The Gold Working of Riqqa, Egypt: Analysis and Comparison. Between the 12th and 18th Dynasties

Lore Troalen, Maria Filomena Guerra, Margaret Maitland, Matthew Ponting, Campbell Price

The Gold Working of Riqqa, Egypt: Analysis and Comparison Between the 12th and 18th Dynasties

Lore Troalen, Maria Filomena Guerra, Margaret Maitland, Matthew Ponting, Campbell Price

Abstract

The analysis of two important groups of jewellery from Riqqa (Tomb 124 and Tomb 296) provides an opportunity to consider a single location and if there is any continuity of workshop traditions between the Middle Kingdom and the New Kingdom, and any possible differences with regard to the alloys employed. The objects were analysed by XRF, µPIXE, and SEM-EDS, and the composition of the gold alloys from both burials are discussed and compared with published data from the same periods. PGE inclusions were observed in almost all jewel- lery, indicating the use of alluvial gold. The analysis of some joins has confirmed the use of hard-soldering, with solders obtained by addition of Cu to the base alloy.

Keywords: jewellery, granulation, cloisonné, electrum, Middle Kingdom, New Kingdom.

INTRODUCTION

Located close to the mouth of the Faiyum region, the cemeteries at Riqqa contain a series of graves ranging from the Predynastic to the Late Period (Engelbach et al. 1915). Two graves contained important jewellery: Tomb 124, from Cemetery A, dating to the second half of the 12th Dynasty (ca.1900–1840 BC); and Tomb 296, from Cemetery C, which has been dated to the New Kingdom (ca.1550–1070 BC). The large group of jewellery from Tomb 124 (Fig. 1a), currently in the collection of the Manchester Museum (MM), includes a gold pectoral and a gold winged scarab beetle, both in cloisonné work forming the name of King Senwosret II (1897–1878 BC), a gold shell pendant bearing the cartouche of King Senwosret III (1878–1839 BC), and a hollow gold pendant in the form of the fertility god Min. The group of jewellery from Tomb 296, in the collection of National Museums Scotland (NMS), includes a gold necklace with two gold-encased scaraboids, a gold-encased lapis lazuli cowroid, and a small gold pendant inscribed with the praenomen of King Tuthmosis III (ca.1479-1425 BC) and the name and title ‘Scribe Beri’ (Fig. 1b, d), and three gold penannular earrings (Fig. 1c).

Both groups of jewellery were analysed as part of the ‘Study of Bronze Age Egyptian Gold Jewellery’ project (CNRS PICS 5995), providing a chronological parallel of the workshop practices in Egypt during the Middle Kingdom and the New Kingdom at Riqqa (Troalen, Guerra 2016; Troalen et al. 2019). Data obtained for these two groups was compared to previous results obtained for jewellery dated to the same periods and analysed within the framework of the project.

ANALYTICAL TECHNIQUES

The objects were examined under stereo-microscopes equipped with digital cameras and, when possible, submitted to X-radiography using a 320 kV Pantak system. The elemental composition of the alloys was determined using several non-invasive techniques: X-ray fluorescence analysis (XRF), scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM-EDS), and particle-induced X-ray emission (µPIXE). The compositional analysis of ternary alloys of gold-silver-copper standards was used to evaluate the inter-instrument compatibility of the analytical techniques (Troalen et al. 2009; Rastrelli et al. 2009).

XRF was carried out with:

1. At NMS, an Oxford Instruments ED 2000 air-path, with Rh target X-ray tube col- limated to a point of about 2 × 1.5 mm2, coupled to a Si(Li) detector. Conditions were 35 kV, 1000 µA with 0.125 mm Rh filter for 150 s, and then 50 kV, 1000 µA, 0.5 mm Cu filter for 300 s. The spectral deconvolution and quantification were performed using ED 2000SW software (Troalen et al. 2009).
2. At MM, with a hand-held thermo-scientific Niton XL3t analyser set to 'Precious Metals' alloy mode, with a 'GOLDD' detector, a 50 kV, 200 µA X-ray tube with Ag anode, a 3 mm spot collimator, and a CCD camera for locating the regions of analysis and an acquisition time of 60 s.

