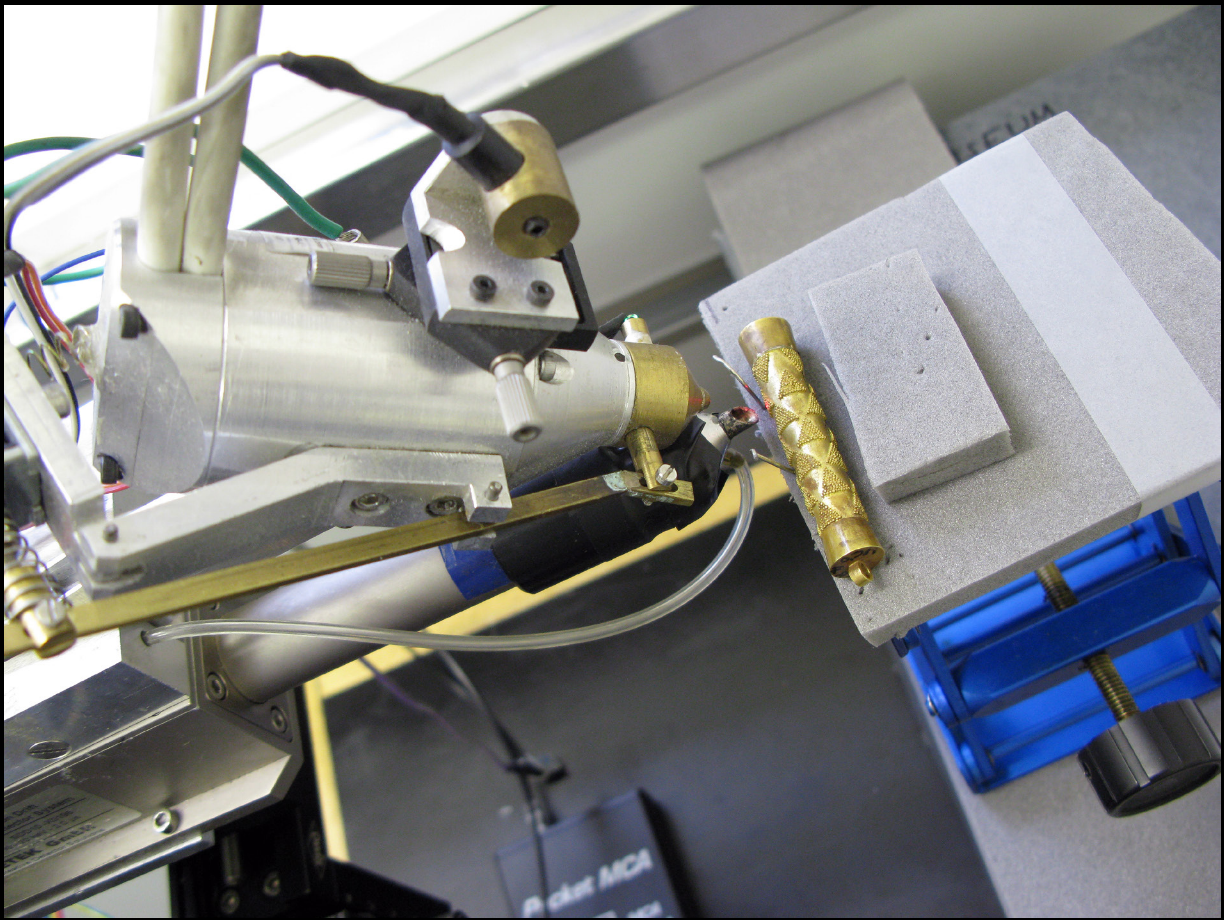
McDONALD INSTITUTE MONOGRAPHS

# Ancient Egyptian gold

## Archaeology and science in jewellery (3500–1000 BC)

Edited by Maria F. Guerra, Marcos Martinón-Torres & Stephen Quirke



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## Archaeology and science in jewellery (3500–1000 BC)

Edited by Maria F. Guerra, Marcos Martinón-Torres & Stephen Quirke

*with contributions from*
Wolfram Grajetzki, Maria F. Guerra, Marei Hacke, Mona Hess, Susan La Niece, Quentin Lemasson, Lindsay MacDonald, Margaret Maitland, Marcos Martinón-Torres, Nigel Meeks, Gianluca Miniaci, Brice Moignard, Jack Ogden, Claire Pacheco, Sandrine Pagès-Camagna, Laurent Pichon, Matthew Ponting, Campbell Price, Stephen Quirke, Martin Radtke, Uwe Reinholz, Ian Shaw, Jim Tate, Isabel Tissot & Lore Troalen

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On the front cover: *Analysis of the gold cylindrical amulet from Haraga at The Petrie Museum of Egyptian Archaeology (UC6482) using a portable XRF spectrometer*.
On the back cover: *Details under the SEM of the triangular designs of granulation on the tube of the cylindrical amulet from Haraga*.

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# Editorial foreword

This volume aims to present a wide range of perspectives on early Egyptian goldwork, integrating the complementary yet distinct approaches of archaeology, materials science, jewellery and Egyptology. On one level, our primary task has been to present new analytical data on the manufacturing technology and elemental composition of dozens of artefacts preserved at six European museums. At the same time, we have sought to anchor and contextualize this new information based on current research from three perspectives: an introduction to the fundamental geochemistry and material properties of gold, a reanalysis of historical sources and of goldwork manufacturing-techniques, and a guide to the key analytical techniques employed. In this way, we wish to ensure that the volume is accessible to specialists and students from different backgrounds. We anticipate that this body of material will provide a rich source of information for further interrogation and discussion in the future, and our concluding chapter offers a first synthesis of some key points emerging from this new research. There we focus particularly on the findings that seem to us most significant, alongside open questions and suggestions for future work. In so doing, we explicitly highlight some of the many strands beyond the scope of the work presented here, hoping that they may provide pointers for others. We emphasize that the volume is addressed not only to those interested in the archaeology of Egypt in the timespan covered, but equally to scholars researching past technologies and archaeological goldwork elsewhere, who may find technical observations of broader scope that could prompt cross-cultural comparisons.

In spite of the substantial amount of data compiled here for the first time, it is important to remind ourselves of some potential biases that are inherent to this work and may thus skew our interpretations. The most important of these concerns the selection of objects. This project starts and, in many ways, remains throughout its course with the exceptional group of gold jewellery buried in Qurna, on the west bank of Thebes in Upper Egypt, with a woman and child whose names are unknown to us, at some point in the 17th or 16th century BC. Today the Qurna group is the most important Egyptian assemblage in the National Museum of Scotland, Edinburgh. In 2008, curator Bill Manley with materials scientists Jim Tate, Lore Troalen and Maria Filomena Guerra launched a programme of new analyses of the goldwork from the group. Already in this first investigation, the scope extended to comparison with jewellery from the preceding and following centuries (Tate et al. 2009; Troalen et al. 2009). With funding obtained from the CNRS, Guerra could then expand the range of collections involved in collaboration with Thilo Rehren at UCL, to include the UCL Petrie Museum of Egyptian Archaeology and the UCL Institute of Archaeology with its laboratory facilities, as well as the National Museums of Scotland and the British Museum as project partners (CNRS project PICS 5995 EBAJ-Au). On the initiative of Jim Tate, contact had been established already with colleagues Matthew Ponting and Ian Shaw at the University of Liverpool. As a result, the Garstang Museum is also participant in the wider project, together with the Manchester Museum, through the support of curator Campbell Price, and the Louvre Museum, through the support of curator Hélène Guichard and the late Sandrine Pagès-Camagna, material scientist at C2RMF (Centre de Recherche et de Restauration des Musées de France). We wish to emphasize here the fundamental role of Sandrine Pagès-Camagna in crucial stages of the project; without her participation the project could not have achieved a significant part of its aims – notably comparison between the Qurna group and the nearest securely dated examples of royal goldwork from the reigns of kings Kamose and Ahmose.

Other institutions participated with the provision of access to particularly specialized equipment: AGLAE facilities at C2RMF, Bundesanstalt für Materialforschung und –prüfung, and LIBPhys at NOVA University of Lisbon

With this new support, the research agenda was able to grow organically, adapting to fresh questions emerging from preliminary results, while contingent on the artefacts present in museums that were accessible to the project. Indeed, the history of the collections has been a significant factor, both enabling and constraining our research. The Louvre collections contain a range of jewellery from early excavations in Thebes, including representative material from the late second millennium BC settlement Deir al-Madina, and major works from 16th century royal burials uncovered during fieldwork directed by Auguste Mariette. The British Museum and the other participating museums in England and Scotland also preserve a mixture of material from documented excavations and earlier undocumented collecting practice. Here colonial history frames the kinds of material available. During and after the full British military occupation of Egypt (1882–1922), the Antiquities Service of Egypt under French Directors permitted officially recognized institutions to excavate in Egypt and, in return for the enrichment of the Egyptian Museum Cairo, to take a share of finds from excavations. Following division of finds in Egypt, excavation funding bodies based at Liverpool (since 1903) and London (since 1882) distributed finds to dozens of sponsoring museums (Stevenson 2019). The university museums in Liverpool and London were among the major recipients of these finds, and also hold substantial excavation archives. The Qurna group itself and several other sets of jewellery analysed during the project are unusual examples of this pattern of dispersal, where the vast majority of items distributed belonged to the types of objects found in large numbers in fieldwork. The project was therefore able to investigate objects from a wide social spectrum, from palace production (Qurna group, Haraga fish and cylinder, items of kings Ahmose and Kamose from Thebes) to finds in cemeteries of regional rural towns and villages (Qau, Badari, Matmar). At the same time, in expanding the chronological scope of analyses forwards to the New Kingdom and back to the late prehistory of Egypt, the participating museums could not cover every social group for every period. Most notably, and perhaps surprisingly for those outside the museum circle, these collections hold none of the major goldwork from the age of the great pyramids, the mid-third millennium BC. At that period, the concentration of power at Memphis around kingship separates the royal court from the regions, and this is reflected in the tombs of the period and in the distribution of finds. Gold and gilt ornaments are more prominent in burials at the Memphite cemeteries: Giza and Saqqara. The single outstanding assemblage of Egyptian goldwork from the mid-third millennium BC is the unparalleled burial of material related to Hetepheres, mother of king Khufu; the finds are on display in the Egyptian Museum Cairo. Egyptologists from Cairo, Vienna, Boston, Hildesheim and Leipzig directed excavations at Giza; their museums received a share in finds (Manuelian 1999). The museums in our project, from Paris to Edinburgh,

**Table 0.1.** *Numbers of artefacts (museum inventory numbers) analysed by site and period.*

| | **Dyn 1-2** | **First IP** | **Middle Kingdom** | **Second IP(-Dyn18)** | **New Kingdom** | **?** | **Total** |
|---|---|---|---|---|---|---|---|
| Memphis | | | | | 2 | | **2** |
| Riqqa | | | 4 | | 7 | | **11** |
| Haraga | | | 13 + 1? | | | | **14** |
| Lahun | | | 5 | | | | **5** |
| Ghurab | | | | | 1 | | **1** |
| Sidmant | | | 1 | | 1 | | **2** |
| Amarna | | | | | 8 | | **8** |
| Qau area | | 15 | | 5 | | | **20** |
| Abydos | 4 | | 2 + 2? | 2 | | 3 | **13** |
| Naqada | | | 2 | | | | **2** |
| Thebes | | | 2 | 2 + 7? | 4 | | **15** |
| *Qurna | | | | 12 | | | **12** |
| Buhen | | | 1 | | | | **1** |
| ? | | 1 | 5 | 2 | 22 | | **30** |
| **TOTAL** | **4** | **16** | **36** | **30** | **45** | **3** | **136** |

are not on that distribution map. With this and other lesser gaps, our sample, however extensive, cannot and does not claim to be random or representative of an underlying population of 'Egyptian goldwork'. On our chronological range from fourth to second millennia BC, there are peaks and troughs in the frequency of artefacts, and we encourage the reader to keep these in mind graphically, in order to assess our interpretations in context and to develop their own further research agendas (see Table 0.1).

Another delimiting factor in the selection of objects derives from our focus on technique, directing our attention predominantly to jewellery, rather than other gold elements such as the prominent use of sheets for gilding larger substrates of wood or plaster. Gold foils were included for comparative purposes, particularly in the investigation of composition, but to a lesser extent. Furthermore, within the rich repertoire of Egyptian gold jewellery, we took a particular interest in select assemblages, starting with the Qurna group itself, and within these certain specific features, such as the small beads found in the child's coffin and the adult's girdle. While these are fascinating manifestations of both technology and consumption, they are not necessarily representative of a broader corpus. We would also emphasize that we sought primarily artefacts with well-recorded archaeological contexts, as these evidently allow for more robust inferences, and provide the most secure foundations on which to build further research. Where the museums could provide access to material not from documented excavations, but acquired before 1970, we have included certain items if they helped to complete gaps in understanding, as a secondary circle of supplementary information. In each such case we have done our utmost to investigate their authenticity and source, but undeniably any interpretation based on an unprovenanced object will have to remain tentative. Indeed, one of our analytical investigations demonstrated the risks in building historical conclusions on material without documented excavation context; a gold shell inscribed with the name of king Taa, who reigned close in time to the Qurna group, presents disconcerting features more consistent with modern rather than with ancient manufacture.

A final and equally important constraint concerns the background and expertise of the editors and contributors to this volume. While together we span interdisciplinary breadth, and have found synergies in our research, inevitably there remain areas beyond our interests and access, and indeed beyond the time scope of the project. For example, our data may be used as a starting point to address issues of provenance, but targeted consideration of the extraction methods and possible geological sources of gold is not addressed in detail in this volume. Instead, much more emphasis has been placed on issues of technology, and the application of the results to a concluding interpretation of the Qurna group. We look forward to seeing how others may take up such topics, and feel sure that the woman and child of Qurna will continue to pose new questions.

Finally, for the opportunity to share our discussions and findings with a wider research audience, we would like to express our gratitude to the McDonald Institute for Archaeological Research for including this volume in its series.

**References**

Manuelian, P. Der, 1999. Excavating the Old Kingdom. The Giza necropolis and other mastaba fields. In *Egyptian Art in the Age of the Pyramids*, ed. D. Arnold. New York: Metropolitan Museum of Art, 139–53.

Stevenson, A., 2019. *Scattered Finds. Archaeology, Egyptology and Museums*. London: UCL Press.

Tate, J., Eremin, K., Troalen, L.G., Guerra, M.F., Goring, E. & Manley, W.P., 2009. The 17th Dynasty gold necklace from Qurneh, Egypt. *ArcheoSciences* 33, 121–8.

Troalen, L., Guerra, M.F., Manley, W.P. & Tate, J., 2009. Technological Study of Gold Jewellery from the 17th and 18th Dynasties in Egypt. *ArcheoSciences* 33, 111–19.

# *Chapter 8*

# Middle Kingdom jewellery

Maria F. Guerra, Susan La Niece, Margaret Maitland, Nigel Meeks, Matthew Ponting, Campbell Price, Stephen Quirke, Ian Shaw & Lore Troalen

*The outstanding Middle Kingdom jewellery, entirely or partially made in cloisonné work, and often containing colourful beads of different materials to produce amazing polychrome effects and surface textures, also includes the earliest examples in Egypt of granulation. Many of these techniques are illustrated through the study of gold objects excavated at sites throughout Egypt: Haraga, Riqqa, Abydos, Lahun and Naqada. Jewellery items, gold foils and gilded artefacts were analysed with a view to comparing the alloys used for the production of these different sorts of objects.*

# Chapter 8.1

# Jewellery in the Middle Kingdom

Maria F. Guerra

Middle Kingdom jewellery provides outstanding examples of the art of the Egyptian goldsmith. Among the various jewellery groups found in burials, those associated to royal tombs and nowadays exhibited in the Egyptian Museum in Cairo and in the Metropolitan Museum in New York are famous examples of the technologies employed in that period. Associated with female bodies in burials excavated at Dahshur (de Morgan 1895), Lahun (Brunton 1920), and Lisht (Mace & Winlock 1916), these items were in their majority found in caches inside the galleries. Even though less frequently cited, the jewellery from the female burial of Neferuptah at Hawara (Farag & Iskander 1971) and the male burial of Wah at Thebes (Winlock 1920, 1975) also provide representative examples of the Middle Kingdom production.

Those groups of jewellery excite our wonder to the point that we tend to perceive them as enormous quantities of precious metals. However, many objects are hollow, or primarily made from sheet gold, containing other materials to create a polychrome contrast. More important than the quantity of gold employed in their manufacture, it is their delicacy, the variety of their types, the diversity, richness and profusion of the colourful materials applied on the gold and electrum supports, and the multiplicity of techniques employed in their construction, altogether contributing to the way in which way Middle Kingdom objects are perceived. It is obvious from their characteristics that they materialize a time of creative effervescence, a time of unhindered circulation of technologies, savoir-faire, crafts, and materials. The remarkable treasure of Tod, found in a temple dedicated to god Mont at Tod, near Luxor (Bisson de la Roque 1937; Bisson de la Roque et al. 1953), exemplifies the richness of the materials that were processed in that period (Pierrat-Bonnefois 2014, 175). It consists of four copper chests containing lapis lazuli, silver ingots, rings, bracelets, (more than 150) bowls, etc., of quite pure silver (containing on average 98–99 wt% Ag)[1] and other objects and materials. Despite the small number of gold objects, the total weight indicated by Bisson de la Roque (1950, ii) in his description of the treasure is *c*. 7 kg. The ten cast gold ingots (CG70505), weighing from 620 to 735 g each, make up *c*. 6.5 kg. The other gold objects are one ingot fragment (CG70506, 81 g), seven 'droplets from casting' (CG 70507 and LM E15136, 3 to 102 g each) weighing *c*. 243 g, two rosette pendants (CG70508, 1.27 g each), and one gold cup (CG70509, 19.95 g).[2] The analysis in 1947 of one of the 'droplets from casting' (CG 70507) by Z. I. Hanna (Bisson de la Roque 1950, 52–5) shows the use of high purity gold alloys (94.8 wt% Au, 3.7 wt% Ag, 1.5 wt% Cu).

As during any other period in Egypt, the Middle Kingdom items containing precious metals can be either solid or hollow, and a large variety is obtained by gilding organic (like wood) or inorganic (like copper) supports. Several objects are made from gold alloys of different colours and nuances. Nonetheless, the variety of jewellery items produced during this period also includes objects made using technologies that were only occasional or absent in Egypt. This is a consequence of the introduction of new techniques and of the pronounced search for polychrome effects.

Indeed, some Middle Kingdom jewellery is entirely or partially made in cloisonné work, often containing colourful beads of different materials strung together. By skilfully arranging those beads, it is possible to produce polychrome effects and give different textures to the objects, creating new perceptions. While the search for polychrome effects is a major art of the Middle Kingdom goldsmith, the chief technological achievement of this period is the introduction of patterns in wire and granulation to decorate the objects. By using wires and applying granules it is possible to obtain transparency and lightness, and to create new textures on the gold surface. Senebtysy's headdress (MMA 07.227.6), discussed in Chapter 4, consisting of a circlet in coiled gold wire and floral wig ornaments, exemplifies the lightness of the design achieved in the Middle Kingdom, in particular when compared to headdresses from other periods (Scott 1964).

Several publications provide very good descriptions and discussion complemented by detailed photographs and drawings of the jewellery contained in Middle Kingdom finds (for example Grajetzki 2014; Oppenheim et al. 2015). Therefore, we considered it important to emphasize in this section only some technological aspects related to the production of this jewellery. In the next sections of this chapter, we try to shed new light on the technologies employed in the Middle Kingdom workshops through the analytical study of jewellery groups and items that are representative of all the expressions of the goldsmith's art. In addition to the groups of jewellery found in tomb 72 in Cemetery A at Haraga and in tomb 124 in Cemetery A at Riqqa, in the next sections we present data for some objects found in tombs excavated at Abydos, Haraga, Lahun and Naqada. Several gold foils and gilded objects excavated at Abydos, Haraga and Lahun were also analysed to gather data on the alloys employed in their production, with a view to comparing alloys used in the production of jewellery in solid and hollow gold and gilding foils.

## Notes

1. The four silver objects in the Cairo Museum analysed by Z. I. Hanna in 1947 (Bisson de la Roque 1950, 52–5) contain 96–99 wt% Ag and 0.9–3.5 wt% Cu. Nineteen silver objects in the collection of the Louvre Museum were analysed in the 1990s (Menu 1994; Pierrat 1994): nine chains (E15202-10), seven ingots (E15194-200), two cups (E15183 and E15185) and one spiral bracelet (E15212) confirm the use of quite pure silver. Only a few items contain more than 1 wt% Cu: one ring in each of chains E15210 (*c*. 4 wt%), E15204 (*c*. 1.5 wt%) and E15203 (*c*. 3 wt%), two rings in chain E15206 (*c*. 4 wt% and *c*. 1.5 wt%), ingot E15195 (*c*. 1.5 wt%) and cup E15185 (*c*. 2 wt%). The silver items found at Southern Asasif in wrappings over the wrists of Wah's mummy (early reign of Amenemhat I) contain similar copper contents: the scarab of the Storehouse Overseer (MMA 40.3.12) 2.9 wt% Cu, the scarab in a bracelet (MMA 40.3.13) 4.1 wt% Cu and the spherical bead necklace (MMA 40.3.19) 4.4 wt% (Mishara & Meyers 1974). The authors discuss the provenance of the metal related to the presence of gold, lead and bismuth in the alloys.
2. In addition, one silver container (CG70510) is decorated with gold foil and one silver bracelet (CG70511) contains a lapis lazuli cuboid set in a gold tray (Bisson de la Roque 1950; Bisson de la Roque et al. 1953).

## References

For references see pp.309–12 at the end of this chapter.

# *Chapter 8.2*

# Haraga tomb 72

Lore Troalen, Margaret Maitland & Maria F. Guerra

Tomb 72 in Cemetery A at Haraga, between the Nile and the Fayum, near the pyramid of king Senusret II (*c*. 1880–1874 BC) (Richards 2005, 93; Grajetzki 2014, 100), was excavated by Reginald Engelbach and Battiscombe Gunn (1923) for the British School of Archaeology in Egypt during the winter of 1913–1914. The tomb was relatively large, consisting of a vertical rock-cut shaft leading to two chambers on the north side, and one chamber on the south, which had been robbed in antiquity. On the west side of the south chamber was another shaft just under a metre deep, which went unnoticed and untouched (Engelbach & Gunn 1923, 14–15, pl. 58; Grajetzki 2014, 103–5). It contained an intact burial of a young girl, dating to the mid-late 12th Dynasty (*c*. 1874–1795 BC), wrapped in linen in a wooden coffin and adorned with a large quantity of jewellery, now in the collection of National Museums Scotland (NMS). The jewellery in gold is shown in Figure 8.1. Other finds from tomb 72 included a scarab of glazed steatite, decorated with scroll-work and rimmed in gold, two uninscribed turquoise scarabs, two calcite kohl pots, a haematite kohl stick, and a few stone vases and pottery vessels (the latter now in National Museums Liverpool).

The high-value grave goods suggest that the family of the young girl in tomb 72 included wealthy members of the ruling elite. However, what makes this assemblage unusual is the presence of five gold catfish and tilapia pendants. Fish pendants were Middle Kingdom amulets, possibly associated with the goddess Hathor and regeneration, that are only represented being worn by young women and are most often found in female burials (Grajetzki 2014; Oppenheim et al. 2015, 203–4). One of these rare representations is a kohl-jar in the collection of the British Museum (BM EA2572) in the form of a kneeling girl holding before her a footed jar; the girl is shown wearing a plait down her back at the end of which is depicted a fish pendant in the form of a tilapia. The girl's only garment is a long skirt from her waist to her ankles, over which, around her hips, she wears a girdle formed from cowrie shells strung between beads. In Figure 8.2, the representation of a daughter of Ukhhotep IV is shown wearing a catfish pendant at the end of her plait, from a wall painting in the 12th Dynasty tomb-chapel of Ukhhotep IV at Meir (Blackman & Apted 1953; Blackman 1925). These representations of fish pendants indicate that typically only a single pendant was worn (Bourriau 1988; Andrews 1990; Blackman & Apted 1953), and other excavated examples have only been found singly or in twos, which gives an unusual aspect to the find of five fish pendants in a single burial.

## The gold jewellery

The girl buried in Haraga tomb 72 was adorned not only with the five gold fish pendants, but also gold beads, and hundreds of beads made from semi-precious stones, which may have formed six necklaces (Aldred 1971, 197, pl. 47), or possibly body-chains (Grajetzki 2014, 125–6). Representations of body-chains are known, for example from fertility figurines such as one in blue faience shown in Figure 8.3, found in the late Middle Kingdom tomb of Neferhotep at Thebes (Winlock 1942, pl. 35).

The hollow beads made from hammered gold foils were reassembled in several strings shown in Figure 8.1. Three strings comprise beads of different forms and dimensions – ribbed biconical beads, simple biconical beads and ball beads; a fourth string comprises a mixture of biconical and spherical beads. Another string includes Red Sea shells tipped with gold. Most of the beads are reddish in colour and display extensive damage to the gold foil with several of them exhibiting a porous surface deteriorating into

**Figure 8.1.** *The gold jewellery from Haraga tomb 72, including beads of different types that were reassembled into five strings (NMS A.1914.1096, A.1914.1097, A.1914.1091, A.1914.1092, A.1914.1094, from the bottom moving inwards), three scarabs (NMS A.1914.1086, A.1914.1084, A.1914.1085, left to right), three catfish pendants and two fragments of the one surviving tilapia pendant (NMS A.1914.1082 A, A.1914.1080, A.1914.1079, A.1914.1081, A.1914.1082 B, left to right).*

**Figure 8.2.** *Representation of a daughter of Ukhhotep IV from a wall painting in his 12th Dynasty tomb-chapel at Meir. She holds in one hand a lotus flower and a bird and at the base of her plait hangs a catfish-amulet. Drawing M. F. Guerra based on Blackman & Apted (1953, 25, pls. XIV, XXVIII-3).*

**Figure 8.3.** *Female fertility figure in blue faience from the tomb of the bowman Neferhotep at Deir el Bahari (Cairo JE 47710) found during the Metropolitan Museum of Art excavations of 1922–1923 (from Winlock 1923, fig. 15; 1942, pl. 35). The figure wears jewellery typical of the Late Middle Kingdom: a necklace, a longer bead necklace, body chains, armlets, a girdle made of beads and shells (Grajetzki 2014).*

cracks, holes and loss of fragments, as described in Chapter 6.8. One of the scarabs is in glazed steatite inscribed with scroll-work and has a gold rim.

As noted above, the most spectacular objects found in the burial were the gold catfish pendants (Engelbach & Gunn 1923, pl. 10.14, 22.5). The finest catfish pendant, shown in Figure 8.4, is remarkably lifelike and the details of its speckles, gills, and fins are intricately worked (Aldred 1950, 53, pl. 74, 1971, 88–98, 213, pl. 78; Bourriau 1988, no. 159; Oppenheim et al. 2015, no. 137). From visual examination, both the beads and the fish pendants were made from sheets of gold, which were hammered, while the decorative details of the catfish pendants were chased, with the parts then being joined together by soldering.

The description of the finds published by Reginald Engelbach and Battiscombe Gunn (1923, 15, pl. 22.5) also mentions silver cowrie shell beads, but these do not appear to have been sent to NMS with the rest of the finds.

**Figure 8.4.** *The three gold catfish pendants from tomb 72 with the finest example on the left (left to right: NMS A.1914.1079; A.1914.1080; A.1914.1081).*

*Beads*

Most of the gold beads are made of gold foils rolled around lime plaster cores (Fig. 8.5a,b), mainly composed of calcium carbonate and quartz. The extensive use of this technique in ancient Egypt was described by Petrie (1910) and reported for the finds from Qau and Badari by Beck (1928, 22). The overlapping of the foil in the joins on several ribbed and plain biconical beads seems to indicate that these particular beads were made by rolling a rectangular foil (Fig. 8.5a); there is no visible remnant of solder on most of these beads. However, a few ribbed beads showed a morphology of the gold surface suggesting heating, and it is also possible that some beads were soldered. We were unable to find any difference between the composition of the area of the join and the gold-based foil. This could be due to the high use-wear of most of the beads and their high level of degradation, with the morphology of the surface being so altered that the area of the join is now invisible. Another difficulty comes from the possible flow of the melted solder inside the bead during soldering.

The ribbed beads are made with thin gold sheet rolled around lime plaster cores, while others are made from thicker gold foils that are stiff enough without the lime plaster core. Only the ribbed biconical beads are decorated, but these beads exhibit such a high level of use-wear that tool marks are now invisible (Fig. 8.5a,b). In addition, most of the beads exhibit advanced corrosion (see Fig. 8.5c), degenerating into cracking, holes and loss of fragments, with the most altered items being those made from thinner sheets.

X-radiographs of the strings revealed different opacities of the gold beads, which can also be seen for beads of the same type and dimension. This is


**Figure 8.5.** *(a,b) Details of a ribbed biconical bead made around a lime plaster core and joining area with possible heating treatment from string NMS A.1914.1091; (c) ball beads from string A.1914.1092 with near invisible seams; and (d) biconical beads from string A.1914.1096 showing the detail of the rectangular gold foil rolled around it with possible heating in the seam areas.*


**Figure 8.6.** *(a) String NMS A.1914.1092 made of a mixture of biconical and ball beads and (b) X–radiograph revealing various densities. The brighter areas correspond to heavier average atomic weight (higher gold content) and/or thicker gold foils. X-ray conditions were 180 seconds exposition at 90 kV, 4 mA at a working distance of 1 m, with Agfa Structurix D7 film and 0.125 mm lead screen intensifier (Plate 20100419-10).*

particularly visible in the heterogeneous necklace A.1914.92, as shown in Figure 8.6, suggesting that these beads could have been made with foils not only of different thicknesses, but also of different alloys. Closer examination of the beads has shown that almost all of them – including the gold tips of the Red Sea shell beads – show signs of intensive use-wear, with the exception of a small number of biconical beads that show very little wear. Differences in use-wear suggest varied origins of the beads that could have been originally strung in separate strings, or perhaps have been made from reused beads.

*Fish pendants*

The catfish pendants are more skilfully made than the gold beads and do not show the same level of use-wear (Fig. 8.4). Two pendants were made from thinner foils, which are now severely degraded, but their shapes suggest tilapia fish. The catfish pendants consist of multiple parts made from gold that were soldered together. Their bodies were made by joining two halves to which the tails and the fins were added as shown in the radiograph of Figure 8.7.

The quantity and quality of the decoration on the fish pendants are variable. Pendant A.1914.1079

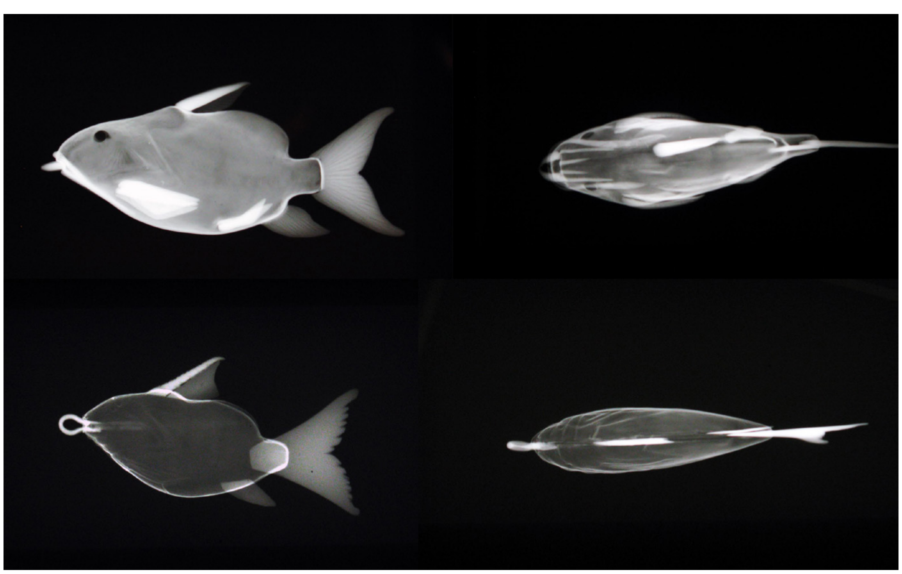


**Figure 8.7.** *X-radiographs of fish pendants (top) NMS A.1914.1079 and (bottom) A.1914.1080, revealing the constructions of both pendants. Note how each part of pendant NMS A.1914.1079 is perfectly fitted with near invisible joins. The various components of pendant NMS A.1914.1080 were inserted and then joined.*

(Fig. 8.8a–d) is the most delicate and consists of several parts joined together, with almost invisible joins. Not only the fins were added to the body, but also a wire to enhance the mouth, representing the whisker-like barbels of the catfish. Details on all the parts have been further enhanced by chasing to create details such as the gills and the scales on the body. The eyes of this pendant were probably originally inlaid with semi-precious stones, but these have fallen out, and only green corrosion products are visible. This corrosion could possibly originate from a core of copper or copper-based alloy that degraded with time and pushed the inlays out of their settings.

