

**Observations and questions on gold artefacts from underwater excavations.** The view from an archaeologist-restorer working *in situ*.

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### Abstract

We will study examples of settlement excavations that can reveal sometimes abundant gold material. These underwater excavations are held in Alexandria and Aboukir bay, Egypt where we found numerous gold or gold-plated objects.

Some objects give us informations about the trades routes, others show us that refinement existed even during the Byzantine period. Some objects tell us fabulous stories, other ones testify to a high mastery of technology.

Through specific examples we will approach the scientific, aesthetical, historical and technological aspects of these gold objects.

Most of the gold objects, jewellery and coins, have been studied and published but given the number of excavated objects, the less spectacular ones or the ones too delicate to interpret have been neglected.

Being an archaeologist specialised in the restoration of metal, I am metallurgist, a technologist or even a numismatist nor an historian specialised in the production or trade of gold objects.

On the boat, underwater or in the land laboratory, many questions are growing concerning these archaeological objects.

With the help of three cases, we will see that some problems raise up and that we need a close collaboration with various gold artefacts specialists to try to solve these uncertainties.

**Keywords :** FTIR, Egypt, goldsmith, gold-working, metal restoration, underwater archaeology.

### Résumé

**Les nombreuses observations et interrogations sur des objets en or provenant de fouilles archéologiques sous-marines**

Le point de vue d'un archéologue-restaurateur travaillant *in situ*.

Seront abordés des exemples de fouilles d'habitats qui parfois peuvent livrer un abondant matériel en or. Ces fouilles sous-marines, sont menées en Egypte, à Alexandrie et Aboukir. Lors de nos campagnes de fouilles, nous avons trouvé de nombreux objets en or ou recouverts d'or. Certains objets nous parlent des voies commerciales, certains nous démontrent un raffinement d'une période dite décadente. D'autres objets nous racontent de fabuleuses histoires, d'autres encore sont des preuves d'une haute maîtrise technologique.

Au travers de quelques découvertes, nous allons approcher l'aspect scientifique, esthétique, historique et technologique de ces objets d'or.

Si la majorité des objets, monnaies ou bijoux, sont étudiés et publiés étant donné la masse de documents exhumés, il en est de moins spectaculaires et de plus délicats à interpréter qui sont délaissés.

Etant un archéologue spécialisé dans la restauration du métal, je ne suis donc ni analyste, ni métallurgiste, ni technologue, ni numismate, ni non plus un historien spécialiste de la production, du commerce ou de la circulation des objets en or, et pourtant, que de questions se posent face à ces objets archéologiques trouvés lors de fouilles et restaurés *in situ*.

A travers trois cas, sera entrevue une base d'étude où seule une collaboration pluridisciplinaire pourrait répondre aux problématiques posées.

**Mots clés :** analyse, archéologie sous-marine, Egypte, milieu marin, orfèvre, restauration du métal.

### Introduction

*The methods employed by the ancient Egyptian goldsmiths have been covered in some detail elsewhere, although there is still a need for a far more comprehensive study.*

(Ogden, J., 2000)

The European Institute of Underwater Archaeology (Institut européen d'archéologie sous-marine, IEASM) lead by Franck Goddio, has been excavating in Egypt for more than ten years.

We are working in the Nile Delta and more precisely in Alexandria and the Abukir Bay where we found under the sea the remnants of the sunken cities of Canopus and Heracleion. More than 15 000 artefacts were discovered and among this abundant material we mainly found stone work. We also found objects in organic material, ceramic, glass and different metals. Some rare objects made of silver, the iron ones generally disappears in the sea water environment, but bronze, lead and gold are frequently discovered.

What is unusual about these sites is that they were abandoned because of several natural cataclysms and not reoccupied during the last centuries. That is why we had the chance to find many intact artefacts like ritual dishes, which are rather infrequent in other excavations.

The corpus of gold artefacts is mainly represented by jewellery and gold coins coming mostly from the Ptolemaic and the Byzantine periods.

