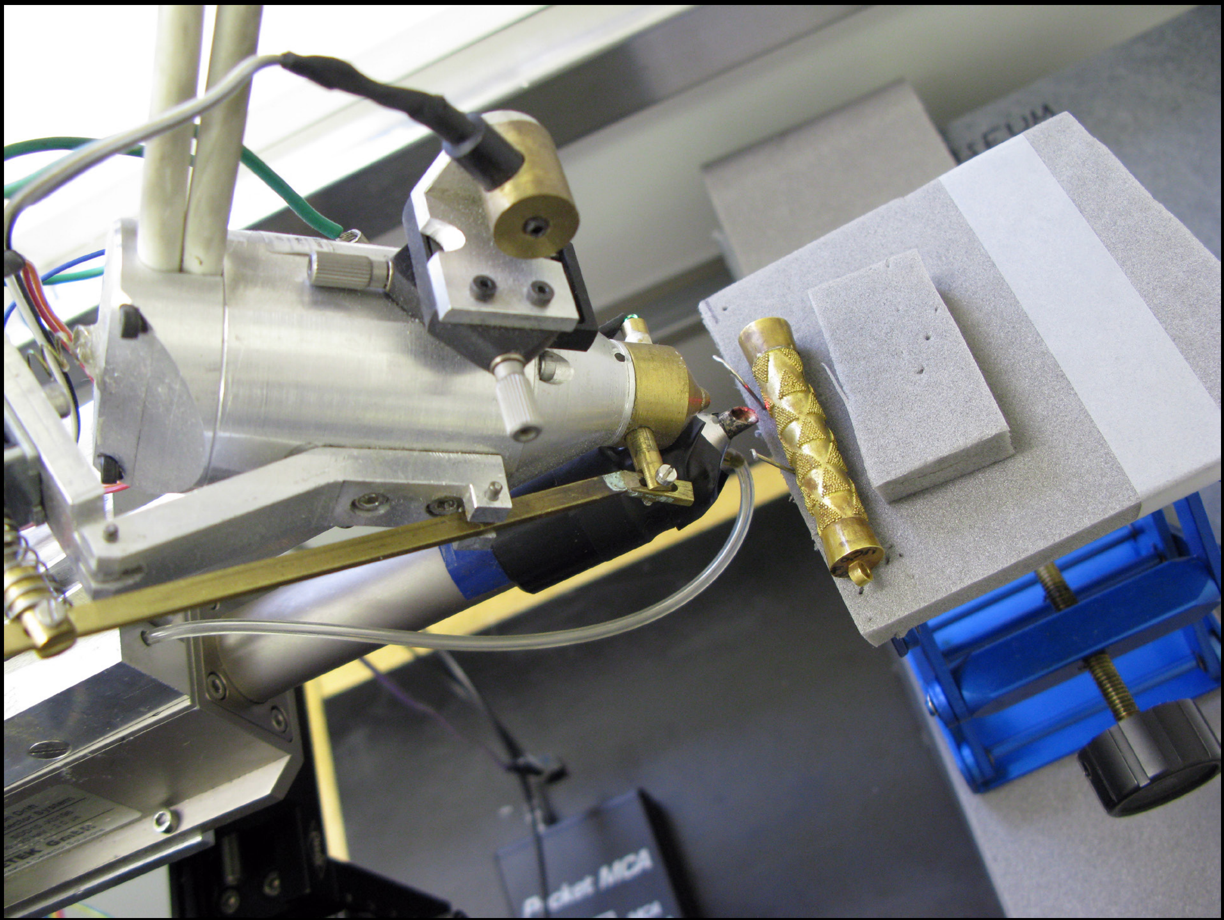
McDONALD INSTITUTE MONOGRAPHS

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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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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Contents

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Figures

Tables

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.

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Chapter 5

Reflections on gold: colour and workshop practices in Egypt

Maria F. Guerra

By combining gold with other materials and by using particular manufacturing techniques, goldsmiths subtly enhanced the objects to achieve wide-ranging visual effects that contributed to their categorization, function and value. Here, the art of the Egyptian goldsmith is approached through the optical properties of the gold alloys, such as colour and lustre. The workshop practices adopted over time in Egypt, which can occasionally be inferred by simple observation of the jewellery produced, are also considered. The quantity of gold necessary to make an object in relation to the quantity of work required to make it is assessed, with reference to specific strings of beads.

Even when made from 'useless' daily life materials, such as lustrous metals and colourful 'stones', an object appearance gives it importance and value (Fleming 2014). One of these metals is gold. By combining gold with other materials and by using particular manufacturing techniques, goldsmiths subtly enhance the objects to achieve wide-ranging visual effects. These effects provide sensory stimulation that contributes through our perception of the objects to their categorization, and thus to their function and value.

Because of its scarcity and special properties, in particular its optical properties, gold has been associated in many cultures to spiritual life, and to political, economic and religious power. As such, it is not surprising that it played such an important role in early Egypt. The delicacy of the Egyptian motifs of decoration and the range of techniques used by the goldsmiths reached a high level even when very simple forms, such as shells and scarabs, were produced. The aim of this chapter is to approach the art of the Egyptian goldsmith through the optical properties of gold (colour, lustre, etc.) and the workshop practices adopted over time, which can occasionally be inferred by simple observation of the jewellery.

A question of colour

It is perhaps in the jewellery items representing simple forms growing in nature that the subtlety of the Egyptian work can be fully appreciated. Very simple forms, such as scarabs or shells (on these items, see Grajetzki 2014), are representative of this. Several gold shell-shaped pendants made using different techniques are shown in Figure 5.1. The simplest ones are undecorated, like those contained in a string found inside Senebtysy's tomb, excavated at Lisht North (Metropolitan Museum of Art 07.227.8, shown in Fig. 5.1a). This string looks like the representation of older strings like one (restrung) excavated in group C cemetery at Aksha in Sudan (ACS CX - Ind. 2, Morfoisse 2014, no. 169). All the other shell-shaped pendants in Figure 5.1 were enhanced using different techniques. The addition to the other pendants of chased motifs and additional parts in gold (such as wires and granulation), parts in natural materials (such as bone or ivory) or further parts in colourful materials (such as gemstones, glass, enamel and such like) changes our visual perception of the 'form'.

The engraved, chased and repoussé motifs added to basic known forms in gold may act as decoding symbols, prompting a new 'reading' of an object. Princess Khnumet's shell-shaped pendant in Figure 5.1b excavated at Dahshur (Cairo CG52979; de Morgan 1895, pl. 12) has chased lines (Vernier 1907-27) drawing a pattern that recalls those of cockleshells. Along with enriching an object aesthetically, the addition of motifs often endows it with a political, a spiritual or a religious role (derived meaning). The shell pendant shown in Figure 5.1c (UC11847 in the Petrie Museum) has a chased cartouche bearing the name of 17th Dynasty king Seqenenra Taa. The presence of this cartouche awakens our interest in

Figure 5.1. *(a) String of faience, carnelian and turquoise beads with undecorated gold shell-shaped pendants. Tomb of Senebtysy, Middle Kingdom, Lisht North, MMA excavations 1906-07 (The Metropolitan Museum of Art, Acc. no. 07.227.8, Rogers Fund 1907). Gold shell-shaped pendants: (b) from Khnumit's tomb at Dahshur (de Morgan 1903, pl. 12); (c) with the cartouche of Seqenenra Taa (UC11847, Petrie Museum); (d) excavated at Riqqa, tomb 124, with the name of Kha-kau-re (Acc. no. 5968, Manchester Museum); (e) with the name of Senusret II, possibly from Memphite Region, Dahshur (The Metropolitan Museum of Art, Acc. no. 26.7.1353, Edward S. Harkness Gift, 1926); and (f) from Mereret's tomb at Dahshur (de Morgan 1895, pl. 20).*

the object, because it links it to a high-ranking personage, entrusting it with a particular meaning.

If a chased motif changes our perception of a shell pendant, the fine work of decoration with patterns in granulation and wire, enriching as well the objects' aesthetics, further suggests a very careful and skilled work. We expect an object of this type to have belonged to a high-rank individual who had access to objects made in particular workshops or by particularly skilled goldsmiths. This is exemplified in Figure 5.1d by a gold shell pendant in the collection of the Manchester Museum (5968) with a cartouche bearing the name of the 12th Dynasty king Senusret III, made in gold wire and placed between two uraei made from wire and granulation. This pendant belongs to the group of jewellery from tomb 124 excavated at Riqqa, discussed in Chapter 8. In Figure 5.1e, another gold shell pendant is decorated with granulation, wire and inlaid motifs (MMA 26.7.1353). The cartouche bearing the name of the 12th Dynasty king Senusret II placed between two uraei is inlaid like the lotus flower with at least carnelian, as no other remains of inlaid material are nowadays visible. The last shell (Fig. 5.1f), from the burial of Princess Mereret at Dahshur in the Cairo Museum (CG53070; de Morgan 1895, pl. 20), is in cloisonné work, in a profusion of colours obtained by inlaying lapis lazuli, carnelian and turquoise.

The two shell pendants in cloisonné work (Figs. 5.1e,f) are very representative of Egyptian polychrome jewellery. The cloisonné work 'replicates' at the surface of the objects the profusion of colours attained by stringing colourful beads. Thin sheets of gold (the walls, or *cloisons*) are joined to gold support plates forming cells where the inlaid materials are set. These materials are in general carnelian, turquoise, lapis lazuli, feldspar and other stones shaped to a precise form according to the pattern to be achieved, but vitreous materials such as enamel were also used (see Chapter 4). Inlays were early in use in the Eastern Mediterranean area.[1] The production of polychrome jewellery by employing different materials is observed during the Bronze Age in other parts of the Mediterranean basin,[2] but not on its Western end.[3] As mentioned above, the application of colourful materials is related to aesthetics and visual

Figure 5.2. *Detail of the pectoral of Sathathoriunet with the name of Senusret II, Middle Kingdom, excavated at Lahun in gold inlaid with carnelian, lapis lazuli, turquoise, and garnet. The Metropolitan Museum of Art, Acc. no. 16.1.3, Rogers Fund and Henry Walters Gift, 1916.*

perception,[4] resulting from predominant traditions in the cultural areas concerned.[5]

In Egypt, many Middle Kingdom pendants and pectorals are made in cloisonné work. Two winged scarabs holding a sun's disc inlaid with cornelian, lapis lazuli and green feldspar, one in the collection of the British Museum (EA54460) and the other from tomb 124 at Riqqa (Engelbach et al. 1915; Chapter 8), are examples of this. Some pieces are obviously made by very skilled goldsmiths. One example is Sathathoriunet's pectoral in gold inlaid with carnelian, lapis lazuli, turquoise, and garnet (MMA 16.1.3; Fig. 5.2). All the details are meticulously made, as demonstrated by the finely incised scarab's legs and head to imitate the animal's morphology and the upper part of the ankh that when fitting the uraeus' body turns into a kind of jump ring, linking the pectoral bottom to its top.