SEM-EDS was carried out for the analysis of joins. At NMS this was undertaken using a CamScan MX 2500 with a Noran Vantage EDX Si(Li) spectrometer and an ultrathin window controlled with Noran Vantage software. Elemental quantification was undertaken at the optimised analytical working distance of 35.0 mm, 300 s acquisition time with electron beam energies of 20 kV and 25 kV, and using the ZAF matrix correction model. At University of Liverpool, this was undertaken using a JSM-5300 microscope with an ultrathin window detector controlled by a PGT Spirit system. Analysis was undertaken at 20 kV acceleration voltage with 100 s acquisition time. Elemental quantification was done using pure element and mineral standards for calibration with the ZAF matrix correction model.

In addition the jewellery items from Tomb 296 were investigated by µPIXE at the extracted beam line of the AGLAE accelerator facility (from the C2RMF in Paris) using a 3 MeV proton beam with Si(Li) detectors, applying a 75µm Cu fi on the high energy detector (Guerra 2004). Quantitative processing of the spectra was carried out with GUPIXWIN software (Campbell et al. 2010), which was coupled to the in-house TRAUPIXE software developed at the AGLAE facility (Pichon et al. 2010).

RESULTS

CONSTRUCTION

The winged beetle and the pectoral from Tomb 124 are both made from a cut gold sheet and cloisonné work inlaid with lapis lazuli, carnelian, and turquoise (Fig. 2a). Their reverse is decorated by chasing with the same motif. The gold pendant in the form of a shell is made by hammering, and is decorated with a motif in wires made by rolling a strip of gold and by granulation (Fig. 2b)—it is one of the earliest examples of the use of granulation in Egypt. The small hollow gold pendant in the form of the fertility god Min is shown standing on a stepped platform and has a feathered crown in cloisonné inlaid with lapis lazuli and turquoise.

In Tomb 296, the three penannular earrings consist of four hollow hoops of triangular section joined together at their bases (Fig. 3a). The necklace consists of 94 round beads alternating with 72 flat lenticular beads, with a central section of 20 small ball beads, a flat rectangular incised pendant also in gold, and at the ends a gold-encased scarab, scaraboid bead, and cowroid bead, with a small biconical bead and a small terminal bead. The flat lenticular and the round beads are made in two halves joined together and the small biconical beads by bending a piece of gold sheet (Fig. 3b).

THE GOLD ALLOYS

The data obtained for the jewellery from Tomb 124 indicates that all alloys are silver-rich electrum, with Ag contents ranging from 27 wt.% to 49 wt.% and Cu contents below 3 wt.% (Table 1). In contrast, the jewellery items from Tomb 296 are made using different gold alloys. The penannular earrings are made of similar alloys with an Ag level of 9–10 wt.% and a Cu content below 1.5 wt.%, but the beads and pendants that constitute the necklace are made from alloys with Ag contents ranging between 13 wt.% and 31 wt.%, with a level of Cu reaching 3 wt.% (Table 1). Each type of bead, however, exhibits a single composition, suggesting that the beads could have been made by batch (Troalen, Guerra 2016). The lenticular beads contain on average 19 wt.% Ag, and the round beads 29 wt.% Ag. The small ball beads exhibit a more diverse composition, containing in average 14 wt.% Ag, but with one being made of high-purity gold alloy with 95.8 wt.% Au, 4.0 wt.% Ag, and 0.1 wt.% Cu. The other elements of Scribe Beri's necklace (casing of the lapis lazuli scaraboid and the terminal bead) are made from high Ag electrum, one very close to the composition of the lenticular beads, while the rectangular pendant, the biconical terminal beads, and the steatite scarab casing all show Ag contents lower than 13 wt.%, compositionally close to the penannular earrings.