The jewellery is relatively standard, it includes ring, earring, bead, pendant, pendant with some gem stones (amethyst, emerald, sapphire, garnets), glass or pearls.

Several rings are delicate and some are made of massive beaded wires. Some are without decoration or just a gem, but some others are finely decorated and show scenes of everyday life.

Through specific examples we will approach the scientific, aesthetical, historical and technological aspects of these gold objects.

### Methods § 1

Some rings show interesting stories like a romantic Byzantine wedding ring coming from Canopus from the 6th or 7th century A. D (Photograph 1). The translation of the Greek inscription engraved inside the ring reads "Peace, which is mine, I give it to you. Amen". This citation comes from the Gospel according to John (14, 27). There are interestingly two orthographic mistakes in this sentence.

On the face is written OMONOIA which means union (lat. concordia), as is traditionally written on wedding rings at that time. OMONIA was chosen by Christians in reference to the first word of the verse 16 of chapter 25 in the book of Sirach, which deals with marital and family relationships. "The Union of brothers, the friendship of neighbours, and wife and husband living in perfect harmony" (Tardieu, M., 2006).



Photograph 1 : Wedding ring and ring with a bezel in the shape of an oil lamp.  
Photographie 1 : bague de mariage et bague avec un chaton en forme de lampe à huile.

The Byzantine period is nicely represented by a fine handcraft ring with a bezel in the shape of an oil lamp (Photograph 1). The details are so perfectly made that the top lid is still movable. Found on the site of Canopus, this ring is dated between the end of the 6th and the beginning of the 7th century AD. This type of ring seems unique, we don't have any parallels, only its decorative waves and vegetal ornament can be compared to the one found in the treasure in of Pantalica, Sicily (Stolz, Y., 2006).

An important discovery was made on the site of Heracleion in 2003, when we found a gold plaque with inscriptions. Unfortunately it was not in its original position but at the bottom of a canal. It is 5 cm high, 10.8 cm wide and 0.8 cm thick. Written in Greek this gold plaque was made to celebrate the construction of a monument (gymnasium) by Ptolemy III. In 1818, a 6 by 6 cm gold blade was found in Abukir, it is also engraved in Greek. This second one is in the British museum N° 1063, with the dedication of a *Temenos* to Osiris in the name of Ptolemy III and Berenice II, (Yoyotte, J., Clauss, M., 2006).

Sometimes, gold objects can help understanding the trade between Egypt and other countries. Coming from Cyprus is the Hemistater of Pumiyaon, with a naked walking Heracles wearing only his traditional lion skin. It dates from the 4<sup>th</sup> c. B.C. What is unusual here, is the fact Heracles is beardless. The reason is that the Cypriot Herakless-Melquart is not heavily bearded like the classical one. On the reverse, a Phoenician inscription with the name of the king Pumiyaon, dates the issue to the seven or eighth year of his reign (355/353 B.C.), (Yoyotte, J., Lichocka, B., 2006).



Photograph 2 : Gold eye of Horus (*Wedjat*).  
Photographie 2 : oeil d'Horus (*Oudjat*).

From a technological point of view we have an interesting gold eye of Horus (*Wedjat*) found in Heracleion (Photograph 2). This bead, hollow inside, is made of two gold blades and a strip of gold sheet for the sides, (Stolz, Y., 2006).

We can imagine the technique used to make the pupil; with a flat sphere, filigree and granulation for the decoration. This object is really small, measures 8 mm and weights 0.4g. It is less than 2mm thick. It makes us wonder how they were able to weld all those small pieces together, and make such tiny details.

Usually this kind of jewellery is embossed or moulded. It is unusual to find filigree and granulation. They really worked hard for such a small object.

## Methods §2

On the boat, underwater or in the land laboratory, a lot of questions arise concerning the archaeological objects and even a simple object can bring many informations but also numerous questions.