Polychrome parts made from other materials offer colour, volume, transparency and opacity to gold objects, in a cultural area where colours have meanings (Vernier 1907), and where colour codes allow new readings of objects. Colours can be obtained by employing different materials, such as those already referred, but subtle nuances of colours can also be explored. An object enhanced with opaque deep blue lapis lazuli has a different effect from an object with, for example, translucent blue stones and faience, or with transparent blue glass. In the collection of the Petrie Museum, the First Intermediate Period string of beads in gold, carnelian, and glass (UC18026) shown in Figure 5.3, found in

Figure 5.3. *Components of different colours in string of beads UC18026, Petrie Museum, found in the First Intermediate Period intact burial of a woman in Badari, tomb 4903.*

tomb 4903 at Badari, which contained the intact burial of a woman, shows the possible effects produced using several blue materials. The beads have different shades of blue and some of them are made from composite glass to create a blueish pattern, perhaps to imitate the naturally occurring patterns in agates.[6]

Making colourful strings

The pronounced search for polychrome effects in Egypt is evident from known strings of beads. However, the manufacture of beads, such as those shown in Figure 5.3, requires high technical knowledge. The beads produced in Egypt are of different types and dimensions and were produced in several materials of different colours (Xia 2014). By skilfully arranging those beads, it was possible to create numerous striking polychrome effects and give different textures to the objects, creating new perceptions. We discuss below the manufacture of gold beads, their application in polychrome strings, and the work that had to be accomplished by the artisans.

Early strings

In 1st Dynasty graves, gold is commonly present in the form of foils and small objects (Chapter 3; Wilkinson 2001; Edwards 1971). We can mention, for example, the gilding strips and foils from the excavations at Saqqara of tomb 3504, dated to the reign of Djet (Emery 1954), and the two gold needles yielded by one of the graves excavated at Giza (Petrie 1907, 4–6, pl. 4).[7] More elaborate pieces of jewellery, made with gold components, were also found in tombs from this period, such as the necklace from tomb 3507 excavated at Saqqara, a string of barrel beads in carnelian alternating with ten tubular gold beads to which were added two pendants and one spherical gold bead. This grave contained the burial of Herneith, possibly the consort of king Den (Emery 1958, pl. 99). Another important group of jewellery was found in tomb N1532 at Naga ed-Deir, containing a body in contracted position still wearing a gold circlet on the head. Scattered in the burial were found many components made from sheet gold such as beads, animal shaped amulets, bangles, etc. (Reisner 1908, 29–33, pl. 6–9).

The richness of the Naga al-Deir tomb and the complexity of Herneith's necklace are however far from the jewellery excavated in the oldest royal cemetery of Egypt, Umm al-Qaab. The kings of the 1st Dynasty were buried in this unique elite cemetery situated at Abydos (Stevenson 2015). It is in the tomb of king Djer that the unlikely discovery of an exquisite group of bracelets took place. When clearing out the disturbed tomb, a worker found a piece of an arm belonging to a female body. Unwrapped by Flinders Petrie, the arm yielded four bracelets, shown in Figure 5.4 (from Vernier 1907–27 partly colourized), which were still laying in their original positions (Petrie 1901, pl. 1). The skilled work of the goldsmith[8] and certainly the exceptional discovery fascinated Flinders Petrie, who affirmed: 'such is this extraordinary group of the oldest jewellery known, some two thousand years before that from Dahshur. Here, at the crystallizing

Figure 5.4. *The four bracelets found around an unwrapped piece of a female arm contained in the disturbed tomb of king Djer at Umm el-Qaab (from Vernier 1907–27). Some components have been coloured to show the polychrome effects of the bracelets.*

Figure 5.5. *Second bracelet from the top of Figure 5.4 (from Petrie 1901, pl. 1) and one of the 'hour-glass' beads contained in the bracelet.*

point of Egyptian art, we see the unlimited variety and fertility of design' (Petrie 1901, 19).

It is not only the bracelets' design that is impressive. In these pieces of jewellery are combined assorted components in stones and gold. The technologies employed point to high goldsmithing skills. The bracelet with the ribbed gold rosette (an opened box with a cover in the form of a flower, set by folding the ribbed edges of the box, Vernier 1907–27, CG52011) is exceptional in that it contains, in addition to regular spherical beads of gold and lapis lazuli, turquoise beads (chips of turquoise) of variable size and shape. The other bracelets are made with regular beads, sometimes involving rather complex mounting. The 'hawk' bracelet, described by Petrie (1901, 16–19),[9] consists of a string of alternating gold and carved turquoise beads of different sizes in the form of a serekh topped with the Horus falcon.[10] The bracelet beads and terminals are pierced horizontally by two holes for stringing (CG52008 in Vernier 1907–27).[11] From the technological point of view, the two other bracelets are particularly interesting. One of them in addition to spherical beads in (hollow) gold, turquoise and lapis lazuli (CG52009 in Vernier 1907–27), contains exquisite ribbed barrel beads of different sizes in gold[12] and lapis lazuli. The last bracelet contains components in gold, amethyst, lapis lazuli and turquoise. The components in gold are of different forms. Gold spacers and terminals enhance both ends of the lozenge-shaped turquoise beads. This bracelet contains exquisite 'hour-glass' beads (as named by Petrie). The thread is wound in their external groove (see Fig. 5.5), between the two pears (like in a pulley), in order to let the beads remain perpendicular to the axis of the bracelet when worn (CG52010 in Vernier 1907–27).

It is difficult to tell whether the four bracelets from king Djer's tomb are representative of Early Dynastic goldwork. They can be the work of an exceptionally skilled goldsmith. Nevertheless, they show the great expertise available in the earliest periods in Egypt and the very early search for polychrome effects by stringing intricate beads made from several colourful materials.

Stringing small beads

Among the most representative strings containing colourful beads strung together to draw different patterns, are the Middle Kingdom examples. A very demonstrative example of the patterns that can be created by stringing beads of different types and the work that has to be achieved by the crafts is provided by Sathathoriunet's jewellery excavated at Lahun (Dorman et al. 1987; Oppenheim et al. 2015). After the beads were found in the burial, the mounting of the broad bracelets and anklets (MMA 16.1.8, 16.1.9, 16.1.10a, 16.1.11a, Oppenheim et al. 2015, 116) was proposed by H. Winlock (Winlock 1934). They are shown in Figure 5.6. The small ring beads used in the manufacture of these items amount to more than 9200. In round numbers, 2600 red rings are in carnelian, 4025 blue rings are in turquoise and 2590 yellow rings are in gold. All the items have separators made by joining gold tubes and rings. The separators consist of groups of two or three gold rings (total 1990) soldered to thinner gold tubes (total 812).

The quantity of gold necessary to produce the gold beads contained in the items can be estimated

Figure 5.6. *Broad anklets and bracelet of Sathathoriunet, 12th Dynasty, in gold, carnelian, turquoise, faience, Egyptian blue, and lapis lazuli. Found in the Fayum Entrance Area, Lahun, Tomb of Sathathoriunet (BSA Tomb 8), Chamber E, box 1, BSAE excavations 1914. The Metropolitan Museum of Art, Acc. nos. 16.1.10a, 16.1.11a and 16.1.8, Rogers Fund and Henry Walters Gift, 1916.*

when the exact bead's weight and composition are known. As this is not the case for Sathathoriunet's items, to make a rough estimation we considered in the calculations below the dimensions provided for the ring beads in one necklace from Dahshur by Vernier (1907–27, CG53018),[13] which we assume to be made of pure gold. Based on these premises, less than 80 g of gold is necessary to produce the gold ring beads and separators of one of Sathathoriunet's bracelet (MMA 16.1.8, the clasp is excluded). Regarding the two bracelets and the two anklets, about 80 g of gold is necessary to manufacture all the minute ring beads and about 280 g to manufacture all the separators, a total of 360 g. It is interesting to note that the gold weight necessary to make an item very much depends on the beads dimensions. We carried out the same calculations considering the minute ring beads in the Second Intermediate Period necklace excavated at Qurna (NMS A.1909.527.43, discussed in Chapter 9). One of them is shown in Figure 5.7. In this case, only 110 g of gold would be necessary to produce the same number of gold ring beads and separators. Less than 20 g would be necessary to manufacture the same number of minute rings beads, and roughly 90 g to manufacture the same number of separators.

The calculations show that to obtain such jewellery patterns it is not the quantity of gold that is astonishing, but the number of beads necessary to produce the objects, and thus the work to be achieved by the crafts. So why make such objects? The use of small ring beads provides delicacy and an incomparable flexibility and movement to an object, enabling it to be perceived as a kind of rich and supple textile. Therefore, small beads or spacers should be produced in large quantities, like the scarabs that were mass-produced in Egypt (Ben-Tor 2007).