In comparison, pendant A.1914.1080 (Fig. 8.9a–d) is less skilfully made and little decorated. While the two parts of the body were embossed and then soldered together, a wire was inserted in the mouth to create a suspension ring and soldered. The green corrosion that is visible, suggests the presence of copper. The fins and tails were inserted inside the body and soldered. These were made from plain sheets of gold with their edges cut using a sharp tool for a more realistic effect.

Finally, pendant A.1914.1081 is heavily damaged (Fig. 8.4), however marks of the small punches used to decorate the body are still visible and the tail was chased, similarly to pendant A.1914.1079. The various parts were inserted and soldered to the body. This pendant exhibits some heavy repairs using a silver-based alloy, rendering it impossible to characterize the original composition of the solder used.

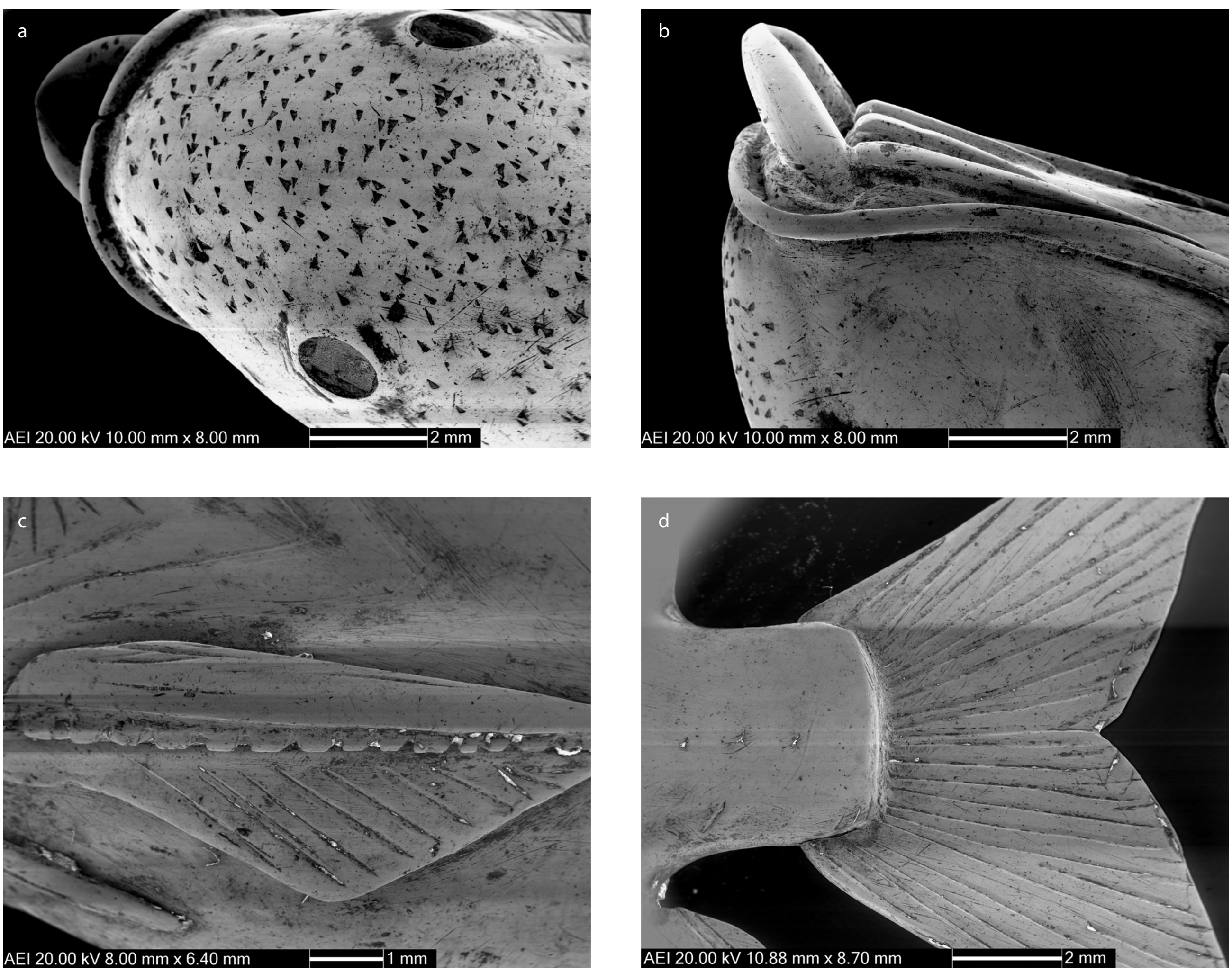



**Figure 8.8.** *SEM-AEI micrographs of pendant NMS A.1914.1079: (a) punch marks representing the scales on the head and the eye holes perforated from the reverse, (b) the application of wires with visible hard solder, one to enhance the mouth and the other to serve as a suspension ring, delicate chasing of (c) the fins, scales and (d) the tail with almost invisible solder.*

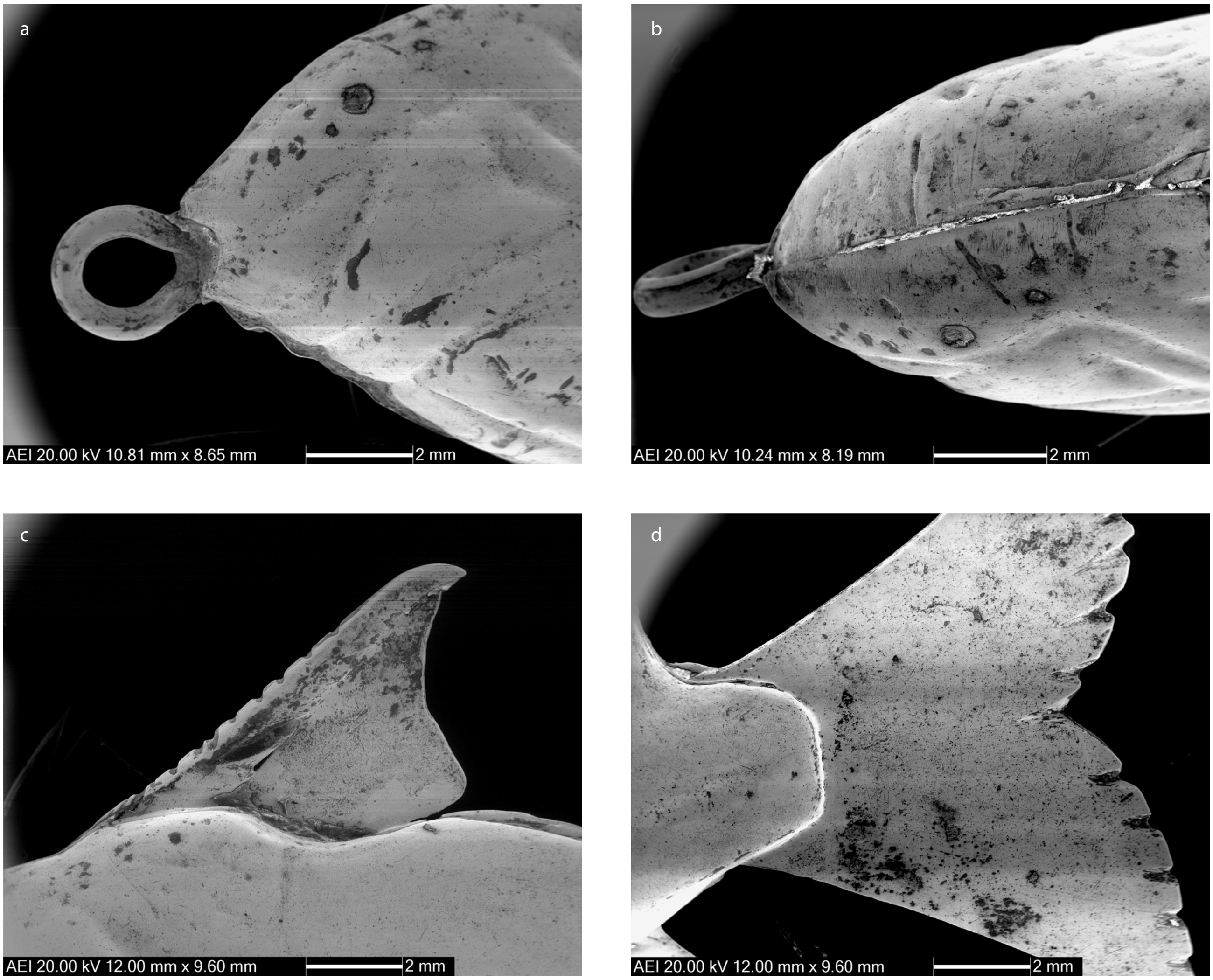



**Figure 8.9.** *SEM-AEI micrographs of pendant NMS A.1914.1080: (a) the embossed head and the wire inserted and soldered to create a suspension ring, (b) the soldering of the two half parts of the body and (c, d) the design of the fin and tail made of plain sheets of gold with their edges cut with a sharp tool to create the design.*

### The gold alloys

Most of the beads analysed are made of electrum, with a silver content of 20–40 wt% and a copper content of 2–6 wt% (Table 8.1). The gold foil around the rim of the scarab has a similar composition. Figure 8.10 shows a plot of Ag vs. Cu contents for these six objects, determined using XRF and μPIXE.

Two rather tight chemical clusters are highlighted in the diagram of Figure 8.10, one containing beads from string A.1914.91 and another beads from string A.1914.94. Each of these groups could originally have been included in one string. Several beads from these two current strings and all the beads from the other current strings are dispersed in the diagram, which reinforces our hypothesis of the diversity of the beads' origins. The analytical data obtained does not allow us to suggest a particular number of original strings, but it is possible that there were more than five. The composition of the Red Sea shells tipped with gold in string A.1914.1097 splits into two groups based on copper contents, which could correspond to a deliberate polychrome effect, but this disparity might also be the effect of analysing areas that represent both the copper-rich solder and the gold foil.

The silver content of all the gold beads, combined with the observation of a few platinum-group element (PGE) inclusions, suggest the use of alluvial gold. The copper content is however, higher than the 2 wt% expected for alluvial gold deposits in Egypt (Ogden

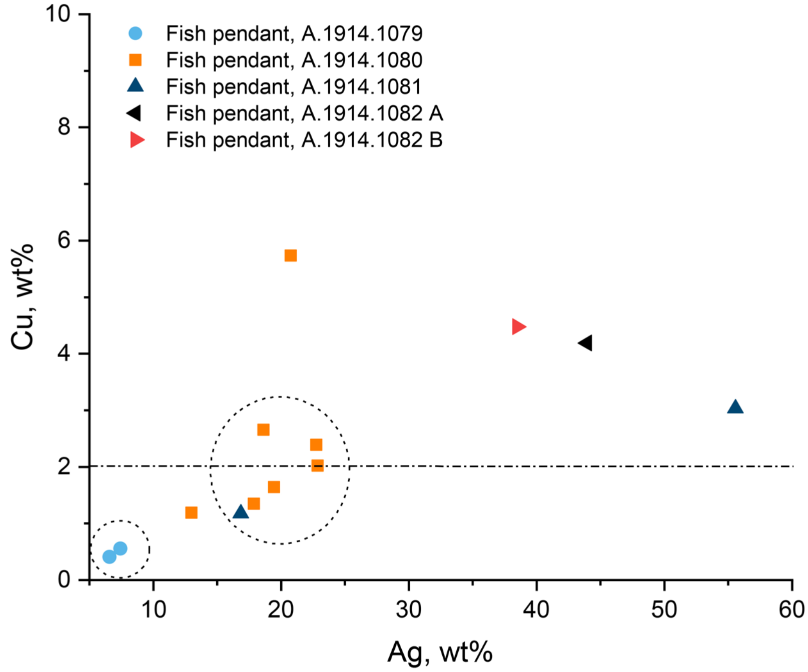



**Figure 8.10.** *Silver versus copper contents obtained by XRF and μPIXE analysis for the five strings from tomb 72 at Haraga.*

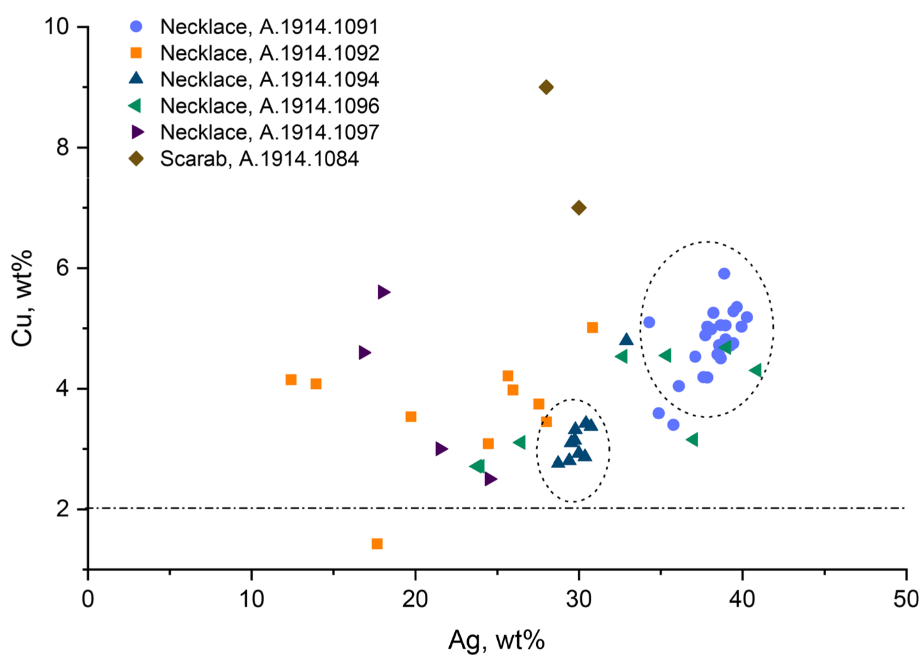



**Figure 8.11.** *Silver versus copper contents obtained by XRF and μPIXE analysis for the fish pendants from tomb 72 at Haraga.*

2000, 162; Klemm & Klemm 2013, 42–3), and suggests an addition of copper to the electrum alloy, a practice that was identified in Middle Kingdom objects from the Ashmolean Museum (Gale & Stos-Gale 1981) and Middle Kingdom gold objects published by Lucas & Harris (1962, 490–1).

The catfish pendants were found to be made with different alloys, ranging from high-purity gold to silver-rich electrum (Table 8.2). Figure 8.11 presents the Ag and Cu amounts determined by XRF and μPIXE for the different parts that constitute these pendants. Pendant A.1914.79 is made of high-purity gold with a silver content of 7 wt% and a copper content below 1 wt%, with all the parts being remarkably similar in composition. In contrast, the body of pendant A.1914.80 is made of an alloy containing 20 wt% Ag and 1.6 wt% Cu, while the fins contain 22–23 wt% Ag and the tail only 13 wt% Ag. Finally, the body of pendant A.1914.81 is made of an alloy containing 17 wt% Ag and 1 wt% Cu, while the tail is made of a silver-rich electrum containing 56 wt% Ag and 3 wt% Cu. Thus, while fish pendant A.1914.79 displays only one gold colour, the other two pendants are polychrome, with yellowish bodies and yellow-whitish fins and tails. High silver contents were found in the fragments A.1914.82 A and B, which are also made with a similar electrum alloy, containing 44 wt% Ag and 4 wt% Cu.

PGE inclusions were observed in several pendants (Fig. 8.12), again indicating the use of alluvial gold. The analysis of one inclusion present in the tail of fish pendant A.1914.81 showed an iridium-osmium-ruthenium alloy with a composition of 38 wt% Ir, 45 wt% Os and 17 wt% Ru, while the two inclusions from pendant A.1914.1080 showed similar composition (see Table 8.3) with 12–19 wt% iridium, 65–76 wt% Os and 12–16 wt% Ru, all corresponding well to the type of compositions expected for Egyptian jewellery (Meeks

**Table 8.1.** *Results obtained by XRF and µPIXE for the Haraga tomb 72 necklaces and scarab.*

| Alloy composition | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| A.1914.1091 (XRF) | | | |
| Ribbed beads | | | |
| Bead 1 | 56.9 | 38.1 | 5 |
| Bead 2 | 56.5 | 38.2 | 5.3 |
| Bead 3 | 58 | 37.9 | 4.2 |
| Bead 4 -1 | 60.6 | 34.3 | 5.1 |
| Bead 4 -2 | 57.4 | 37.7 | 4.9 |
| Bead 5 | 56.7 | 38.6 | 4.7 |
| Bead 6 | 58.2 | 37.6 | 4.2 |
| Bead 7 -1 | 56 | 38.9 | 5 |
| Bead 7 -2 | 57.1 | 37.8 | 5 |
| Bead 8 | 56 | 39.2 | 4.7 |
| Bead 9 -1 | 54.6 | 40.3 | 5.2 |
| Bead 9 -2 | 55.3 | 39.4 | 5.3 |
| Bead 10 | 57 | 38.5 | 4.6 |
| Bead 11 -1 | 60.8 | 35.8 | 3.4 |
| Bead 11 -2 | 61.5 | 34.9 | 3.6 |
| Bead 12 | 55.8 | 39.4 | 4.8 |
| Bead 13 | 55 | 39.9 | 5 |
| Bead 14 | 56.3 | 38.7 | 5.1 |
| Bead 15 | 56.9 | 38.6 | 4.6 |
| Bead 16 | 56.8 | 38.7 | 4.5 |
| Bead 17 | 59.9 | 36.1 | 4 |
| Bead 18 | 58.4 | 37.1 | 4.5 |
| Bead 19 | 55.2 | 38.9 | 5.9 |
| Bead 20 | 56.2 | 38.9 | 4.8 |
| Bead 21 | 55 | 39.7 | 5.4 |
| A.1914.1092 (PIXE) | | | |
| Biconical & ball beads | | | |
| Round bead 11 | 68.5 | 28 | 3.5 |
| Long bead 12 | 82 | 13.9 | 4.1 |
| Round bead 13 | 72.4 | 24.5 | 3.1 |
| Long bead 14 | 83.4 | 12.4 | 4.1 |
| Long bead 15 | 70 | 26 | 4 |
| Round bead 17 | 64.2 | 30.8 | 5 |

| Alloy composition | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| Large bead round. yellowish | 68.7 | 27.5 | 3.7 |
| Long bead next to label | 80.9 | 17.7 | 1.4 |
| Round bead next to above | 70.1 | 25.7 | 4.2 |
| Long bead next | 76.7 | 19.7 | 3.5 |
| A.1914.1094 (XRF) | | | |
| Ball beads | | | |
| Bead 4 | 65.9 | 30.7 | 3.4 |
| Bead 5 | 66.2 | 30.4 | 3.4 |
| Bead 6 | 66.9 | 29.8 | 3.3 |
| Bead 7 | 67.8 | 29.4 | 2.8 |
| Bead 8 | 67.1 | 29.7 | 3.1 |
| Bead 9 | 68.5 | 28.7 | 2.8 |
| Bead 9 | 67.1 | 30 | 2.9 |
| Bead 10 | 66.8 | 30.4 | 2.9 |
| Bead 11 | 62.3 | 32.9 | 4.8 |
| A.1914.1094 (PIXE) | | | |
| Removed ball bead | 67.4 | 29.5 | 3.1 |
| A.1914.1096 (XRF) | | | |
| Biconical beads | 73.5 | 23.8 | 2.7 |
| | 62.8 | 32.7 | 4.5 |
| | 59.8 | 37 | 3.2 |
| | 54.8 | 40.9 | 4.3 |
| | 56.3 | 39 | 4.7 |
| | 60.1 | 35.4 | 4.6 |
| | 70.4 | 26.5 | 3.1 |
| | 73.3 | 24 | 2.7 |
| A.1914.1097 (XRF) | | | |
| Red Sea shells | 78.6 | 16.8 | 4.6 |
| | 75.5 | 21.5 | 3 |
| | 76.5 | 18 | 5.6 |
| | 73 | 24.5 | 2.5 |
| A.1914.1084 (XRF) | | | |
| Scarab | 63 | 28 | 9 |
| | 63 | 30 | 7 |

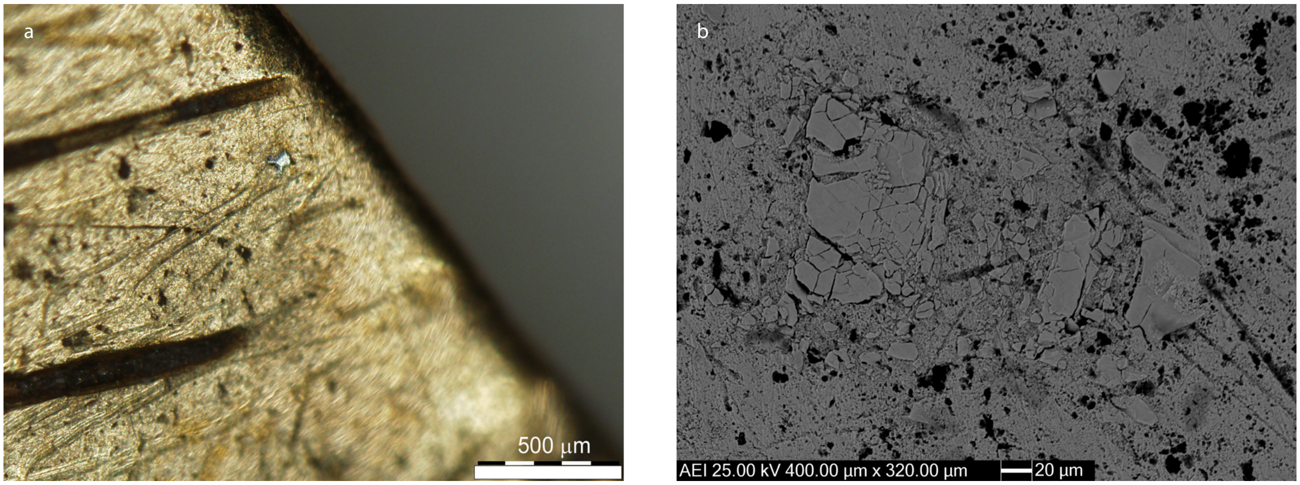



**Figure 8.12.** *(a) PGE inclusion present in the tail of pendant NMS A.1914.1081 under the stereomicroscope and (b) SEM-AEI micrograph of two PGE inclusions observed on the tail of pendant NMS A.1914.1080. The EDS analysis showed an iridium-osmium-ruthenium alloy.*

**Table 8.2.** *Results obtained by XRF and µPIXE for the Haraga tomb 72 pendants.*

| Alloy composition | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| A.1914.1079 (PIXE) | | | |
| Body -1 | 91.1 | 8.4 | 0.5 |
| Body -2 | 91.1 | 8.3 | 0.6 |
| Body -3 | 91.6 | 7.8 | 0.6 |
| Tail | 93 | 6.6 | 0.4 |
| A.1914.1080 (PIXE) | | | |
| Body -1 | 79.1 | 19.3 | 1.6 |
| Body -2 | 78.8 | 19.4 | 1.7 |
| Body -3 | 78.7 | 19.6 | 1.6 |
| Eye | 80.8 | 17.9 | 1.3 |
| Ring | 78.7 | 18.6 | 2.7 |
| Large tail | 73.5 | 20.7 | 5.7 |
| Small tail -1 | 75.1 | 22.9 | 2 |
| Small tail -2 | 74.8 | 22.8 | 2.4 |
| Tail end -1 | 87.3 | 11.6 | 1 |
| Tail end -2 | 84.3 | 14.3 | 1.4 |
| A.1914.1081 (XRF) | | | |
| Body -1 | 81.3 | 16.6 | 1.2 |
| Body -2 | 81.3 | 16.8 | 1.1 |
| Tail end -1 | 41 | 56 | 3 |
| Tail end -2 | 41.8 | 55.1 | 3.1 |
| A.1914.1082 A (XRF) | | | |
| Outside | 52 | 43.9 | 4.1 |
| Inside | 51.9 | 43.7 | 4.2 |
| A.1914.1082 B (XRF) | | | |
| Outside | 51.6 | 44.1 | 4.3 |

**Table 8.3.** *Results obtained by SEM-EDS for the PGE inclusions analysed in the Haraga tomb 72 jewellery.*

| Acc. No. | | Ru wt% | Os wt% | Ir wt% |
|---|---|---|---|---|
| A.1914.1080 | PGE-1 | 12 | 76 | 12 |
| A.1914.1080 | PGE-2 | 16 | 65 | 19 |
| A.1914.1081 | PGE-1 | 17 | 45 | 38 |

& Tite 1980; Troalen et al. 2009, 2014; Miniaci et al. 2013; Troalen & Guerra 2016).

## Conclusion

The investigation of the Middle Kingdom gold jewellery from Haraga tomb 72 revealed the use of gold alloys ranging from high-purity gold to silver-rich electrum, the presence of several levels of use-wear, and the use of low annealing temperatures that accelerated the atmospheric corrosion (Tissot et al. 2015; Troalen et al. 2015) of several beads, presently highly corroded and fragmented.

The gold beads were found to be of five types and were made in their majority by rolling foils of different thicknesses around a lime plaster core. The catfish pendants consist of bodies made by joining two halves to which the tails and the fins were added by soldering. The quality of the soldering process and of the decoration of the most skilfully-crafted catfish pendant is reminiscent of the highly skilled jewellery from the burials of the 12th Dynasty royal women at Lahun described by Winlock (1934), suggesting that this pendant might have originated in a palace workshop.

The silver-rich electrum alloys predominate in the jewellery from Haraga tomb 72 over the gold alloys. Only the most skilfully-crafted catfish pendant was made with a high-purity gold alloy containing less than 7 wt% Ag and almost no copper. The other catfish and tilapia pendants that were found to be of lesser craftsmanship were made from silver-rich electrum containing up to 6 wt% Cu and are polychrome. In comparison, this seems to denote differing access to resources in spite of the use of an equivalent technology.

Similarly to the fish pendants, the gold beads were made from silver-rich electrum alloys containing 12–40 wt% Ag and with systematic additions of up to 7 wt% Cu, possibly to change the properties of the alloys. The presence of PGE inclusions in all the items suggests the use of alluvial gold.

**References**

For references see pp.309–12 at the end of this chapter.

# Chapter 8.3

# Riqqa tomb 124

Lore Troalen, Maria F. Guerra, Margaret Maitland,
Matthew Ponting & Campbell Price

Excavated by Reginald Engelbach on behalf of the British School of Archaeology in Egypt at the end of 1912, the cemeteries discovered at Riqqa, located close to the mouth of the Fayum region, contain a series of graves ranging from the Predynastic to the Late Period (Engelbach et al. 1915). Inside tomb 124 in cemetery A was found a coffin containing the remains of an adult male dated to the second half of the 12th Dynasty. Over the coffin, crushed in the past by the roof collapse, were found the arm-bones of another body. Considering the position of both the bones and the coffin, Engelbach suggested that one looter, certainly when unwrapping the mummy to steal the jewellery, 'had been suddenly crushed while in a standing, or at least a crouching position, when the fall occurred' (Engelbach et al. 1915, 12).

After removing the fallen materials, an important group of jewellery, nowadays in the collection of the Manchester Museum, was found damaged and dislocated on the mummy's body. This group, shown in Figure 8.13, includes a gold pectoral and a gold winged beetle, both in cloisonné work forming the name of king Senusret II (*c*. 1897–1878 BC), a gold shell pendant bearing the cartouche of king Senusret III (*c*. 1878–1839 BC), and a hollow gold pendant in the form of the fertility god Min. A short letter written by Flinders Petrie on 8 November 1913 to Winifred Crompton, Assistant Keeper of Archaeology at Manchester Museum (MM archive ID 332), indicates that the pectoral was flattened by a goldsmith at Petrie's behest, but the attempts made to restore the damaged god Min amulet were unsuccessful. Now the amulet is close to its original form, but the methodology followed by the restorer is unknown.

**Manufacture and restoration**

Engelbach provides a short description of the group of jewellery from tomb 124 at Riqqa and the location of the finds in the burial (Engelbach et al. 1915). On the mummy's chest were found an incomplete winged beetle pendant supported by lotus flowers (MM 5967) and a pectoral (MM 5966), both in gold and cloisonné inlaid with lapis lazuli, carnelian and turquoise. When complete, the winged beetle pendant with the light-on-horizon hieroglyph and the sun-disk above gives part of throne-name of Senusret II, Khakheperra. The shell-shaped pectoral gives the throne-name of his son, Senusret III, Khakaura, who followed on the throne. It is possible that the two objects were made at the same time if a short coregency took place, or later (names of kings were used in some instances posthumously), as the names of both kings continue to be used for amuletic protection into the 13th Dynasty. It is even possible that they were made at the same place. Other groups of jewellery have been found with names of kings who are farther apart and are known not to have had a coregency. One example is the group from Sathathoriunet's burial at Lahun (Senusret II and Amenemhat III) now in the collection of the Metropolitan Museum of Art, New York (Grajetzki 2014; Stünkel 2015a).

The group of jewellery (Fig. 8.13) has been recently investigated (Troalen et al. 2019); similar inlaying techniques were used for the winged beetle pendant (MM 5967) and the pectoral (MM 5966), with the majority of the inlaid materials not separated by a cloison. The pendant is identical to winged beetle EA54460 in the collection of the British Museum (Andrews 1990). The pectoral represents one standing bird[1] on each side of an *ukh* pillar, each standing on the hieroglyph for gold, flanked by papyrus plants, and above two *wedjat*-eyes flanking a sun disc.

The same motif was chased on the reverse of both pieces. A few engraved lines might result from the restoration. Cracks certainly caused by flattening during restoration and scratches are visible in different areas. One of them is shown in Figure 8.14a. Only the *ukh* pillar base is a modern addition.


**Figure 8.13.** *The gold pectoral (Acc. no. 5966), the figurine of god Min (Acc. no. 5969), the gold shell (Acc. no. 5968), and the winged beetle pendant (Acc. no. 5967) from tomb 124 at Riqqa, in the collection of the Manchester Museum.*


**Figure 8.14** *Details showing (a) under the stereomicroscope some of the surface scratches and cracks of the restored pectoral (Acc. no. 5966, Manchester Museum), and (b) under the SEM one of the modern wires soldered to the original lotus flower of the winged beetle pendant (Acc. no.5967, Manchester Museum).*

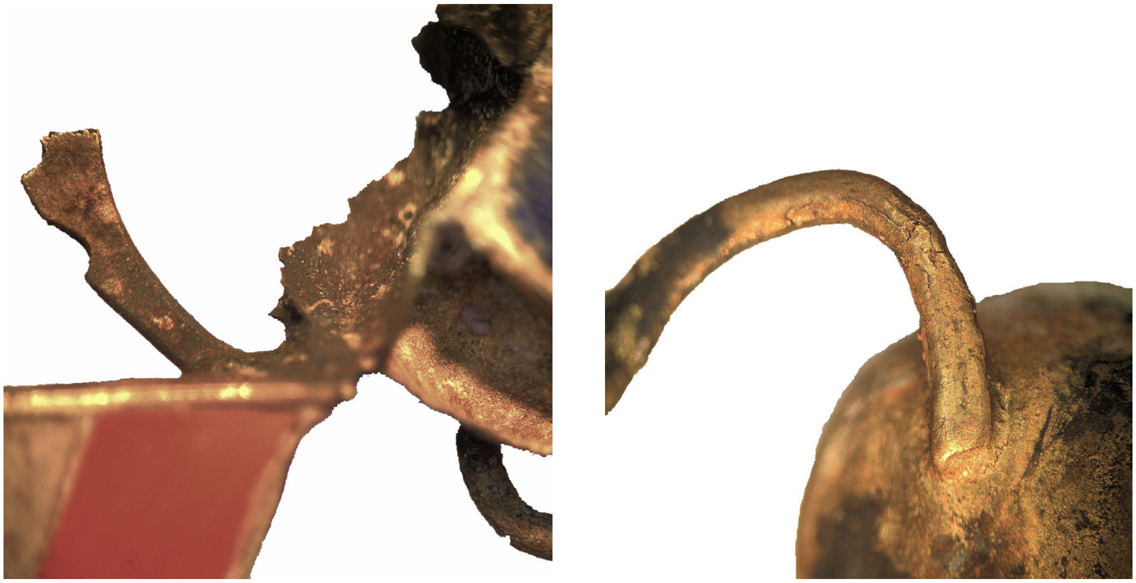


**Figure 8.15.** *Details of the winged beetle pendant (Acc. no.5967, Manchester Museum) under the stereomicroscope showing (left) the remains of the original front legs and (right) the modern round wire added to recreate the rear legs.*

On the winged beetle are visible remains of a modern lead-tin solder in many joins and addition of small modern wires replacing broken and lost parts (Fig. 8.14b). For example, the beetle's rear legs are made from modern plain round section wire while the original upper legs are flat, made by cutting a gold sheet. The original and modern legs are shown in Figure 8.15.

