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The authenticity of the false

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Abstract. Since its first appearance, the jewel is not a mere expression of vanity and seduction, but it is associated with the decorative function with a multitude of meanings that transform it to all effects into a complex and fascinating communication code [1]. The jewel is a perfect combination of nature, technique and individual creativity that interprets the collective sensibility in the various eras. If we then join up it to its being made of precious metals, it becomes the most advantageous and profitable object of forgery [2]. The fakes and counterfeiters began at much the same time and flourished ever since. Most of the early productions are not very convincing, either stylistically or technically, this was due to a general lack of detailed stylistic information and an almost total ignorance of ancient technology. Until the middle of the last century there was no real science applied to the study of cultural heritage and the falsification or counterfeiting could be unmasked only by stylistic errors or anachronistic details detectable by visual observation although with the help of optical microscopes. With the establishment of Archaeometry, each diagnostic application became a real scientific research [3]. In the present work, the chemical and physical studies on ancient goldsmith's art in the last forty years, highlight the peculiarity of the manufacturing technique and the scientific knowledge of the artisan, which allows not only to discover modern copies, falsifications or counterfeits, but also to unveil the modern experimental approaches implemented for a faithful reproduction of an ancient jewel.

Keywords. Ancient jewellery, archeometry, fakes, Castellani family, Prenestina fibula.

Only micro/nanodiagnostic allows to understand and distinguish jewels made as a copy-replica, jewels inspired by ancient artworks or made as a counterfeit. In fact, all the handicraft and the technical procedures included in the jewel manufacturing sequence pertain to the goldsmith's personality … which cannot be easily reproduced by the forger.

INTRODUCTION

In every civilization luxury products represent, in addition to the desire to embellish the appearance, a sign of social distinction, witnessing the wealth and often the power of those who own them.

The cultures of the ancient ages, including those that were developed in the Italic area, are no exception: in the classification that Pliny the Elder,

who lived in Rome in the first century AD, reports in his work, a list of the most coveted goods from his contemporaries, in order of preference

In this list all the materials used in the goldsmith's art appear on time – the processing of precious metals, i.e. gold, silver and their alloy, the electrum – and the glyptic. With this word, deriving from the Greek term γλύφω ("engrave"), we mean either the set of materials of inorganic nature (precious stones and hard stones) and organic materials (amber, ivory, coral, shell) that could be carved and engraved, either the art itself.

> *As concerns the real products, however, the highest value, among those of the sea, is attributed to the pearls; among those of the earth's surface, to the crystals; among those of the subsoil, to the diamond, to the emeralds, to the gems…. Among the products derived from animals with respiratory system, for terrestrial animals the highest value is the elephant's tusks, for the marine ones the shell of turtles … between the terrestrial and marine products, the shells and the purple …*
> *We must not omit to say that gold, for which all mortals do follies, occupies only the tenth place in the scale of values, and the silver, with which gold is alloyed, yes and no the twentieth … (Pliny the Elder, Naturalis Historia, cap. XXXVII, 204)*

Around the eighth century BC, the acceleration of economic-social differentiation processes and the concentration of huge wealth in the hands of the indigenous aristocracies of Etruria, Campania and Lazio induce, in central Tirrenic Italy, the establishment of huge accumulations of precious metals that stimulate the luxuriant development of goldsmith craftsmanship.

Subsequently, with the emergence of Rome power and the extension of its influence due to the territorial conquests and the annexation of new provinces, as early as the first century AD new luxury goods such as hard and precious stones, pearls, ivory, silk, begin to flow along the trade routes that connect Rome with Asia and Africa.

In Italy it is possible to bring back the origins of Italian archaeological jewelry to the excavations of Herculaneum and Pompeii that provided the first jewels, sources of inspiration. Thus the reproductions and the diffusion are more precocious in Naples than in the rest of Italy.