Production of small beads or spacers in the workshops required the availability of stonecutters who made the stone beads, and goldsmiths to form the gold rings and gold tubes. Instead of goldsmiths, workers specialized in the production of gold beads only would ensure a higher level of efficiency. Solder the rings that constitute the separators is a different part of the labour. This quite repetitive and long work has to be achieved by several workers who dedicated time and energy to the manufacturing process. The variability in the small ring beads in red (carnelian), in blue (turquoise) and in yellow (gold) contained in Sathathoriunet's bracelet and anklets (Fig. 5.8) are suggestive of the involvement of several artisans. A closer look at the necklace containing gold shell-shaped pendants and gold, faience, carnelian and turquoise biconical beads from the burial of Senebtysy excavated at Lisht (MMA 07.227.8, Rogers Fund, 1907) shows the same irregularity of the strung beads. Differences in bead shapes and dimensions can also be observed in

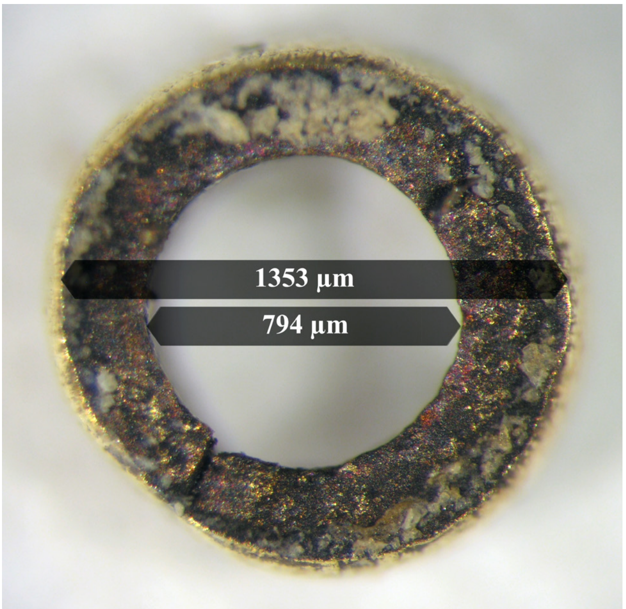


Figure 5.7. *One of the ring beads from the Qurna child's necklace (NMS A.1909.527.43); height* c. *0.5 mm, diameter* c. *1.35 mm, thickness* c. *0.55 mm and weight 6–7 mg.*

published details of king Tutankhamun's jewellery, when beads are skilfully arranged to produce motifs and polychrome effects. One example is the tiny gold tubular beads in the necklace with a pectoral in the form of a solar boat (shown in Atiya 2007, 31; Hawass 2008, 191). The necklace of the rising sun (shown in Hawass 2008, 194–5) contains tiny gold tubular and ring beads as well as the ornamental flexible bracelet with the lapis lazuli disc (JE 62369, James & de Luca 2000, 246–7). The latter also contains biconical gold beads of very variable dimensions such as the necklace with the triple scarab pectoral (James & de Luca 2000, 215).

Beads of several types being standard components of strings (such as spacers) were certainly produced by several workers, in a sort of serial production system. The beads could have been organized by type in containers, easy to control even in large workshops, perhaps put together with beads of the same types from recycled objects.[14] A serial production system of standard components in gold and in other materials to be employed in jewellery when necessary could take place at least during some periods or for particular occasions when a large number of objects had to be made. The representation of jewellery making in, for example, a late 18th Dynasty wall painting from the Theban tomb-chapel of the Fayum governor Sobekhotep (EA920 in the collection of the British Museum) shows several artisans drilling and stringing beads. A similar but less rich scene is represented in an earlier tomb-chapel, that for Amenhotep Sase, who held the office of Second God's Servant of Amun in the reign of Thutmes IV (Davies 1920, 38).

In brief, to simplify the control of the precious materials in the royal workshops and to be productive, artisans could have worked at the same time in different steps of production of gold-base items (and in other materials), some of them, as referred, integrating a production chain built for 'serial production systems'. One interesting step is string the beads. Stringing might have been a distinct process integrated in the production chain, carried out by other workers, who were 'experts' on 'stringing beads', and who would

Figure 5.8. *Details of the beads and separators strung in Sathathoriunet's anklets and bracelet shown in Figure 5.6 showing the variable dimensions of the beads. The Metropolitan Museum of Art, Acc. nos. 16.1.10a, 16.1.11a and 16.1.8, Rogers Fund and Henry Walters Gift, 1916.*

be provided with the patterns and the beads made by other workers. Providing the necessary number of beads for a certain pattern would be easy to control, by counting and/or by weighing. However, the workers who produced the assembled object would not necessarily have learned the skilled art of goldsmithing. Stringing beads does not need such knowledge and can be done by specific individuals whose time is only dedicated to this work. The existence of separated stringing operations in the workshops could be confirmed by the title 'overseer of necklace-stringers' identified in a few inscriptions, one of them designating 'director of necklace-stringers and director of gold' (Fischer 1996, 193), which tends to confirm a workshop organization based on several operational sections. A separate stage of stringing can also be seen in the scenes in Old Kingdom tomb-chapels, in some cases emphasized further by the presence of dwarves as the workers engaged in stringing (see Chapter 2).

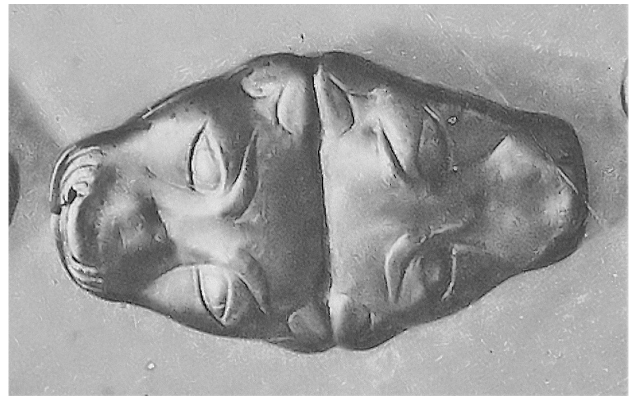
In the same vein, and considering that the least expensive gold foil is the thinnest one, the production of huge quantities of gold sheets and foils would require expertise in hammering gold, but no knowledge of the practice of a wider range of techniques such as, for instance, chasing, engraving, soldering, etc. Therefore, the repetitive work of making sheet gold may have been accomplished by less skilled (in other techniques but very skilled and with a high level of efficiency in the one they practised) and perhaps less expensive workers, reducing the final costs. In addition, while goldsmiths who needed specific tools and particular working conditions should work in a specialized workshop, there is no particular reason why those who beat gold into foils or strung beads should work in the same workshops. These artisans could work either in independent workshops or, in the case of those who beat gold, in workshops where the objects to be gilt were produced, for example those in wood. One reason to keep gold beaters, bead stringers and goldsmiths in a single workshop is the centralization of the precious raw materials control and a consequent reduction of the administrative staff and thus the costs.

One object, several goldsmiths

Strings with different aspects are obtained by using larger beads and pendants of several particular shapes and dimensions. Figure 5.9 shows a detail of the cowrie shell beads and the beard and fish pendants of necklace EA3077 in the collection of the British Museum, which is discussed in Chapter 8. These hollow beads and pendants are made from gold sheets soldered together, sometimes enhanced by chasing; they are the work of skilled goldsmiths with expertise in several techniques. The large gold beads employed in Egyptian jewellery are frequently hollow and generally elaborate and regular. They are the work of goldsmiths who seem more skilled in this art than those who produced the gold spacers and the minute beads discussed in the previous section. Several examples of big beads can be found in the group of Sathathoriunet's jewellery, such as the gold lying lions in her bracelets (Oppenheim et al. 2015). Some of her anklets (MMA 16.1.7a) consist of round hollow gold beads strung with round amethyst

Figure 5.9. *Detail of necklace EA3077 in the collection of the British Museum, said to be from Thebes, showing different gold components: cowrie-shell beads, a beard pendant, a fish amulet pendant, and spherical beads.*

a



b

Figure 5.10. *Feline-head shaped hollow gold beads from two girdles: (a) girdle of Sathathoriunet, The Metropolitan Museum of Art, Acc. no. 16.1.6, Rogers Fund and Henry Walters Gift, 1916. (b) Girdle of Mereret, Cairo Museum (from de Morgan 1895, pl. 22).*

beads; one of her necklaces (MMA 16.1.4) consists of drop beads in lapis lazuli, carnelian, green feldspar, amethyst and (hollow) gold, strung together with smaller round stone beads.

A closer look at gold beads of particular types and dimensions shows a different system of production from those discussed in the previous section. The regularity of the sets tends to demonstrate that a single goldsmith produced all the components of each string. However, several goldsmiths had ability to produce the same type of beads. The feline head-shaped beads in Sathathoriunet's (MMA 16.1.6) and Mereret's girdles (Cairo CG53075), whose details can be seen for example in Seipel (2001, 49, 63), show that these very particular gold beads are very similar, and belong to a unique workshop tradition. In Figure 5.10 beads from each collar are illustrated. While each set of feline head-shaped beads is the work of one goldsmith, the two sets are the work of different goldsmiths. Small differences are easy to detect, such as the leopard's ears and eyes. In Mereret's girdle, the ears are more 'floral' and the eyes more 'lifelike' than in Sathathoriunet's girdle. However, in Sathathoriunet's girdle all the beads look similar and could had been made by one goldsmith while in Mereret's girdle in two of the eight beads the feline has simpler eyes and more squared ears.

Perhaps several 'master' goldsmiths produced intricate goldwork in the same royal workshop. It is possible to imagine several artisans producing similar small objects. Two hinged inlaid arm or ankle bands from the tomb of the three foreign wives of Thutmes III in Wadi Gabbanat el-Qurud in Thebes (shown in Lilyquist 2003, 236) are similar is shape and dimensions, but have inscriptions made by different goldsmiths. The decoration of the back of the birth of the sun pectoral ornament from the burial of king Tutankhamun (Carter 1972, 145; Hawass 2008, 194–5) might be the result of a two-stage work, perhaps the work of two goldsmiths. A closer look at the object itself is however necessary to confirm this suggestion.