Two gold suspension rings are soldered to the base plates of both the beetle and the pectoral, indicating that they were worn hanging. Several examples of pectorals bearing a royal name hold in a string of beads are known (Grajetzki 2004, 2014; Oppenheim et al. 2015; Wilkinson 1971; Vernier 1907-27; Aldred 1971). The suspension rings applied on the reverse of the beetle's pendant and the pectoral are made with different technologies, as shown in Figure 8.16, by rolling a gold strip in the case of the pendant and by coiling a wire in the case of the pectoral. This difference indicates that they were probably produced by different goldsmiths.

Close to the beetle on the mummy's chest, a gold pendant was found in the form of a shell decorated with one uraeus on each side of the cartouche of king Senusret III (MM 5968). The motif was made in wires

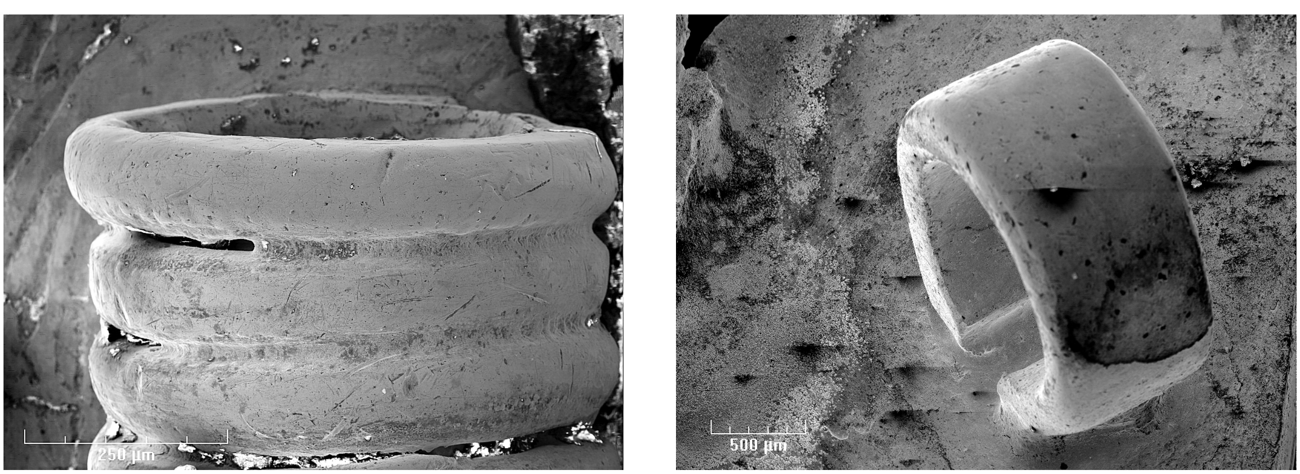



**Figure 8.16.** *The suspension rings of (left) the pectoral and (right) the winged beetle pendant (Acc. nos. 5966 and 5967, Manchester Museum).*

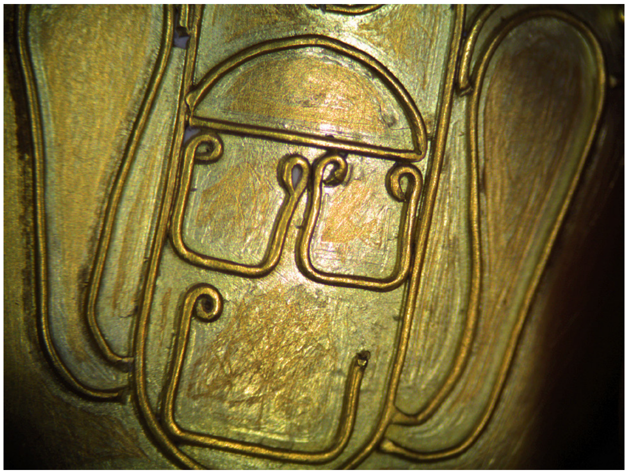



**Figure 8.17.** *Details of the shell shaped pendant (Acc. no. 5968, Manchester Museum) with visible surface scratches, showing (left) the decorative round wires and (right) one of the granules used for the eyes.*

and two granules (Fig. 8.17). Therefore, the shell is one of the earliest examples in Egypt of the use of granulation. The thin wires are of rounded section, but the end of one of them has a square section (Fig. 8.17); perhaps made by hammering (Oddy 1977), the wires were cut and soldered to the shell. The granules that are a little flattened on the top were also soldered to the shell. The suspension ring is a bent gold strip soldered to the top of the shell. On the shell surface many scratches are visible. Scratches are often found at the surface of gold objects decorated in cloisonné enamel, but this technique does not seem to have been in use at that time (Buckton 1982). Therefore, the observed scratches could be the result of mechanical cleaning during the restoration process.

Behind the mummy's neck was found the last element of this group of jewellery, a small hollow gold pendant in the form of the fertility god Min standing on a stepped platform (MM 5969). The feathered crown is in gold cloisonné with lapis lazuli and turquoise, placed without cloisons. On the reverse, the main feather veins are hollow wires soldered to the gold sheet where the barbs were cut and chased. The incomplete personage is very tarnished, with areas of different colours that go from red to black, suggesting different phases of corrosion (Tissot et al. 2019), and with signs of severe restoration to reform the body that, being hollow, was crushed when the chamber roof felt. Only one of the suspension rings, made from a bent strip of gold, remain on the back indicating that the object was originally hung. The poor state of the surface, which suffered cleaning and then tarnishing, meant that it was not possible to identify tool marks.

**Analytical data**

A few inlays of different colours set in the gold cloisons of the pectoral (MM 5966) were qualitatively analysed by SEM-EDS. The elements visible in the EDS spectra, reported in Table 8.4, confirm the expected use of light blue-green turquoise, red carnelian, and dark blue lapis lazuli.

The ancient parts in gold of all the objects from tomb 124 are made from Ag-rich electrum alloys, containing 27–49 wt% Ag and copper contents ranging between 1 and 3 wt%. Data obtained by XRF are summarized in Table 8.5 and plotted in Figure 8.18, showing that the alloys employed are quite homogeneous by object. It is only for the highly restored and tarnished god Min amulet (MM 5969), containing the highest silver amounts (44–49 wt%), that some differences can be observed. SEM-EDS analysis has shown the presence of zinc amounts reaching 28 wt% in the restored parts of the pendant amulet and of the winged beetle pendant, which is consistent with early 20th-century restoration work (Ogden 1999).

The winged beetle and the pectoral are made from different alloys, consistent with the hypothesis of the

**Table 8.4.** *Elements visible in the spectra obtained by SEM-EDS for a few inlays on the pectoral (Acc. no. 5966).*

| Colour | Elements detected | Identification |
|---|---|---|
| Light green inlay | O, Al, P, Ca, Cu | Turquoise |
| Light blue inlay | O, Al, P, Cu | Turquoise |
| Red inlay | O, Si | Carnelian |
| Dark blue inlay | O, Na, K, Mg, Al, Si, S, K, Ca, Cu | Lapis lazuli |

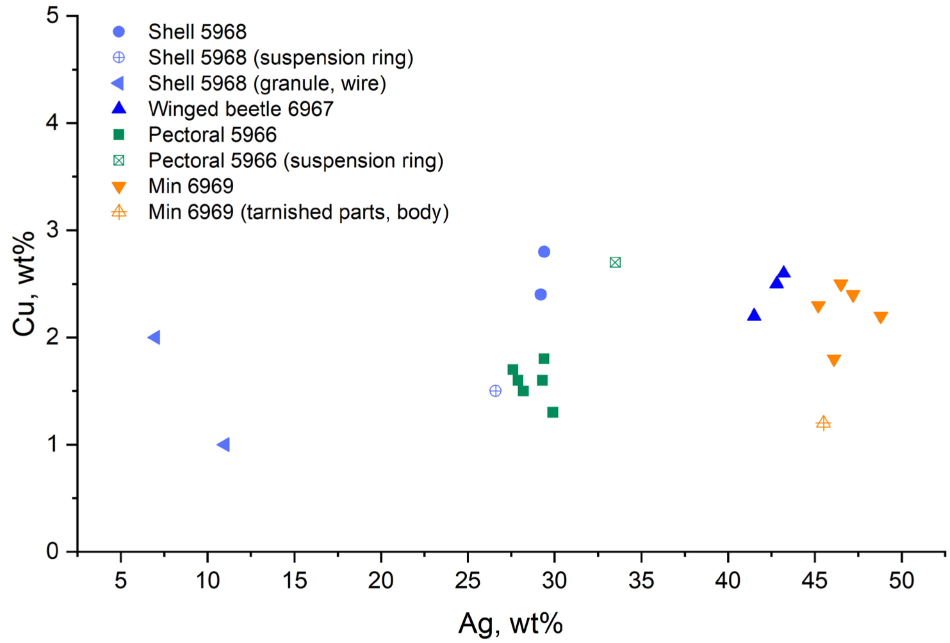



**Figure 8.18.** *Silver versus copper contents obtained by XRF and SEM-EDS analysis for the jewellery from tomb 124 at Riqqa.*

**Table 8.5.** *Results obtained by XRF and SEM-EDS for the different components of the jewellery items from tomb 124 at Riqqa.*

| Object | Au wt% | Ag wt% | Cu wt% | Zn wt% |
|---|---|---|---|---|
| Shell 5968 | | | | |
| Front (XRF) | 68.4 | 29.2 | 2.4 | |
| Back (XRF) | 67.8 | 29.4 | 2.8 | |
| Ring (XRF) | 71.9 | 26.6 | 1.5 | |
| Granule (EDS) | 88 | 11 | 1 | |
| Wire (EDS) | 91 | 7 | 2 | |
| Winged beetle 5967 | | | | |
| Lotus flower back (XRF) | 54.7 | 42.8 | 2.5 | |
| Wings back 1 (XRF) | 54.2 | 43.2 | 2.6 | |
| Wings back 2 (XRF) | 56.3 | 41.5 | 2.2 | |
| Average modern/ ancient wires (XRF) | 45.4 | 46.1 | 8.4 | 2.2 |
| Lotus flower back (EDS) | 68 | 30 | 2 | |
| Suspension rings (EDS) | 86 | 13 | 1 | |
| Suspension rings (EDS) | 81 | 18 | 1 | |
| Pectoral 5966 | | | | |
| Wedjat-eyes back (XRF) | 70.5 | 27.9 | 1.6 | |
| Wedjat-eyes side (XRF) | 70.7 | 27.6 | 1.7 | |
| Birds back (XRF) | 69.0 | 29.3 | 1.6 | |
| Under pillar back (XRF) | 68.8 | 29.9 | 1.3 | |
| Papyrus back (XRF) | 70.3 | 28.2 | 1.5 | |
| Papyrus side (XRF) | 68.8 | 29.4 | 1.8 | |
| Rings (XRF) | 63.8 | 33.5 | 2.7 | |

| Object | Au wt% | Ag wt% | Cu wt% | Zn wt% |
|---|---|---|---|---|
| Min amulet 5969 | | | | |
| Platform (XRF) | 49.0 | 48.8 | 2.2 | |
| Body (XRF) | 53.3 | 45.5 | 1.2 | |
| Head (XRF) | 51.0 | 46.5 | 2.5 | |
| Legs (XRF) | 52.1 | 46.1 | 1.8 | |
| Flag (XRF) | 52.5 | 45.2 | 2.3 | |
| Arm (XRF) | 53.3 | 44.4 | 2.2 | 1 to 5 |
| Crown (XRF) | 50.5 | 47.2 | 2.4 | |
| Body (EDS) | 57 | 11 | 5 | 28 |
| Face (EDS) | 55 | 38 | 3 | 4 |
| Neck (EDS) | 66 | 13 | 5 | 16 |

work of two goldsmiths, based on the manufacture of the suspension rings. The pectoral contains 28-29 wt% Ag and about 1.5 wt% Cu, whilst the winged beetle contains 42–43 wt% Ag and about 2.5 wt% Cu. The suspension rings are also made using different alloys. Plotted in Figure 8.18, the shell pendant matches the pectoral and the amulet pendant matches the winged beetle pendant. The few analyses carried out by SEM-EDS on the wires and granules applied on the shell pendant have shown as expected (Eluère 1989; Rastrelli et al. 2009) the use of high quality alloys containing 88–90 wt% Au.

**Table 8.6.** *Results obtained by SEM-EDS for one of the cell plates and adjacent solder alloy in the pectoral (Acc. no. 5966).*

| | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| Solder cell | 70.5 | 26.4 | 3.1 |
| Cell | 73.2 | 25.2 | 1.6 |

**Table 8.7** *Results obtained by SEM-EDS for the four analysed PGE inclusions identified at the surface of the winged beetle and the pectoral from tomb 124 at Riqqa (nd = not determined).*

| | Os wt% | Ir wt% | Ru wt% |
|---|---|---|---|
| Winged beetle 5967 | | | |
| PGE 1 | 26 | 48 | 25 |
| PGE 2 | 28 | 47 | 25 |
| Pectoral 5966 | | | |
| PGE 1 | 23 | 77 | nd |
| PGE 2 | 22 | 78 | nd |

The analysis of some of the pectoral joins revealed the use of a hard solder process by using a solder alloy containing a higher level of Cu than the gold base alloy. Table 8.6 provides the composition obtained for the joining area of one of the inlaying cells.

Several PGE inclusions are visible on the surface of the winged beetle pendant and of the pectoral, which indicates the use of alluvial gold at least for the manufacture of these two objects. Table 8.7 summarizes the data obtained by SEM-EDS for the four inclusions analysed, showing that those in the winged beetle pendant are iridium-osmium-ruthenium alloys and those in the pectoral are iridium-ruthenium alloys, corresponding well to the type of compositions expected for Egyptian jewellery (Meeks & Tite 1980; Troalen et al. 2009, 2014, 2019; Miniaci et al. 2013; Troalen & Guerra 2016).

It is difficult to make further comments on the technologies employed in the production of the studied items, because of the processes applied in the past to restore the jewellery. The data obtained shows however that the incomplete scarab beetle pendant related to the throne-name of Senusret II, Khakheperra, and the shell-shaped pectoral that gives the throne-name of Senusret III, Khakaura, were not made by a single goldsmith. The composition of the objects correlates with other Middle Kingdom jewellery items, such as those in the Ashmolean Museum (Gale & Stos-Gale 1981) and from tomb 72 excavated at Haraga (Chapter 8.2), with the use of electrum alloys containing low copper contents (< 3 wt%). The visible PGE inclusions at the surface of several objects is indicating of the use of alluvial gold, while hard soldering technique was used to join parts that are decorated by chasing.

## Notes

1. Possibly the pectoral evokes queenship. The *hetes*-sceptre, with the bird identified possibly as a swallow (though it looks more like a kite), used to write the word *wrt* 'great', in the prominent title of queens 'great one of the *hetes*-sceptre' (*wrt-hetes*). This association would agree with the presence of multiple-figure pectorals in depictions of women associated with the king (statue of Amenemhat II's daughter, Neferet) and in their burials.

## References

For references see pp.309–12 at the end of this chapter.

# *Chapter 8.4*

# Objects from excavations at Haraga, Lahun and other sites

Maria F. Guerra & Stephen Quirke

A few gold objects in the collection of the Petrie Museum from the excavations of two major sites, Haraga and Lahun, were selected for analytical study. Their study should provide information on Middle Kingdom technological achievements by complementing the data obtained in the previous sections for the groups of jewellery from tomb 72 excavated at Haraga and tomb 124 excavated at Riqqa.

The objects selected from excavations at Haraga are one gold shell-shaped pendant (UC6391), one fish-shaped pendant (UC6411) and one cylindrical amulet decorated with granulation (UC6482), and from the fieldwork by Petrie at Lahun a group of beads restrung for display but said to have been found together (UC7537). An unprovenanced scarab mounted on a gold plinth (UC11365) was also investigated as comparative material. As the process of hammering gold into foils for the decoration of multiple supports is such a specific craft that it can be supposed to be carried out in distinct workshops by distinct artisans, we also selected for analytical study gold foils from tombs excavated at Haraga and Lahun. The composition of their alloys was compared with the composition of the jewellery.

The study was completed by the analytical study of a few gold beads and scarabs also in the collection of the Petrie Museum, from other excavated sites. The two selected scarabs were acquired by Petrie during his excavations at Naqada. One (UC11353) is a private scarab of amethyst set in a gold plinth and the other (UC29057) is a black jasper scarab set into a gold base plate. One gold bead (UC 21026) from the excavations of the fortress at Buhen in Sudan was also analysed to search for any difference in the alloy composition.

## The objects from Haraga

Fish pendant UC6411 was found in Wady II tomb 520 during a series of excavations carried out in Haraga (Engelbach & Gunn 1923). Engelbach describes Wady II cemetery as a late Middle Kingdom to Second Intermediate Period 'series of shallow graves packed tightly into the soft sand' between cemeteries F and G. In his description, he adds the following: 'They were packed as closely as possible, and I have had to omit showing many groups of pottery and beads, as, in some cases, it was not possible to separate the burials' (Engelbach & Gunn 1923, 2–3, pl. 2). According to Engelbach, cemetery G is mainly Predynastic (Engelbach & Gunn 1923, 2), so the Wady II cemetery would be at the northern edge of the main area of Middle Kingdom burials in cemeteries F and A.

Even if today in poor condition – split into several pieces – all the materials used in the manufacture of fish pendant UC6411, shown in Figure 8.19, are conserved. From the remainder, it can be assumed that this amulet consisted of several parts that were soldered together. The body was made by joining two embossed halves made from hammered gold sheets to which was added the tail in copper. One copper wire forming a loop was certainly inserted in the fish's mouth to create a suspension ring. One dorsal fin in copper (missing) could have been originally added to the fish, similarly to one catfish pendant in the collection of the Walters Art Museum (57.1981). This pendant is made using equivalent technology and has a gold body and tail and a silver dorsal fin.[1]

The eyes of fish pendant UC6411 (Fig. 8.20) were made by piercing the gold sheet and the rather geometrical body decoration was made by chasing. Even if gills and scales are somehow represented in the motif chased on the fish body, the quite schematic motif contrasts with the lifelike motif of some of the gold fish amulets from tomb 72 excavated at Haraga (see Chapter 8.2) and from tomb W32 excavated at Hu (University of Pennsylvania Museum E3989; Silverman 1997, 236). Because its state of preservation is very


**Figure 8.19.** *Fish pendant UC6411 (Petrie Museum) from tomb 520 excavated at Haraga with a detail of the decoration of the fish's body.*

delicate, only the two biggest gold foils of fish pendant UC6411 were analysed using handheld XRF, without removing them from the box. The undetermined core is not copper, the material used for the two complete fish pendants from tomb 72.[2]

The second object selected for study is one of the few contextualized cylinder amulets decorated with triangular patterns in granulation. It consists of a hollow gold tube with a copper core and a cap at each end. Finely described by Petrie (1927, 6), who provides a total of 1848 granules for its decoration, amulet UC6482 was found in the north of cemetery A of Haraga, in tomb 211, a partially robbed tomb that contained the skull and femora of a skeleton identified as male (Engelbach & Gunn 1923, 16). The amulet, shown in Figure 8.21, was found in a corner of the chamber, together with beads made from different materials, cowrie shell-shaped gold beads, and another cylinder amulet with gold caps, also shown in Figure 8.21, made from disks in copper, lapis lazuli and green feldspar (Engelbach & Gunn1923, 16, pl. 14.5). Despite having the form of an amulet case (Ogden 1990, 212–13), cylindrical pendant UC6482 having a copper core was described by Petrie (1927, 6) as 'only for show' as it 'could not contain any charm, or be opened'.

On the top of one of the gold caps of amulet UC6482, made from sheet gold, is soldered the suspension ring, made of one bent gold strip with bevelled ends (Fig.8.22a). The gold tube is cracked in several areas (one is shown in Fig. 8.22b), certainly weakened by the processes of plastic deformation, annealing and soldering and to the increase in volume of the copper

**Figure 8.20.** *Fish pendant UC6411 (Petrie Museum). Details showing the head with the eye obtained by piercing the gold sheet and the copper-based tail now broken in two parts.*

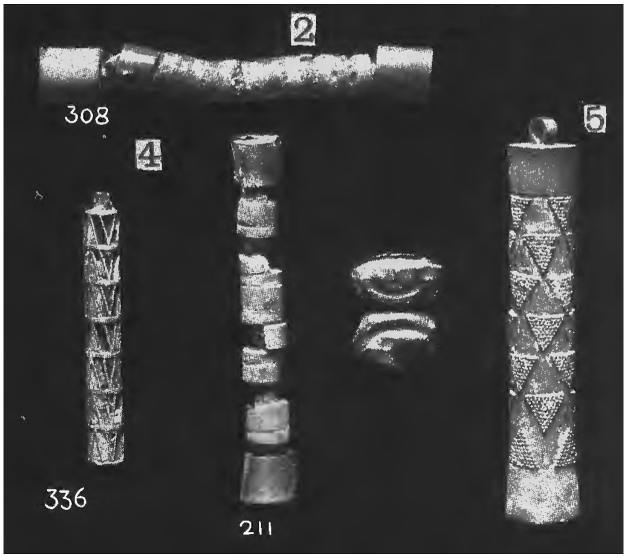



**Figure 8.21.** *The two cowrie shell-shaped gold pendants and the two cylinder amulets with gold caps from tomb 211 (group 5 in the figure) excavated at Haraga (from Engelbach & Gunn 1923, pl. 14). On the right, is shown the hollow cylinder gold amulet decorated with triangular patterns in granulation UC6482 (Petrie Museum).*

core caused by the development of corrosion products (Rapson 1990). However, the corrosion was already growing when the amulet was found, as noticed by Petrie, who commented on the burst gold sheet.

The granules, less regular than what has been suggested ('0.020 inch each, but a few are rather larger, about 0.025' Petrie 1927, 6; 'about 0.4 mm diameter' Ogden 1992, 52), show marks of wear. Figure 8.23 compares the form of those located in the middle of the amulet,

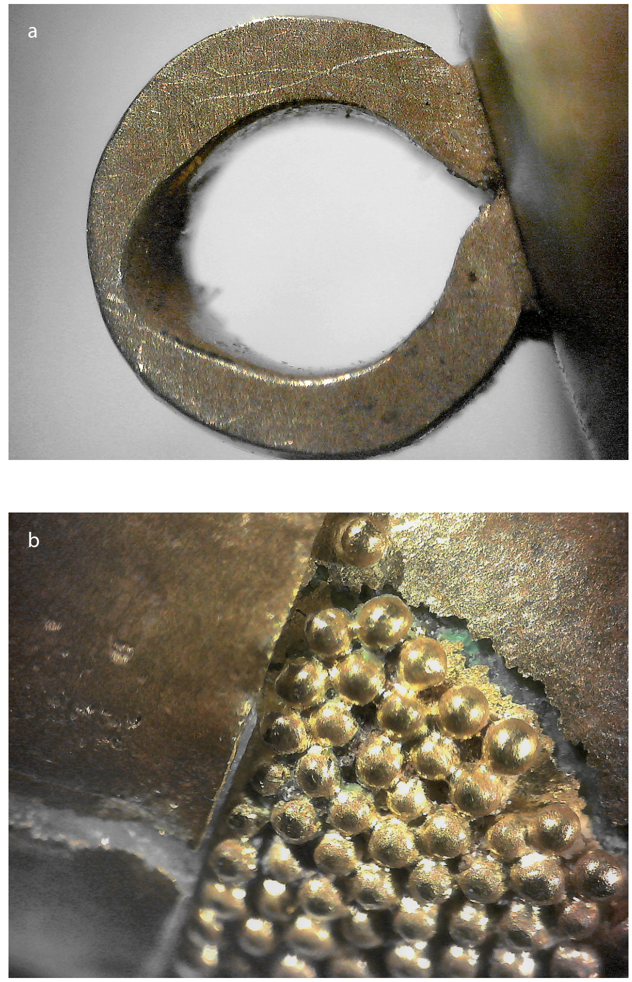



**Figure 8.22.** *Details of cylinder gold amulet UC6482 showing (a) the suspension ring, and (b) the tarnished gold cap and the cracked gold tube decorated with granulation.*

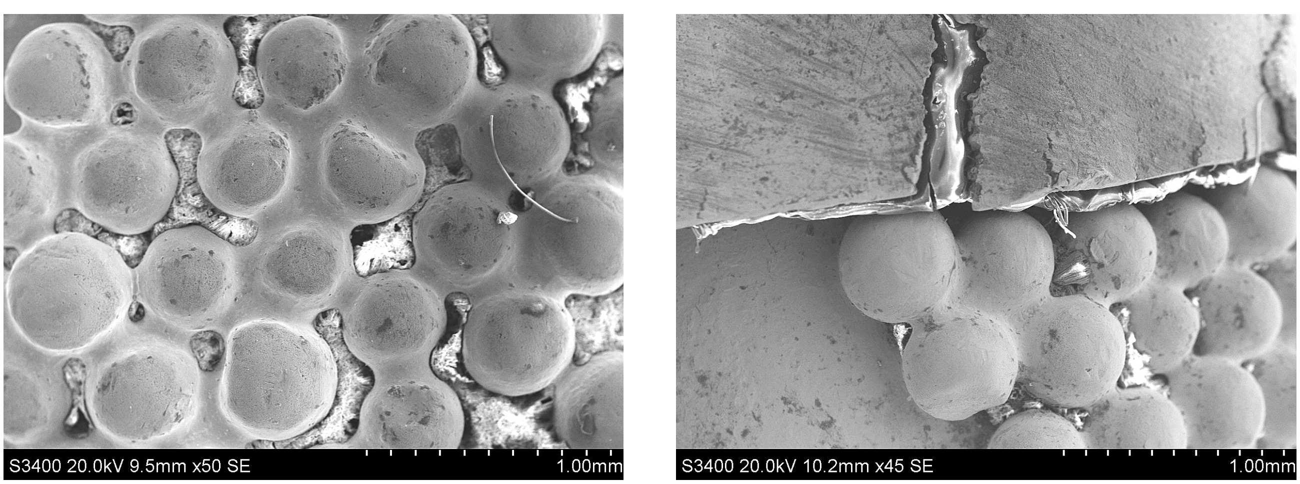



**Figure 8.23.** *Details under the SEM of the granules soldered to the surface of amulet UC6482. Those protected by the cap are perfectly round and show no signs of use wear while those in the middle of the gold tube are flattened by friction.*

**Figure 8.24.** *Detail of the pierced hole (modern?) used for suspension of the gold shell shaped pendant UC6391 (Petrie Museum) from excavations at Haraga.*

exposed in particular to friction when worn (chafing), to the form of those in the region protected by the protruding cap. The protected granules are perfectly round whilst the others are flattened by use wear. There can also be observed in Figure 8.23 a few non-spherical specimens, with forms regularly observed in ancient granulation patterns (Guerra 2007) expected when using ancient technologies (Nestler & Formigli 2004, 49). The very visible joins are said to be obtained by using a 'rather paler gold solder' (Petrie 1927, 6) made with a 'silver-rich gold alloy' (Ogden 1992, 52). The elemental analysis of the different parts that constitute the amulet are presented and discussed in Chapter 8.5.

A third object from the excavations of Haraga was selected for analytical study. It is a small gold shell-shaped pendant (UC6391) for which the find context is not securely recorded. This object is today in poor condition; its surface is covered with a thick layer of corrosion products with colours that are typical of those that result from the degradation of gold alloys rich in copper and silver. The shell-shaped pendant made from sheet gold has a 'fresh' hole pierced from inside to outside, shown in Figure 8.24, instead of the expected suspension ring to hang it as a pendant.

Finally, a group of undecorated gold foils (UC6475) from the excavations of tomb 67 at Haraga was selected for analysis of the alloy compositions, though their date is uncertain from the published and archival sources. The excavation report records a Middle Kingdom burial of a woman in a chamber, and a late 18th Dynasty burial in the tomb shaft, without reference to the gold (Engelbach & Gunn 1923, pls. 58, 63). The Petrie Museum archive includes two tomb-cards filled in by the site supervisor at the excavation, one for each burial, with 'gold foil' on the card for the late 18th Dynasty burial, but without further documentation on the positions of finds within the shaft. We include the find here as possible comparative material.

### The objects from Lahun

Among the objects in the collection of the Petrie Museum from excavations at Lahun is a string of beads, amulets and one scarab, made from lapis lazuli, agate, amethyst and blue glaze, for which no find-spot within the site is recorded, but identified as 'found together' on an old museum label. String UC7537 includes one bead in gold, which is shown in Figure 8.25. The composite gold bead consists of one hollow


**Figure 8.25.** *Restrung string UC7537 (Petrie Museum) from the fieldwork by Petrie at Lahun with a detail of the gold bead.*

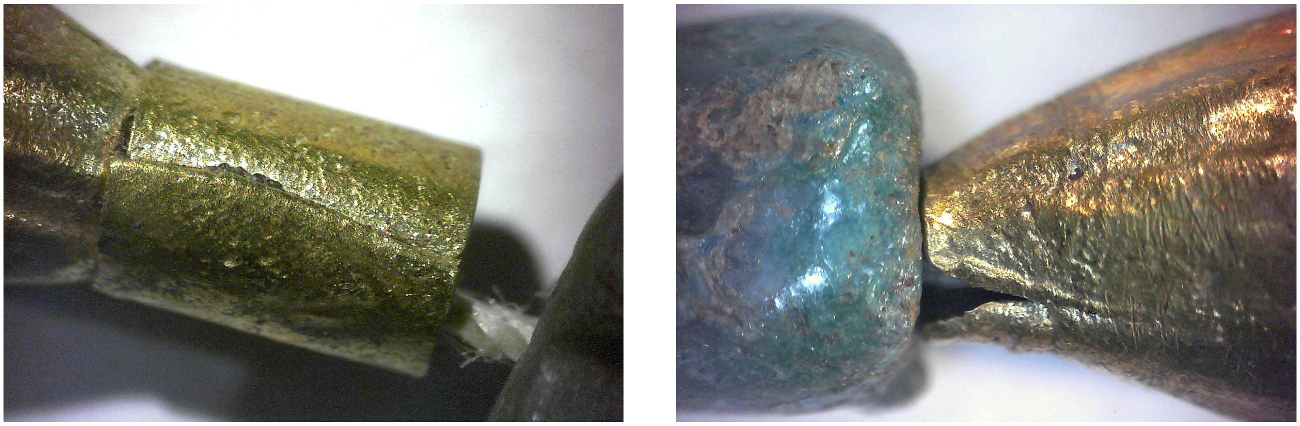


**Figure 8.26.** *Details of the two ends of the gold bead in string UC7537.*

gold ribbed conical elongated form made by soldering two halves, to which was soldered one gold tube, as shown in Figure 8.26. The ribbed bead approaches a seed-shaped form.[3] However, on the other end of the bead, as shown in Figure 8.26, a few marks on the surface demonstrate that this element was in contact with another one. The marks correspond more likely to the presence of a (today) missing gold tube, identical to the tube applied on the other side of the bead, than to friction with an adjacent bead. Therefore, the form proposed by Xia Nai for type M61e (Xia 2014, 160, pl. IX), one gold ribbed conical elongated bead between two gold tubes, seems plausible.

We also selected for study a private scarab of steatite rimmed in a gold sheet of unknown provenance, but securely dated by object type and personal name Iufseneb to the late Middle Kingdom (and accordingly catalogued in Martin 1971, 13 no.84). It is inscribed 'estate manager of the granary, Iufseneb' (Petrie 1917, pl. 15, 12 AD). Scarab UC11365 is shown in Figure 8.27. One hole runs through the scarab's body from end to end. The gold sheet where the scarab is rimmed is incised with a line under the scarab's head and goes into the scarab's hole. No joining substance was seen between the scarab and the gold sheet.

Finally, there was analysed for the composition of the gold alloys a group of gold foils from the excavations of disturbed royal tombs 7 (UC7605 i–iii, UC7606, and UC7607i–iv) and 8 (UC6571), two of the four shaft tombs cut on the south side of the Lahun pyramid for women related to the burial of king Senusret II (Brunton 1920).