The mounting of the majority of the jewellery investigated in this study exhibits clear visible joins corresponding to the use of hard-soldering technique (Fig. 3a–b), with copper reach- ing 4 wt.% to 10 wt.% in the joining areas. The use of the hard-soldering process has been also evidenced among items from the Middle Kingdom and the Second Intermediate Period (Troalen et al. 2009; Troalen, Tate, Guerra 2014; Lemasson et al. 2015; Troalen et al. 2016). The morphology of the ancient joins in all of the objects from Tomb 124 similarly revealed the use of hard-soldering. EDS analysis of a few pectoral joins confirmed the addition of Cu to the base gold alloy to produce the solder alloys (Troalen et al. 2019), whereas the joins on the gold beads of the necklace from Tomb 296 are almost invisible even in the SEM, but their morphology suggests the use of heating. The composition of the joins for a few other items was determined by mapping with EDS and µPIXE, supporting the use of gold alloys produced by adding Cu to lower the melting point (Troalen, Guerra 2016).

PGE INCLUSIONS

Platinum group element (PGE) inclusions were observed in all of the jewellery from Riqqa. These inclusions are visible under stereo-microscope and were sometimes found to be abundant, such as in the cartouche and the terminal bead of the necklace of Scribe Beri from Tomb 296 (Fig. 4). These inclusions are commonly reported in Egyptian gold jewellery and their presence is characteristic of the use of alluvial gold deposits (Ogden 1976; Meeks, Tite 1980; Troalen et al. 2009; Troalen, Tate, Guerra 2014; Guerra, Pagès-Camagna 2019). Two inclusions from the pectoral and the winged beetle pendant in Tomb 124 were analysed by SEM-EDS. One inclusion was found to be a rutheniridosmine alloy and the other is an iridosmine alloy (Troalen et al. 2019). Eleven inclusions were analysed in the jewellery from Tomb 296 (Troalen, Guerra 2016), their composition was found to be variable within the same object, but all the inclusions were rutheniridosmine (Harris, Cabri 1991) with levels of ruthenium ranging between 4 wt.% and 40 wt.%.

DISCUSSION

The jewellery groups from Middle Kingdom Tomb 124 and New Kingdom Tomb 296 found at Riqqa provide an opportunity to compare the work of Egyptian goldsmiths in one location at different periods. The two groups of objects exhibit the use of different colours of gold alloys. The jewellery items from Tomb 124 are made from whitish gold alloys containing 25–50 wt.% Ag and are inlaid with colourful materials; while in comparison, the penannular earrings and necklace beads and amulets from Tomb 296 are made from yellowish alloys containing 10–28 wt.% Ag (Fig. 5).

With regard to the types of alloys used in Tomb 124, the jewellery items analysed correspond to alloys found in Middle Kingdom items (Lucas, Harris 1962; Troalen et al. 2016), including several Middle Kingdom objects in the collection of the Ashmolean Museum (Gale, Stos-Gale 1981; Gale 1981). However, it should be noted that high-purity gold alloys have also been character- ised in objects dated to the same period, for example a fish-pendant from Tomb 72 at Haraga (Troalen et al. 2016).

In comparison, none of the jewellery items from Tomb 296 were made using silver-rich electrum. There has been little systematic analysis of 18th Dynasty gold jewellery items, but of note is the large group from the so-called ‘tomb of the three foreign wives’ of Tuthmosis III (Wadi Qurud, Thebes) in the Metropolitan Museum of Art (Lilyquist 2003). In this group, the majority of the objects were found to be made with gold containing 25–35 wt.% Ag, and only two items were made of silver-rich electrum with more than 40 wt.% Ag (Lilyquist 2003). The analysis of eight penannular earrings from the same period revealed use of the same type of alloys as found in Tomb 296, containing in general 10–25 wt.% Ag, but two specimens have shown the presence of more than 40 wt.% Ag (Troalen, Guerra 2016). Interestingly, one finger ring, probably from an Amarna royal tomb of the late 18th Dynasty, is made from a high-purity alloy containing about 5 wt.% Ag (Troalen et al. 2009). It should be noted that high-purity gold alloys with less than 5 wt.% Ag have been characterised in the Second Intermediate Period jewel- lery (Guerra, Pagès-Camagna 2019), such as the penannular earrings from the Qurna burial, probably of a royal woman (Troalen, Tate, Guerra 2014). In Tomb 296, the presence of alloys systematically containing less than 28 wt.% Ag is therefore remarkable and the close composition of the three penannular earrings suggests that they could possibly correspond to a batch alloy.