It is also possible to imagine several artisans collaborating in the production of one large object. Gold-plated objects and objects in solid gold from the burial of king Tutankhamun are regularly decorated by chasing, a traditional technique in the Egyptian workshops, as discussed in Chapter 4. Many motifs in those objects are hatched by incising lines with liners; others are textured by stamping areas with pearl-punchers, or enhanced with circle-punchers that draw circles or half-circles depending on the effect sought. It is interesting to consider the small shrine in wood plated with gold in the form of the sanctuary of the

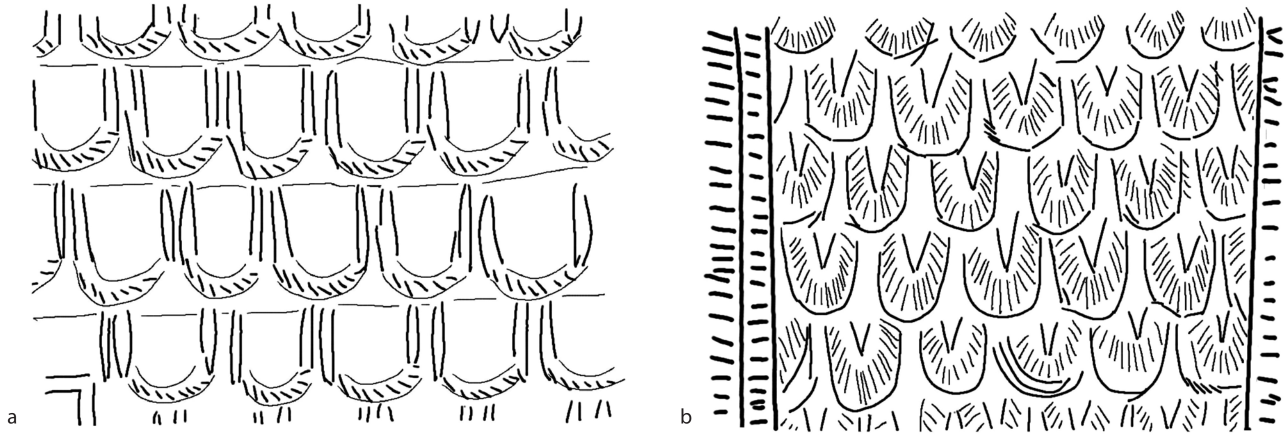


Figure 5.11. *The ropes of motifs in two Tutankhamun's items: (a) the small wooden plated shrine in the form of Nekhbet's sanctuary and (b) the ceremonial dagger with sheath. Drawings M. F. Guerra based on Hawass (2008, 6–7 and 133–5).*

vulture goddess Nekhbet (Carter & Mace 1923, pl. 68; Soddert Gilbert et al. 1976, pl. 9). In one of the published details of the ornamenting scenes representing the king and the queen (Hawass 2008, 63), the differences between the symmetrical left and right decorations of the king's seat and broad collar correspond to a work in two phases, perhaps by two artisans.

In another scene showing the seated king facing the standing queen (Hawass 2008, 6–7), the king's seat, defined with long chased lines, is decorated with feather motif comprising stripes and groups of four hatched lines.[15] The quite regular motifs (Fig. 5.11a) are obtained by punching twice with a liner and by chasing a curved line in-between. The feathers follow (visible) auxiliary lines.[16] Despite the use of the same techniques, the meticulous decoration of the small motifs that enhance king Tutankhamun's ceremonial daggers with sheaths (Carter & Mace 1927, pls. 87–8) show the work of another skilled goldsmith.[17] The feather motif (Hawass 2008, 133-5) that decorates the sheaths (Fig. 5.11b) is made by chasing one larger curved line defining an area decorated with hatching lines. The goldsmith 'balanced' the decoration by repeating in a rather symmetrical way the motif, by shifting the ropes, and by finishing both sides of the ropes with an incomplete motif. The image resolution shown in Hawass (2008, 133–5) is insufficient to be sure that auxiliary lines were not drawn. However, the quite irregular dimensions of the chased volute palmetto motif on the other side of the sheath[18] could result from the absence of those lines delineating the motif.

These two motifs decorate other pieces found inside the tomb of Tutankhamun. On the obverse of the pendant with the name of the king (Hawass 2008, 185) can be observed the one used to decorate the small shrine. The motif that decorates the dagger with sheath can be observed in the canoptic coffins (but less regular) and on the obverse of both the pectoral with the winged scarab in lapis lazuli and the necklace with the scarab in lapis lazuli (Hawass 2008, 170, 193 and 195) as well as in the human-headed winged cobra (Edwards 1976, no. 23).

Many other small details in the pieces from king Tutankhamun's tomb reveal the work of skilled goldsmiths and the use of different techniques. Relevant examples among these pieces include the amuletic bracelet with one lapis lazuli barrel bead (Carter & Mace 1923, pl. 82; Hawass 2008, 132), the scarab pendant with the king's name (Hawass 2008, 185), and the small cylindrical beads of the pectoral ornament representing the nocturnal journey of the moon across the sky (Soddert Gilbert et al. 1976, pl. 19). The use of both gold wires and false coiled wires in one group of jewellery demonstrates developed knowledge of different techniques in the New Kingdom, and perhaps the work of several goldsmiths.

Gold, another colour

The variety of techniques employed in different groups of goldwork from burials demonstrates the Egyptian goldsmiths' ability to produce different visual stimuli with subtle differences. To achieve such splendid items by combining colourful materials with gold, it is necessary not only to have access to raw materials, but also excellent crafts with full knowledge on the versatile properties of metals.

When making objects in gold, the mechanical properties of the metal govern the forming steps of the object. It is however the optical properties, related to the transmission, refraction, absorption, scattering and reflection of light in the material, that chiefly dictate the visual perception of the finished object. The behaviour of metals as a function of the frequency of light, explained by the band theory (conduction of electrons), makes reflectivity dependent not only on the refractive index of the metal but also on its absorption coefficient. For metals, high absorption goes together with high reflection. Therefore, gold is more than 'another yellow'. We use words such as colour, shine, lustre, texture, gloss, to describe the appearance of an object in gold, transcribing the surface properties that result from our visual perception.

The optical properties of gold

Even though nowadays gold is alloyed with many different metals depending on the projected function and on the expected appearance of the final product (Cretu & van der Lingen 1999), in the past several properties of the gold alloys were only controlled by varying the concentrations of silver and copper. Our visual perception of an object in gold results mainly from the colour of the alloys employed and the reflectivity of the golden surface.

The visible light spectrum goes from violet to red, in the range of 400 to 800 nm (Loebich 1972). The reflectivity of gold at the high extreme of the visible light spectrum makes it look yellow; on the contrary, a 100 nm thick gold leaf transmits a blueish-green light (Choudhury 2014), because it absorbs the lowest part of the visible light spectrum. In sum: gold absorbs from blue-green to violet and reflects from red to green. At the same time, the high reflectance of silver makes it appear white whilst copper absorbing in the green-blue region of the visible light spectrum reflects in orange-red (Campbell 2008). By increasing the amounts of these elements in a gold alloy it is possible to change its appearance.

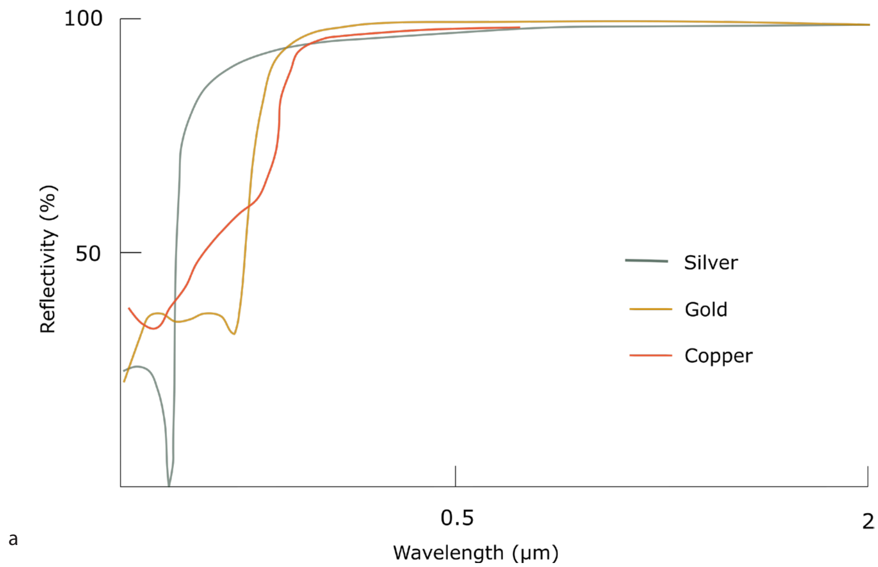
The variation of the absorption coefficient with the light wavelength induces a change in the colours seen. In the case of ternary gold-silver-copper alloys, the object becomes in general pale yellow, greenish and whitish with the addition of silver, and reddish with the addition of copper. For a given gold content, the colour of the alloy will vary according to the chosen amounts of silver and copper, but reflectivity only increases when the amount of silver increases. Surface reflectance has two components, namely specular and diffuse reflectance; it is the first component that prevails for metals, which is why gold is said to shine (gloss), and also why metals are perceived not only as specific materials but also as specific colours (Okazawa et al. 2011). Figure 5.12a shows the reflectance spectra of the three pure metals contained in the gold alloys, where the high reflectivity of silver stands out. The reflectivity of a ternary gold-silver-copper alloy changes with the varying concentrations of copper and silver, but, as mentioned, increases with growing amounts of silver. Figure 5.12b shows this increase of reflectivity for binary gold-silver alloys (based on Shiraishi & Tilley 2014). By adding silver to a gold alloy, it is thus possible to keep (to the naked eye) the colour of gold and obtain high gloss surfaces. Reflection increases additionally with the decrease in surface roughness, which explains the important role of the finishing processes when making objects in gold.

The gold palette in Egypt

The optical properties of the gold alloys play a crucial role in the visual perception of the items. According to the amounts of silver and copper, the 'yellow' material 'gold' acquires different colours, shades and gloss that result in a change of the object appearance, which can be enhanced by the surface texture. The polychrome variety that can be attained in this system may be represented in a ternary diagram that indicates the amounts of gold, silver and copper present in the alloy, and the corresponding colours (discussed in Chapter 1 and shown in Fig. 1.1).