The analysed scraps of gold leaf from tomb 7 were found in the debris of the antechamber and may have come from the coffin, the canopic-box lid, or the mummy's jewellery. The very few remains of this tomb are insufficient to ascertain whether a woman of the royal family had been buried in the tomb. However, the style and work of the sarcophagi and of the canopic chests and the few beads from the original jewellery found inside the tomb indicate that this tomb is the


**Figure 8.27.** *Private scarab of steatite mounted in a gold sheet UC11365 (Petrie Museum).*

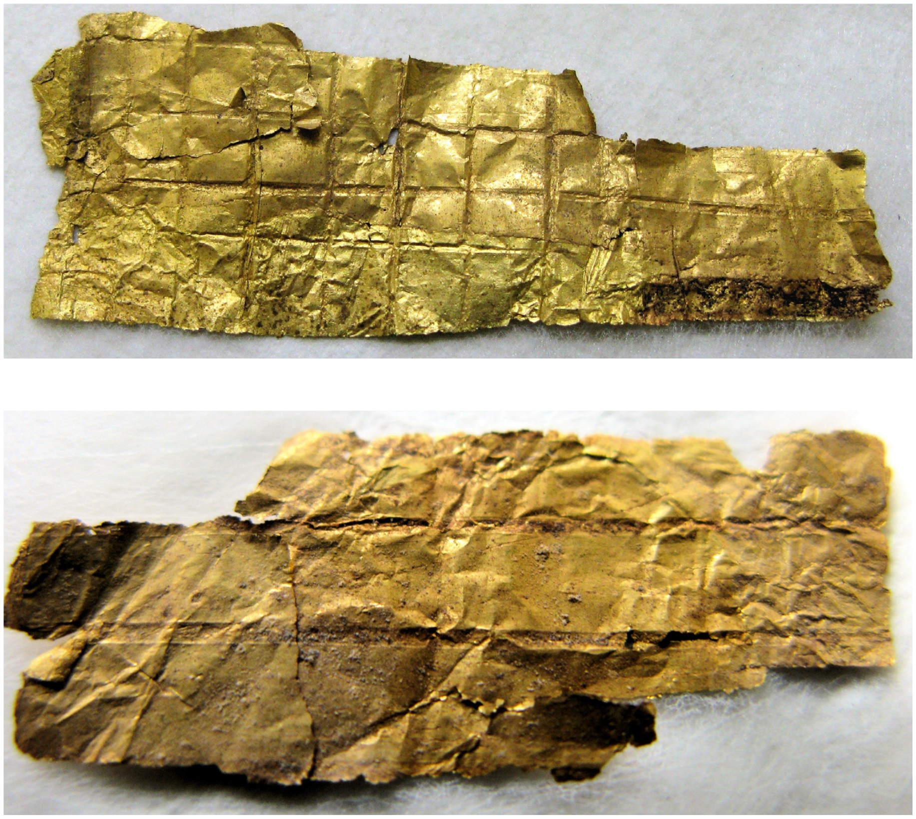


**Figure 8.28.** *Two scraps of gold foil with decoration found inside the sarcophagus of royal tomb 8 at Lahun, UC6571 (Petrie Museum).*

burial of an important personage. The variety of types and the richness of the materials used in the production of the beads are similar to those found in the burial of Senusert II, in the royal tombs at Dahshur, and in the tomb of Senebtysy at Lisht (Brunton 1920, 14–17, pl. 13).

Tomb 8 is the roughest in construction of the four shaft tombs found in Lahun, but it was used for the burial of a princess under Amenemhat III. Despite being fully robbed, an important group of jewellery was found in an intact cache inside the chamber (Brunton 1920, 17–22). Scraps of gold foil were found inside the sarcophagus, from the ornamented coffin and the canopic box. Some of these scraps were analysed in this work. Contrary to those from tomb 7, many of the gold scraps from tomb 8 are decorated with longitudinal lines that sometimes form squares, as shown in Figure 8.28. Decorated gold sheet was identified in other tombs. Senebtysy's gilded coffin is an example; this feature is said by the excavators to be common at Dahshur and related to a type of ornamentation for the edges of coffins and canopic boxes: 'Around all the edges ran bands of gold 32 mm. wide. The same stucco base was laid as in the case of the eye-panel. Each band was then lightly incised with five lines ruled parallel to the edges, and the chequers which resulted from their crossing at the corners were repeated every 16 cm. along the sides. The plaster was then sized and the gold leaf rubbed in to show the rulings' (Mace & Winlock 1916, 31, fig. 15). The application of geometrically decorated gold foils was in use long before the Middle Kingdom, as shown by a gold foil from the burial of king Qaa at Abydos, now in the University of Pennsylvania Museum (E6883), also decorated with parallel lines.

## Objects from Naqada and Buhen

A few selected objects from other excavated sites were also submitted to analytical study. One of them is a gold bead from the excavations of the Egyptian fortress at Buhen (Sudan) that might be expected to have been made with Sudanese gold, though fortress commanders and their retinue and senior visitors might equally plausibly have brought items such as jewellery with them from Egypt. Two scarabs mounted on gold plinths from the Petrie season of fieldwork at Naqada complete the group of selected objects.

The lozenge-shaped gold bead UC21026 from Buhen, shown in Figure 8.29, made from two halves joined together, was found with a fragment of a blue faience ring. The scraped surface can be related either to discovery and burial conditions or to some type of undetermined surface decoration or finishing. The bead might have been an element of a necklace or a girdle. One lozenge-shaped gold bead, enhanced by chasing,

**Figure 8.29.** *Lozenge shaped gold bead UC21026 (Petrie Museum) from the excavations of Buhen Fort (Sudan) showing the surface scratches and the joining seam.*

is contained in a girdle found in tomb MMA 840, in the Asasif section of the Theban necropolis (MMA 13.180.11). Dated to the Late Middle Kingdom - Second Intermediate Period, the girdle is a string of carnelian and amethyst spherical beads and cowrie shell beads in electrum with two holes at each end.

The two inscribed scarabs mounted on gold bases in the collection of the Petrie Museum studied in this work come from the season of fieldwork directed by Petrie in 1894–5 at Naqada. UC11353 is an amethyst scarab set on a gold base. According to an entry in his pocket notebook, Petrie purchased the item from Qena traders (Petrie Museum archive, Petrie Notebook 75, at p.22 from the back). The base gold sheet is inscribed with the title and name of a woman of high status (Petrie & Quibell 1896, 66, pls. 80–7), within an oval scroll border (Petrie 1917, pl. 14-12, T): 'king's ornament, Munuib' (Stefanović 2009). The scarab was set into a cloison in gold joined to a base gold sheet; together they form a kind of open box. At each end of the plinth, around the hole that runs through the scarab's body from end to end, was soldered an undecorated gold collar (Fig. 8.30). The scarab could have been the bezel of a swivel ring (Newberry 1908). Several incomplete specimens are known, including shanks without bezel (for example, Williams 1924, 86–7, pls. 8–22).

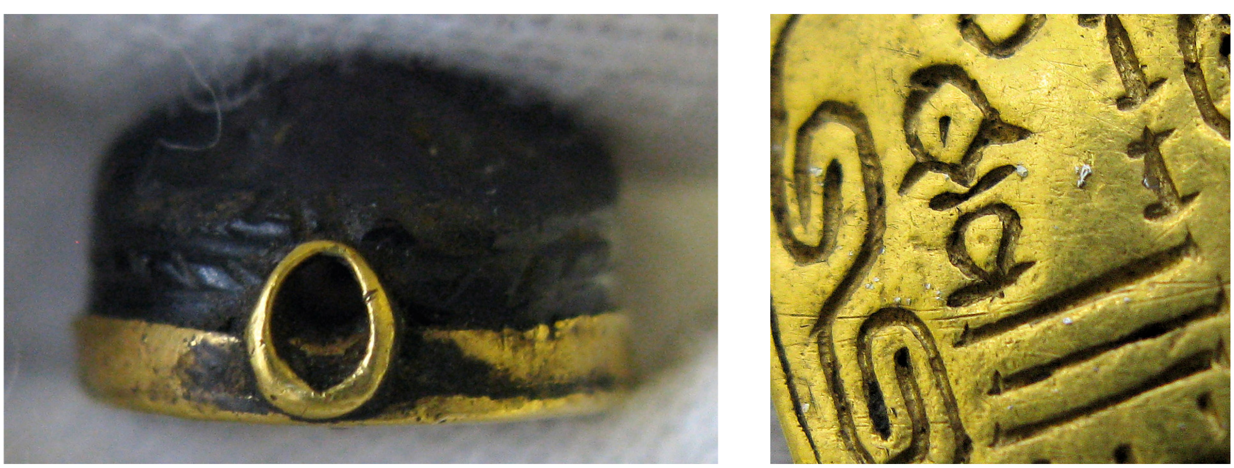


**Figure 8.30.** *Details of private scarab of amethyst set in a gold plinth UC11353 (Petrie Museum) acquired during the excavations at Naqada showing one of the undecorated collars and the PGE inclusions on the gold base sheet with deeply chased motifs.*

**Figure 8.31.** *Details of black jasper scarab set in a gold base plate from excavations at Naqada, UC29057 (Petrie Museum).*

Scarab UC11353 has marks of wear. The chased base gold sheet contains PGE inclusions visible under naked eye (Fig. 8.30). Petrie noticed these inclusions: 'The scarab of Muen-ab contains in the gold the first specimen of Osmiridium yet known from Africa' (Petrie & Quibell 1896, 66).

UC29057 is a black jasper scarab set into a gold base plate decorated with plants and *ankh*/*nefer* signs made by chasing (Petrie & Quibell 1896, 66, pl. 80.67; Ben-Tor 2007, pl.1.41 with parallels for the design on late Middle Kingdom scarabs). One hole runs through the scarab's body from end to end. The base plate is made from sheet gold that was bent in the borders to enclose the scarab. The plinth was reinforced at both ends with a gold strip that goes into the hole to attach the scarab to the plinth (Fig. 8.31).

## The gold alloys

Data obtained by XRF for the gold objects and foils from Haraga are summarized in Table 8.8 and plotted in Figure 8.32. The objects are made using different silver-rich gold alloys containing amounts of copper under 3 wt%, with a single exception. Their silver contents range from 20 to 55 wt% and their colours go from green yellow to whitish. The high silver content (55 wt% Ag) in the small gold shell-shaped pendant UC6391 explains its corroded surface. In contrast with the objects, gold leaf from Haraga split into two groups. One of them comprises the foils made from alloys containing 6–7 wt% Ag and the other those made from alloys containing 17–18 wt% Ag. Both compositions correspond to the use of yellow and pale yellow gold. However, the different compositions indicate that the gold scraps could come from at least two different items; considering the presence of Middle and New Kingdom material from that context, the results may also reflect two distinct periods (see above on tomb 67).

Data obtained by XRF for the gold objects and gold scraps from Lahun are summarized in Table 8.9 and plotted in Figure 8.33. All of them contain low copper contents, except the gold bead in string UC7537 made from an alloy containing higher silver and copper contents than the other analysed items. This difference reinforces the singularity of the bead. Like those from Haraga, the gold scraps from Lahun form two groups, but there is no relation between the composition of the

**Table 8.8.** *Results obtained by XRF for the gold scraps and the different parts of the jewellery from excavation at Haraga (*average result obtained in a 3 mm diameter area that may include granulation and solder).*

| Acc. No. | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| UC6475 | 90.1 | 7.7 | 2.4 |
| | 81.9 | 16.9 | 1.9 |
| | 92.6 | 6.1 | 1.5 |
| | 92.7 | 6.1 | 1.5 |
| | 91.2 | 6.9 | 2.1 |
| | 93.1 | 5.8 | 1.3 |
| | 90.9 | 6.8 | 2.5 |
| | 81.2 | 17.8 | 1.8 |
| | 91.4 | 7.2 | 1.7 |
| | 90.9 | 7.1 | 2.3 |
| UC6391 | 43.6 | 55.1 | 1.3 |
| | 44.8 | 53.9 | 1.3 |
| UC6411 | | | |
| body big sheet | 53.8 | 45.9 | 2.0 |
| head small sheet | 56.2 | 43.3 | 2.1 |
| UC6482 | | | |
| gold sheet* | 72.9 | 24.2 | 2.9 |

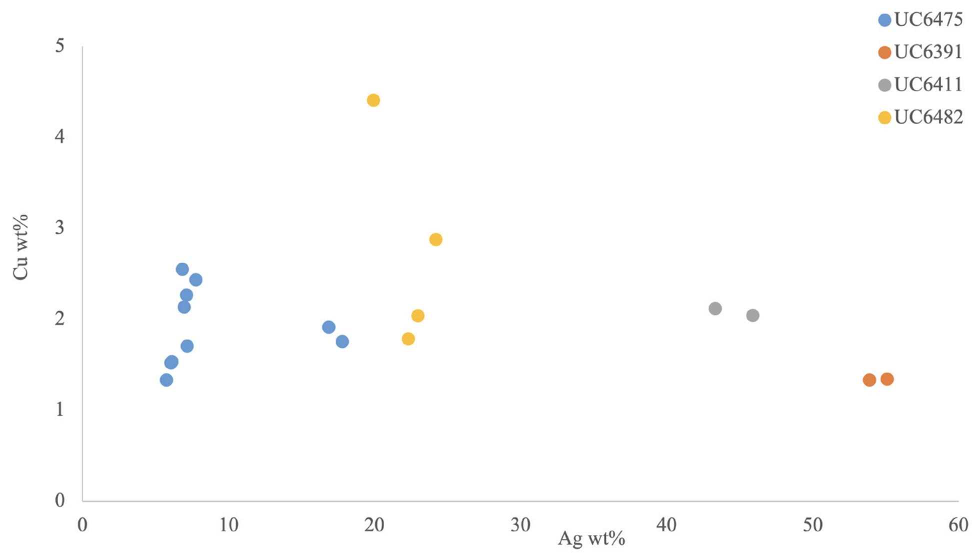



**Figure 8.32.** *Silver versus copper contents obtained by XRF for the gold jewellery and gold leaves from excavations at Haraga.*

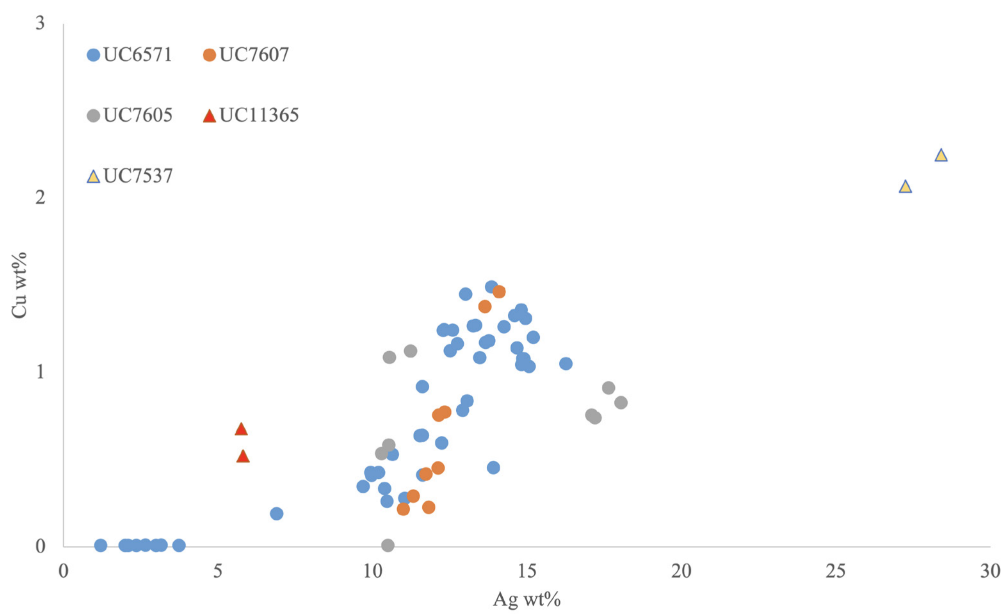



**Figure 8.33.** *Silver versus copper contents obtained by XRF for the gold jewellery and gold leaves from the excavations at Lahun.*

alloys and the decorative geometric patterns. One of the groups contains the gold scraps with quite dispersed silver contents ranging from 10 to 20 wt%. Inside this group, gold scraps UC7605 from royal tomb 7 split into two subgroups, based on their slightly different copper and silver levels: one group corresponds to *c*. 10–11 wt% Ag and 0.5 wt% Cu and the other to *c*. 17–18 wt% Ag and 1 wt% Cu. This could indicate that these foils originally decorated two different items.

The second group of gold foils in the diagram of Figure 8.33, characterized by the high gold contents (the alloy contains less than 4 wt% Ag and amounts of copper under the detection limits), corresponds to scraps from royal tomb 8. This type of alloy was not found in Haraga.

Data obtained by XRF for the other contextualized gold objects in the collection of the Petrie Museum are summarized in Table 8.10 and plotted in Figure 8.34

**Table 8.9.** *Results obtained by XRF for the gold scraps and the different components of the jewellery from excavation at Lahun.*

| Acc. No. | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| UC6571 | 86.0 | 13.2 | 1.3 |
| | 83.3 | 16.3 | 1.1 |
| | 84.2 | 15.2 | 1.2 |
| | 86.6 | 12.7 | 1.2 |
| | 86.8 | 12.5 | 1.1 |
| | 84.5 | 15.1 | 1.0 |
| | 86.0 | 13.5 | 1.1 |
| | 97.7 | 2.4 | <0.01 |
| | 98.9 | 1.2 | <0.01 |
| | 98.0 | 2.1 | <0.01 |
| | 89.1 | 11.0 | 0.3 |
| | 86.7 | 12.6 | 1.2 |
| | 86.9 | 12.3 | 1.2 |
| | 86.9 | 12.3 | 1.2 |
| | 90.0 | 9.9 | 0.4 |
| | 85.9 | 13.3 | 1.3 |
| | 84.4 | 14.8 | 1.4 |
| | 98.1 | 2.0 | <0.01 |
| | 97.1 | 3.0 | <0.01 |
| | 96.4 | 3.7 | <0.01 |
| | 90.3 | 9.7 | 0.3 |
| | 89.7 | 10.4 | 0.3 |
| | 89.7 | 10.5 | 0.3 |
| | 87.9 | 11.6 | 0.9 |
| | 86.2 | 13.9 | 0.5 |
| | 85.7 | 13.7 | 1.2 |
| | 85.6 | 13.8 | 1.2 |
| | 84.7 | 14.8 | 1.0 |
| | 84.6 | 14.9 | 1.1 |
| | 84.6 | 14.9 | 1.1 |
| | 84.6 | 14.6 | 1.3 |
| | 86.8 | 12.9 | 0.8 |
| | 85.2 | 13.9 | 1.5 |
| | 87.6 | 12.2 | 0.6 |
| | 88.2 | 11.6 | 0.6 |
| | 88.3 | 11.5 | 0.6 |
| | 84.3 | 14.9 | 1.3 |
| | 89.2 | 10.6 | 0.5 |
| | 90.0 | 10.0 | 0.4 |
| | 84.7 | 14.7 | 1.1 |
| | 93.2 | 6.9 | 0.2 |
| | 96.9 | 3.2 | 0.0 |
| | 97.4 | 2.7 | 0.0 |
| | 85.0 | 14.2 | 1.3 |
| | 88.4 | 11.6 | 0.4 |
| | 89.8 | 10.2 | 0.4 |
| | 86.0 | 13.0 | 1.4 |
| | 86.6 | 13.1 | 0.8 |
| UC7607 | 87.9 | 12.1 | 0.5 |
| | 88.8 | 11.3 | 0.3 |
| | 88.3 | 11.7 | 0.4 |
| | 87.4 | 12.3 | 0.8 |
| | 87.6 | 12.1 | 0.8 |
| | 89.2 | 11.0 | 0.2 |
| | 88.4 | 11.8 | 0.2 |
| | 85.5 | 13.6 | 1.4 |
| | 85.0 | 14.1 | 1.5 |
| UC7605 | 81.8 | 18.0 | 0.8 |
| | 82.1 | 17.6 | 0.9 |
| | 89.3 | 10.5 | 0.6 |
| | 89.6 | 10.3 | 0.5 |
| | 88.1 | 11.2 | 1.1 |
| | 88.8 | 10.5 | 1.1 |
| | 82.7 | 17.2 | 0.7 |
| | 71.6 | 10.5 | 0.0 |
| | 82.8 | 17.1 | 0.8 |
| UC11365 | 93.6 | 5.7 | 0.7 |
| | 93.7 | 5.8 | 0.5 |
| UC7537 | | | |
| conical bead | 69.4 | 28.4 | 2.2 |
| top ring | 70.7 | 27.2 | 2.1 |

**Table 8.10.** *Results obtained by XRF for the gold components of the jewellery from excavations at Naqada and Buhen.*

| Acc. No. | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| Buhen | | | |
| UC21026 | 68.1 | 30.6 | 2.5 |
| | 69.4 | 29.8 | 2.0 |
| Naqada | | | |
| UC11353 | | | |
| plate sheet | 92.4 | 7.4 | 0.5 |
| collar 1 | 88.9 | 9.6 | 1.9 |
| collar 2 | 89.9 | 9.1 | 1.3 |
| UC29057 | | | |
| plate sheet | 88.8 | 8.6 | 3.0 |
| strip | 88.7 | 6.5 | 5.0 |

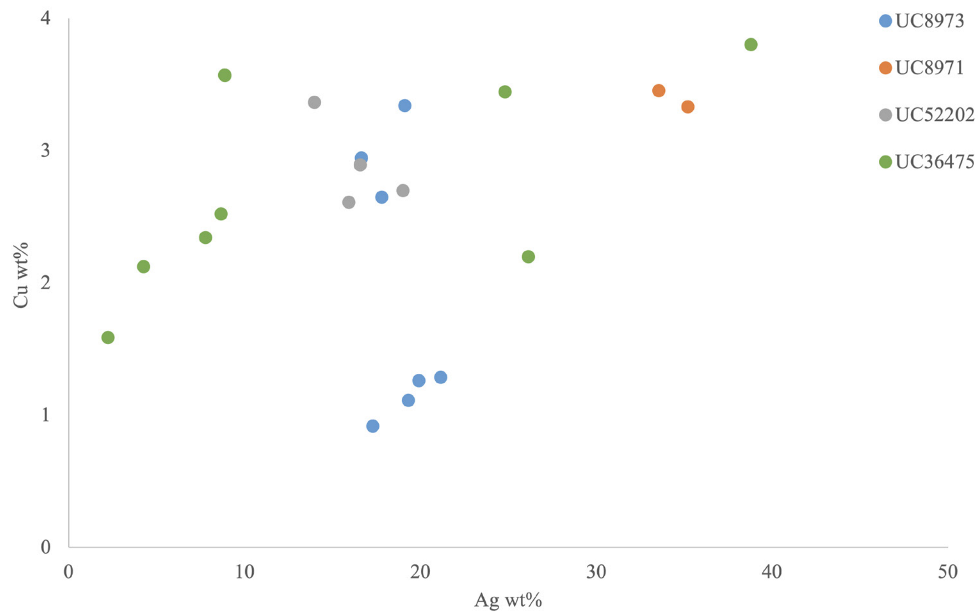



**Figure 8.34.** *Silver versus copper contents obtained by XRF for the gold jewellery from different excavated sites and from the excavations at Lahun and Haraga in the collection of the Petrie Museum.*

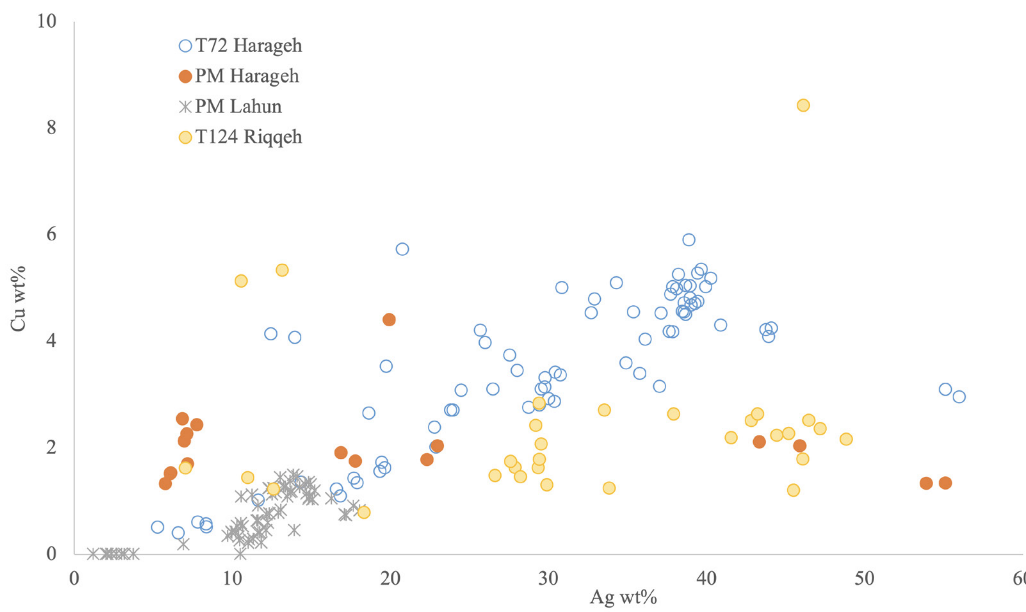



**Figure 8.35.** *Silver versus copper contents obtained by XRF for the gold jewellery and gold leaves from the excavations of Lahun and Haraga compared to the data obtained for the groups of jewellery from tombs 72 at Haraga (Chapter 8.2) and 124 at Riqqa (Chapter 8.3).*

together with the data obtained for the objects from the excavations of Haraga and Lahun. The gold scraps were not included in the diagram. The objects from the excavations of Naqada and Buhen are contained in a chemical region defined by the analysis of the objects from Lahun and Haraga. The two scarabs set in gold plinths from the excavations of Naqada have similar compositions, even if UC29057 contains slightly higher amounts of copper. Their silver contents match those of scarab UC11365 from the excavations of Lahun. The scarabs are all contained in the diagram in an area corresponding to silver contents under 10 wt%. All the other objects have higher Ag levels, including the bead from the excavations of Buhen, which is made from an alloy with about 30 wt% Ag.

In Figure 8.35 we plotted the data obtained for the jewellery and gold scraps from Lahun and Haraga in the collection of the Petrie Museum with the data obtained for the groups of jewellery found in tomb 72 excavated at Haraga (see Chapter 8.2) and in tomb 124 excavated at Riqqa (see Chapter 8.3). The objects from Naqada and Buhen (Fig. 8.34) form an equivalent chemical pattern. It is evident from the diagram that in contrast to those from Haraga and Riqqa, the foils and objects from Lahun are all made from alloys containing high gold contents, as if yellow gold was preferred to green, pale green or whitish gold employed in the manufacture of the items from the other tombs. This could however be caused by the fact that the majority of items from Lahun are in gold foils. In fact, alloys richer in gold are more appropriate for production of foil by hammering, on account of their higher malleability and ductility.

Just as for the groups of jewellery from tomb 124 excavated at Riqqa and tomb 72 excavated at Haraga, the silver levels in the jewellery in the collection of the Petrie Museum cover a larger range than the 5–30 wt% suggested by Klemm & Klemm (2013) for the composition of Egyptian Eastern Desert and Nubian Sudanese native gold. The results match however, the data obtained for the collection of the Ashmolean Museum of Oxford by Gale & Stos-Gale (1981, Oxalid).

Several PGE inclusions could be identified on the surface of the jewellery, certifying the alluvial origin of the gold. Some are quite visible, such as the one referred by Petrie at the surface of scarab UC11353 from Naqada (Petrie & Quibell 1896, 66). These inclusions were not analysed by SEM-EDS, but the average composition obtained by XRF for the region of the gold plinth of scarab UC11353 that contains the visible PGE inclusion showed the presence of Ir and Os. No PGE inclusion could be identified at the surface of the gold scraps.

Despite the use of native gold alloys, bead UC21026 from the excavations of Buhen in Sudan, and so possibly made from Sudanese gold, contains 30 wt% Ag. Based on data by Klemm & Klemm (2013), this level is more characteristic of the Eastern Desert gold from Egypt. Another possibility is the use of an artificial alloy.

## Notes

1. Description of catfish pendant 57.1981 in The Walters Art Museum: 'The hollow body is made of two pieces of sheet gold formed in repoussé. The sheet gold tail and the dorsal fins of silver (of which only one remains) were inserted into the body. The lines of gills and the "hood" behind are softly chased. The ridge around the eye was produced by a punch. The hole in the mouth is presumably for suspension'.
2. In addition to the gold fish amulet found in tomb W32, tomb G32 yielded one of the rare known fish pendants in silver, today incomplete, which has a core in faience. Dating, like the gold example, to the 12th Dynasty, the silver pendant is also now in the collection of the University of Pennsylvania Museum (E3990).
3. Beads of this type, but not ribbed, can be found for example in the lion's head ornament of the Aigina Treasure (Fitton et al. 2009, 20, fig. 48) as well as in several jewellery items from the royal tombs of Ur (Zettler & Horne 1998, 110–13 for example).

## References

For references see pp.309–12 at the end of this chapter.

# *Chapter 8.5*

# Granulation in Egypt and the cylindrical amulet from Haraga

Maria F. Guerra & Nigel Meeks

Cylindrical amulet UC6482, shown in Figure 8.36, was found in partially robbed tomb 211, excavated in the north of cemetery A at Haraga, which contained the burial of a male (Engelbach & Gunn 1923, 16, pl. 14). It consists of one gold tube closed by two gold caps of different colours, one at each end of the tube. On the top of one of the gold caps is soldered a suspension ring, made by bending a gold sheet with bevelled ends (see Fig. 8.22). Like other objects in gold with a copper core, the development of expanding corrosion products from the underlying core has induced the gold sheet to crack visibly along most of the length of the amulet (Fig. 8.36).

This amulet is one of the rare contextualized artefacts decorated with triangular patterns in granulation, and one of the earliest examples in Egypt of the use of this technique of decoration. As previously mentioned and shown in Figure 8.23, this might not be strictly a funerary object, because the granules in the middle of the tube are flattened by use-wear, contrary to those protected by the protruding caps, which kept their original roundness. For all of these reasons, we devote this section to the question of granulation in Egypt.

**A question of technology?**

The art of decorating jewellery with wires and granules attained its highest excellence in the first millennium BC, in the hands of Etruscan artisans, whose master goldsmiths formed complex patterns by soldering thousands of granules and very thin wires (of about one hundred μm diameter, Guerra 2006, 2007) to thin gold supports.

To produce jewellery decorated with patterns in wires and granules, good expertise is required in forming thin wires (Oddy 1977, 2004) and minute granules in gold (Wolters 1981–82, 1981; Nestler & Formigli 2004; Ogden 1982). Hammering gold into sheets and wires, a process fully achieved in Egypt since early times, is a necessary first step to form small and thin jewellery components; but twisting thin strips cut from sheet gold into wires or producing granules by heating small pieces of gold are technologies that require a specific and skilled *chaîne opératoire*. The technical skill requirements do not stop at this stage. These small gold components, counted in tens, hundreds or even thousands, need to be joined to a support in specific locations defined by the motif. Several techniques are employed to join gold parts (see Chapter 5), but based on the evidence available the typical joining technique in Egypt seems to be hard soldering (Roberts 1973; Ogden 1990; Schorsch 1995; Troalen et al. 2014; Troalen & Guerra 2016; Guerra & Pagès-Camagna 2019). These processes need accurate control of the heat-transfer mechanisms; the solder should melt without melting the parts to be joined, and have good flow and 'wetability' on a clean metal surface, using fluxes, necessary to achieve a perfect joint. A meticulous choice of the solder composition is necessary, because the alloy should have a lower melting point (about 20°C less) than the parts to be joined, but it should also have the same colour. This would usually mean the addition of silver and copper to gold to lower the melting point; the addition of copper also compensates for the pale silver colour.[1] The complexity of the motif increases the number of components to be joined and thus the difficulty of the work to be achieved. In some cases, it may have been necessary to operate by sequential steps with solder alloys of different compositions starting with the highest melting temperature solder followed by lower melting point solders to prevent groups of components de-soldering when followed by the succeeding solder operations.

The application of wires and granules started long before the Etruscans. In the third millennium BC, high quality decoration with wires was already in use, as attested for example by the Abbabashti necklace found in Uruk (Limper 1988, 63–6, pls. 23–5). Coiled wires,


**Figure 8.36.** *Cylindrical amulet UC6482 (Petrie Museum) from tomb 211 at Haraga and the largest fissure caused by underlying corrosion.*

which could have been an evolution of Late Chalcolithic-Early Bronze Age gold spiral-shaped ornaments, were applied at least since the mid-3rd millennium in Eastern workshops. This is exemplified by several finds, such as the gold bead from EM II tombs IV–VI excavated at Mochlos (Davaras 1975, pl. 70b); the beads in filigree and coiled wire in Pu-Abi's cape[2] found in Ur; the pendant in gold, silver and lapis lazuli mounted with three rows of coiled gold wire found inside the treasure jar of the Royal Palace of Mari (Parrot 1968, 28, pl. 15; Nicolini 2010, 93–4, pls. 54–7); and the biconical bead in coiled gold wire found in Early Dynastic context (*c.* 2700 BC) at Khafajah in Iraq (Oriental Institute Museum A11563[3]). Also worth noting, is one biconical bead, said to be made of coiled gold wire,[4] found in grave 7 of cemetery 7 at Shellal in Sudan, in the burial of an adult male, dated by Reisner (1910, 50–1, pl. 68b4) to his Late B-group.

