to lift the gold object or form out of its recess safely.

To further aid conservation management, the collection has acquired more stringent security measures and an increased awareness for regular environmental monitoring of both storage and exhibition of the gold collection. Current plans are underway to complete an updated inventory and allocate permanent accession numbers, so as to implement minimum standards for curation of the gold collection; much progress has been made towards this goal. At the time of writing, all the gold has been re-documented and photographed to meet international CIDOC documentation standards, thereby ensuring a proper and fully documented collection to facilitate identification, condition checking and for future research access. The international standard ISO21127:2006 has been adopted by the University of Pretoria Museums (signatories to the International Council of Museums) for the controlled exchange of heritage information, to enhance accessibility to the collections and in light of the increase in illicit trafficking of archaeological artefacts.²³

Conclusions

This article outlines the conservation processes that have established a sense of order to the once-neglected and fragmented Mapungubwe

²³ ISO 21127:2006. *Information and Documentation—A Reference Ontology for the Interchange of Cultural Heritage Information*, http://www.iso.org/iso/catalogue_detail.htm?csnumber=34424 (accessed 1 March 2013).

archaeological gold collection. The most significant outcome of the gold conservation programme was the conservation of about 460 gold artefacts, particularly bringing to light never-before-seen gold animal figurines and several emergent fragmentary forms. Whilst the conservation treatment outlined here is a mere fraction of the entire conservation process, it highlights the need for further research on the gold, particularly regarding more materials analyses and re-interpretations of Mapungubwe which could be debated for decades to come. All conservation undertaken remains soundly documented with all conditions of the legal permit having been met as well as a final report resulting from the work lodged with the South African Heritage Resources Agency, to facilitate knowledge and information sharing. A portion of the gold collection is on permanent display in the Mapungubwe Museum under the curatorship of the University of Pretoria and a minor collection is now exhibited at an Interpretation Visitor Centre on site, ensuring greater community access. Future curation of this collection remains unstable, due to informal calls for restitution, together with the archaeological site being under threat from nearby mining activities. Whilst the conservation planning process for this gold collection took place over a number of years, the greatest challenge was, and still is, to lay a sound ethical basis for all treatments and curation. Further challenges include providing guidelines for the decision-making process to demonstrate the immense efforts by conservators, curators and custodians to ensure that such archaeological collections meet best practice requirements and to instil a sense of sustainability for future generations.

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Abstract

This article documents the conservation of the Iron Age gold collection, under the curatorship of the University of Pretoria from the archaeological site of Mapungubwe Hill in the Limpopo Province of South Africa. The primary objective was the stabilization of a national archaeological museum collection, involving active treatment to halt further deterioration, re-uniting dissociated fragments and improving the collection for further handling and future research. Conservation on the gold collection spanned a period of three years (and over 6000 hours of benchwork), allowed for the reversal of post-excavation damage, major sorting, stabilization, elucidation of previously obscure forms and overall improvement of the gold collection for sustainable curation. This conservation programme further provided the opportunity to set in motion best practices for

archaeological objects conservation in South Africa and brought a permanent museum collection up to international standards.

Résumé

«La conservation de la collection d'objets en or de Mapungubwe en Afrique du Sud»

Cet article retrace la conservation de la collection d'or datant de l'Age du Fer, sous la tutelle de l'Université de Pretoria, en provenance du site archéologique de Mapungubwe Hill dans la province de Limpopo en Afrique du Sud. L'objectif principal était la stabilisation de la collection du musée archéologique national, ce qui impliquait un traitement curatif pour prévenir davantage de détérioration, la réunification des fragments dissociés et la consolidation de la collection pour permettre sa manipulation et de futures recherches. La conservation de la collection d'or, déployée sur une période de trois ans (et plus de 6000 heures d'atelier), a permis la réparation des dommages survenus après les fouilles, un tri majeur, une stabilisation, une compréhension de formes auparavant obscures et une amélioration générale de l'état de la collection d'or sur le long terme. Ce programme de conservation a en outre fourni l'occasion de mettre en œuvre de meilleures pratiques dans le domaine de la conservation des objets archéologiques en Afrique du Sud et a mis aux normes internationales la collection permanente du musée.

Zusammenfassung

„Die Konservierung der Mapungubwe Gold Sammlung, Südafrika“

Dieser Artikel dokumentiert die Konservierung einer eisenzeitlichen Goldsammlung in der kuratorischen Verantwortung der Universität Pretoria aus der archäologischen Stätte Mapungubwe Hill und Limpopo Provinz in Südafrika. Von primärer Wichtigkeit war die Stabilisierung dieser

nationalen archäologischen Museumssammlung, aktive Behandlungsmassnahmen waren notwendig, um weiteren Verfall aufzuhalten, zerstreute Fragmente zusammenzuführen und um die Sammlung für weitere Handhabung und zukünftige Forschung zu stabilisieren. Konservierung/Restaurierung der Goldsammlung dauerte drei Jahre und nahm über 600 Stunden praktischer Arbeit in Anspruch. Dies erlaubte uns den Schaden, der den Objekten nach der Ausgrabung zugefügt worden war, rückgängig zu machen, die Sammlung zu ordnen und zu stabilisieren, versteckte Formen wiederzuentdecken und die allgemeine Verbesserung der Goldsammlung für eine nachhaltige Kuratation. Dieses Restaurierungsprogramm gab uns die Möglichkeit, beste Standards für archäologische Objektrestaurierung in Südafrika anzuwenden und brachte eine Museumssammlung auf ein internationales Level.