Gold alloys of different compositions and thus colours and shades, can be used in the production of simple (one component) or composite (several components) jewellery items. Figure 5.13 shows one string in the Petrie Museum (UC18092), from First Intermediate Period tomb 7923 at Qau. This string contains cowrie shell-shaped gold beads, whitish gold small ring beads and discs of blue faience, nowadays discoloured. Although the elemental composition of the faience was not searched, the composition of the alloys used in the fabrication of the metallic beads was determined (see Chapter 7). By using the average data obtained for the metallic parts,[19] it is possible to imagine the original polychrome effect that was searched. The possible original colours were represented in Figure 5.13 by adding on one side blue faience disc beads. The contrasting effects that were searched for this string were not only based on the application of different materials (metal and faience) but also on the use of complementary colours of one of the 'materials', gold. It is also possible to conceive that, in the period concerned, the two gold alloys employed were natural, but coming from different sources and thus perceived as 'two materials' or as the 'same material' taking 'aspects' that depend on the source.

Data obtained for string UC18092 demonstrate that the skilful search for gold polychrome effects in addition to the use of colourful components in other materials was early in use in Egypt. The whitish, yellowish and reddish gold ring beads that constitute the child's necklace from the Second Intermediate Period



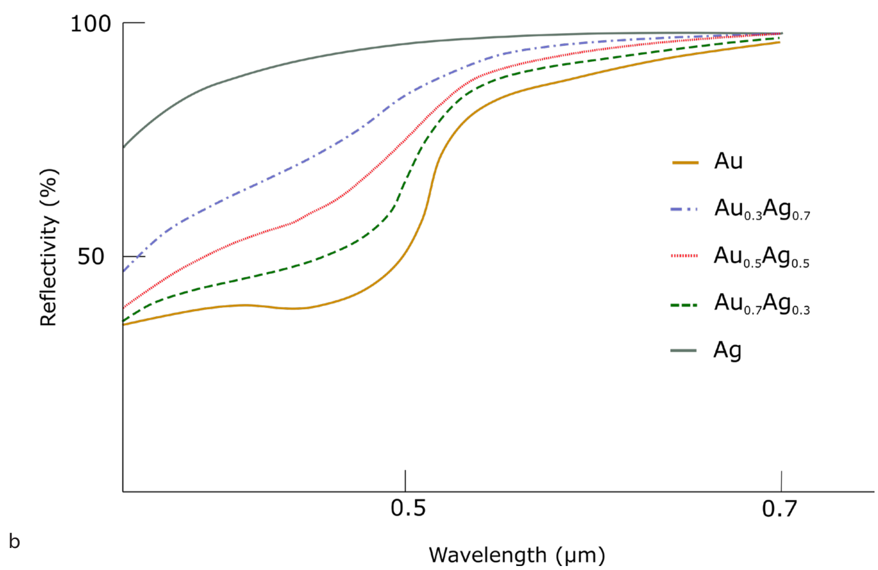


Figure 5.12. *(a) Reflectivity spectra of copper, silver and gold, and (b) estimated reflectivity of several Au-Ag alloys. Drawings A. Mattei, based on (a) Blaber et al. (2010) and Shanks et al. (2016) and (b) Shiraishi & Tilley (2014).*

burial excavated at Qurna (NMS A.1909.527.11), containing silver amounts ranging between 17 wt% and 32 wt% (Troalen et al. 2014, see Chapter 9 for further details), prove the continuity in Egypt of the use of several gold shades and colours. In particular, the use of pale gold, one type of alloy that is mentioned in the Amarna letters: '(…) you have sent thirty minas of gold that looks like silver for my greeting gift. They melted down that gold in the presence of Kasî, your envoy and he witnessed' (EA3: 13–17, Rainey 2015, 69).

Gold alloys with high silver contents are not exclusive to Egypt. In the Andean area, for example, metals were skilfully combined to obtain gold alloys with precise requirements.[20] The intended effect could be an interpretation based on the visual perception by connecting the object to the shining sun, based on the relation between sun and gold (Berthelot 2009) deeply rooted in the Andean religion and between sun and gloss (Saunders 1998). Closer to Egypt, other early gold objects also contain high silver contents, such as some from the Ur tombs (Plenderleith 1934; La Niece 1995; Hauptmann & Klein 2016; Hauptmann et al. 2018; Hauptmann 2020). The same situation appears for objects from the cemetery of Varna (Hartmann 1982; Echt et al. 1991; Leusch et al. 2015, 2017), from Tepe Gawra[21] (Tobler 1950), from the Nahal Qanah cave[22] in western Samaria (Gopher et al. 1990), and from Klady and Kudakhurt in Central Caucasus (Ivanova 2013).[23] The alloys employed in the manufacture of some of those objects are represented in the ternary diagram of Figure 5.14, demonstrating the use of gold with colours that ranged from yellowish to whitish and

Figure 5.13. *Detail of string of beads UC18092 (Petrie Museum) from tomb 7923 excavated at Qau, containing yellow gold cowries, whitish gold ring beads and (originally blue, but now discoloured) faience discs. In order to show the original polychrome effect of this string, on the right, blue faience discs have replaced the discoloured faience discs.*

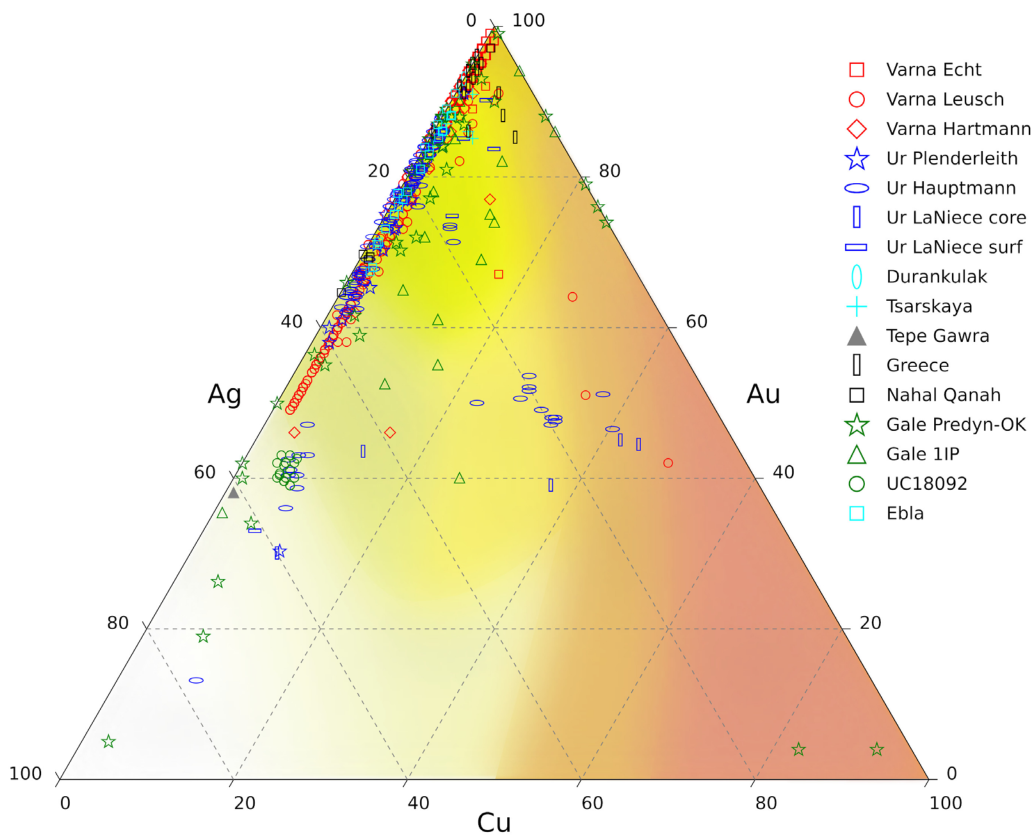


Figure 5.14. *Elemental composition of the beads from string UC18092 compared to objects dated from the Predynastic period to the First Intermediate Period. The objects in the collection of the Ashmolean Museum were published by Gale & Stos-Gale (1981, Oxalid). The others are from the following sites as mentioned in the text: Ur tombs (data published by Plenderleith 1934; La Niece 1995; Hauptmann et al. 2018); cemetery of Varna (data published by Hartman 1982; Echt et al. 1991; Leusch 2019); Durankulak (data published by Leusch et al. 2015, 2017); Tepe Gawra (data published by Tobler 1950); Nahal Qanah cave (data published by Gopher et al. 1990); Greece (data published by Maniatis et al. 2000); Ebla (data published by Felici & Vendittelli 2013); and Tsarskaya (data published by Trifonov et al. 2019).*

containing silver amounts that give the objects a shining appearance. In the particular case of the objects from Ur, which split into several groups corresponding to different Ag and Cu contents, it must be noticed that some of them contain high copper contents, which accentuates their yellowish to reddish appearance.[24]

It is also noticeable in the diagram of Figure 5.14 that the composition of the tiny whitish beads of string UC18092 match the composition of one adze (B16691; Zettler & Horne 1998, 170, fig. 149) excavated at Ur analysed by Hauptmann et al. (2018). However, only the mentioned adze and one spear-head analysed by Plenderleith (1934) and La Niece (1995) and one toilet set analysed by Hauptmann et al. (2018) contain more than 50 wt% Ag.