It is harder to suggest when and where the technique of granulation started to be used. The earliest known examples are also roughly dated to the mid-3rd millennium BC and tend to demonstrate the Eastern Mediterranean origin of this technique of decoration (Wolters 1981–82, 1981, 1983; Lilyquist 1993; Maxwell-Hyslop 1971). In fact, a few objects with granulation were discovered during excavations at Ur: a gold sheet with granules, a gold ring consisting of six joined granules (Maxwell-Hyslop 1977), and a gold basket-shaped earring that could be an import (Maxwell-Hyslop 1971, 34). Earrings with granulation patterns were found in other sites dated to the same period (Laffineur 2008). Gold jewellery in Troy hoard 'A', the Priam treasure, dated to the mid-3rd millennium BC (Treister 2002), includes crescent-shaped earrings with rows of granules (Tolstikov & Treister 1996, 71–2) and basket-shaped earrings with pendants containing rows and floral patterns with granulation (Tolstikov & Treister 1996, 48–52). The same types of gold earrings were found in Poliochni (Lemnos) inside a vessel in room 643 (Bernabò Brea 1957) and in Eskiyapar, buried under a floor (Bingöl 1999, 86). Examples of other objects are: one gold cylindrical bead decorated with wires and granulation (Aruz & Wallensfels 2003, 185) found in tomb 7 at Tell Banat,[5] and one silver ring made from granules joined together contained in one string of beads found at Tell Brak (Mallowan 1947, 177, pl. 33).

## Granulation in Egypt

The art of granulation seems to begin in Egypt later than in the Eastern Mediterranean area. All the earliest examples so far known of Egyptian jewellery containing granulation are dated to the Middle Kingdom, as if this technique became suddenly available under the 12th Dynasty. Among the better known objects from this period are Khnumet's five-pointed starts and butterfly pendants, entirely decorated with granulation (Seipel 2001, 53; Rosenberg 1915, 1918). These objects, typologically and technologically unique in Egypt, suggest an Eastern origin and could therefore be an import. However, besides Khnumet's jewellery, a few other gold items decorated with granulation were found in Dahshur. In fact, two finger-rings from Mereret's burial, shown in Figure 8.37a,b (52.238 and 52.239 in Vernier 1907–27), are decorated with geometrical patterns containing granules, similarly to the gold bracelet found on the top of one of the two boxes of the Tod treasure (Bisson de la Roque et al. 1953, 9; Lilyquist 1993, 78). While these quite simple patterns are technologically far from those employed in the manufacture of Khnumet's jewellery, they appear to follow the same inspiration as those employed in the decoration of Mereret's cylindrical pendant amulet shown in Figure 8.37c (from de Morgan 1895).[6] In addition, the pattern formed by wires and

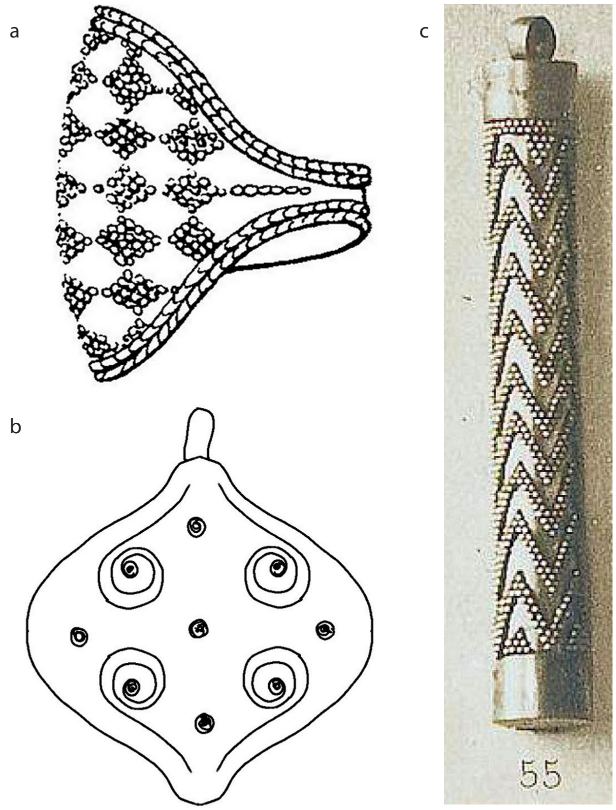



**Figure 8.37.** *Jewellery from Mereret's burial in Dahshur. (a) Finger-ring decorated with granulation (from Vernier 1907–1927, 89), (b) finger-ring decorated with wire and granulation (drawing M.F. Guerra based on Vernier 1907–1927, pl. 22), and (c) a cylindrical gold pendant amulet decorated with granulation (from de Morgan 1895, pl. 24).*

granules applied to one of Mereret's finger-rings, shown in Figure 8.37b, stylistically resembles the decoration of the cylindrical pendant amulet from tomb E 108 at Abydos (University of Pennsylvania Museum E9198: Garstang 1901, 4–5, pl. 1). This tomb also yielded a lapis lazuli scarab inscribed for the high official Hor.[7] Interestingly, during the excavations of Byblos, in contexts dated to the same period, two cylindrical gold pendants were found, one decorated with wire spirals with granules, and the other with rows of chevrons (respectively nos. 1859 and 2314 in Dunand 1937, pl. 136) similar to the Egyptian ones (see Lilyquist 1993 for further discussion).

Cylindrical pendant amulets decorated with geometric patterns are among the earliest examples of Egyptian jewellery containing patterns in granulation. Cylindrical amulets, which seem to be quite popular Middle Kingdom adornments, are in general of two types. One type consists of alternate discs of gold and stones with a gold cap at each end and a gold suspension ring, similar to an amulet from tomb 459 in the North Cemetery at Abydos (E.2365 in the collection of the Garstang Museum of Archaeology in Liverpool is discussed in Chapter 8.6; Snape 1986). The other type consists of a gold decorated tube with a gold cap at each end and a gold suspension ring. Even if the decoration consists quite often of the application of wires and granulation (Williams 1924, pls. 1–2), it can also be obtained by chasing (an example is an amulet from excavations at Abydos, E7567 in the collection of the Oriental Institute Museum in Chicago).

Besides amulets UC6482 from tomb 211 at Haraga, E9198 from Abydos tomb E 108, and Mereret's specimen from Dahshur, several other gold amulets decorated with wires and granulation can be cited. Examples are those found during the excavations at Lisht (Brooklyn Museum 59.199.1, Metropolitan Museum of Art 22.1.61), and Saqqara (Brooklyn Museum 37.701E; Bleiberg 2008, 88). Two of them are shown in Figures 8.38 and 8.39.

**Figure 8.38.** *Cylindrical gold amulet pendant from Lisht North, cemetery south of pyramid, between Houses A1:2 & A2:4, Pit 368, MMA excavations 1920–21. The Metropolitan Museum of Art, Acc. no. 22.1.61, Rogers Fund and Edward S. Harkness Gift, 1922.*

**Figure 8.39.** *(left) Hollow cylindrical gold amulet pendant from Saqqara,* c. *1938–1759* BC *(4.8 cm high × 0.8 cm diameter). Two rough-cut garnets were found in it. The outer case is gold and originally had an inner cylinder of copper or bronze. (right) Broken in centre but reconstructed. Several pieces of the metal are missing from this broken centre area and several pieces of granulation are missing due to the break. Brooklyn Museum, Acc. no. 37.701E, Charles Edwin Wilbour Fund. Photos: 37.701E_PS2.jpg and 37.701E_37.718E_37.788E_37.789E_GrpA_SL4.jpg.*

These amulets recall 2nd millennium BC tubular gold beads such as one found with a fragment of another certainly larger during excavations at Tell Atchana (British Museum 1938,0108.110 and 1938,0108.112), shown in Collon (1995, 119, fig. 96), and two from the excavations of Marlik (Parrot 1968). The latter are tubular gold beads filled with natural bitumen (Negahban 1996, pl. 76); one from tomb 26 (no. 310) is 3 cm long and the other, from tomb 32 (no. 311), is 6 cm long. Smaller specimens are contained, for example, in the necklace from Kamid el-Loz (Lilyquist 1994, pls.18–20).

The similarity between the Egyptian amulet pendants and the Eastern gold beads raises several questions. In fact, the 'abrupt' introduction of granulation in the Egyptian workshops can be related either to the work of foreign craftspeople who produced the first objects and trained Egyptian goldsmiths to gain skill on it, or to the import of objects. When we consider, for example, the two shell-shaped pendants with the name of Senusret II, one containing a row of granules surrounding the cartouche (Metropolitan Museum of Art 26.7.1353), and another with the cartouche in wires and two granules (from Riqqa tomb 124, see Chapter 8.2), it is tempting to accept the first hypothesis, because they were made in the 'Egyptian tradition'. However, when we consider the rather particular jewellery of Khnumet and the earlier Sumerian and other beads with granulation, the second hypothesis becomes quite plausible. Despite the small size of these beads, one of those from Marlik (no. 311, from tomb 32, Negahban 1996, pl. 76) is 6 cm long. It is thus also tempting to imagine, if they existed in earlier periods, a change of the beads' function by adding caps and suspension rings, necessary to make cylindrical amulets.

It is difficult to provide further discussion on this question; however, it is still possible to consider the geometric patterns in granulation. Triangles, lozenges and zigzags obtained by application of lines and fields of granules are quite widespread in decoration of the earliest jewellery. This is attested, for example, by a pair of earrings from the excavations of Mari dated to the end of the 3rd millennium BC (Nicolini 2010, 124–5, pls. 98–101). These patterns became popular during the 2nd millennium BC, as illustrated by the gold bead and fragment from the Tell Atchana Palace. Like the one from Marlik, those from Tell Atchana have triangular patterns in granulation similar to those that decorate many of the Middle Kingdom Egyptian pendant amulets cited above. Other gold beads from Marlik are a little different. The biggest one (6 cm long) is decorated with groups of three granules, recalling the decoration of the silver amulet in a necklace from the Classic Kerma period (1700–1550 BC) found in cemetery S at Kerma (Museum of Fine Arts Boston K 1067.1913), and the four specimens in gold found in the New Kingdom tomb of the three foreign wives of Thutmes III (Lilyquist 2003, 259, nos. 182–5).

Finally, we must mention the bracelet found at the top of one of the boxes of the treasure of Tôd (Bisson de la Roque 1950, 4–5, pl. 9). It consists on a silver rolled wire and a gold mount containing a block of lapis lazuli and decorated with lines and triangules of granules. Lilyquist (1993) associates this to the decoration of an earring found in tomb 20 excavated at Assur.

**Technical study of amulet UC6482**

To shed light on amulet UC6482, in this section we describe its construction and investigate the composition of the alloys employed to manufacture the different parts of the object.

As noted above, the amulet is a hollow gold tube with a copper core and a gold cap at each end. One of the caps and the suspension ring of the amulet are shown under the SEM in Figure 8.40. The cap is a slightly tapered cylinder made by curving a gold strip to which is soldered a closing disc in gold. The circular suspension ring is also a bent strip of gold. The visual colour assessment indicates the use of different gold alloys: caps are reddish and the granulated body is yellowish. Under the SEM, perhaps due to the finishing process, their surface textures also look different.

The amulet was analysed by EDS for the composition of the different parts. The results obtained are provided in Table 8.11. They show that the gold sheet that forms the amulet's body contains high Ag contents, contrary to the caps. One of the caps contains high copper contents, a result that agrees with the visual reddish colour observed. The other cap is made from an alloy containing a similar quantity of silver but lower copper contents. Its composition is also different from the amulet's body composition.

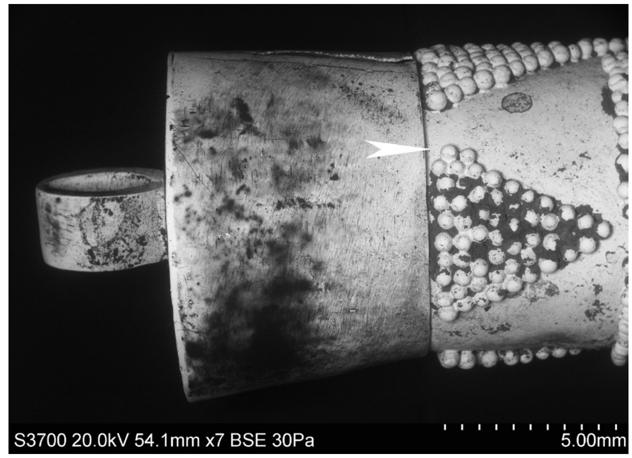



**Figure 8.40.** *Detail under the SEM of the cap and suspension ring of amulet UC6482 as well as one of the triangles in granulation that decorate the gold tube. The two highlighted outer granules either were added by mistake or moved when being soldered.*

A closer look at the surface of the gold tube (Fig. 8.41) reveals a structure that can be associated to stress corrosion cracking at grain boundaries, certainly accelerated by the development of corrosion products at the surface of the copper core, which have expanded to occupy a larger volume. One of the caps, shown in Figure 8.41, is also cracked. In this figure is visible the joining seam of the curved sheet that forms the cylindrical body and its border that seems to have been polished.

The point analysis of the core through the big fissure, shown in Figure 8.36, confirmed the presence of the usual corrosion products of copper: copper oxides and chlorides (see Table 8.11). The black deposits that are visible under the SEM among some granules (Fig. 8.42) are organic-rich contamination.

**Table 8.11.** *Results obtained by SEM-EDS for the tube and the caps of amulet UC6482. On the exposed core surface were identified the common corrosion products of copper.*

| Region of analysis | Cu wt% | Ag wt% | Au wt% | O wt% | Cl wt% |
|---|---|---|---|---|---|
| *Region 1* | | | | | |
| bottom cap | 10 | 3 | 88 | | |
| upper cap | 2 | 5 | 92 | | |
| body sheet 1 | 2 | 16 | 82 | | |
| body sheet 2 | 3 | 17 | 80 | | |
| core | 62 | | | 23 | 15 |

Before going further with the analysis of amulet UC6482, it is interesting to consider its complete description by Petrie (1927, 6): '7 rows of 4 triangles each, of polysphere work; each triangle has 11 spheres on the side, or 66 in it; total 1848 spheres. Normally, the globules are 0.020 inch[8] each, but a few are rather larger, about 0.025. The ground is thin sheet gold, quite flexible, over a core of copper. The rusting of the copper has burst the sheet gold down one side. The globules were clearly all separate, and are held down by a rather paler gold solder. The heating was not done from under the sheet gold, as the solder only just joins the globule to the sheet, leaving hollow spaces between, but it has run freely between the globules. This shows that the heating was done by blow pipe on the top. How the globules could be held in position, on the curved surface, is hard to see. The caps at the end are of stout sheet gold, with sides coiled, and soldered to the ends. Such cases as this were of course only for show, and could not contain any charm, or be opened'.

One of the triangles in granulation is shown in Figure 8.42 under the SEM. It can be seen that the joins between some of the granules are relatively thick although they are not flooded with solder, which shows very delicate soldering using a very small amount of well placed solder. The solder forms a small meniscus joining adjacent granules. The granules have rather variable diameters. Two granules are highlighted, because they are representative of the maximum and minimum diameters that could be observed. The largest one has a diameter of *c.* 0.6 mm

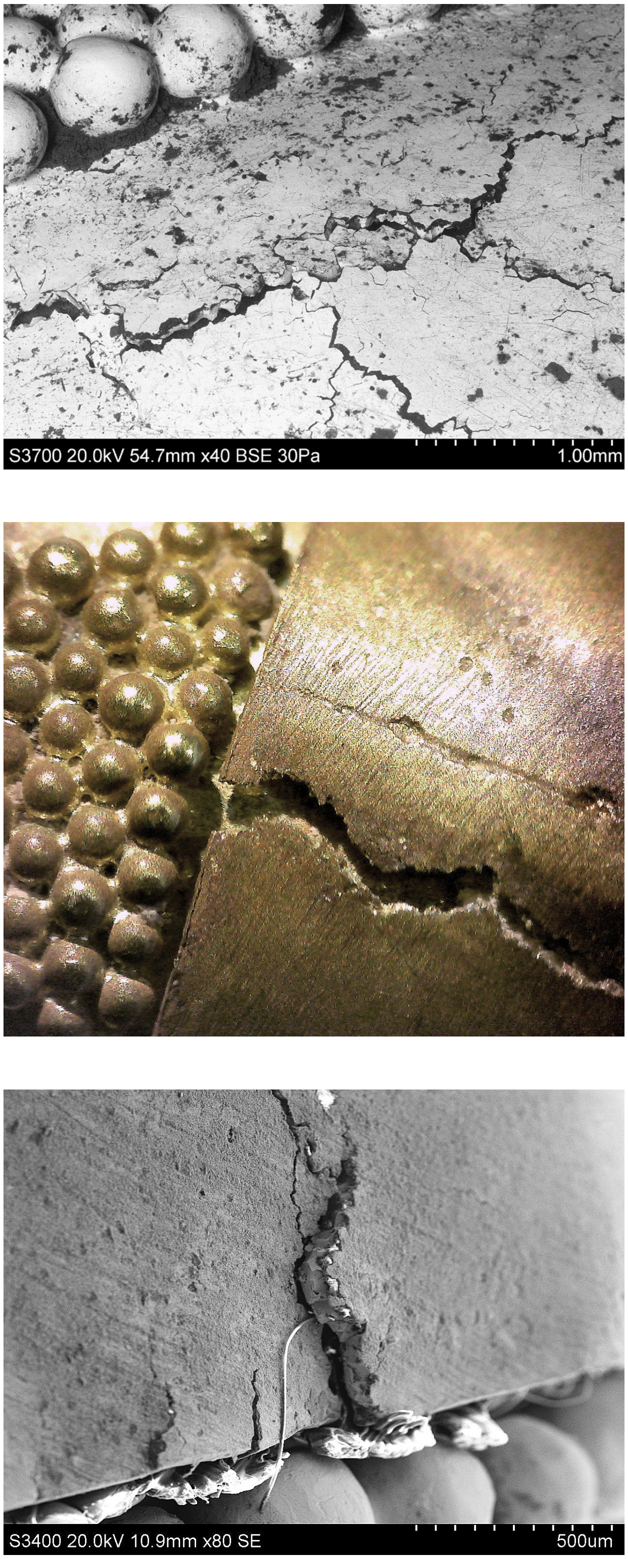



**Figure 8.41.** *Details of regions containing cracks on the surface of amulet UC6482: (top) of the gold tube under the SEM and (middle and bottom) of the gold cap under the stereomicroscope with a detail under the SEM.*

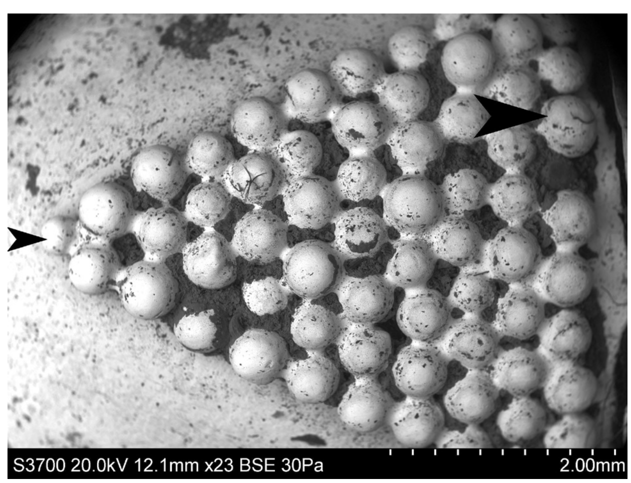



**Figure 8.42.** *SEM-SE image showing triangular geometrical designs of granulation on the tube of amulet UC6482. The largest (*c. *0.6 mm) and the smallest (*c. *0.3 mm) granules are highlighted.*

**Table 8.12.** *Results obtained by SEM-EDS for the granules and solders in several triangles in granulation applied on the body of amulet UC6482.*

| | Cu wt% | Ag wt% | Au wt% |
|---|---|---|---|
| *Region 2* | | | |
| granule1 | 1 | 2 | 97 |
| granule2 | 0.1 | 2 | 98 |
| granule3 | 0.5 | 2 | 98 |
| granule4 | 0.3 | 3 | 97 |
| solder 1-2 | 2 | 15 | 83 |
| solder 2-4 | 3 | 14 | 84 |
| solder 3-4 | 3 | 13 | 85 |
| *Region 3* | | | |
| granule1 | 0.3 | 2 | 98 |
| granule2 | 0.4 | 2 | 98 |
| granule3 | 0.5 | 2 | 97 |
| solder 1-2 | 4 | 19 | 77 |
| solder 1-3 | 7 | 11 | 82 |
| *Region 4* | | | |
| granule1 | 1 | 2 | 97 |
| granule2 | 0.5 | 2 | 97 |
| solder 1-2 | 3 | 22 | 75 |
| granule3 | 1 | 3 | 96 |
| granule4 | 1 | 2 | 97 |
| solder 3-4 | 4 | 21 | 76 |
| granule5 | 0.4 | 3 | 97 |
| granule6 | 0 | 2 | 98 |
| solder 5-6 | 2 | 14 | 84 |

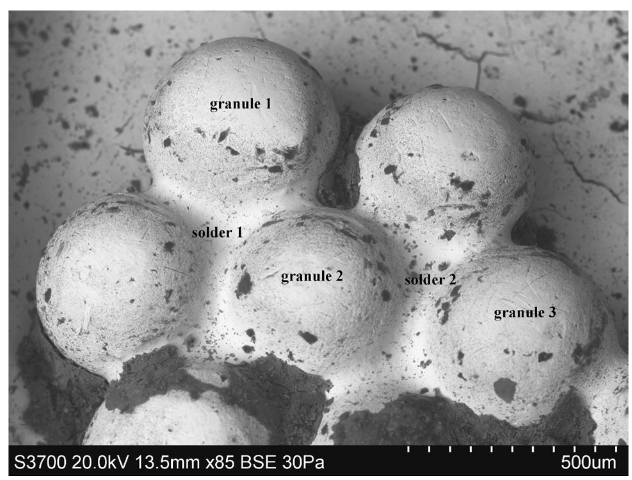
and the smallest one a diameter of *c*. 0.3 mm, which means that the granules are more heterogeneous than suggested by Petrie.

The rather visible joins of the granules were said by Petrie (1927, 6) to be obtained by using a 'rather paler gold solder' and by employing a 'silver-rich gold alloy' as noted by Jack Ogden (1992, 52). We analysed the compositions of the granules and the solder alloys in several granulated triangles. Figure 8.43 shows the SEM details for one of the analysed regions and the data obtained by surface EDS for the granules and adjacent solders. The granules are made from gold alloys quite high in gold, whilst the solders contain higher amounts of copper and 21–22 wt% Ag, which is typical of hard solders. The compositions correspond to the use of pale greenish yellow alloys for the solders and yellow alloys for the granules.

Several other granules and joins were analysed in different areas, with the data summarized in Table 8.12. The solder between granules always contains higher silver and copper contents than any granule. In all of the analysed solder alloys, silver contents range from 11 to 22 wt% and copper contents range from 2 to 7 wt%. When compared to the composition of the amulet's body, provided in Table 8.11, we can say that the solder was in this case an alloy with lower melting point by containing higher amounts of silver and some more copper.[9]

The gold tube finely decorated with granulation and the caps are not made with the same type of alloys. The tube is made in a silver rich gold alloy, containing 16 wt% Ag and 2 wt% Cu. The caps are different: one is made from an alloy containing 5 wt% Ag and 2 wt% Cu and the other is made in an alloy particularly rich in copper, containing 10 wt% Cu and 3 wt% Ag. To the top of the first cap is soldered the suspension ring of identical composition (5 wt% Ag and less than 1 wt% Cu). The solder alloy employed to join the suspension ring to the cap contains higher amounts of both silver (11 wt%) and copper (5 wt%) to lower the melting point.

The variability in the alloys employed in the manufacture of amulet UC6482 appears to suggest that alloys, sheet, wire, granules and final assembly of an object were a product of a multi-disciplinary




| Area of analysis | Cu wt% | Ag wt% | Au wt% |
|---|---|---|---|
| solder 1 | 3 | 21 | 76 |
| solder 2 | 3 | 22 | 74 |
| granule 1 | 1 | 8 | 91 |
| granule 2 | 1 | 6 | 93 |
| granule 3 | 1 | 3 | 96 |

**Figure 8.43.** *Detail under the SEM of one of the analysed triangles in granulation applied on the body of amulet UC6482 and the composition of the granules and solders obtained by EDS.*

workshop, each artisan with their own speciality, rather than a single artisan making everything. The most intriguing result obtained is the composition of the solder alloys. Instead of reducing the melting point by adding copper to the gold alloy, which seems to be so far the common practice in the Egyptian workshops (Roberts 1973; Troalen et al. 2014; Troalen & Guerra 2016; Guerra & Pagès-Camagna 2019), the solder used to join the granules contains in fact a higher amount of copper but particularly high amounts of silver.

As mentioned in the previous section, tubular beads decorated with patterns in granulation seem to be much more commonly represented in the work of the Eastern goldsmith. Gold objects from Ur are quite often made from alloys containing high silver contents and sometimes quite high copper contents (Hauptmann et al. 2018). The composition of the solders was not accurately determined, but in his report on the solders used to mount some objects from the excavations at Ur, E. A. Smith (1930), indicates the use of alloys quite rich in silver, reaching at least 40 wt%, in one of the studied pieces because of the whitish colour of the join. This author also provides the composition of two gold beakers from Ur. The two pieces are made from gold alloys containing 23–25 wt% Ag and 1–2 wt% Cu, comparable to those employed to solder the granules of amulet UC6482. It is also interesting to consider the composition of the Late Uruk gold cast dog-shaped pendant found at Susa (Sb 5692 in the collection of the Louvre Museum). The animal is made from an alloy containing 9 wt% Ag and 1 wt% Cu and the solder used to join the suspension ring contains 15–20 wt% Ag and 5–6 wt% Cu (Duval et al. 1987; Eluère 1998).[10]

Therefore, amulet UC6482 could either result from the reuse and repurposing in Egypt of an Eastern tubular bead, or the joint work of one Eastern goldsmith and one Egyptian goldsmith, perhaps working in one workshop. One would have made the granulated tube and the other finished the amulet.

## Notes

1. The liquidus temperatures of gold alloys vary with the amounts of the alloying elements (see Chapter 1). For example, a gold alloy containing 6.3 wt% Ag and 2.1 wt% Cu has a liquidus temperature of 1024°C, while another containing 21.4 wt% Ag and 3.6 wt% Cu has a liquidus temperature of 976°C (Jacobson & Humpston 2010, 180).
2. For example, the string of beads University of Pennsylvania Museum 83-7-1.16.
3. Private houses and graves, Diyala region, Khafajah, level unknown, P47, Kh.III 28 (Delougaz et al. 1967, 57).
4. Grave 190, burial A, object 7: 'A necklace of small gold beads with 6 ball beads and a large bead of coiled spiral wire welded together (…) all of gold. Like beads found in 1st to 3rd Dynasties in Egypt, (…)' (Reisner 1910, 50–1).
5. Tomb 7 (2600–2450 BC) contained many gold objects. Detailed images of the mention bead published by Prévalet (2014) show that all the wires and granules are flattened by use-wear.
6. The four cylinder amulets of Mereret are shown in Müller & Thiem (1999, 94, fig. 191).
7. The decoration of the cylindrical amulet from tomb E108 consists of lines of five spiral 'S' in gold wire enhanced each with two granules, which is quite different from the decoration of the other known amulets of this type. Here were also found the two small fish-shaped pendants in gold and feldspar. This group of jewellery is in the collection of the University of Pennsylvania Museum (Wegner 2014, 47).
8. Corresponding to 0.5 mm.
9. A particular liquidus temperature can be attained using different alloys. For example, one gold alloy containing 4.2 wt% Ag and 4.2 wt% Cu, and another containing 21.4 wt% Ag and 3.6 wt% Cu have close liquidus temperatures (respectively, 971°C the first and 976°C the second, Jacobson & Humpston 2010, 180).
10. One bracelet from the same site dated to the 3rd millennium BC was however mounted using a solder richer in copper (Duval et al. 1989).

## References

For references see pp.309–12 at the end of this chapter.

# *Chapter 8.6*

# Jewellery from Abydos excavated by Garstang

Maria F. Guerra, Lore Troalen, Matthew Ponting & Ian Shaw

Following his fieldwork in Cemetery E for the Egyptian Research Account under Petrie in 1899–1900, John Garstang, Professor of Archaeology at the University of Liverpool, undertook extensive excavations between 1906 and 1909 at Abydos, in Upper Egypt, over the area called the 'North Cemetery', containing tombs from across the 2nd and 1st millennia BC. A detailed corpus was created by Steven Snape, based on Garstang's field notes and archival data (Snape 1986).

Many of the objects from Garstang's Abydos excavations are now in the Garstang Museum of Archaeology at the University of Liverpool, including a small group of gold jewellery, gilded wooden objects and gold leaves that were selected for analytical study with the aim of understanding the art of the goldsmith at Abydos in the Middle Kingdom. As the process of hammering gold to leaves for the decoration of multiple supports is a specific craft that might be presumed to be the work of distinct craftspeople or workshops, we compared the composition of the gold alloys employed at Abydos for the manufacture of jewellery to the hammered leaves used for decoration. Data obtained for Abydos is also compared to data presented in the previous chapters for gold items from other Middle Kingdom excavated sites.

## The analysed corpus

During the 1907 and 1908 seasons respectively, Garstang excavated tombs 381 and 533 at the southern edge of the North Cemetery at Abydos, which contained gilded objects. On the basis of the other contents of these two tombs, including such diagnostic items as a decorated wooden coffin fragment in tomb 381 and an anhydrite vessel in tomb 533, both are thought to have contained the burials of Middle Kingdom individuals, although this does not exclude intrusive burials in later periods. In particular, the motifs on gilded object E.5728 recall Late Period depictions of amulets (Stünkel 2015b).

These objects were analysed for the composition of the gold alloys employed in their production, together with a quantity of gold leaves in the Garstang Museum that had probably originally been attached to a wooden artefact destroyed by burning. These leaves almost certainly derive from Garstang's Abydos excavations in 1908, since they are stored in the museum alongside objects clearly labelled as deriving from that season at Abydos. There is, however, no longer any indication of the date or location of the specific grave in which the leaves were found.

In addition to the gilded objects and gold leaves, we studied two items from tombs 405 and 459 excavated by Garstang during the same seasons, and also containing the burials of Middle Kingdom individuals. Inside tomb 405 was found a gold mount for a heart-scarab (E.944) together with other objects, including a gold shell-shaped pendant and a gilded fragment of wood (Snape 1986, 252). Inside tomb 459 was found, alongside two vessels and one scarab, a cylindrical pendant amulet (E.2365) made of blue faience with gold caps at each end (Snape 1986, 253). Finally, a third object from tomb 492 (excavated in 1908) was also considered; this was actually a group of spherical, ring, drop and barrel beads today strung together (E.2380), made of several materials including gold (Snape 1986, 260). Those in gold are one barrel bead and two small ring beads, typologies regularly found in contexts dated to many different periods. The contents of tomb 492 also featured a *wedjat*-eye amulet, a fragment of a clay seal impression and pottery, including three examples of Garstang's drop-shaped type 55, which is described by Stephen Snape as one of 'the most typical Second Intermediate Period/Early Eighteenth Dynasty pottery types' (Snape 1986, 128, 193; see, more recently, a similar example from Edfu, illustrated in Wodzińska 2010, 37).

## Technological study

The gilded objects from the excavation of tomb 381 (E.5727 and E.5728) and tomb 533 (E.5726) at the southern edge of the North Cemetery at Abydos are shown in Figures 8.44, 8.45 and 8.46. All of them are in gilded wood, but one of them is decorated with black painted figures (E.5728). In order to examine the composition of the gold alloys employed at Abydos in the Middle Kingdom for the production of sheet gold, we also analysed several gold leaves on or from wooden artefacts (432-24 and 432-25) found (probably) in tomb 432 during Garstang's Abydos excavations in 1907 (Snape 1986, 247).

During the 1907 excavations of other burials in the North Cemetery at Abydos, Garstang discovered several gold objects. We selected two of them for analytical study. One is the gold mount for a heart-scarab (E.944) found in tomb 405. It consists of a roughly cut gold sheet to which a gold rim was hard soldered, forming an open box where the missing scarab should have been originally set (Fig. 8.46). The underside of the gold base sheet, was chased (parts engraved) with Book of the Dead spell 30b.