Case 1-The most interesting questions concern a carved lime stone holding more than one kilo of gold leaves. Among the gold leaves was a kind of hard black substance.

After microchemistry tests in the Expert Center laboratories in Lausanne, we established that it was an organic substance and after analyses with FTIR (Fourier transform infra-red spectrometry) and GC-MS (gas chromatography - mass spectrometry) we now know that it was a natural resin like colophane with what seems traces of perfume resin like myrrh or aloe vera.

The gold foil does not have a regular size but a constant layer thickness of  $12.3 \pm 0.9 \mu\text{m}$ , almost comparable to chocolate paper.

The examination of the gold composition by XRF (X-ray fluorescence spectrometry) and AAS (Atomic Absorption spectrometry) made by the research laboratory of the Swiss National Museum gave the composition of the metal. The gold contains silver, platinum, iron but no copper (Table I).

Denomination	% Sn	% Pb	% As	% Sb	% Pt	% Ti	% Ag
Gold sample	<0.0010	0.0006	<0.0010	<0.0010	0.0202	<0.0020	0.1741

% Ni	% Bi	% Co	% Zn	% Fe	% Cu	*% Au
0.0007	<0.0010	<0.0010	<0.0010	0.0176	0.0025	99.7843

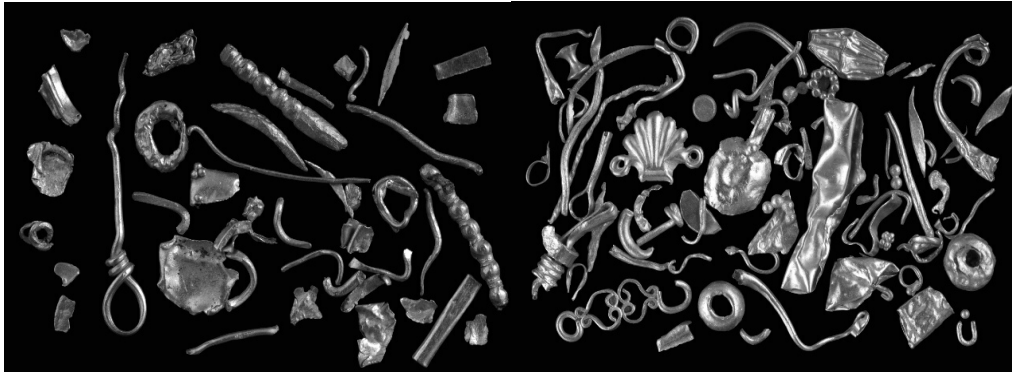
\*% Au: The gold composition has been calculated (100% - composition of trace elements)

Table I: Gold leaves composition.  
 Tableau I : composition des feuilles d'or.

Does this information allow us to say that it was used in a temple as an offering to the gods with gold and perfume resin, or that it was some kind of offerings deposited in the foundation wall during the construction of an important building like a foundation deposit?

Is it possible that it was the hide of a goldsmith and that metal was meant to be melted again, or that it was a sort of kit for gilding with the resin used as glue?

As mentioned in the literature (Higgins, R. A., 1961 ; Pliny the Elder) it was not unusual to find this thickness for a gold leaf, but was this type of gold leaves made to gild what kind of material, stone, metal or wood?



Photograph 3 : Deposit of gold fragments.  
Photographie 3 : dépôt de fragments d'or.

Case 2-Gold is stable even underwater but on land excavations, the fragments of gold artefacts or even small objects are mixed with sediment. Gold starts to tarnish and we cannot easily distinguish it from other material or sediment.

On the other hand, in sea water gold is not altered; in the Nile clay, in the sand or other sediment, gold keeps its shiny metal reflection. The objects are so shiny and dense that we can see them immediately in sediment or in the sifter rejected by the water dredge. That is why we found a considerable amount of small pieces of gold and elements of goldsmith, a less common phenomenon in land excavations.