It is difficult to draw further conclusions on the types of alloys used in Egypt or to suggest the sources of gold. The gold used in the periods addressed in this work could originate from local primary and secondary sources (Klemm, Klemm 2013), but the recycling by melting of previous items must also be considered. Recycling without melting also has to be considered, as this practice was suggested for the child’s jewellery in the Qurna burial (Troalen, Tate, Guerra 2014). The scattered composition in some elements of the necklace from Tomb 296 might indicate the same type of workshop practice.

CAPTIONS

Fig. 1. Jewellery from Riqqa (Tomb 124 and Tomb 296). a. Jewellery from Tomb 124. From left to right clockwise: figurine of the god Min (Manchester Museum, acc. no.: MM 5969), gold shell pendant (MM 5968), gold winged beetle (MM 5967), and gold pectoral (MM 5966). © M.F. Guerra/CNRS. b. Jewellery from Tomb 296. The Scribe Beri's necklace (A.1913.388). © National Museums Scotland. c. Jewellery from Tomb 296. One of the three penannular earrings (A.1913.389). © National Museums Scotland. d. Jewellery from Tomb 296. Detail of the square pendant from the Scribe Beri's necklace with the praenomen of Tuthmosis III. © National Museums Scotland.

Fig. 2. Stereo-microscope details of the manufacturing techniques observed on the Middle Kingdom jewellery from Tomb 124. a-b © M.F. Guerra/CNRS, Courtesy of the National Museums Scotland. a. Carnelian, lapis lazuli, and turquoise inlays used to decorate the pectoral (MM 5966); note that no cloison separates the majority of the materials inlaid. b. Detail of the shell pendant (MM 5968) containing a motif in filigree and granulation representing a uraeus on each side of the cartouche of King Senwosret III.

Fig. 3. Stereo-microscope details of the manufacturing techniques observed on the New Kingdom jewellery from Tomb 296. a. Stereo-microscope observation of one penannular earring (A.1913.390) exhibiting the use of hard solder to join the triangular tubes at the base; scale bar is 2 mm. b. Joining of lenticular beads from the Scribe Beri's necklace (A.1913.388); scale bar is 1 mm. © M.F. Guerra/CNRS, Courtesy of the National Museums Scotland.

Fig. 4. Stereo-microscope detail of New Kingdom jewellery from Tomb 296: platinum group inclusions (PGE) observed in the rectangular pendant from the Scribe Beri's necklace (A.1913.388); scale bar is 500 µm. © M.F. Guerra/CNRS

Fig. 5. Comparison of the colours of gold alloys used in jewellery from Tomb 124 and Tomb 296 at Riqqa. Ternary representation of the colours of gold alloys is adapted from McDonald, Sistare 1978.

Table 1. The composition of the alloys of jewellery from Tomb 124 and Tomb 296 (mean values obtained from multiple measurements).

BIBLIOGRAPHY

Campbell, J.L., Boyd, N.I., Grassi, N., Bonnick, P., Maxwell, J.A., "The Guelph PIXE Software Package IV", Nuclear Instruments Methods B 268, 2010, pp. 3356–3363.

Engelbach, R., Murray, M.A., Petrie, H., Petrie, W.F.M., Riqqeh and Memphis VI, BSAE 25, London, 1915.

Gale, N.H., ED XRF Data for Bronze Age Greek, Cypriot and Egyptian Gold and Silver, online database, 1981 [Available from: OXALID], <http:/ oxalid.arch.ox.ac.uk/The%20 Database/TheDatabase.htm>, accessed 2 Feb. 2020.

Gale, N.H., Stos-Gale, Z.A., "Ancient Egyptian Silver", JEA 67, 1981, pp. 103–115.

Guerra, M.F., "Fingerprinting Ancient Gold with Proton Beams of Different Energies", Nuclear Instruments and Methods in Physics Research Section B 226, 2004, pp. 185–198.