Despite the poor condition of the sheet edges of the heart-scarab mount, there are no marks of wear and the motifs look quite 'fresh'. However, this is not very skilled work. The text was roughly chased (a few lines seem engraved), as illustrated in Figure 8.47a, perhaps using inappropriate tools or unsuitable methods. In fact, considering both the work that was being undertaken and the malleability of gold, there is no apparent reason why chasing should have been conducted with such force to the hammer, to obtain the motifs by plastic deformation. Under grazing light, the entire text appears blistered on the other side of the gold sheet. The force applied is so strong that in some hieroglyphs the metal was pierced, as shown in Figure 8.47b.

The second object selected for analytical study is one of the most popular Middle Kingdom artefacts (E.2365): a cylindrical pendant amulet in gold and blue faience, very similar to a finer specimen in gold and lapis lazuli found in Middle Kingdom tomb H213 at Kumma (Sudan) by the Harvard University – Boston Museum of Fine Arts Expedition (MFA 27.918). The amulet E.2365 was found during the excavations of tomb 459. It consists of ring beads strung along a copper rod, with gold caps at each end, as shown in

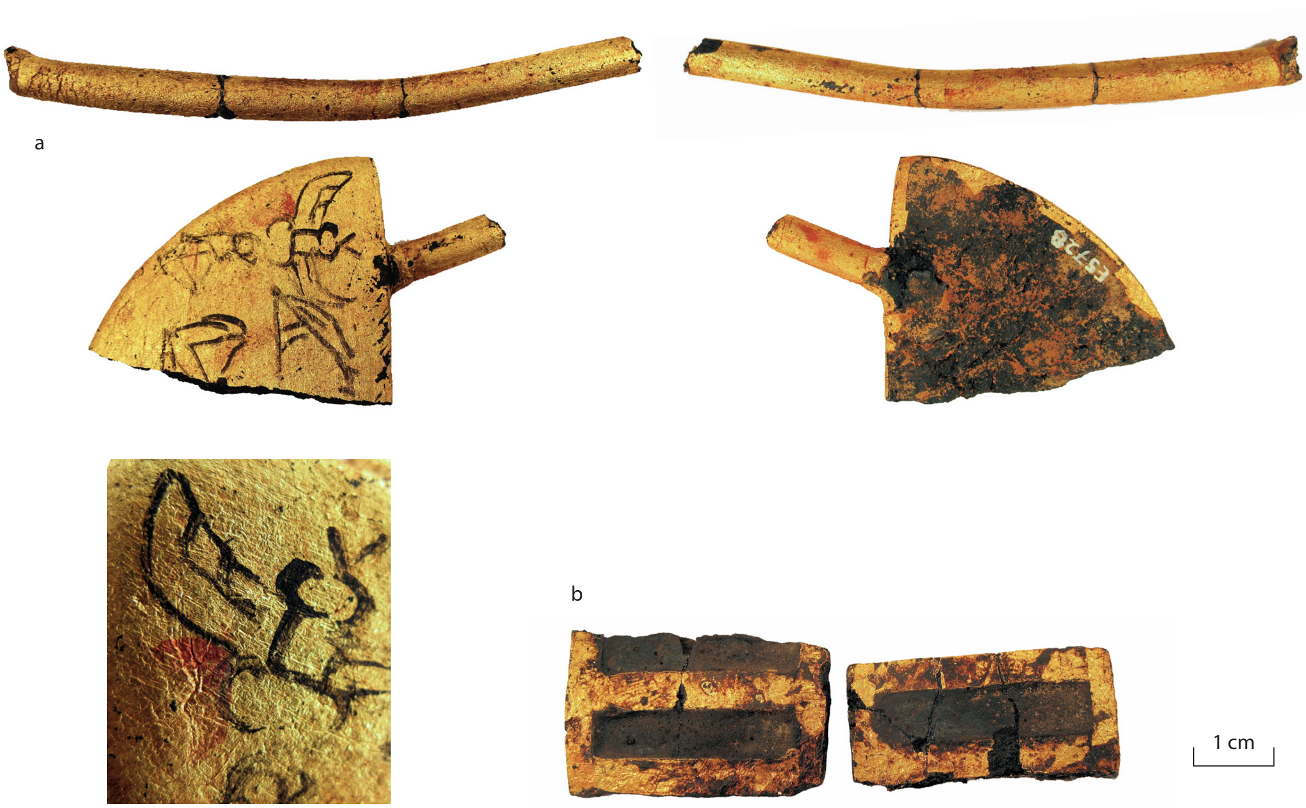



**Figure 8.44.** *Gilded objects from the excavation of tomb 381 at Abydos in the collection of the Garstang Museum: (a) wooden object with gold leaf and black painted figures (E. 5728) with a detail of the painted motif and (b) fragments of wood with gold leaf (E. 5727).*



**Figure 8.45.** *Fragments of gilded wooden artefacts from excavation at Abydos in the collection of the Garstang Museum: (a) from tomb 533 (E. 5726) and (b) found probably in tomb 432 during excavations in 1907 (E.432-24).*

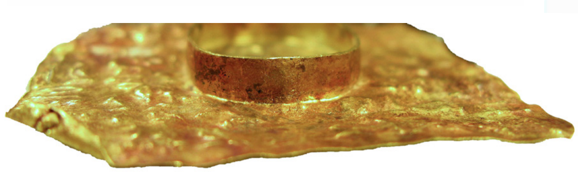



**Figure 8.46.** *Gold mount for a heart-scarab found in tomb 405 at Abydos (E. 944, Garstang Museum) with a detail of the hard-soldered rim.*

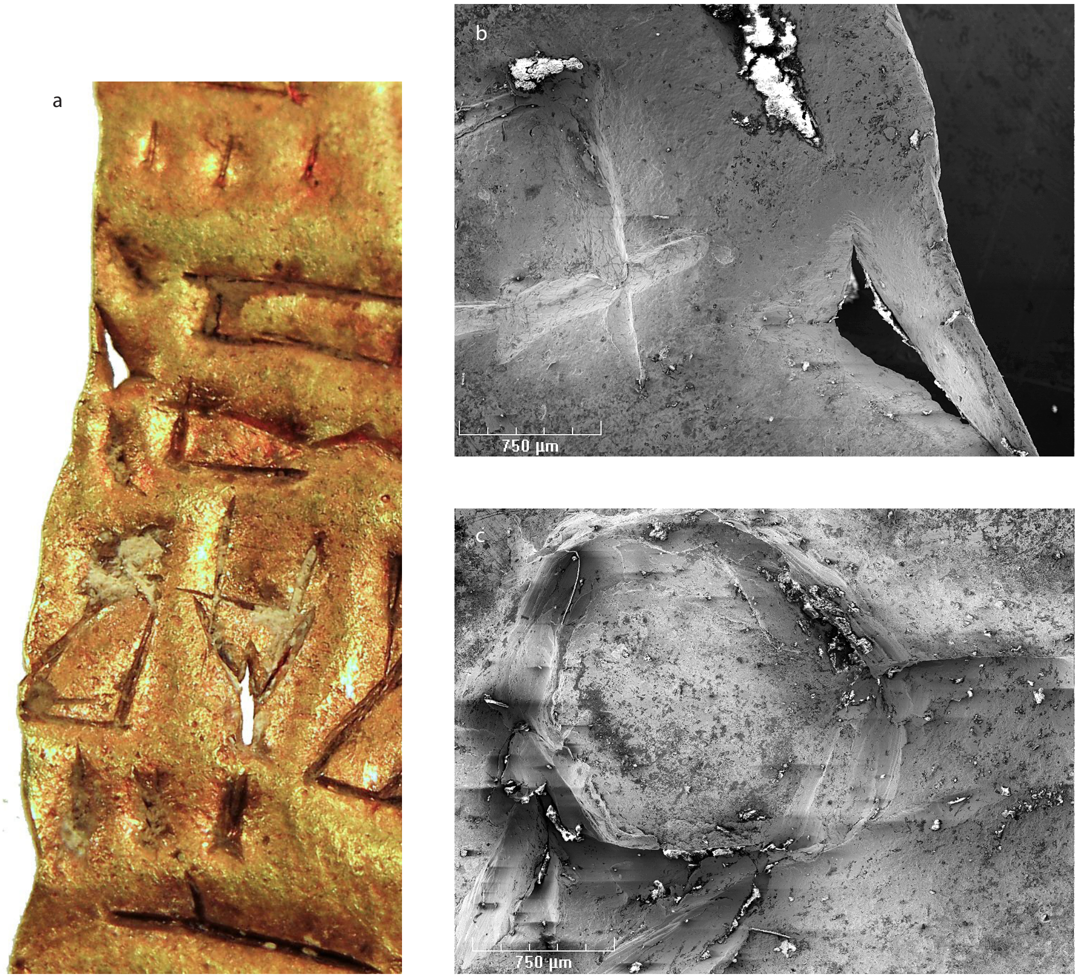



**Figure 8.47.** *Details of the gold mount for a heart-scarab (E. 944). (a) One of the regions where the gold sheet was pierced when chasing the motif. Details under the SEM of (b) the pierced gold sheet and (c) the chased lines of the motifs.*

Figure 8.48. The missing caps in one amulet of this type, supposedly from de Morgan's excavations at Dahshur (Metropolitan Museum of Art 26.71308), means that in this instance the stringing rod is visible.

The blue ring beads alternate with six gold rings. The gold rings are thin strips of gold bent over an undetermined core. Figure 8.49 shows details of one of these gold rings. The observation under the stereomicroscope reveals that the gold sheet could have been pre-marked before cutting the strips. After bending, the gold sheet was soldered, with the joining seam still visible under the SEM.

The two gold caps (Fig. 8.50) are different. The top one, which covers the upper part of the copper rod, leaving the suspension ring in coper visible, is a folded and creased gold sheet. The bottom cap that

**Figure 8.48.** *Cylindrical pendant amulet with gold caps from tomb 459 at Abydos in the collection of the Garstang Museum (E. 2365).*

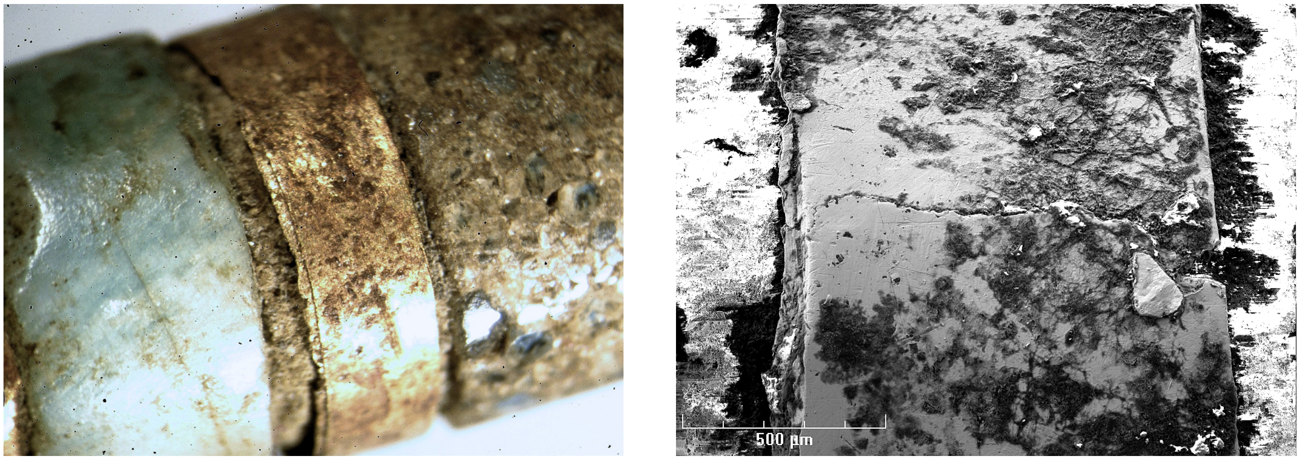



**Figure 8.49.** *One of the gold rings in cylindrical pendant amulet with gold caps (E.2365) showing that the gold strip was cut from a pre-marked sheet. After coiled over the core the strip was soldered.*

covers the end of the copper rod is a small tube closed at the bottom by a gold disc.

Finally, we studied one restrung set of beads from tomb 492 (E.2380) that contains two small ring beads in gold and one hollow barrel bead in electrum; although the pottery in this grave indicates a date in the Second Intermediate Period or early 18th Dynasty, the beads may be reused or from a Middle Kingdom burial within the same grave. All three of these tomb 492 beads are made from sheet gold. The ring beads are folded strips of gold (Fig. 8.51) and the barrel bead shows at each end marks of wear-use caused by friction with the adjacent beads, which were certainly made from a harder material than gold, such as stone (Fig. 8.51).

**Figure 8.50.** *The gold caps of the cylindrical pendant amulet (E.2365): (above) the top one, where the copper rod is bent to form the suspension ring and (below) the bottom one that hides the copper rod end.*

### The gold alloys

Data obtained by SEM-EDS and XRF for the gold leaves from Garstang's excavations at Abydos are summarized in Table 8.13 and plotted in Figure 8.52. The amounts of copper are mostly under 2 wt% while the silver contents range from 0 to 12 wt%, indicating the choice of gold alloys with good malleability for the hammering process. The gilding leaves that decorate the wooden objects from tombs 381 and 533 contain high gold contents. The other analysed gold leaves are of different compositions, which supports the supposition that they come from different objects and must have been applied to several different types of substrate.

In Figure 8.53 we plotted the composition of the gold foils from the excavations at Lahun and Haraga, presented in Chapter 8.4, together with those from the excavations at Abydos. The majority of the analysed foils are contained in an area of the graph characterized by silver contents of about 10–15 wt%. A few others contain higher silver contents and the remaining are contained in an area characterized by silver contents ranging from 0 to *c.* 10 wt%. Interestingly, the gold foils from Abydos match those of different composition from royal tombs 7 and 8 excavated at Lahun in the collection of the Petrie Museum (see Chapter 8.4).

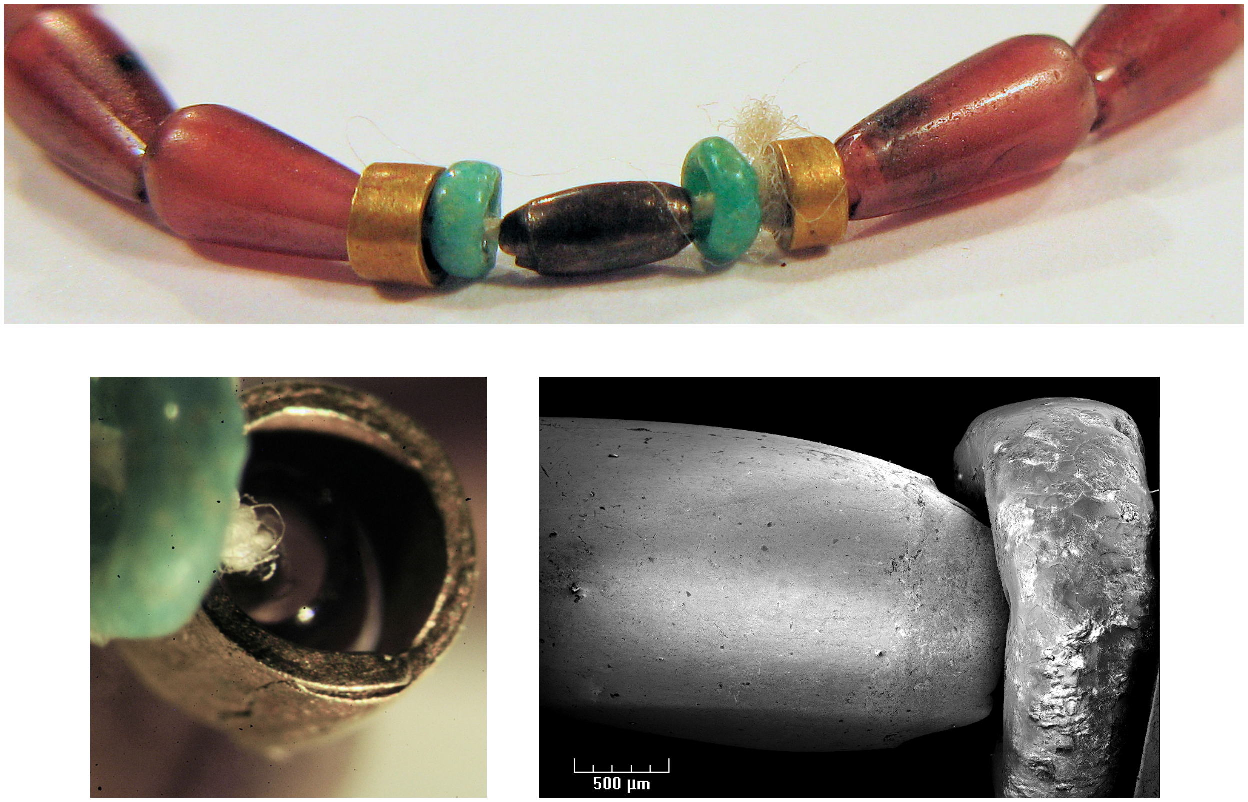



**Figure 8.51.** *The gold and electrum beads in the string from tomb 492 excavated at Abydos in the collection of the Garstang Museum (E.2380), with details of one of the gold ring beads and the wear marks at the end of the barrel bead.*

**Table 8.13.** *Results obtained by SEM-EDS for the foils and jewellery from excavations at Abydos.*

| Objects | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| String E 2380 | | | |
| ring bead 1 | 94.0 | 4.8 | 1.1 |
| ring bead 2 | 95.0 | 3.9 | 1.1 |
| barrel bead | 38.9 | 58.7 | 2.4 |
| Amulet E2365 | | | |
| cap 1 | 85.9 | 11.6 | 2.5 |
| cap 2 | 77.9 | 19.3 | 2.8 |
| bead 1 | 74.8 | 16.1 | 9.1 |
| bead 2 | 60.8 | 35.0 | 4.2 |
| bead 3 | 80.6 | 16.4 | 2.9 |
| Heart-scarab E944 | | | |
| base sheet | 83.2 | 16.3 | 0.5 |
| rim | 83.0 | 15.2 | 1.9 |
| solder | 78.6 | 17.3 | 4.1 |
| Gold leaves 432-25 | 96.9 | 1.4 | 1.7 |
| | 91.5 | 7.2 | 1.3 |
| | 93.9 | 5.1 | 1.0 |
| | 96.6 | 2.3 | 1.2 |
| | 89.0 | 10.0 | 1.0 |
| | 87.4 | 11.6 | 0.9 |
| | 89.7 | 9.4 | 0.9 |
| Wooden fragments with gold foil | | | |
| E 5726 | 94.6 | 4.0 | 1.3 |
| | 98.1 | 1.0 | 0.8 |
| | 98.2 | 0.2 | 1.5 |
| E5727 | 95.6 | <0.02 | 4.4 |
| | 98.3 | <0.02 | 1.7 |
| | 97.6 | <0.02 | 2.4 |
| E5728 | | | |
| part 1 | 97.9 | <0.02 | 2.1 |
| part 2 | 98.1 | <0.02 | 1.9 |
| 4321-24 | 96.7 | 2.1 | 1.2 |
| | 96.7 | 1.4 | 2.0 |
| | 94.6 | 3.7 | 1.7 |
| | 90.6 | 8.7 | 0.6 |
| | 90.4 | 8.7 | 0.8 |
| | 91.0 | 8.3 | 0.6 |

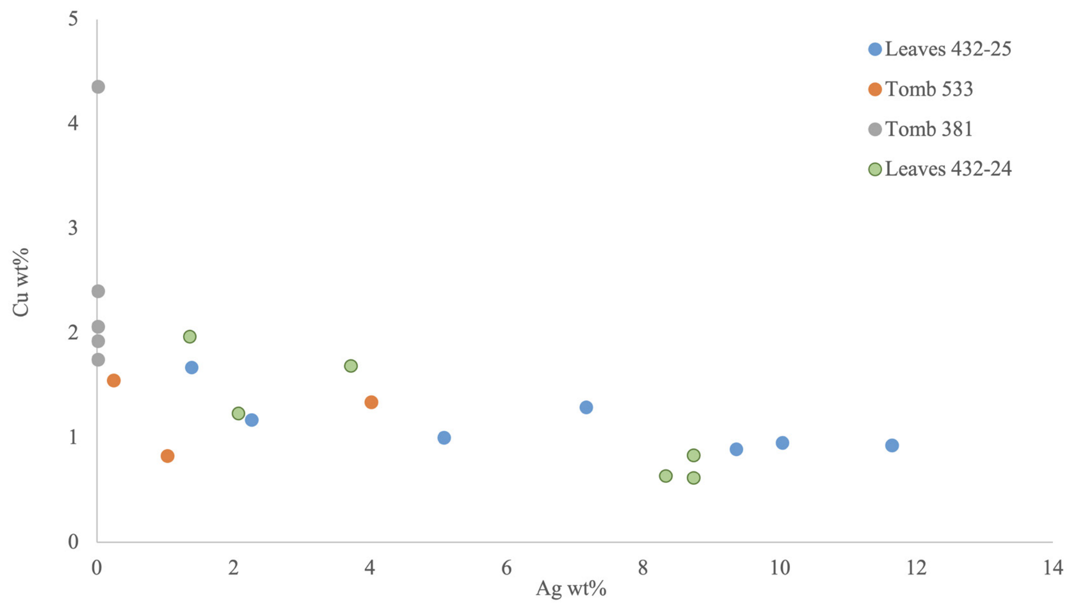



**Figure 8.52.** *Silver versus copper contents obtained by SEM-EDS for the gold leaves and wooden gilded objects from the excavations at Abydos.*

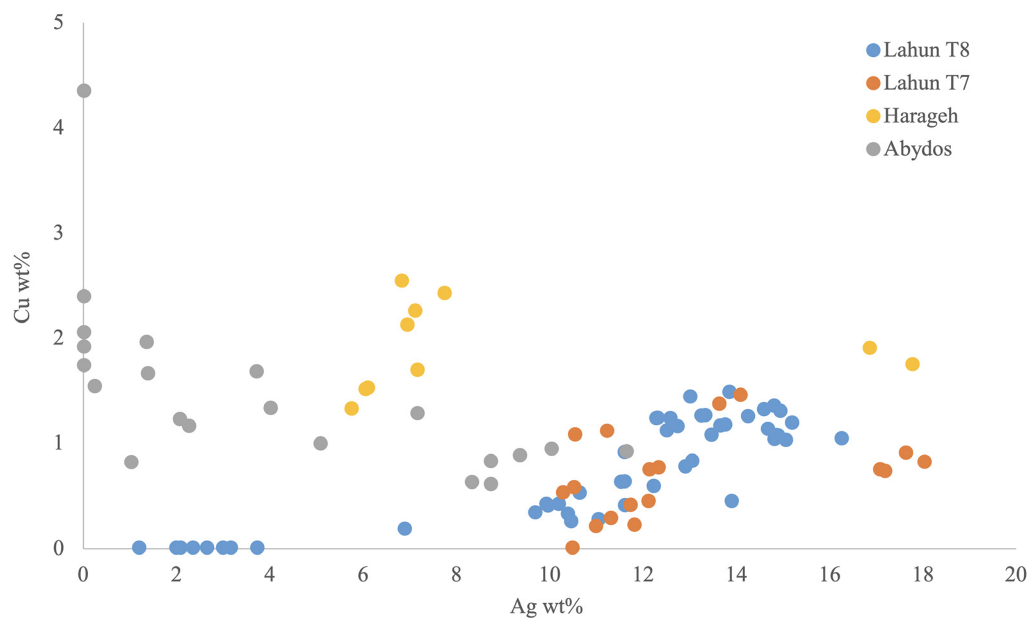



**Figure 8.53.** *Silver versus copper contents obtained by SEM-EDS for the gold leaves and wooden gilded objects from the excavations at Abydos compared to the data obtained by XRF for the gold leaves from the excavations at Haraga and Lahun in the Petrie Museum (see Chapter 8.4).*

The gold foils containing the highest gold contents were found in tombs 381 and 533 at Abydos and a few in tomb 8 at Lahun. In fact, those from Lahun are typically gold alloys containing silver amounts higher than *c.* 10 wt% (when the few richer in gold are excluded), while those from Abydos are typically gold alloys containing silver amounts under *c.* 10 wt% and copper contents that may attain 4 wt%, such as part of the gold foil from Haraga.

Data obtained by SEM-EDS for the gold objects from Garstang's excavations at Abydos are also summarized in Table 8.13 and plotted with the gold foils

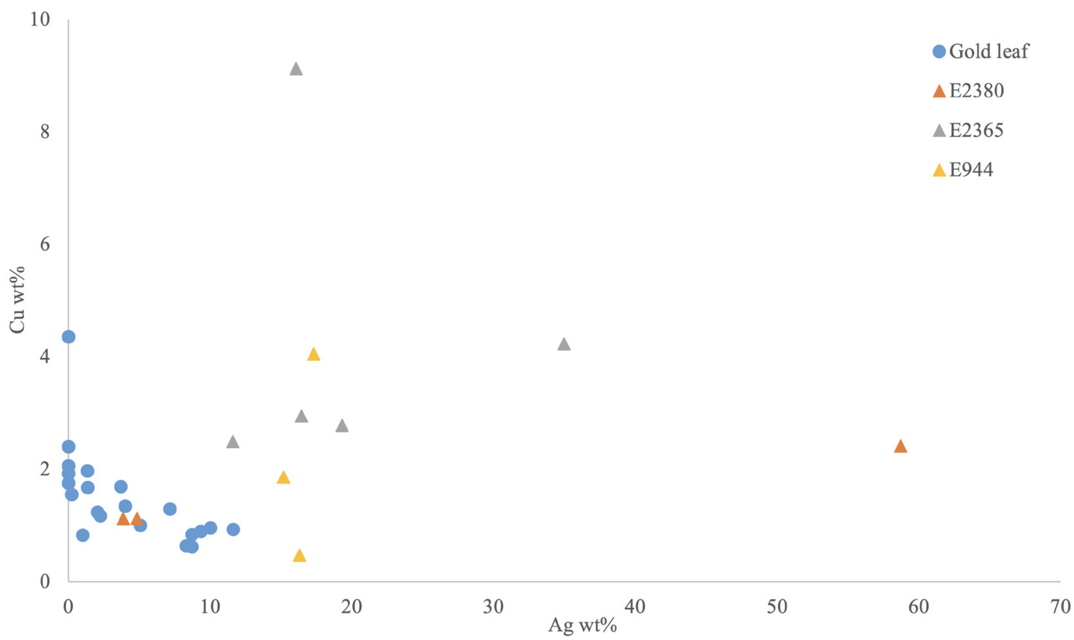



**Figure 8.54.** *Silver versus copper contents obtained by SEM-EDS for the gold leaves, wooden gilded objects and gold jewellery (heart-scarab mount E.944, cylindrical amulet E.2365 and string of beads E.2380) from excavations at Abydos.*

from the same site in Figure 8.54. As expected, the objects are made from alloys containing, in general, higher silver and copper contents than the gold leaf. The heart-scarab mount E.944 and the cylindrical amulet E.2365 are basically made from gold alloys with silver contents ranging from 10 to 20 wt%, which are typical values for natural alloys in Egypt. The use of alluvial gold at Abydos is confirmed by the presence at the surface of the heart-scarab mount of one visible osmium-iridium PGE inclusion (Fig. 8.55). Small quartz inclusions[1] were also visible at the surface of the heart-scarab and of some of the gold leaves. The analysis by the newly developed $D^2XRF$ technique at the BESSY II synchrotron (see Chapter 6) of a few gold leaves (432-25) allowed us to determine the presence of about 200 ppm of Pt in two of them, confirming that alluvial gold was also used in the production of gold foils (Tissot et al. 2015; Radtke et al. 2016).

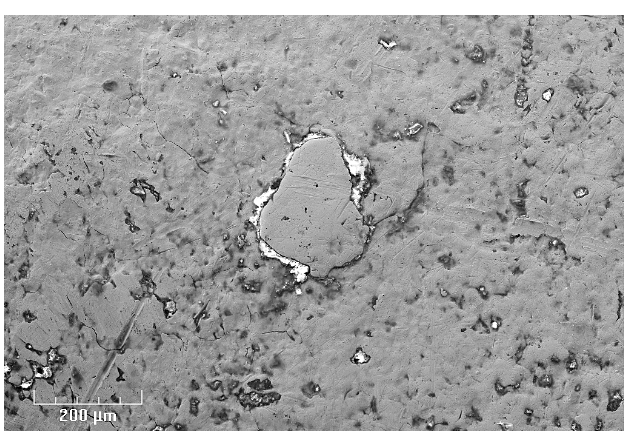



**Figure 8.55.** *One PGE inclusion at the surface of heart-scarab mount (E.944) under the SEM.*

Two rings in the cylindrical amulet E.2365 are however made from different alloys. One of them contains about 35 wt% Ag, and another contains 9 wt% Cu. This difference could indicate a possible desire for gold polychromy in the object by using alloys with several colour nuances (yellow, greenish and reddish) possibly together with the different shades of the blue faience, although this was not analysed.

It was also possible to verify one traditional Egyptian workshop practice that is the use of hard soldering process. The join between the gold base sheet and the gold rim that together form the heart-scarab mount E.944 was analysed by SEM-EDS. From the data obtained for the copper contents in the alloys of the base and the solder (see Table 8.13), and considering the morphology of the join under the SEM, it is possible to say that the hard soldering process was employed. The solder is a gold alloy containing a higher amount of copper to lower the melting point, a technique that was observed in several Middle Kingdom objects, such as the necklace of Wah (Schorsch 1995) and objects from tomb 72 at Haraga and tomb 124 at Riqqa analysed in this volume.

Concerning string E.2380, the barrel bead is an electrum alloy containing the highest Ag content (60 wt%) observed for the analysed items from the excavations at Abydos. In addition, none of the excavated Middle Kingdom objects that were analysed for this project showed such high silver contents. Only the shell-shaped pendant UC6391 from the excavations at Haraga (see Chapter 8.4) is close, with about 55 wt% Ag. Silver-rich alloys of this type were however, occasionally observed for objects dated to the Second Intermediate Period (see Chapter 9), such as the adult's girdle from Qurna (Troalen et al. 2014). It is to this period that some of the pottery contained in tomb 459 was attributed by S. Snape (1986). It is also interesting to consider some of the Middle Kingdom objects in the collection of the Ashmolean Museum analysed by Gale & Stos-Gale (1981). A few of them from the excavations of Abydos (unfortunately, none from tomb E30, Garstang 1901, 4–5) were shown to contain *c*. 60 wt% Ag or more. This indicates that the use of whitish gold alloys could be a workshop practice at Abydos in a period running from the Middle Kingdom to the early New Kingdom.

## Notes

1. As the presence of quartz as part of a natural gold nugget would mean that the nugget was hammered but not melted, the quartz grain probably became embedded in the matrix while hammering the gold.

## References

For references see pp.309–12 at the end of this chapter.

# Chapter 8.7

# Middle Kingdom jewellery in the collection of the Petrie Museum

Maria F. Guerra & Stephen Quirke

Besides the objects from excavations at Haraga, Lahun, Naqada and Buhen discussed in Chapters 8.4 and 8.5, the collection of the Petrie Museum includes a few further specimens dated to the Middle Kingdom that were selected for analytical study. All of them, with the exception of one string of thirty-five small gold ring beads (UC18836) from grave 1300 in the cemetery of Sidmant (Petrie & Brunton 1924), are unprovenanced, but their types are typical of the Middle Kingdom production.

The first item is one amulet in the form of a cylindrical case. Amulet UC52202 consists of an assemblage of gold sheets. As shown in Figure 8.56, and such as the top sheet, the bottom gold sheet that closes the amulet is folded over the amulet's body and the suspension ring is a curved ribbed sheet of gold soldered to one of the caps.

Because it contains one cowrie shell-shaped bead in gold strung with several components in amethyst, string UC8971 was also selected for study. The gold bead is made from two halves soldered together. The toothed edges of the shell's aperture were obtained by chasing. The cowrie shell-shaped bead was certainly not originally mounted in one simple string. As shown in Figure 8.57, the bead has two holes at each end. The cowrie-shaped bead makes a tinkling noise when shaken indicating the presence inside of metallic beads, such as those from the tomb of Hor at Abydos (Silverman 1997, 197). In the girdles of Mereret (Andrews 1990, 141–2) and Sathathoriunet (Patch 2015a, 2015b) the cowrie shell beads and the double leopard head beads also sound when shaken. Contrary to the cowrie shell beads in the girdles found in those royal tombs at Dahshur and Lahun,[1] this one has a gap-opening aperture. Cowrie shell-shaped beads of this type in the collection of the Metropolitan Museum of Art were found at Lisht, in the girdle from the burial of Hepy (MMA 34.1.154) at Lisht South, in a tomb situated west of the tomb of Senusretankh, and at Lisht North, during the excavations of the cemetery south of the tomb of Senusret (MMA 09.180.1200). They have as well two holes at each end. Figure 8.58 shows two of the cowrie shell-shaped beads from Hepy's girdle and one from Sathathoriunet's girdle.