We can focus on two small representative deposits of gold fragments, one contains 63 gold pieces and the other one 42 fragments. When we have a closer look at the fragments we see that they are small pieces of objects and mostly jewellery.

We can recognise fragments of objects, palmette-shaped appliqué, beads of different size and shape, chain links, ornaments, earrings, parts of necklaces, bracelets, annuli, granules, pendants, wire, etc.

The question is : did they break naturally, were they here to be melted, or were they intentionally broken to be offered to the gods and then spread onto the land?

In the area of one temple we found many small factice offering lead coins, thousands of them. It conveys perhaps a similar phenomenon : instead of offering jewellery, they preferred to offer a large amount of precious metal - but in small fragments.

Case 3-Very often, we see that Egyptian archaeological bronze sculptures have been gilded and we can observe traces of gold or technological details for the gilding preparation. A crown found in Heracleion, from a life-size statue, has a roughened surface with a lot of cross hatchings made with gravers tools or burins; but we could not find any trace of gold on it.

It is not rare in Egypt to find bronze sculptures overlaid with gold, using the technique of roughening by stippling or chiselling the surface in order to facilitate the adhesion of the gold leaf to the copper alloy (Oddy, W.A. and Al., 1988).

This strong and thick gilding need requires different layers of gold leaves to cover the cross hatching. In some cases there is a mineral preparation between the two metals sheets (Oddy, W.A., 1981).

On the other hand some objects are perfectly polished and gilded, and in many cases we can still observe gold leaves. The fire gilding, using mercury-gold amalgam, was unknown prior to the Ptolemaic period (Ogden, J., 2000). Other methods were used.

In the research laboratory of the Swiss National Museum we analysed a Mummiform Osiris found in Heracleion. This sculpture has gold blade inlaid for the eyes and is overlaid with extremely thin gold leaves on the body. The antic surface was polished without any intentional engraving. Between the metal and the gold leaves, it seems that there was a resin or a drying oil. In seawater, an organic material like resin can be well preserved. The analyses were performed to see if we could recognise which kind of medium they used to glue the gold leaves. This method has been attested in Egypt since the third millennium B. C (Raub, C., 1993). Unfortunately the result was negative and we were not able to find any organic component but only gold and products from the bronze corrosion.

Does this mean that the gold leaves can stick directly to the metal without any preparation, just with heat and strongly burnished?

As we know from the literary sources, this technique seems to have been attested in Egypt since the second millennium B. C (Oddy, W.A., 1982). But specialists do not agree on this subject (Ogden, J., 2000).

They ancient artists were able to cast a life size sculpture in bronze, to polish its surface, to chisel all the details and after they spend a huge number of hours only to scratch, to hatch and engrave the nice skin of the sculpture, they would disfigure it for the only purpose of having a terribly roughened surface. This method must have higher issues. Creation then destruction. But if they were able to apply simply the gold leaf directly on the polished metal surface, with a very nice result and while using less gold, being faster and needing less preparation; the question is why, in the same period, in the same place, on the same bronze support, for the same object, would they have used different methods for gilding?

On an object like an Osiris, they used two different types of gold; one for gilding with very thin gold leaves, the other, being thick gold blades, for inlaying the eyes.

We have used on the same object : gold blade, gold leaves without resin and a roughened surface, at the same period, in the same archaeological site, and even in the same temple. Why so many different techniques?

### Conclusion

As archaeologist we do not find many gold objects on our excavations; as restorers specialized in metal we do not have to perform many interventions on stable gold objects but we have many interrogations and so much information to obtain from these small precious objects.

Sometimes, as restorers, we get the privilege to have access to some technological details and useful information. We spend so many hours on and with the objects, that we know them very closely. For example, we can observe gold traces in the corrosion products which will disappear during the restoration treatment. But if we have the privilege, we also have the responsibility to describe and to document our observations. Most of the time we do our best but we are not specialized in and we miss some technological knowledge on archaeological gold objects. We lack reference articles and one cannot help but notice that we need more close collaboration with specialists and experts.

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