Identical workshop practices to those at Ur were identified in Egypt by Stos-Fertner & Gale (1979) and by Gale & Stos-Gale (1981), who analysed a large group of Egyptian objects in the collection of the Ashmolean Museum at Oxford. It is interesting to observe in the ternary diagram of Figure 5.14 that only some Egyptian objects analysed by those authors and a few from Ur and Tepe Gawra attain silver contents higher than 50 wt% and a colour and shine that approach an appearance expected for silver. In fact, also represented in Figure 5.14 are some early gold objects from other sites: the beads from Durankulak (Leusch et al. 2015, 2017), the gold periapts (icons) in the Greek National Archaeological Museum (Maniatis et al. 2000), the gold beads from kurgan 2 at Tsarskaya (Trifonov et al. 2018), and fragment foils from excavations at Ebla (Felici & Vendittelli 2013). With the exception of the foils from Ebla that contain 10–31 wt% silver (and a copper content under 2 wt%), all of them contain silver contents under 15 wt%. In the case of Egypt, the composition of an Early Dynastic gold sheet from excavation at Umm al-Qaab (by M.C. Friedel in Amélineau 1899, 274) and of one Middle Kingdom shell pendant (E.302a,1947; Ogden 2000, 164) in the collection of the Fitzwilliam Museum at Cambridge confirm the early use in Egypt of silver-rich gold alloys. The first is made from an alloy containing *c*. 60 wt% Ag and 1.5 wt% Cu, and the second *c*. 60 wt% Ag and 3 wt% Cu.

The use of alloys with high silver contents would seem occasional. In fact, Tobler (1950, 88) indicates that at Tepe Gawra 'gold beads were found in Tombs 109,110,111 (cist), 114, and 31, but electrum beads were found in Tomb 109 only'. Data published for Varna by Leusch (2019) shows that all objects containing more than 35 wt% Ag were found in one single tomb, no. 43. In the case of Egypt, the items in the collection of the Ashmolean Museum (E.4238-44) from the group of jewellery from Middle Kingdom tomb E 30, excavated at Abydos by Garstang (1901, 4–5, 25, pl. 1), contain all quite high silver contents (Gale & Stos-Gale 1981, Oxalid; Stos-Gale & Gale 2009). However, only one of the pendants contain more than 40 wt% Ag. In the group of jewellery from the Second Intermediate Period burial excavated at Qurna only the adult's girdle (NMS A.1909.527.17) contains more than 40 wt% Ag (Troalen et al. 2014 and Chapter 9).

As suggested by Gale & Stos-Gale (1981), the scarcity of silver in Egypt certainly reinforced the search for whitish gold. Would the use of such silver-rich gold alloys be the result of chance in the search of gold sources (native alloys), or technological circumstances (artificial alloys)? It is difficult to answer this question, which is approached below by focusing on workshop practices.

Gold alloys, chance or circumstances?

The search for polychrome effects in Egyptian jewellery by using different colours and shades of gold required the use of alloys of varied compositions, containing high silver contents to obtain the pale shades or high copper contents to obtain the reddish ones. As mentioned by Ogden (2000, 163), gold can be used as found or as an alloy by adding to native gold amounts of copper and/or silver. It can also be refined and used very pure, or refined to be alloyed to precise copper and/or silver amounts.

For the most remote periods, we expect then use of native gold only. In this case, to use different colours it is necessary to have access to many sources of gold naturally bearing different compositions, which means containing, in general, variable amounts of silver. However, gold procurement depends on the development of the necessary technology and on particular political, social and economic contexts.

It is possible to imagine that gold coming from different sources (Coptos, Kush, Amu, Ombos, etc. as cited by Harris 1961), perhaps of different colours, was melted to obtain artificial alloys with different hues to which copper could have been early added to increase the palette. This type of operations could have been intensified when access to different sources of gold was possible regularly. Under Senusret I, gold mines in several Egyptian and Nubian regions were intensely exploited (Hayes 1978, 179–80; Klemm & Klemm 2013), providing the raw material necessary to the royal workshops. The variety of the gold compositions and access to copper certainly simplified the production of alloys during the Middle Kingdom, justifying the diversity and richness of the jewellery from that period found in the burials. The opening up in the 3rd millennium BC of the trade routes passing through Egypt and Mesopotamia that included important economical states such as Ebla, Byblos, Mari, Assur, etc. (Sherratt & Sherratt 1991; Wilkinson 2014; Massa & Palmisano 2018), certainly provided (when mixing was carried out) the necessary silver[25] to enhance the Egyptian gold palette. By increasing the diversity of the gold alloys available, it would have allowed the work of the goldsmith to attain 'superb skill and taste' that 'have never been surpassed', as specified by Aldred (1950, 26).

However, this practice raises one question: when do Egyptians start adding silver to native gold?

An Egyptian workshop might plausibly have applied similar approaches to the control of materials as we find in royal workshops further East.[26] The tightly supervised operations referred in Old Babylonian and Ur III texts (Potts 1997) exemplify the care taken when dealing with precious metals. In the list of gold offerings during the reign of Shulgi (de Mieroop 1986), all losses during purification, lamination, and further work as well as weight adjustments are reported, detailed, and with the calculated equivalent silver values. Sometimes, even certain expected losses by weight of precious metal over the process were recorded.[27] Friberg (1999, 2007) indicates that in Sumerian and Old Babylonian texts gold and silver were carefully measured by weight, using a particular system that included precise small units for silver and sixteen times smaller units for gold. The texts from Ebla, which also carefully record recycling of objects in precious metals (Maiocchi 2010, 21), give the weight by piece of even the smallest components of the jewellery (Archi 2015). One example is a necklace containing '117 spherical beads, 112 double conoid beads, 10 beads in the shape of acorns, 10 beads in the shape of grapes, 228 grains in the shape of cloves', the latter weighing 0.08 g each, as described by Archi (2002, 192). To give an estimation, if spherical and in pure plain gold, the smallest beads would be *c*. 0.2 cm diameter.

Equivalent control measures are described in the texts from Mari (beginning of 2nd millennium BC). In these texts, operations connected to the reuse of gold items are reported (which includes objects weights and compositions checked and described during dismounting) together with the value of the goldsmith's work (25–50% of the initial value added) and of the precious stones included in the jewellery (Joannès 1989). Among the most interesting written sources from this period, one may highlight the list of objects offered to the gods of Qatna, found during the excavations at el-Mishrifeh-Qatna, in Syria. This list indicates varieties that could correspond to the places of origin of gold in addition to varieties designated by Bottéro (1949, 17) as green gold, light (perhaps white) gold, electrum, red gold, fine (or first quality) gold and refined gold. The latter designations denote the gold appearance, which is often related to its purity level, and which might make reference either to native or to artificial alloys. In Egyptian documentary sources, words for the use of gold, silver and electrum appear frequently (see already Lepsius 1877), sometimes linked to a notion of purification and colour that seems to diversify during the New Kingdom (Harris 1961), as discussed in Chapter 2.

Purer gold is obtained by refining. As discussed in Chapter 1, refining requires, however, the acquisition of two levels of technology: cupellation to separate gold from base metals such as copper, and parting to separate gold from silver. Cupellation was employed very early to recover silver from lead-silver ores (Helwing 2014, 2018; Weeks 2012). This technique was attested in Iran from the 4th millennium BC onwards (Nezafati & Hessari 2017). Therefore, it is possible to imagine that it was early employed in gold processing with a subsequent practice of addition of different amounts of copper to native gold, in order to obtain a certain (somehow limited) gold palette. The purity of the resulting mass of gold could have been tested by loss of weight (fire assay), a process mentioned in several Amarna letters (EA3: 13–17, EA4: 36–40 and EA10: 8–14), and later, by using a touchstone (a colorimetric method, Oddy 1983, 1993).

Texts dated to the 3rd Dynasty of Ur (end of 3rd millennium BC) already indicate the use of different varieties of gold, which might of course simply reflect different available grades of native gold. Those texts also specify that the gold varieties were melted together to obtain further varieties. Limet (1960, 44–5) suggested the combination of red gold with fine gold to produce a mixed gold and the combination of fine gold with copper to produce red gold. These 'normal' and 'mixed' varieties correspond to different levels of purity and thus to different values with silver:gold ratio varying from 21:1 to 6.5:1 (Powell, 1990). As abovementioned, the use of reddish gold alloys (containing up to 50 wt% Cu) was observed in a few tools from the Ur excavations (La Niece 1995; Hauptmann et al. 2018). In Egypt, a few objects analysed by Gale & Stos-Gale (1981, Oxalid) contain high copper contents and Ogden (1992) suggested the use of reddish gold during the reign of Akhenaten. The suggestion was based on the colour and composition of a few objects, among them one signet ring bearing the name of the king (formerly in the Goodison collection) that contains *c*. 20 wt% Cu. Other two signet rings from the same period are also reddish. One (MMA 26.7.767; Hayes 1959, fig. 180) was found by Petrie during excavations at Amarna (Petrie 1894, pl 14.31) and the other, bearing the praenomen of king Akhenaton, is in the collection of National Museums Scotland (A.L.190.1; its reddish colour is visible compared to others from the same period in Aldred 1971, pl. 69). Although no mention of gold containing high amounts of copper can be found in the Amarna letters (contrary to gold containing high silver quoted in EA3: 13–17), the term 'red gold' appears in EA283: 7–13: '(…) into the presence of the king, my lord, to take the gold and the red gold of the king (…)' (Rainey 2015, 1097). It is however unlikely that the term 'red' was applied to gold containing high copper contents. Indeed, Kleber (2020, 20–1) affirms that '(…) gold in Babylonian texts is (…) distinguished by colour (red, white, green), by form (nuggets, dust, scrap gold, ingots, golden objects), by treatement (washed, purified, cast), by price, or by unspecified adjectives (such as first-class, good, ordinary, etc.) (…) the deep golden hue of gold of high degree of fineness (…) was perceived as 'red' (…) red gold was the most expensive gold (…) it is the Mesopotamian term for high quality gold'. Moreover, Cassin (1968, 104–5) points out the use in Mesopotamia of 'red', 'fire' and 'shine' to designate 'splendour', emphasizing that 'red' was at the origin of very old and complex notions of wealth and power.