Resumen

“La conservación de la colección de oro de Mapungubwe, Sudáfrica”

Este artículo documenta la conservación de la Collection de oro de la Edad de Hierro del lugar arqueológico de Mapungubwe Hill en la provincia de Limpopo de Sudáfrica, a cargo de los comisarios de la Universidad de Pretoria. El objetivo principal fue la estabilización de la colección nacional arqueológica del museo, consistiendo en un tratamiento activo para detener su deterioración, la reunión de fragmentos disociados y la mejora de la colección con vistas a su futuro manejo e investigación. La conservación de la Collection de oro se realizó durante un periodo de tres años y más de 6000 horas de trabajo práctico de conservación. Se revirtió el daño causado después de las excavaciones, se reorganizó y estabilizó la colección; se establecieron formas que anteriormente estaban ocultas y en general, se mejoró la colección de oro hacia una curación sostenible. Además, este programa de conservación ha proporcionado la oportunidad de poner en marcha prácticas adecuadas en la conservación arqueológica de Sudáfrica y mejorar la colección permanente de un museo hacia estándares internacionales.

Biographies

Sian Tiley-Nel is currently the Chief Curator at the University of Pretoria Museums and is a specialist on the Mapungubwe Collection in the Department of UP Arts, University of Pretoria (South Africa). She is formally qualified and trained in

Archaeology, Applied Anthropology and Museum Science with postgraduate degrees. Since 2004, she has received technical conservation training and has specialized in archaeological conservation and completed the 2011 Graduation Programme, with distinction in the class of Honoratus within the Ceramics Conservation Department, and has been inducted into the Order of Merit *Laureatus Conservator* at *The South African Institute for Objects Conservation*. She has also initiated the establishment of the Museums Objects Conservation Research Laboratory, responsible for conservation at the University of Pretoria Museums. Sian is currently Chairperson of the Museums Committee, co-ordinating museum research and training within a team of curators on various research projects, exhibitions as well as conservation projects and preventive conservation of the University of Pretoria Museum collections. She is a member of the Professional Association of southern African Archaeologists (ASAPA), the Society of Africanist Archaeologists and a member of the South African Guild of Ceramics Conservators. Sian has also published both in the academic and public domain as well and has produced two specialist books on Mapungubwe.

Hazel Botha has been a full-time conservator since 1988. Her areas of specific expertise extend to the specialist fields of ceramics and metals conservation. Her formal studies include specialist residential courses at West Dean College, Chichester, UK as well as mid-career training at Winterthur Institute & Museum, Wilmington, USA. Amongst her mid-career qualifications, she has undertaken courses on ‘Chemistry for Conservators’, ‘Analytical Techniques for Conservation’, ‘The Conservation of Metals’, under the tutelage of Valentin Boissonnas (Professor at the Haute École Arts Applique) and ‘Teaching Skills for Conservators’. During 2005, she also participated in a course programme at West Dean College entitled, ‘The Conservation and Repair of Architectural Metal Work’ as well as in the Metals Conservation Summer School Programme presented by the Higgins Armory Museum and the Worcester Polytechnic Institute, Worcester, Massachusetts, USA. From 1994 to present, Hazel Botha has worked at The South African Institute for Objects Conservation, where she holds the offices of Head Conservator (Metals and Ceramics), Curriculum Developer (Metals and Ceramics) and Principal Tutor to the respective departments of Metals Conservation and Ceramics Conservation.

Materials and suppliers

Chromic feline gut sutures:
Sutures Manufacturing Company
93 A-B Smit
IV Phase
Peenya
Bangalore
India

Paraloid®-B72 (Ethyl methacrylate copolymer):
Rohm and Haas Co
100 Independence Mall West
Philadelphia
PA19106-2399
USA

Renaissance wax (micro crystalline wax):
Picreator Enterprises
44 Park View Gardens
Hendon
London NW4 2PN
UK

Non-proprietary materials & tools (binocular microscope; ultrasonic cleaner; wooden picks; sharp point tweezers; flat nose pliers; bead sieve; acetone; butyl alcohol; Japanese hinging paper; paint brushes; blotting paper; metal trays; silicone rubber (poly-siloxane); glass bristle brushes):

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Polyethylene coated paper:
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Niederschlag 1
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Synperonic® NPIO (Polyethylene glycol nonylphenyl ether) - CAS 9016-45-9:
Sigma-Aldrich
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