Guerra, M.F., Pagès-Camagna, S., “On the Way to the New Kingdom: Analytical Study of Queen Ahhotep’s Gold Jewellery (17th Dynasty of Egypt)”, Journal of Cultural Heritage 36, 2019, pp. 143–152.

Harris, D.C., Cabri, L.J., “Nomenclature of Platinum Group Element Alloys: Review and Revision”, The Canadian Mineralogist 29, 1991, pp. 231–237.

Klemm, R., Klemm, D., Gold and Gold Mining in Ancient Egypt and Nubia: Geoarchaeology of the Ancient Gold Mining Sites in the Egyptian and Sudanese Eastern Deserts, Heidelberg, 2013.

Lemasson, Q., Moignard, B., Pacheco, C., Pichon, L., Guerra, M.F., “Fast Mapping

of Gold Jewellery from Ancient Egypt with PIXE: Searching for Hard-Solders and PGE Inclusions”, Talanta 143, 2015, pp. 279–286.

Lilyquist, C., “Appendix 2: Analyses of Catalogued Metal Objects Believed Ancient”, in C. Lilyquist, The Tomb of the Three Foreign Wives of Tuthmosis III, New Heaven, London, 2003.

Lucas, A., Harris, J.R., Ancient Egyptian Materials and Industries, 1926, 4th ed., London, 1962.

McDonald, A., Sistare, G.H., “Part I: Coloured Gold Alloys”, Gold Bulletin 11, 1978, pp. 128–131.

Meeks, N.D., Tite, M.S., “The Analysis of Platinum-Group Element Inclusions in Gold Antiquities”, JAS 7/3, 1980, pp. 267–275.

Ogden, J., “The So-Called ‘Platinum’ Inclusions in Egyptian Gold Work”, JEA 62, 1976, pp. 138–144.

Pichon, L., Beck, L., Walter, P., Moignard, B., Guillou, T., “A New Mapping Acquisition and Processing System for Simultaneous PIXE-RBS Analysis with External Beam”, Nuclear Instruments and Methods in Physics Research Section B 268, 2010, pp. 2028–2033.

Rastrelli, A., Micio, M., Troalen, L.G., Martinon-Torres, M., Guerra, M.F., Siano, S., Sumbera, A., Vitobello, M.L., “Modern and Ancient Gold Jewellery Attributed to the Etruscans: A Science-Based Study”, Archeosciences 33, 2009, pp. 357–364.

Tissot, I., Troalen, L.G., Manso, M., Ponting, M., Radtke, M., Reinholz, U., Barreiros, M.A., Shaw, I., Carvalho, M.L., Guerra, M.F., “A Multi-Analytical Approach to Gold in Ancient Egypt: Studies on Provenance and Corrosion”, Spectrochimica acta Part B 108, 2015, pp. 75–82.

Troalen, L.G., Guerra, M.F., “Gold from the Tomb of Scribe Beri: A Comparative Analytical Approach to the New Kingdom Gold Grave Goods from Riqqa (Egypt)”, Applied Physics A 122, 2016, pp. 210–216.

Troalen, L.G., Tate, J., Guerra, M.F., “Goldwork in Ancient Egypt: Workshop Practices at Qurneh in the 2nd Intermediate Period”, JAS 50, 2014, pp. 219–226.

Troalen, L.G., Tate, J., Guerra, M.F., Manley, W.P., “Technological Study of Gold Jewellery Pieces Dating from the Middle Kingdom to the New Kingdom in Egypt”, Archeosciences 33, 2009, pp. 111–119.

Troalen, L.G., Tissot, I., Maitland, M., Guerra, M.F., “Jewellery of a Young Egyptian Girl: Middle Kingdom Gold Work from Haraga Tomb 72”, Historical Metallurgy 49/2, 2016, pp. 75–86.

Troalen, L.G., Guerra, M.F., Maitland, M., Ponting, M., Price, P., “Analytical Study of the Middle Kingdom Group of Gold Jewellery from Tomb 124 at Riqqa, Egypt”, X-Ray Spectrometry 48/6, 2019, pp. 586-596.