String of carnelian ball beads UC8973 was also selected for study. As shown in Figure 8.59, it containing a few components in gold. The gold spherical beads of different dimensions are hollow, and made from bent sheet gold with soldered joints. The gold caps of the carnelian biconical beads are also made from sheet gold.

One string containing garnet spherical beads and several types of amulets and pendants, shown in Figure 8.60, was also selected. String UC36475 contains two gold nasturtium seed beads, four gold barrel beads, one gold shell-shaped pendant and one gold and agate cylindrical amulet. The shell-shaped pendant is today attached to the string with a modern ring of coiled drawn wire. Its suspension ring is, as expected, a bent gold strip soldered to the top of the shell. The cylindrical amulet consists on a cylinder in agate with gold caps at both ends, and with a hole that runs from end to end. The caps are a mounting of gold sheet. On the top of one of the gold caps was soldered a small ring made by bending a gold strip. This type of mounting is regularly used for beads in strings and in swivel rings (for example Williams 1924, 85–6, pl. 6.20e). As shown in Figure 8.61, the four gold barrel beads are made from thin sheet gold over an undetermined core. The two gold nasturtium seed beads, showing marks of wear, are made from thick ribbed gold sheet curved and soldered.

To complete the study, a last string containing thirty-five small gold ring beads from grave 1300 in the cemetery of Sidmant was studied. Sidmant context 1300 yielded no human remains, but contained a diverse assemblage of over fifty items, comprising both Egyptian and imported material. The excavators

**Figure 8.56** *(left and above). Details of cylindrical case amulet UC52202 (Petrie Museum) showing the bottom gold sheet and the ribbed suspension ring soldered to the top sheet.*

**Figure 8.57.** *The gold cowrie shell shaped bead with two holes at each end in string UC8971 (Petrie Museum) consisting of spherical and barrel beads and two jabiru (hieroglyph 'ba') pendants in amethyst.*

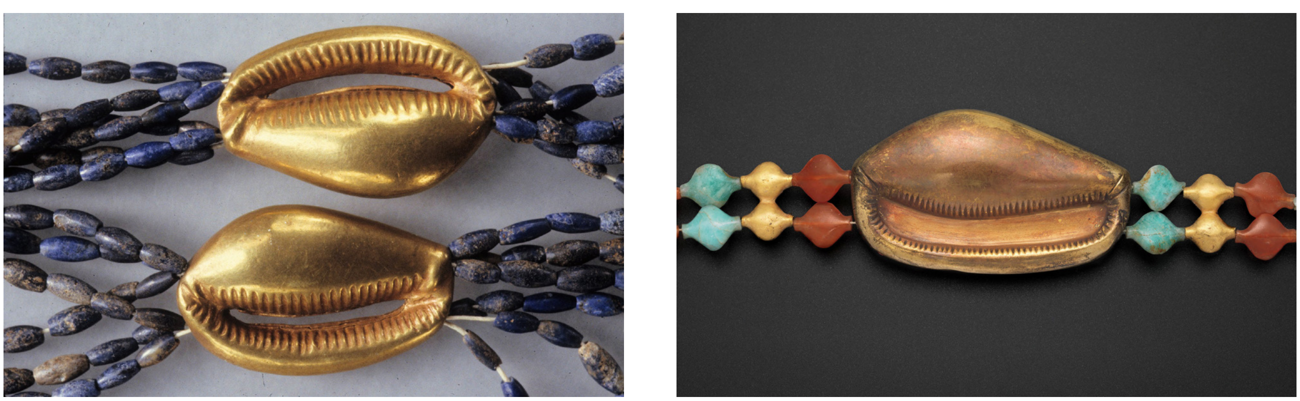


**Figure 8.58.** *Cowrie shell shaped beads in two girdles in the collection of The Metropolitan Museum of Art. On the left, from the tomb of Hepy west of the tomb of Senusretankh, Pit 3, MMA excavations 1933–34, Lisht South, Acc. no. 34.1.154, Rogers Fund 1934. On the right, from BSA Tomb 8, Sathathoriunet, Fayum Entrance Area, Lahun, Chamber E, box 1, BSAE excavations 1914, Acc. no. 16.1.5, Rogers Fund and Henry Walters Gift 1916.*

**Figure 8.59.** *Some of the gold components of string UC8973 (Petrie Museum) and a detail of one of the spherical beads showing the joining seam of the rolled gold sheet.*

**Figure 8.60.** *Some of the gold components of string UC36475 (Petrie Museum): the cylindrical amulet in gold and agate, the shell-shaped pendant and two nasturtium seed beads.*

**Figure 8.61.** *One of the barrel beads in string UC36475 made from gold foil.*

suggested tentatively that the deposit was 'a dump for lootings from other burials in the cemetery' (Petrie & Brunton 1924, 19). Christine Lilyquist has re-assessed the group, noting its location in a cemetery with several features more typical of the Pan Grave culture, nomads from the desert regions east of southern Upper Egypt and Nubia nomads (Lilyquist 2009). From her study, the finds seem consistent with a date of deposit at the end of the late Middle Kingdom (indicated in particular by the two pottery cups UC18813-4 with 'vessel index' of about 156 and 148, see Arnold 1988, 140–1; note however later dates for seal-amulets, requiring further investigation, Lilyquist 2009, 301 with n.14). It remains unclear whether the objects were originally intended to accompany one or more bodies, or whether other religious or economic motives lie behind this and smaller miscellaneous deposits in this cemetery (Lilyquist 2009, 303).

The beads in string UC18836 are very regular in shape, diameter and colour. A few are shown in Figure 8.62. They have 'V' shaped edges where no signs of solder could be detected and do not show signs of intense use-wear. They were possibly made by wrapping narrow strips of gold around a former and cutting longitudinally across the spiral wire, as discussed in Chapter 7.

The selected objects were analysed *in situ* for the composition of the alloys using handheld XRF. The data

**Figure 8.62.** *Some of the small ring beads in string UC18836 (Petrie Museum) found in deposit 1300 at Sidmant.*

**Table 8.14.** *Results obtained by XRF for Middle Kingdom gold objects in the collection of the Petrie Museum.*

| Acc. No. | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| UC8971 | 63 | 33.5 | 3.5 |
| | 61.5 | 35.2 | 3.3 |
| UC8973 | | | |
| spherical beads | 79.6 | 19.3 | 1.1 |
| | 81.8 | 17.3 | 0.9 |
| | 78.8 | 19.9 | 1.3 |
| | 80.4 | 16.6 | 2.9 |
| | 77.6 | 21.1 | 1.3 |
| caps | 77.5 | 19.1 | 3.3 |
| | 79.5 | 17.8 | 2.6 |
| UC36475 | | | |
| barrel beads | 89.9 | 7.8 | 2.3 |
| | 88.8 | 8.7 | 2.5 |
| | 87.6 | 8.9 | 3.6 |
| | 87.6 | 8.9 | 3.6 |
| nasturtium seed beads | 93.6 | 4.3 | 2.1 |
| | 96.2 | 2.2 | 1.6 |
| shell | 57.4 | 38.8 | 3.8 |
| amulet caps | 71.7 | 26.1 | 2.2 |
| | 71.7 | 24.8 | 3.4 |
| UC52202 | | | |
| body | 81.5 | 15.9 | 2.6 |
| top sheet | 80.5 | 16.6 | 2.9 |
| base sheet | 82.7 | 14 | 3.4 |
| suspension ring | 78.3 | 19 | 2.7 |
| UC18836 | | | |
| ring beads | 93.5 | 6.2 | 0.3 |
| | 93.6 | 6.1 | 0.4 |
| | 93.6 | 6.1 | 0.3 |
| | 93.2 | 6.4 | 0.4 |
| | 93.6 | 6.1 | 0.3 |
| | 93.5 | 6.2 | 0.3 |

obtained was summarized in Table 8.14 and plotted in Figure 8.63. The silver amounts range from 1 to 40 wt% and the copper contents are always under 4 wt%. These results are close to those obtained for other Middle Kingdom objects analysed in the previous sections of Chapter 8. One exception is the gold shell-shaped pendant UC6391 from excavations at Haraga (Chapter 8.4), which contain higher silver contents.

The tiny beads in string UC18836 from Sidmant, quite homogeneous in shape and dimensions, are all made from a gold alloy containing only *c.* 6 wt% Ag and *c.* 0.3 wt% Cu, suggesting that they were from the same batch of alloy. Only the nasturtium seed beads in string UC36475, containing only 2–4 wt% Ag, are made from gold alloys of higher purity. The barrel beads in the same string are made from gold alloys containing about 8–9 wt% Ag and 2–4 wt% Cu. Conversely, amulet UC52202 and the gold beads and bead caps in string UC8973 are made from gold alloys containing 15–20 wt% Ag, but different copper contents. The components of string UC8973 separate into two groups by type (beads and caps) based on their copper contents.

Interestingly, the shell-shaped pendant and the cylindrical amulet in string UC36475 as well as the cowrie shell-shaped bead in string UC8971, traditional components of the Middle Kingdom jewellery, contain the highest silver amounts observed for the studied items. The copper contents vary from 2 to 3.5 wt%. These forms seem to be quite regularly produced in

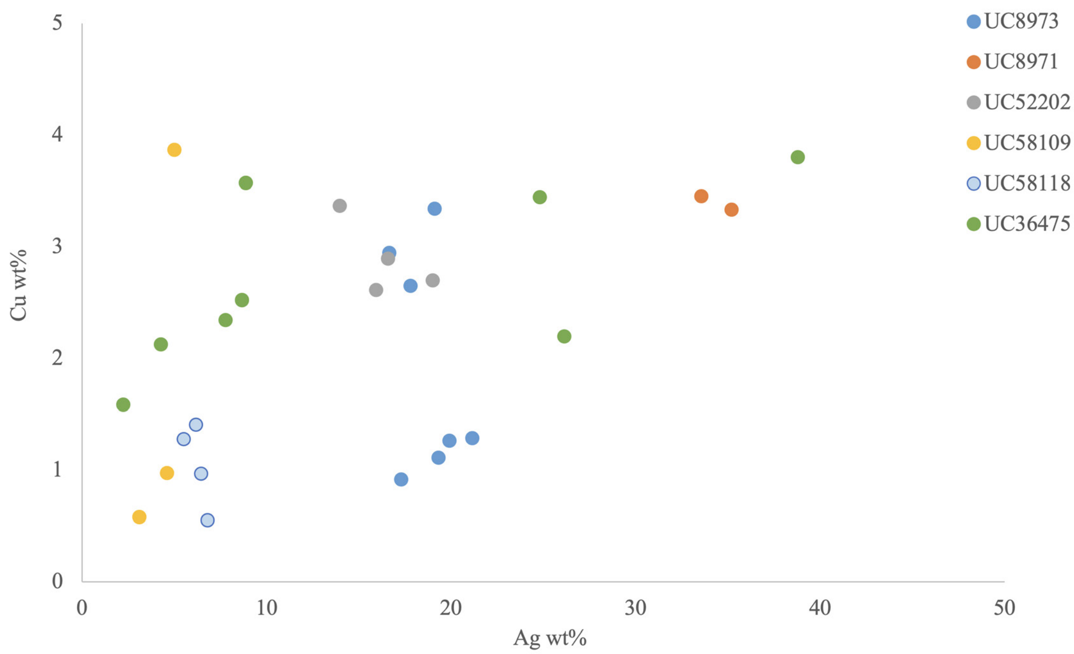



**Figure 8.63.** *Silver versus copper contents obtained by XRF for the Middle Kingdom gold jewellery in the collection of the Petrie Museum.*

greenish and pale greenish yellow gold alloys. It is also noticeable that alloys containing 15–20 wt% Ag are quite regular in Egypt. In addition to the objects analysed in this chapter, we can also cite one bead from Princess Nubheteptikhered's necklace analysed by Berthelot (1906, 63), which contains 16.6 wt% Ag and 0.5 wt% Cu, and one bead from the gold necklace of Wah, which contains 20.3 wt% Ag and 5.7 wt% Cu (Schorsch 1995, 132). The use of these alloys is certainly explained by the composition of native gold in Egypt.

The use of native gold is demonstrated by the presence of PGE inclusions visible in the majority of the objects analysed in this chapter. The object containing the highest number of inclusions is cowrie shell-shaped bead in string UC8971. Some of them are shown in Figure 8.64 under the stereomicroscope.

To conclude on the gold alloys employed in the production of the jewellery in the collection of the Petrie Museum, we compare in Figure 8.65 the data obtained for the unprovenanced objects (the tiny beads of string UC18836 from Sidmant are plotted separately) with data obtained for the contextualized objects analysed in Chapter 8. These are objects from tomb 72 and other tombs excavated at Haraga, from tomb 124 at Riqqa, and from several tombs excavated at Lahun, Naqada, Abydos and Buhen. Unprovenanced and contextualized jewellery show similar compositions. The majority of the data are contained in an area defined by silver amounts under *c.* 40 wt% and copper amounts under *c.* 5 wt%. A few objects contain higher copper contents, but only very few contain more than 6 wt%. Some objects are made from silver-rich alloys, with silver contents ranging from 40 to 60 wt%. The others contain quite variable silver contents, as if whitish and yellowish alloys were

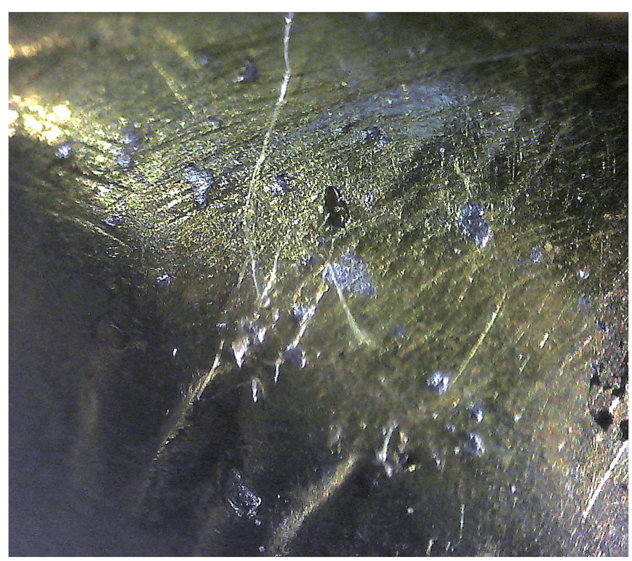


**Figure 8.64.** *Some of the many PGE inclusions visible at the surface of gold cowrie shell shaped bead in string UC8971.*

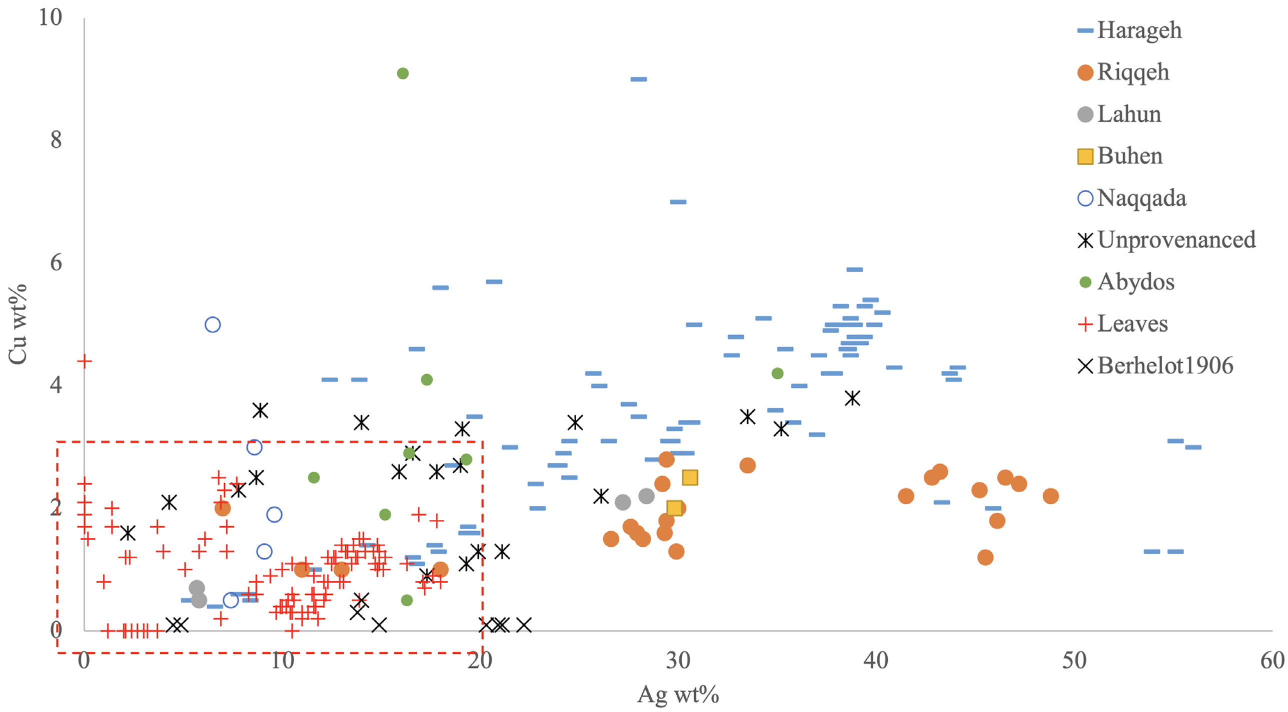



**Figure 8.65.** *Silver versus copper contents obtained for the Middle Kingdom gold jewellery in the collection of the Petrie Museum compared to data obtained for Sidmant and in the previous sections for the jewellery from tombs at Haraga, tomb 124 at Riqqa, and several tombs at Lahun, Naqada, Abydos and Buhen. The gold leaves added to the diagram are those from tombs at Lahun, Haraga and Abydos studied in previous chapters and those published by Berthelot (1906, 20–3, 62–5).*

intentionally made to produce polychrome effects, such as in the case of the fish pendants from tomb 72 at Haraga (see Chapter 8.2).

We added to the diagram of Figure 8.65 the data previously presented in Chapter 8 for the gold foils used to decorate several types of supports, from excavations at Lahun, Haraga and Abydos. Berthelot (1906, 20–3, 62–5) analysed some gold foils dated to the Middle Kingdom added to the diagram. Some of them are from coffins excavated at Dahshur (the coffin of Auibra Hor) and Bersha (the coffin of Djehutynakht) and were provided by G. Maspero while the others, provided by J. de Morgan, were found at Dahshur (from the coffins of Auibra Hor and from one of the treasure boxes). Berthelot also analysed tiny cylindrical beads from the tomb of Nubheteptikhered, buried close to king Auibra Hor. All the foils clearly form a group characterized by lower amounts of silver and copper, which, considering the mechanical properties of the gold alloys, is expected for items obtained by plastic deformation.

## Notes

1. The group of jewellery found by Garstang in the Abydos tomb with the lapis scarab inscribed for the high official Hor (E108, Garstang 1901, 4, pl.1) includes a girdle containing ten hollow cowrie shell-shaped beads in electrum (University of Pennsylvania Museum E9195) similar to those from the royal tombs of Dahshur and Lahun. Decorated by chasing, they show different tool marks, certainly related to different phases of decoration or to the work of different goldsmiths.

## References

For references see pp.309–12 at the end of this chapter.

# Chapter 8.8

# Necklace British Museum EA3077 said to be from Thebes

Nigel Meeks, Susan La Niece, Stephen Quirke & Maria F. Guerra

Part of the collection of the British Museum, necklace EA3077, said to be from Thebes (Fig. 8.66), and purchased in 1835 from Henry Salt, is a restrung set of diverse components in gold and electrum: six cowrie shell beads, two half-cowrie shell beads that serve as a clasp, two sidelock pendants, two fish amulets, and a pendant consisting of a papyrus umbel in cloisonné work attached to an amulet with the form of god Heh. The other components of necklace EA3077 are spherical and oblate beads in gold, carnelian, amethyst, lapis lazuli and green feldspar.

The papyrus umbel element is inlaid with glass, indicating a probable New Kingdom or later date of production, while all other components seem consistent with an early Middle Kingdom date. The Heh pendant in gold is attested in Qau and Badari (see Chapter 7) from contexts dated by Seidlmayer to Qau-Matmar phase III, which falls around the early Middle Kingdom (Seidlmayer 1990). The spherical beads, fish pendants and cowrie shells beads are paralleled in late 12th Dynasty contexts, so the Heh pendant could be a slightly older item within the same group in one deposit, or from an adjacent slightly older burial next to the find. The find itself is only known from the wording of Giovanni Athanasi (Yiannis Athanasiou), the main person involved in forming the collections for Henry Salt from 1818 to Salt's death in 1827. Athanasi, born in 1799, was the son of a Greek merchant from Lemnos, who went to Cairo in 1809 (Dewachter 1995); the young Giovanni/Yiannis started working in his role at Thebes alongside Belzoni around 1817 and became the main agent after Belzoni and Salt fell out in 1818. In the posthumous 1835 Sotheby's sale of material still in the possession of Salt when he died, Athanasi provided the notes for the material. The entry for lot number 763, which became string EA3077, provides the following description (Athanasi 1836, 213): 'A very elegantly formed Necklace, consisting of seven gold shells, two gold fish, the head of Horus, a curious mosaic and pendant ornament in the form of the lotus flower, and numerous beads in gold, cornelian, lapis lazuli, etc. Thebes £35.15s.'; below this is the note in smaller type: 'This was taken from the mummy of a female; and is highly interesting, as illustrating the ornamental art of the ancient Egyptians. The formation of the clasp is precisely the same as made at the present period'.

The 'head of Horus' is presumably the Heh pendant; the two gold sidelock pendants do not seem to be mentioned here, but otherwise it seems that the concoction as a 'necklace' is already established by the time the object is sold in 1835. It is not certain that the whole group was 'taken from the mummy', as the entry in smaller type may be an extract from a text in which 'This' referred to some but not all of these items. The point about the clasp being identical in form to current (=1830s) clasps is somewhat disturbing. It is in fact exactly the same type of clasp that closes, for example, the girdle with cowrie shell-shaped beads from Lahun (Brunton 1920, 30, pl. 3.12).

There is some evidence for considering the description of the group as, at least in part, deriving from the same deposit or burial, identified as that of a female perhaps because it contained cowrie shell beads, commonly included in girdles, and fish pendants, which are feminine amulets. The association between the components strung in necklace E3077 and the Theban provenance is confirmed by the research conducted by Michel Dewachter. In the archives of *Bibliothèque nationale de France* he found a note by Prisse d'Avennes (BN, NAF 20420, fol. 217)[1] identifying the 1835 Sotheby catalogue notes as extracts from a journal of finds by Athanasi and his compatriot and companion collection-former Triantaphyllos (Dewachter 1985).

In order to shed more light on the origin of necklace EA3077, we carried out the technological study of the components in gold.

**Figure 8.66.** *Necklace EA3077 in the collection of the British Museum, said to be from Thebes.*

All the cowrie shell-shaped beads are similar, except the one that serves as clasp. The clasp is a slip into slot closing system, made by closing two half-cowries with gold sheets. One of the sheets was incised whilst on the other was soldered a gold wire that when inside the incision closes the cowrie shell and thus the string of beads. This closing system, as noted, was regularly employed in the Middle Kingdom.

The cowrie shell-shaped beads consist of two halves joined by soldering and perforated twice at each end (Fig. 8.67). The toothed edges of the shell's aperture are chased. As mentioned in the previous section, the cowrie shell-shaped beads in the girdles found in the royal tombs of Dahshur and Lahun as well as in the tomb with the scarab of Hor at Abydos (E108) have no gap-opening aperture (see Fig. 8.58), like the specimens in necklace EA3077. The X-radiography of the necklace showed that inside the cowrie shell beads are contained two or three spheres to produce sounds when shaken (Fig. 8.67). Gold cowrie shell-shaped beads and other

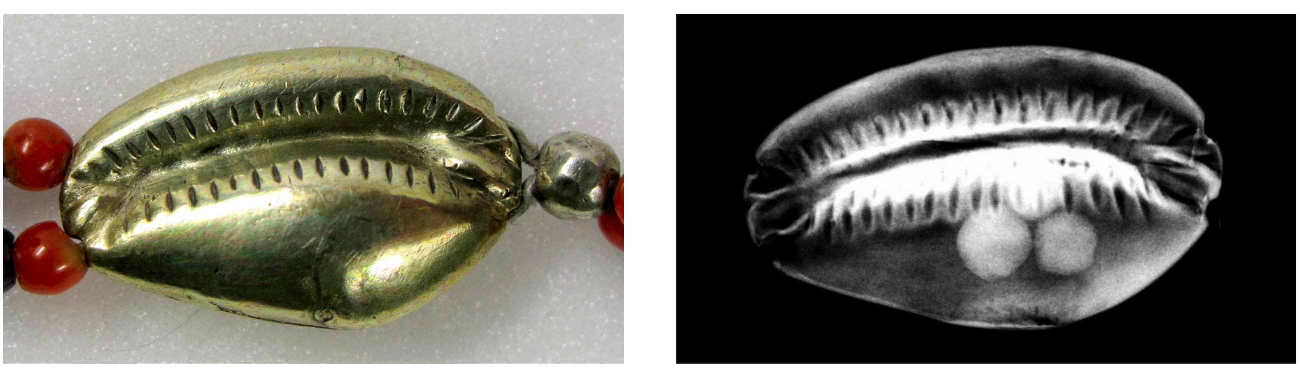


**Figure 8.67.** *One of the cowrie shell beads in necklace EA3077 and the X-radiograph showing the spheres inside the beads. X-radiographic image produced using a Siefert DS1 X-ray tube operating at 100 kV with an exposure of 20 mA for two minutes.*

**Figure 8.68.** *X-radiograph showing the mounting of the two fish pendants in necklace EA3077. Images produced using a Siefert DS1 X-ray tube operating at 100 kV with an exposure of 20 mA for two minutes.*

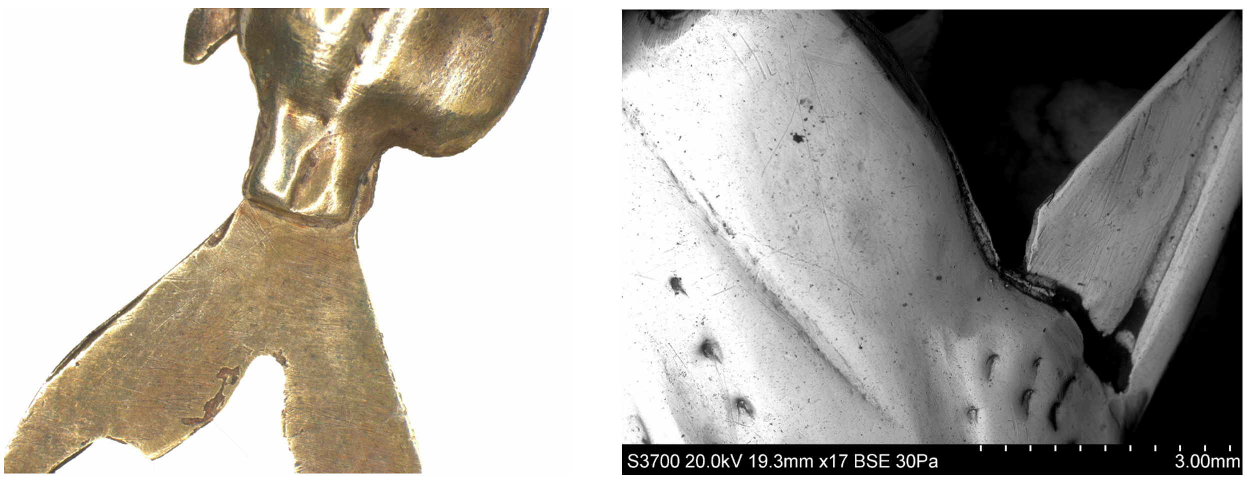



**Figure 8.69.** *Details of the two fish pendants in necklace EA3077: (left) the body and tail under the stereomicroscope and (right) the body and upper fin under the SEM.*

types of beads in girdles would sound when shaken (Andrews 1990, 141–2; Patch 2015a, 2015b; see discussion in Chapter 8.7).

The two fish pendants are hollow, as shown in Figure 8.68. Their construction is analogous to those of fish pendant amulets excavated at Haraga (those from tomb 72 are described in Chapter 8.2, and the one from tomb 520 is described in Chapter 8.4). Their bodies are made from two gold halves soldered together, between which are inserted the tail and two fins, in this case also in gold. The suspension ring is a gold rod coiled at the top, which was added to the bodies in the same way as the fins and the tail. Some details of the fish pendant amulets are shown in Figure 8.69. The tails are undecorated gold sheets cut in the form of a fish's tail; the fins are similarly made, but the upper part is bent. The fish eyes were pierced in the gold sheets forming the fish's body, where the scales and gills are represented in repoussé and chasing.

Like the fish pendant amulets and the cowrie shell-shaped beads, the two sidelock-shaped pendants in gold are hollow specimens made by soldering two halves and decorated by chasing, as shown in Figure 8.70. A gold sheet is folded at the top of the sidelock pendants to close them and to support the suspension ring, a bent gold strip. Remains of soldering could, however, be observed in certain regions. The chased decorations were applied after the pendants' assembly, as shown in Figure 8.70, where the chased lines continue over the folded upper sheet.

Finally, the middle pendant of necklace EA3077 consists of a papyrus umbel in cloisonné work to which an amulet in the form of god Heh was attached (Fig. 8.71). The papyrus umbel pendant shows signs

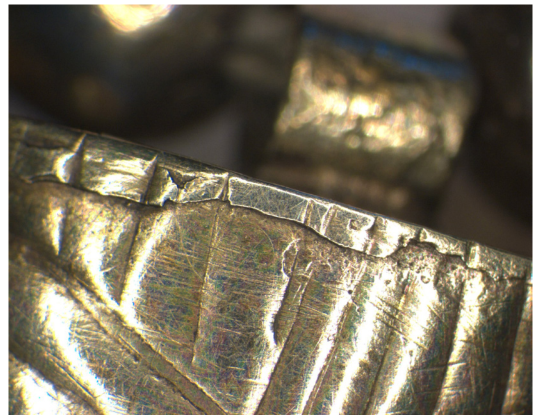


**Figure 8.70.** *One of the sidelock pendants in necklace EA3077, chased after mounting the upper gold sheet.*

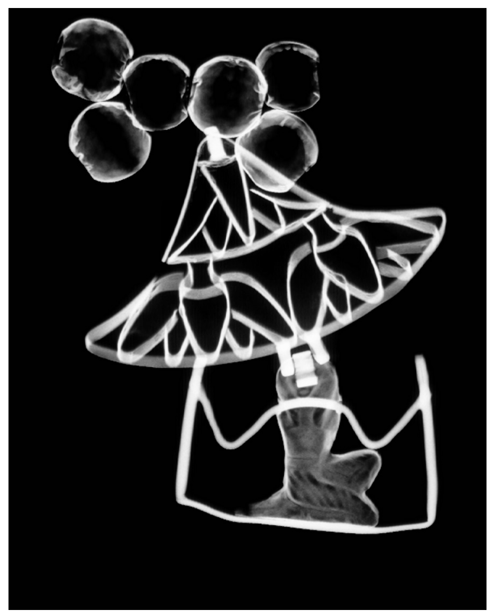


**Figure 8.71.** *Front and X-radiograph of the papyrus umbel pendant with an amulet in the form of the god Heh in necklace EA3077. X-radiographic image produced using a Siefert DS1 X-ray tube operating at 100 kV with an exposure of 20 mA for two minutes.*

of use-wear and would have originally been part of another item, as confirmed by the now missing suspension ring on the back. This pendant is made in two parts using the same technology. The cloisons are soldered to the base-plate to form cells where the inlaid materials are set. A detail of the cloisonné work is provided in Figure 8.72. As in the case of the winged-scarab and the pectoral from tomb 124 at Riqqa, described in Chapter 8.3, some materials are set without cloisons.

The amulet in the shape of god Heh, one knee to the ground and the other raised, is made in repoussé and is closed on the back with a gold sheet cut to the form. The fine morphological and garment details enhanced by chasing, contrast with the schematically represented extended arms and palm ribs held in each hand, made from simple gold wires (Fig. 8.72). One wire forms the bordering 'U' that represents the palm ribs. The X-ray radiography of the pendant in Figure 8.71 shows that another wire forms both arms. The front sheet of the figure's body was pierced to let this wire pass through.

The remaining gold components of necklace EA3077 are spherical beads made by applying gold foils over an undetermined core. Several of these beads are damaged, perhaps by use-wear; one is shown in Figure 8.73.