When indicating a colour of gold, the perception of shade or hue is in general also expressed. Thavapalan (2020, 123–6) discusses the varying association in Mesopotamia of glow to colour depending on the material (gold, amber, different liquids) and, based on the sequence of colours mentioned in glass recipes with raising temperatures (already discussed by Campbell Thompson 1936), indicates that the most valuable quality of gold, the purest one, is yellow with a reddish hue. In the ternary diagram representing the gold-silver-copper contents in gold alloys, shown in Figure 1.1, the highest gold contents are indeed represented in the top area corresponding to the indicated colour and hue. In 1985, Waetzoldt suggested that the purest gold in the list of objects offered to the gods of Qatna, mentioned above, is the red gold,[28] a shining gold with a red hue (in Thavapalan 2020, 224). This quality in the Ur III texts worths 15–21 times the value of silver (Powell 1990). This could explain why in the late Kassite period gold (used as 'money') that is 'red' is twice as expensive as gold that is 'bright' as revealed by Powell (1996, 230–1), who considers that the varying values of gold correspond to different qualities and not to price fluctuations (Powell 1990, 80). In Egypt, Baines (1985, 288) associates to that fact the representation in scenes of gold objects in a more orange yellow, outlined in dark orange or brown, than other yellow materials. The range of colours and hues seems however more limited in Egypt. Schenkel (2007, 215) when commenting on inscriptions of the Ptolemaic Period indicates four types of gold ore related to colour: 'gold', 'fine Desert gold', 'gold of the third quality' and 'two-thirds gold'.

Analytical data by A. Murr on native gold samples from Egypt and Nubia, collected by Klemm & Klemm (2013, fig 4.1) show that the gold contents range from 70 to 95 wt%. Assuming that 'two-thirds gold' means *c*. 66 wt% Au, the quality classified this way would correspond to the lowest grade of native gold from the Eastern Desert deposits (*c*. 70 wt% Au). In the same sense, we can suggest that the 'fine Desert gold' could correspond to gold from the Nubian deposits (containing *c*. 90 wt% Au). It is interesting to consider one nugget with a ribbed suspension ring to serve as pendant (MFA 23.311), found in tomb Beg. W. 859 at Meroë by the Harvard University - Boston Museum of Fine Arts Expedition. Analysed by Gänsicke & Newman (2000), it has shown to contain 91.2 wt% Au. Gold from Eastern Desert mines could be named simply 'gold' (perhaps from some Nubian deposits too) when of 'regular' purity (*c*. 80–85 wt%). One nugget mentioned above from a burial excavated at Elkab by Quibell (1898, 7) when analysed by Stos-Fertner & Gale (1979) revealed the presence of 85 wt% Au. In addition, the gold in quartz veins exploited by the end of the 1940s by the Egyptian Mining Company at Wadi al-Sidd, *c*. 4 km from Wadi Hammamat, contained 20 wt% silver (Goyon 1949). Finally, the designation 'gold of the third quality' is vague. It might correspond to a particular native quality either containing less than 70 wt% Au or a particular composition that assigned it the third place in the 'grade scale', for example 75–80 wt%.

The evolution of the gold palette with modulation of the gloss in Mesopotamia and Egypt raises many questions. Its expansion is quite limited when only copper and native gold are mixed. The easiest and most precise way to obtain the 'best' ternary gold alloy for a given purpose, including the selection of gold shades, is to have pure gold, copper and silver as starting materials. This, however, requires the availability of parting technology. Archaeological evidence dated to the 6th century BC, found during the excavations of Sardis, indicates that parting was discovered much later than cupellation (Craddock et al. 2005). The use of parting in Lydia would coincide with the advent of bimetallism, which means the replacement of electrum coinage by a system based on separate silver and gold coinage. Analysis of Lydian coins (croesids, darics and double-darics) and of Alexander's type staters struck in Babylone and Sardis, showed the use of both refined gold (reaching more than 99 wt%) and of artificial electrum[29] obtained by addition to gold of silver, because the amounts of silver are correlated to the amounts of lead in the alloys (Paszthory 1980; Nicolet-Pierre

& Barrandon 1997; Cowell et al. 1998; Gondonneau & Guerra 2000; Gondonneau et al. 2002; Craddock et al. 2005). The composition of the monetary alloys and of gold globules in sherds excavated at Sardis from the vessels employed in the refining process, analysed by Meeks (2000), were found to be the same.

In spite of this, there have been some suggestions of the very early use of surface treatments to remove both copper and silver from the surface of gold alloys (Craddock 2000a; Shalev 1993). Objects found in the 3rd millennium tombs excavated in Ur (Plenderleith 1934; La Niece 1995) and in the 4th millennium BC Nahal Qanah Cave (Gopher et al. 1990) have different surface and core compositions, suggesting that the removal of copper and silver (Levey 1959) from the golden surface, by depletion gilding, could have started before the 1st millennium BC. In fact, the use of salt is an efficient technique to eliminate silver from the surface of gold alloys (Jesus 1980). Diodorus Silicus, who travelled in Egypt in the 1st century BC provides one of the oldest descriptions of this process. He indicates the addition of both lead and salt to gold in the same crucible. This ancient process was successfully tested by Notton (1974), who could remove all the copper from a gold alloy and some silver, raising the amount of gold from 37.5 wt% to 93 wt%. Further discussion on the salt cementation process is given by Craddock (2000b).

Interestingly, one text from Ur (UET III 1498 in Legrain 1947), listing the goods in a goldsmith's workshop, mentions 20 *sila* of salt (= 20 l) suggesting that the salt could have been used to carry out in this workshop a process that could be related to refining (perhaps cementation) (Potts 1984, 1997). It is however difficult to imagine gold (routinely) refined in a goldsmith's workshop, because the metallurgical process would involve expert craftmenship, particular equipment and different workshop organization. The Neo-Babylonian texts from Sippar (despite more recent as dated to the second half of the 1st millennium BC) indicate that precious metals were given to the bronzesmith, not to the goldsmith, to refine and assay the metals and to cast ingots (Zawadzki 1991, 44–5). A routine refining process is only necessary, even obligatory, when mass production and reproducibility are imposed, characteristics intrinsically related to coinages, made from a defined alloy. Therefore, the archaeological remains excavated at Sardis would correspond to a (royal?) workshop routinely refining high quantities of gold, using a process that had certainly been introduced earlier. In this sense, the 20 silas of salt mentioned in the text from Ur would simply correspond to possible use by the goldsmith for surface enhancement of (certain?) gold items.

The possible use of 'salt enhancement' since the 3rd millennium BC in Ur is often used to explain[30] the excerpt of one of the letters written by Burraburiyaš, king of the land of Karduniyaš, to Amenhotep IV complaining about the quality of the Egyptian gold sent to him: 'the twenty minas of gold that were sent were not complete. And when they put them in the kiln, not five minas came out! [The gold] which did come out had the look of ashes when it turned dark (cooled). [As for the gold, wh]en did they ever verify it?' (EA 10: 8–24, Rainey 2015, 96–9). We must nevertheless consider some other passages in the Amarna letters that might lead to another understanding of the loss of 15 sillas (75% of the total weight) in the kiln. This would mean that the alloy contained 25 wt% gold only and would therefore be either too pale or too reddish. The metal would have to be gilded or plated to look like 'gold'.

In EA29 is mentioned that gold was sent from Egypt as ingots and in bags, thus as dust or nuggets[31] (Rainey 2015, 305). In the same letter (69–79) we can see that gold is also sent in other forms: 'and my brother sent statues of wood, but the golden ones [of which Nimmure]ya had said that I would see them, were not gold and were not so[lid,...]'. The loss in the kiln of 15 sillas might refer (to reinforce the argument) to loss of 'material' not loss of 'metal'. Indeed, the gold sent from Egypt does not seem to correspond to what was expected. Always in the same letter (162–5) it is clearly stated what was desired: 'so statues of solid chased gold, [may my brother give] and much gold that has not been worked'. We can imagine that receiving gold items ('statues of solid chased gold') instead of gold ingots or gold dust or nuggets ('gold that has not been worked') should not pose any problem as far as the gold items were in plain gold and not plated (?). In fact, letter EA20 (46–79) is an 'ode' to the satisfaction brought by the quality of the received gifts, in 'unworked gold',[32] with an insisting request for this type of gold (71–9): 'may he send me much gold that has not been worked'. In letter EA19, the request for 'unworked gold' is pointed out three times (39–42, 49–53 and 59–70; Rainey 2015, 143).

Even if the often mentioned relation between letter EA10 and the use of cementation is difficult to confirm, the early use of the process since the beginning of the 2nd millennium BC was proposed based on new translations of the ancient texts. Paoletti (2016) discussed this possibility associated to gold objects both found near Bernstorf in Bavaria (Radtke et al. 2017; Wagner et al. 2018) and inside the Ur tombs (Hauptmann et al. 2018), and Kleber (2020) reconsiders the use of electrum in Mesopotamia. It is however difficult to accept these suggestions. Indeed, some of them are based on Klemm & Klemm (2013, 45–9) analysis of gold leaf from the so-called Akhenaten's coffin, which is, in fact, the coffin found in tomb KV 55. It is noticeable the controversy that has surrounded not only tomb KV55 since its discovery in 1907 (Aldred 1988, 195–218), because the identity of the owner is still disputed, but also the gold foils from this burial. With some components removed from the Cairo Museum between restoration by Carlo Oropesa in 1915 and Engelbach's inventory in 1931, some of the foils entered the collection of the Metropolitan Museum of Art (Bell 1990). Others, apparently from the coffin's bottom decoration, previously in N. Koutoulakis' collection, were offered to the State Museum of Egyptian Art at Munich. The gold decoration was restored (the final piece is shown in Der Spiegel, Schulz 2000) and in 2002 repatriated to Egypt.

The foils analysed by Klemm & Klemm (2013) are fragments from those foils. In addition, the surface structure of gold leaf obtained by hammering and annealing is different from the surface structure of refined gold sheets – such as those resulting from replication experiments carried out by Geçkinli et al. (2000) at Sardis – and refining should not be the last step of the process of making gold leaf. The thickness of the gold samples from the coffin found in tomb KV55 is omitted, but the thickness of all the 30 gold foils analysed by Hatchfield & Newman (1991) and the eight foils in the gilder's book in the Louvre collection analysed by Darque-Ceretti & Aucouturier (2012) is always under 10 μm and they are therefore too thin to be handled during a refining process. The two gold leaf samples from Tutankhamun's coffin analysed by Rifai & El Hadidi (2010) are thicker, but still too thin: one is under 20 μm and the other under 48 μm thick.