The alloys employed in the production of the gold components of necklace EA3077, analysed by SEM-EDS, are summarized in Table 8.15 and plotted

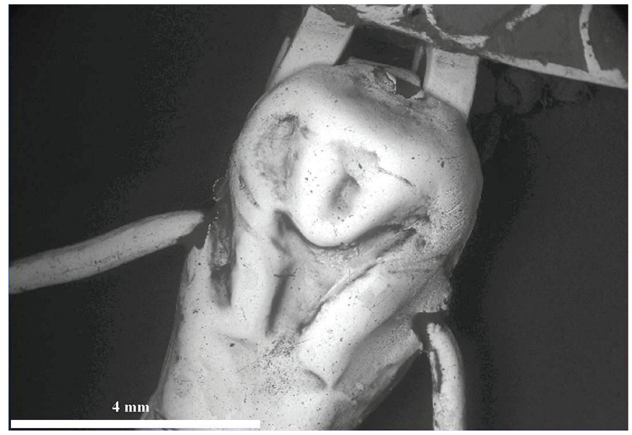



**Figure 8.72.** *Detail of the cloisonné work of the papyrus umbel pendant in necklace EA3077 and of the body and arms of the Heh amulet (SEM).*

in Figure 8.74. All of them are silver-rich gold alloys containing 37 to 66 wt% Ag and copper contents ranging from 2 to 4 wt%. The slight variation of the cowrie shell beads compositions can be explained by the use of surface EDS, which increases analytical uncertainty. However, the beads have very similar copper content, as shown in Table 8.15. This might suggest that the alloys originally used were from different batches, to account for some being similar in composition and others being of very different composition.

The cowrie shell-shaped beads, the bodies of the fish pendant amulets, the sidelock-shaped pendants and the clasp are made from similar alloys. The fish tails are made from a different alloy, which contains a higher gold content, but not enough to indicate deliberate polychrome effects such as those observed for one of the fish pendants from tomb 72 excavated at Haraga (see Chapter 8.2). The papyrus umbel pendant, which is likely to be a late element, is made from an alloy containing copper and silver contents equivalent to the values observed for the fish tails. While all the components are in pale yellow gold, the single spherical bead analysed revealed the use of a whitish alloy, containing 66 wt% Ag.

**Table 8.15.** *Results obtained by SEM-EDS for necklace EA3077.*

| Object | Au wt% | Ag wt% | Cu wt% |
|---|---|---|---|
| cowrie shell beads | 56 | 42 | 3 |
| | 50 | 47 | 3 |
| | 54 | 44 | 3 |
| | 53 | 44 | 3 |
| | 59 | 39 | 2 |
| | 49 | 48 | 2 |
| cowrie shell clasp | 48 | 48 | 4 |
| fish 1 | | | |
| body | 47 | 49 | 4 |
| tail | 60 | 37 | 3 |
| fish 2 | 48 | 49 | 3 |
| lotus-flower pendant | 57 | 39 | 4 |
| beard pendants | 45 | 51 | 4 |
| | 53 | 44 | 3 |
| ball bead | 32 | 66 | 3 |

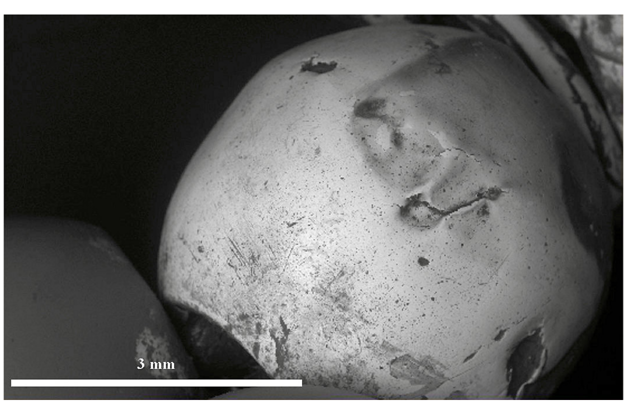



**Figure 8.73.** *SEM image of one of the spherical beads of gold foil in necklace EA3077.*

When considering the results obtained for excavated objects presented in the previous sections (see Fig. 8.65 where the amounts of silver and copper contained in the majority of the analysed Middle Kingdom jewellery and gold sheet in this volume are plotted), the alloys employed in the construction of necklace EA3077 seem typical of the quite whitish Middle Kingdom gold productions. The presence of some PGE inclusions on the surface of some of the components of this string reveals the expected use of alluvial gold.

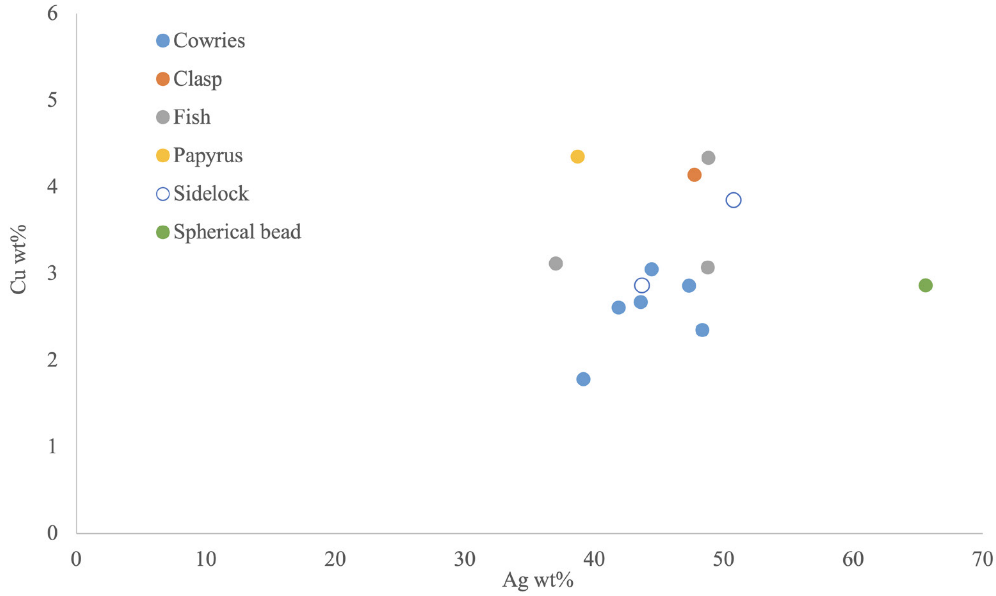
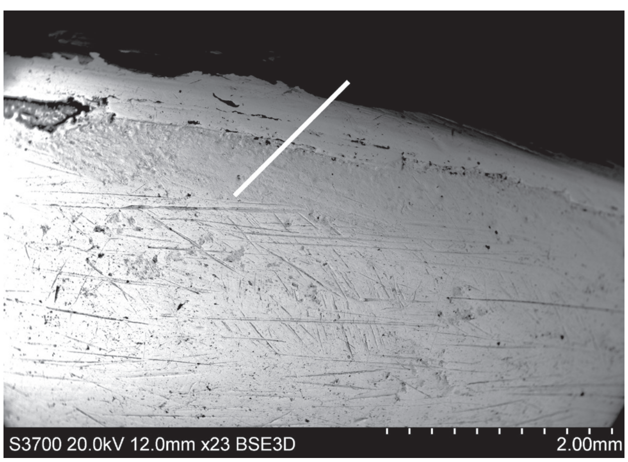



**Figure 8.74.** *Silver versus copper contents obtained by SEM-EDS for the components of necklace EA3077 (see Table 8.15).*




| Au wt% | Ag wt% | Cu wt% |
|---|---|---|
| 59 | 39 | 2 |
| 62 | 36 | 2 |
| 62 | 36 | 2 |
| 53 | 40 | 8 |
| 55 | 42 | 4 |
| 54 | 41 | 5 |
| 50 | 46 | 4 |
| 51 | 45 | 4 |

**Figure 8.75.** *SEM-EDS point analysis data obtained tracking across the edge seam solder of one of the cowrie-shell shaped beads of necklace EA3077 along the line in the image. The first three analyses are on the gold sheet, the last five are on the solder.*

Finally, we searched for the joining technique employed in the construction of the cowrie shell-shaped beads. The SEM image and the data obtained by EDS across the edge seam solder of one of the specimens is shown in Figure 8.75. The values obtained indicate the use of hard soldering, by using an alloy with higher copper and silver contents than the adjacent sheet gold (see the table in Fig. 8.75), and the copper is also higher than contained in the gold cowrie shell bead alloys (Table 8.15). Use of hard solder is typical of ancient Egyptian manufacture.

## Notes

1. The note says (Dewachter 1995): « Le manuscrit de cette publication est un extrait du journal de fouilles et d'achats faits par Triandafilo et Yanni d'Athanasi. Vardé ou Triandafilo a gardé l'original qui contenait quelques dessins faits par Dupuy et des voyageurs de passage à Thèbes, à la requête de Triandafilo qui a bien voulu me le communiquer. Un extrait de ce journal accompagnait la momie d'Enintef vendue au Musée de Leyde et dont Leemans a fait usage dans sa Lettre à Salvolini et que j'ai publié aussi dans ma notice sur le musée britannique » (*The manuscript of this publication is an excerpt from the journal of excavations and purchases made by Triandafilo and Yanni d'Athanasi. Vardé or Triandafilo kept the original which contained some drawings made by Dupuy and travellers passing through Thebes, at the request of Triandafilo who kindly communicated it to me. An excerpt from this diary accompanied Enintef's mummy sold to the Leiden Museum and was used by Leemans in his Letter to Salvolini, the one that I also published in my notice on the British Museum*).

## References (for complete Chapter 8)


Aldred, C., 1950. *Middle Kingdom art in Ancient Egypt (2300–1590 BC)*. London: A. Tiranti Lda.

Aldred, C., 1971. *Jewels of the Pharaohs: Egyptian jewellery of the Dynastic Period*. London: Thames & Hudson.

Andrews, C., 1990. *Ancient Egyptian jewellery*. London: British Museum Publications.

Arnold, D., 1988. Pottery, in *The Pyramid of Senwosret I*, ed. D. Arnold. New York: Metropolitan Museum of Art, 106–46

Aruz, J. & Wallenfels, R. (eds.), 2003. *Art of the first cities: the third millennium B. C. from the Mediterranean to the Indus*. New York: The Metropolitan Museum of Art.

d'Athanasi, G., 1836. *A brief account of the researches and discoveries in Upper Egypt made under the direction of Henry Salt/by Giovanni d'Athanasi. To which is added a detailed catalogue of Mr Salt's collection of Egyptian antiquities*. London: John Hearne.

Beck, H.C., 1928. Report on Qau and Badari beads, in *Qau and Badari II*, ed. G. Brunton. London: British School of Archaeology in Egypt 45, 22–5.

Ben-Tor, D., 2007. *Scarabs, chronology, and interconnections: Egypt and Palestine in the Second Intermediate Period*. Orbis Biblicus et Orientalis 27. Fribourg, Switzerland: Academic Press, Vandenhoeck & Ruprecht Cöttingen.

Bernabò Brea, L., 1957. *Recenti scavi a Poliochni nell'isola di Lemnos*. *Bollettino d'Arte del Ministero della Pubblica Istruzione* III-IV, 193–217.

Berthelot, M., 1906. *Archéologie et histoire des sciences*. Paris: Gauthier-Villars imprimeur-libraire.

Bingöl, F.R.I., 1999. *Ancient jewellery*. Ankara: Museum of Anatolian Civilisations. Kültür Bakanligi Anitlar, Muzeler Genel Mudurlugu Publications.

Bisson de la Roque, F., 1937. *Tôd (1934 à 1936)*. Cairo: Institut français d'archéologie orientale, Fouilles de l'Institut français du Caire 17.

Bisson de la Roque, F., 1950. *Catalogue général des antiquités égyptiennes du Musée du Caire. Le trésor de Tôd*. Cairo: Institut français d'archéologie orientale.

Bisson de la Roque, F., Contenau, G. & Chapouthier, F., 1953. *Le trésor de Tôd*. Cairo: Institut français d'archéologie orientale, Fouilles de l'Institut français du Caire 11.

Blackman, A.M., 1925. Philological Notes. *The Journal of Egyptian Archaeology* 11(3/4), 210–15.

Blackman, A.M. & Apted, M. R., 1953. *The rock tombs of Meir VI*. London: Archaeological Survey of Egypt 29.

Bleiberg, E., 2008. To live for ever. Egyptian funerary beliefs and practises, in *To live forever. Egyptian treasures from the Brooklyn Museum*, ed. E. Bleiberg. New York: Brooklyn Museum, 23–107.

Bourriau, J., 1988. *Pharaohs and mortals: Egyptian art in the Middle Kingdom*. Cambridge: Cambridge University Press, Fitzwilliam Museum Publications.

Brunton, G., 1920. *Lahun I. The treasure*. London: Bernard Quaritch, British School of Archaeology and Egyptian Research Account.

Buckton, D., 1982. Enamelling on Gold. A historical perspective. *Gold Bulletin* 15(3), 101–9.

Collon, D., 1995. *Ancient Near Eastern Art*. London: The Trustees of the British Museum.

Davaras, C., 1975. Early Minoan Jewellery from Mochlos. *The Annual of the British School at Athens* 70, 101–14.

Delougaz, P., Hill, H.D. & Lloyd, S., 1967. *Private Houses and Graves in the Diyala Region*. Oriental Institute Publications 88. Chicago: The University of Chicago Press.

Dewachter, M., 1985. Nouvelles informations relatives à l'exploitation de la nécropole royale de Drah Aboul Neggah. *Revue d'Égyptologie* 36, 43–66.

Dewachter, M., 1995. Un Grec de Louqsor collaborateur de Champollion et Lepsius : Ouardi-Triantaphyllos, in *Entre Égypte et Grèce*, ed. J. Leclant. Paris: Académie des Inscriptions et Belles-Lettres, Cahiers de la Villa Kérylos 5, 119–29.

Dunand, M., 1937. *Fouilles de Byblos I: Atlas*. Paris: Librairie orientaliste Paul Geuthner.

Duval, A., Eluère, C., Hurtel, L. & Tallon, F., 1987. La Pendeloque au chien de Suse. Étude en laboratoire d'une brasure antique. *Revue du Louvre* 3, 176–9.

Duval, A., Eluère, C. & Hurtel, L.P., 1989. Ancient techniques in ancient gold jewellery. *Jewellery Studies* 3, 5–13.

Eluère, C., 1989. A 'gold connection' between the Etruscans and Early Celts? *Gold Bulletin* 22(2), 48–55.

Eluère, C., 1998. Orfèvres du IV$^{e}$ millénaire à Suse: la pendeloque au petit chien. *Technè* 7, 19–20.

Engelbach, R., Murray, M.A., Petrie, H.F. & Petrie, W.M.F., 1915. *Riqqeh and Memphis VI*. London: British School of Archaeology in Egypt and Egyptian Research Account 19.

Engelbach, R. & Gunn, B., 1923. *Harageh*. London: British School of Archaeology in Egypt 28.

Farag, N. & Iskander, Z., 1971. *The Discovery of Neferwptah*. Cairo: Antiquities Department of Egypt, Ministry of Culture.

Fitton, J.L., Meeks, N. & Joyner, J., 2009. The Aigina treasure: catalogue and technical report, in *The Aigina treasure: Aegean Bronze Age jewellery and a mystery revisited*, ed. J.L. Fitton. London: The British Museum Press, 20–31.

Gale, N.H. & Stos-Gale, Z.A., 1981. Ancient Egyptian silver. *Journal of Egyptian Archaeology* 67, 103–15.

Gale, N.H. & Stos-Gale, Z.A., OXALID. *ED XRF data for Bronze Age Greek, Cypriot and Egyptian gold and silver*. Oxford Archaeological Lead Isotope Database (OXALID) database. Oxford: Isotrace Laboratory (http://oxalid.arch.ox.ac.uk/).

Garstang, J., 1901. *El Arábah*. London: British School of Archaeology in Egypt 6.

Grajetzki, W., 2004. *Harageh an Egyptian burial ground for the rich, around 1800 BC*. London: Golden House Publications. Second imprint.

Grajetzki, W., 2014. *Tomb Treasures of the Late Middle Kingdom: The Archaeology of Female Burials*. Philadelphia: University of Pennsylvania Press.

Guerra, M.F., 2006. Etruscan gold jewellery pastiches of the Campana's collection revealed by scientific analysis, in *De Re Metallica: dalla produzione antica alla copia moderna*, eds. M. Cavallini & G.E. Gigante. Rome: L'Erma Di Bretschneider,Studia Archaeologica 150, 103–28.

Guerra, M.F., 2007. Examen et analyse élémentaire de bijoux étrusques de la collection Campana, in *Les bijoux de la collection Campana : de l'antique au pastiche*, eds. C.

Metzger & F. Gaultier. Paris: École du Louvre ed., 145–77.

Guerra, M.F. & Pagès Camagna, S., 2019. On the way to the New Kingdom. Analytical study of Queen Ahhotep's gold jewellery (17th Dynasty of Egypt). *Journal of Cultural Heritage* 36, 143–52.

Hauptmann, A., Klein, S., Paoletti, P., Zettler, R.L. & Jansen, M., 2018. Types of Gold, Types of Silver: The Composition of Precious Metal Artifacts Found in the Royal Tombs of Ur. *Mesopotamia, Zeitschrift für Assyriologie* 108(1), 100–31.

Jacobson, D.M. & Humpston, G., 2010. Gold in Metal Joining, in *Gold, science and applications*, eds. C. Corti & R. Halliday. CRC Press, Taylor & Francis Group, 161–90.

Klemm, R. & Klemm, D., 2013. *Gold and gold mining in Ancient Egypt and Nubia: Geoarchaeology of the ancient gold mining sites in the Egyptian and Sudanese eastern deserts*. Berlin-Heidelberg: Springer-Verlag, Series in Natural Science in Archaeology.

Laffineur, R., 2008. Aspects of Early Bronze Age Jewellery in the Aegean, in T*he Aegean in the Neolithic, Chalcolithic and the Early Bronze Age*, eds. H. Erkanal, H. Hauptmann, V. Şahoğlu & R. Tuncel. Ankara: Ankara University Press, 323–32.

Lilyquist, C., 1993. Granulation and Glass: Chronological and Stylistic Investigations at Selected Sites, c. 2500–1400 BCE. *Bulletin of the American Schools of Oriental Research* 290/291, 29–94.

Lilyquist, C., 1994. Objects Attributable to Kamid el-Loz and Comments on the Date of Objects in the 'Schatzhaus', in *Kamid el-Loz 11 – Das 'Schatzhaus' im Palastbereich: Die Befunde des Königsgrabes*, ed. W. Adler. Bonn: Habelt, Saarbrücker Beiträge zur Altertumskunde 47, 207–20.

Lilyquist, C., 2003. *The Tomb of Three Foreign Wives of Tuthmosis III*. New York: The Metropolitan Museum of Art.

Lilyquist, C., 2009. Mayana K 1300 at Sedment el-Gebel: Traces of Ethnicity, in *Sitting beside Lepsius: studies in honour of Jaromir Malek at the Griffith Institute*, eds. J. Bourriau, D. Magee & S. Quirke. Leuven: Peeters, 289–313.

Limper, K., 1988. *Uruk. Perlen, Ketten, Anhänger*. Mainz am Rhein: Philipp von Zabern, Deutsches Archäologisches Institut, Abteilung Baghdad: Ausgrabungen in Uruk-Warka 2.

Lucas, A. & Harris, J.R., 1962. *Ancient Egyptian materials and industries* (4th edition). London: Edward Arnold.

Mace, A.C. & Winlock, H.E., 1916. *The tomb of Snebtisi at Lisht*. New York: The Metropolitan Museum of Art.

Martin, G.T., 1971. *Egyptian Administrative and Private-Name Seals, Principally of the Middle Kingdom and Second Intermediate Period*. Oxford: Griffith Institute

Maxwell-Hyslop, K.R., 1971. *Western Asiatic Jewellery c. 3000–612 BC*. London: Methuen & Co, Lda.

Maxwell-Hyslop, K.R., 1977. Sources of Sumerian Gold: The Ur Goldwork from the Brotherton Library, University of Leeds. A Preliminary Report. *Iraq* 39(1), 83–6.

Meeks, N.D. & Tite, M.S., 1980. The analysis of Platinum-group Element inclusions in Gold Antiquities. *Journal of Archaeological Science* 7, 267–75.

Menu, M., 1994. Analyse du trésor de Tôd. *Bulletin de la Société Française d'Egyptologie* 130, 29–45.

Miniaci, G., La Niece, S., Guerra, M.F. & Hacke, M., 2013. Analytical study of the first royal Egyptian heart-scarab, attributed to a Seventeenth Dynasty king, Sobekemsaf. *British Museum Technical Research Bulletin* 7, 53–60.

Mishara, J. & Meyers, P., 1974. Ancient Egyptian Silver: A review, in *Recent Advances in Science and Technology of Materials 3*, ed. A. Bishay. New York: Plenum, 29–46.

Mollowan, M.E.L., 1947. Excavations at Brak and Chagar Bazar. *Iraq* 9, 1–259.

de Morgan, J., 1895. *Fouilles à Daschour mars-juin 1894*. Viena: A. Holzhausen ed.

Negahban, E.O., 1996. *Marlik: The Complete Excavation*. Philadelphia, University of Pennsylvania, University Museum Monograph 87.

Nestler, G. & Formigli, E., 2004. G*ranulazione etrusca un'antica arte orafa*. Sienna: Nuova imagine.

Newberry, P.E., 1908. *Scarabs: an introduction to the study of Egyptian seals and signet rings*. London: Archibald Constable and Co. Ltd.

Nicolini, G., 2010. *Les ors de Mari*. Mission archéologique française à Tell Hariri/Mari 7. Beyrouth: Presses de l'Ifpo, Bibliothèque archéologique et historique 192.

Oddy, A., 1977. The production of gold wire in Antiquity. Hand-making methods before the introduction of the draw-plate. *Gold Bulletin* 3(10): 79–87.

Oddy, A., 2004. The manufacture of wire since the Bronze Age: a technological investigation using the microscope, in *Physics methods in archaeometry*, eds. M. Martini, M. Milazzo & M. Piacentini. Amsterdam: IOS Press, 257–67.

Ogden, J., 1982. *Jewellery of the Ancient World*. London: Trefoil.

Ogden, J.M., 1990. *Gold jewellery in Ptolemaic, Roman and Byzantine Egypt*. PhD Dissertation, Department of Oriental Studies, Durham University.

Ogden, J., 1992. *Ancient jewellery*. London: British Museum Press.

Ogden, J., 1999. *Age & authenticity, the materials and techniques of 18th and 19th century goldsmiths*. London: National Association of Goldsmith.

Ogden, J., 2000. Metals, in *Ancient Egyptian Materials and Technology*, eds. T. Nicholson & I. Shaw. Cambridge: University Press, 148–75.

Oppenheim, A., Arnold, D., Arnold, D. & Yamamoto, K. (eds.), 2015. *Ancient Egypt transformed: The Middle Kingdom*. New York: The Metropolitan Museum of Art.

Parrot, A., 1968. *Le trésor d'Ur*. Mission archéologique de Mari 4. Beyrouth: Presses de l'Ifpo, Bibliothèque archéologique et historique 87.

Patch, D.C., 2015a. Cowrie shell girdle of Princess Sithathoryunet, in *Ancient Egypt transformed: The Middle Kingdom*. New York: The Metropolitan Museum of Art, 118–19.

Patch, D.C., 2015b. Feline-headed girdle, anklets, and bracelets of Princess Sithathoryunet, in *Ancient Egypt transformed: The Middle Kingdom*. New York: The Metropolitan Museum of Art, 117–18.

Petrie, W.M.F., 1910. *The arts and crafts of ancient Egypt*. London and Edinburgh: T.N. Foulis.

Petrie, W.M.F., 1917. *Scarabs and cylinders with names*. London: British School of Archaeology in Egypt, Egyptian Research Account, University College London.

Petrie, W.M.F., 1927. *Objects of daily use*. London: British School of Archaeology in Egypt and Egyptian research account.

Petrie, W.M.F. & Brunton, B., 1924. *Sedment*. London: B. Quaritch.

Petrie, W.M.F. & Quibell, J.E., 1896. *Naqada and Ballas*. London: B. Quaritch.

Pierrat, G., 1994. A propos de la date et de l'origine du t,résor de Tôd. *Bulletin de la Société Française d'Egyptologie* 130, 18–28.

Pierrat-Bonnefois, G., 2014. Les échanges entre l'Egypte et le Proche-Orient, in *Sésostris III Pharaon de légende*, eds. F. Morfoisse & G. Andreau-Lanoë. Gand: Snoeck, 170–81.

Prévalet, R., 2014. Étude technique d'une perle en or de Tell Banat (Syrie) et réflexion sur la diffusion des savoirs au IIIe millénaire av. J.-C. *Syria* 91, 247–60.

Radtke, M., Buzanich, G., Guilherme, A., Reinholz, U., Riesemeier, H., Scharf, O., Scholz, P. & Guerra, M.F., 2016. Double Dispersive X-Ray Fluorescence ($D^2$XRF) based on an Energy Dispersive pnCCD detector for the detection of platinum in gold. *Microchemical Journal* 125, 56–61.

Rapson, W., 1990. Tarnish resistance, corrosion and stress corrosion cracking of gold alloys. *Gold Bulletin* 23(4), 125–33.

Rastrelli, A., Miccio, M., Troalen, L.G., Martinón-Torres, M., Guerra, M.F., Siano, S., Sumbera, A. & Vitobello, M.L., 2009. Modern and ancient gold jewellery attributed to the Etruscans: a science-based study. *ArcheoSciences* 33, 357–64.

Reisner, G.A., 1910. *The archaeological survey of Nubia: report for 1907-1908*. Cairo: National Printing Department.

Richards, J., 2005. *Society and death in ancient Egypt: mortuary landscapes of the Middle Kingdom*. Cambridge: Cambridge University Press.

Roberts, P.M., 1973. Gold brazing in antiquity. Technical achievements in the earliest civilisations. *Gold Bulletin* 6, 112–19.

Rosenberg, M., 1915. *Geschichte der Goldschmiedekunst auf technischer Grundlage. Abteilung: Granulation*. Frankfurt: Verlag von H. Keller.

Rosenberg, M., 1918. Eine selten granulationsarbeit. *Monatshefte für Kunstwissenschaft* 11(1), 15–16.

Schorsch, D., 1995. The gold and silver necklaces of Wah: a technical study of an unusual metallurgical joining method, in *Conservation in Ancient Egyptian Collections*, eds. C.E. Brown, F. Macalister & M. Wright. London: Archetype Publications, 127–35.

Scott, N.E., 1964. Egyptian Jewelry. *The Metropolitan Museum of Art Bulletin New Series* 22(7), 223–34.

Seidlmayer, S.J., 1990. *Gräberfelder aus dem Übergang vom Alten zum Mittleren Reich*. Heidelberg: Heidelberger Orientverlag, Studien zur Archäologie der Ersten Zwischenzeit 1.

Seipel, W., 2001. *Gold der Pharaonen*. Kunsthistorschen Museum. Viena: Skira ed.

Silverman, D., 1997. *Searching for Ancient Egypt.* Dallas: Dallas Museum of Art, Cornell University Press.

Smith, E.A., 1930. Solders used by the goldsmiths of Ur. *Discovery* (January), 20–3.

Snape, S., 1986. *Mortuary Assemblages from Abydos I*. PhD Dissertation, University of Liverpool.

Stefanović, D., 2009. *The Non-royal Regular Feminine Titles of the Middle Kingdom and Second Intermediate Period: Dossiers*. London: Golden House Publications, Egyptology 11.

Stünkel, I., 2015a. Royal Women: Ladies of the Two Lands, in *Ancient Egypt transformed: The Middle Kingdom*. New York: The Metropolitan Museum of Art, 92–6.

Stünkel, I., 2015b. An amulet plaque and a Book of the Dead papyrus from the Metropolitan Museum of Art and some observations on gold amulets, in *Weitergabe: Festschrift für die Ägyptologin Ursula Rößler-Köhler zum 65. Geburtstag*, eds. L.D. Morenz & A. El Hawary. Wiesbaden: Harrassowitz Verlag, 407–27.

Tissot, I., Troalen, L.G., Manso, M., Ponting, M., Radtke, M., Reinholz, U., Barreiros, M.A., Shaw, I., Carvalho, M.L. & Guerra, M.F., 2015. A multi-analytical approach to gold in ancient Egypt: studies on provenance and corrosion. *Spectrochimica Acta Part B* 108, 75–82.

Tissot, I., Correia, J., Monteiro, O.C., Barreiros, M.A. & Guerra, M.F., 2019. When gold stops glittering: corrosion mechanisms of René Lalique's Art Nouveau jewellery. *Journal of Analytical Atomic Spectrometry* 34: 1216 –22.

Tolstikov, V.P. & Treister, M.Y., 1996. *Le Trésor de Troie. Les Fouilles d'Heinrich Schliemann*. Paris: Gallimard, Electa.

Treister, M., 2002. The relative and absolute chronology of the Trojan treasures, in *Mauerschau: Festschrift für Manfred Korfmann I*, eds. A. Aslan, S. Blum, G. Kastl, F. Schweizer & D. Thumm. Gremshalden-Grunbach: Verlag Bernhard A. Greiner, 245–58.

Troalen, L., Guerra, M.F., Tate, J. & Manley, W.P., 2009. Technological study of gold jewellery pieces dated from Middle Kingdom to New Kingdom in Egypt. *ArcheoSciences* 33, 111–19.

Troalen, L., Tissot, I., Maitland, M. & Guerra, M.F., 2015. Jewellery of a young Egyptian girl: Middle Kingdom goldwork from Haraga tomb 72. *Historical Metallurgy* 49(2), 75–86.

Troalen, L.G., Tate, J. & Guerra, M.F., 2014. Goldwork in Ancient Egypt: workshop practices at Qurneh in the 2nd Intermediate Period. *Journal of Archaeological Science* 50, 219–26.

Troalen, L. & Guerra, M.F., 2016. 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 (3). 209–20.

Troalen, L.G., Guerra, M.F., Maitland, M., Ponting, M. & Price, C., 2019. Analytical study of the Middle Kingdom group of gold jewellery from tomb 124 at Riqqa, Egypt. *X-Ray Spectrometry* 48(6), 586–96.

Vernier, É., 1907-27. *Bijoux et orfèvreries*. Catalogue général des antiquités égyptiennes du musée du Caire, Fascicule I-IV. Cairo: Institut français d'archéologie orientale.

Wegner, J.H., 2014. Hidden treasures: Abydos in the Basement. *The Magazine of the University of Pennsylvania Museum of Archaeology and Anthropology* 56(1), 43–51.

Wilkinson, A., 1971. *Ancient Egyptian jewellery*. London: Methuen & Co Ltd.
Williams, C.R., 1924. *Catalogue of Egyptian Antiquities, Gold and Silver Jewelry and Related Objects*. New York: The New York Historical Society.
Winlock, H.E., 1920. The Egyptian Expedition 1918–1920. II: Excavations at Thebes 1919-20. *The Metropolitan Museum of Art Bulletin* 15, 12–32.
Winlock, H.E., 1923. The Museum's Excavations at Thebes. Part 2: The Egyptian Expedition 1922–1923. *The Metropolitan Museum of Art Bulletin* 18(12), 11–39.
Winlock, H.E., 1934. *The treasure of El Lahun*. New York: The Metropolitan Museum of Art.
Winlock, H.E., 1942. *Excavations at Deir el Bahri: 1911–1931*. New York: The Macmillan Company.
Wodzińska, A., 2010. *A Manual of Egyptian Pottery 3: Second Intermediate through Late Period*. Boston: Aera Field Manual Series.
Wolters, J., 1981. The ancient craft of granulation. A re-assessment of established concepts. *Gold Bulletin* 14(3) 119–29.
Wolters, J., 1981–82. A Short History of the Art of Granulation. Part I. *Aurum* 6, 8–14; Part II 7, 6–13; Part III 9, 6–13.
Wolters, J., 1983. *Die Granulation, Geschichte und Technik einer alten Goldschmiedekunst*. Munich: Callwey Verlag.
Xia, N., 2014. *Ancient Egyptian Beads*. Heidelberg: Springer-Verlag Berlin.
Zettler, L. & Horne, R.L., 1998. *Treasures from the royal tombs of Ur*. Philadelphia: University of Pennsylvania Press.

# Ancient Egyptian gold

This book aims to provide a new level of synthesis in the study of gold jewellery made in Egypt between 3500 BC and 1000 BC, integrating the distinct approaches of archaeology, materials science and Egyptology. Following accessible introductions to the art and use of gold in Ancient Egypt, and to current advances in technical analyses, the volume presents detailed results on the manufacturing technology and elemental composition of some 136 objects in the collections of six European museums, with discussion of the findings in historical and cultural contexts. The questions generated by the jewellery buried with a woman and a child at Qurna (Thebes) led to investigation of assemblages and individual artefacts from later and earlier periods in varied social contexts, from the rural environment of Qau and Badari, to sites connected with urban or royal centres, such as Riqqa, Haraga and Lahun. A final discussion of the Qurna group provides an agenda for future research.

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