It is possible that surface enhancement by depletion gilding, and not parting, is the process alluded to in the ancient documents. If this technology was available, even if only in specific workshops and occasionally used, it could however be the basis of an early practice consisting also of the addition of also silver to native gold in order to produce artificial alloys of many different colours. If this workshop practice existed in Mesopotamia to produce alloys containing variable silver amounts, it would have certainly been brought to Egypt, perhaps during the Middle Kingdom or even earlier, at least for the production of specific gold objects. Against this background, the analytical study of Egyptian goldwork presented in this volume provide important data on the chronological variation of the gold alloys, as a starting point to address the metallurgical operations employed in the goldsmith's workshops.

Notes

1. Among the earliest known examples are gold finger-rings: one from the excavations of Telloh is inlaid with lapis lazuli and carnelian (Sarzec 1884–1912, 391, pl. 44ter-3) and another from the excavation of the Royal Cemetery of Ur is inlaid with lapis lazuli (British Museum 1928,1010.38).
2. For axample in the Mycenaean workshops that flourished in 15th–13th centuries BC, facing Egypt.
3. In contrast, goldsmiths in the Iberian Peninsula were producing at the same time mainly solid gold items.
4. By the end of the 19th century, Art Nouveau creators, who marked the revival of the art of ancient goldsmiths, in a search for polychrome effects under japonisme used many materials with gold and silver (Tissot et al. 2016, 2019).
5. The Iberian Peninsula is under the Atlantic influence whilst the Egyptian and Mycenaean jewellery illustrates the art and tradition of the goldsmith work in further East.
6. Further information on the production of beads can be found in the work of Xia Nai, who describes their manufacture in Egypt (Xia 2014), and many publications focus on the fabrication of glass and faience in Egypt (see for example Shortland 2012; Shortland et al. 2006; Tite & Shortland 2003; Tite et al. 2002; Henderson 2013; Rehren & Pusch 2005),
7. Among the remaining prestigious goods in the looted high-ranking graves in cemetery S at Abydos were found one piece of gold foil in grave S548 and one bead covered with gold foil in grave S602 (Peet 1914, 33–4), demonstrating that gold was present in the burials.
8. A. Wilkinson provides a detailed drawing of the four bracelets (Wilkinson 1971, 16–19).
9. The gold serekh beads said cast by Petrie, are in fact made from sheet gold and in two parts, the box and the hawk (Wilkinson 1971).
10. Another 'hawk bracelet, but with blue glazed beads, was found in a monumental 1st Dynasty tomb at Giza, which also contained 2 needles in gold (Petrie 1907, 4–6, pl. 4). The gold covering foil of the handle of a flint knife supposedly from king Djer tomb is also inscribed the king's 'hawk' name (Needler 1956).
11. One loose serekh ivory bead from the same tomb in the collection of the British Museum (EA35528), certainly from another string, is also pierced horizontally by two holes.
12. Ten gold beads found in tomb 1532 at Naga al-Deir are ribbed (Reisner 1908, pl. 6). Their manufacture seems less skilled than the gold beads in king Djer's bracelet. Certainly based on the gold beads found in the Royal cemetery of Ur (one string for example in Maxwell-Hyslop 1960, pl. 11–4), those ribbed beads are said made by wounding a gold wire. However, another gold ribbed bead (large with thin edges, and slightly bowed) dated to the 1st Dynasty found at Naqada has to be considered. De Morgan, who found it during the excavations of the royal tomb, affirmed that the bead has 'no signs of soldering' and that it was 'cut from a sheet' of electrum (de Morgan 1897, 197, fig. 744).

13. The dimensions provided for the ring beads are 1 mm height and 1.5–2.5 mm diameter (CG53018 in Vernier 1907–27). We assumed the average 2 mm diameter. As their thickness is not provided, we assumed 0.3 mm, which corresponds to about 1/3 of their height. The rings in the separators were assumed to have the same thickness and diameter, but twice the height of the other rings; the tubes were assumed to have the same thickness, an outer diameter of 1.7 mm, and a height of three and five times those of the rings.
14. The very irregular, in form and colour, gold beads from the Qurna child's necklace discussed in Chapter 9 have often a slightly hammered border suggesting adjustment and could be gold spacers issued from the reemployment of ancient objects. A system of reemployment of standard gold components without melting avoids loss of raw material, combustible and working-time of skilled crafts. The description of the complex and highly controlled dismantling of gold objects for melting and reuse is described by F. Joannès (1989, 119) for the city of Mari based on documentary sources.
15. In other scenes representing the king and queen, the use of pearl-punchers to texturize can be observed, and a circle-punch to decorate (Hawass 2008, 62–3). By tilting the punch, the goldsmith also obtained half circles, such as over the king's head.
16. Auxiliary lines are formerly drawn to delimitate the areas to be decorated. Pre-drawn motifs can be detected in other parts of the scene, for example in the queen's headdress ornamented with a uraeus, and in other objects, like the vultures chased on the back of the clasp of the birth of the sun pectoral ornament (Carter 1972, 145; Hawass 2008, 194–5).
17. The skilled work of goldsmithing is evident from the granulation patterns applied on the objects and the richness of the materials employed. While the dagger with a gold blade represents the skilled work of cloisonné and granulation, the other dagger manufacture includes patterns in granulation decorating the hilt, a blade in meteoritic iron (Comelli et al. 2016), and a pommel made of rock crystal.
18. On the other sheath, some flat surfaces of the animal scenes are scratched, a technique that is used to improve the adherence of an applied hot semi-molten glassy material or to provide more grip for an adhesive employed in stone inlaying (Guerra & Rehren 2009). Therefore, originally the sheath might had been intended to be entirely inlaid. Closer examination of the object is necessary to confirm this possibility.
19. The cowrie beads contain *c*. 80 wt% Au, 16 wt% Ag, 4 wt% Cu and the ring beads *c*. 36 wt% Au, 60 wt% Ag, 4 wt% Cu.
20. For example, silver contents of 30–50 wt% were used by the Incas, which keeps the yellow colour of gold, but significantly increases the reflectivity of the surface (Guerra 2018).
21. The only bead analysed was found in tomb 109 in level X (end of 4th millennium BC), a burial of an adult in a coffin: 38.05 wt% gold, 61.39 wt% silver, 0.56 wt% copper (Tobler 1950).
22. Eight gold ring-shaped objects were found in one of the graves at the cemetery of the Nahal Qanah cave, in western Samaria, that were assigned to a 4th millennium BC culture (Gopher et al. 1990).
23. Ivanova (2013, 288) indicates that Maikop gold objects from Klady and Kudakhurt contain 10–50 wt% Ag.
24. It is noticeable that chisels from Quenn Pua-bi grave are made by depletion gilding (Grimwade 1999) of copper-rich gold alloys, and one chisel containing in the core 43 wt% Ag and 13 wt% Cu contains at the surface 18 wt% Ag and 8 wt% Cu (La Niece 1995).
25. Perhaps along with lapis lazuli. The distribution map of lapis lazuli (sources, raw, objects) for the Near East during the EBA is provided by M. Massa (2016, 496, fig. 7.54).
26. Evidence for very tight control of base metal was recorded in Egypt. According to Berlev (1969) based on copper blades for tools: 'The extent of control for precious metals can be gauged from the extremely detailed recording of even small copper blades, as documented in the accounts on one royal construction project in the reign of Senusret I, in Dynasty 12 (Papyrus Reisner II: see the comments in Berlev 1969).'
27. It is recorded (Limet 1960, 148-9) for example that for 5 shekel silver rings (1 shekel= 8.33 g) 'la freinte pour la mine à raison de 10 grains, a été enlevée', which means 'the wastage at the rate of 10 grains per mina was removed' (1 mina= 60 shekels, 1 grain=1 shekel/180). For two 5 shekel silver finger rings each it is recorded that 'la freinte est de 1/3 de sicle; 23 grains de rognures', which means 'wastage is 1/3 shekel; scraps 23 grains'.
28. Similar interpretation is given by Dercksen (2005) and Erol (2019) for the gold types cited in the Kültepe-Kanish documents (beginning of the 2nd millennium BC).
29. Van Alfen & Wartenberg (2020) recently published a state of the art on early electrum coinage.
30. Despite arguments against this possibility provided by others such as Ogden (2000, 163).
31. 'He gave an ingot of gold to Keliya that was one thousand shekels in weight.' (31–4) and '[He sent] seven bags of gold [with the one in]got of go[ld] of [one thousand sh] ekels [in wei]ght of Keliya' (35–9)
32. EA 20: 46–59 (Rainey 2015, 153): [And with regard to the gold] which my brother sent, I assembled all my [foreign gue]sts. [My] brother, [the gold that he sent] in the presence of all of them, now, they were cut open, [....a]ll of them, they were sealed and the gold was u[nworked!]. [They became f]ull [of anger] and they wept grievously, [saying,] 'Are all of these [tru]ly of gold? It is unworked!' [And] they said. 'In the land of Egypt, gold is more plentiful than dirt.' [And[, my brother, furthermore, 'He loves you very much. As for mankind, [he] who loves, then to him(!) things like these he would not gi[ve]. Whoever desires, it is more plentiful than dirt in the land of Egypt, but who would give to someone things like these of which the sum is so mi[serly! But (rather)] with out reckoning (would he give).' I verily said thus, 'I cannot say before you, "My [broth]er, the king of the land of Egypt, loves me very much".'

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Ancient Egyptian gold

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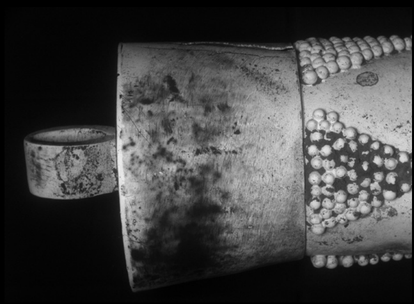

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