Augusto Castellani in the "Discorso sull' Oreficeria Antica" [4], argues that the first attempts to copy exactly the ancient creations were made in Naples at the beginning of the nineteenth century, in the goldsmith Mariano Sarno's bottega. Later on, this activity would be undertaken by his father Fortunato Pio, in Roma. The goldsmith bottega of Sarno, on the advice and encouragement of learned Neapolitan archaeologists and customers, begins to restore excavation jewels, to imitate them in style and to push their creations to falsification. The goldsmith production, under the guidance of Sarno, had, for a few years, a great success, and then gradually closed its activity [5].

In addition to the well-known Neapolitan archaeological discoveries, in Italy there were many other intense explorations often crowned with unexpected as well as important discoveries like that of the Regolini-Galassi tomb in 1836, in Cerveteri (Caere) or the Bernardini tomb discovered in Palestrina at the end of February 1876 during the excavations financed by the Bernardini brothers [6].

In this last tomb, a dragon-like gold fibula dating back to the mid-7th century B.C was found. A text that constitutes the oldest written testimony in Latin, is engraved on its elongated part, however it has been the subject of doubtful falsification / authenticity issues that raised a twenty years-long discussion.

In the context of the nineteenth century, characterized by the rediscovery of the classical world and the strong diffusion of collecting and the antiquarian market, originals, copies, falsifications and pastiche often live with no particular hardships and difficulties both for the craftsman and for the client. [7].

It was common practice, among the artisans of the age, to touch up, reintegrate and reconstruct damaged or mutilated artefacts to satisfy the needs of an antiquarian market, particularly attentive to the integrity of the object rather than to its authenticity.

These practices sometimes went as far as the meticulous copies of ancient jewels, which however, in the popular imagination of the average purchaser of the time, had the same value as the original ones [8].

A report of Monthly Magazine about the London exhibition of 1862, asserts that "every piece on display is an original copy of a true authentic exemplary of an ancient work; that not only the ornamental style, but the procedures used in ancient times have been followed"

These arguments are enshrined in our Constitution with Article 21 which, in the most rigorous respect for the fundamental principle of freedom of expression, protects the right of every citizen to be able to realize and express their thoughts through the creation and dissemination of their production, without any substantial control over the content of the operations performed.

It is possible also to cite Article 33, which is the principle of freedom of art and science, Article 35 according to which, the Republic protects the work in all its forms and Article 2575 of the Civil Code, which fixes the original character of creativity that identifies

the personality of the author and reveals its ability to express an idea, or a feeling. [9]

In 1977 Bloch [10], to describe the phenomenon of ancient reworkings, distinguishes these different types of artifacts:

- **copies-replicas** from a prototype, according to a practice already widespread in the ancient world
- **copies-counterfeits**: products that are exclusively subject to a market law, not by preventing creativity, an essential element of the artist
- **pastiches**, the realization of a work of art, by assembling authentic, i.e. ancient, materials with others of modern production.

The difference between the first two classes of artifacts lies in intentionality, which satisfies a precise practical function, that of placing a responding object in the art market, by means of a malicious operation and under the appearance of truth, to a question that would otherwise be unsatisfied [11].

Ruled by an economic law, the falsification follows the fluctuations of taste and it is no coincidence that the most famous fakes coincide, over time, with the great archaeological discoveries, of which they imitate the findings.

The first Etruscan fakes appear in the eighteenth century, the great era of collecting and of the *etruscan style*. But we must wait for the second half of the nineteenth century, for the production of the finest examples of fakes [12].

The discovery of the Regolini Galassi tomb in the year 1835, sets a very important date as kick off to the development of a goldsmith's art that proposes the study of the ancient technologies, undertaken by the Castellani workshop.

Fortunato Pio, in fact, was called by the papal authority, as a consultant for the restoration and study of Etruscan jewelry and from this moment, a Castellani production of archaeological-style jewelry starts. Alessandro Castellani [8] commented this important discovery in the conference held in London at the Archaeological Institute in 1861[13]:

> *Since there are no scientific studies on ancient goldsmiths' techniques, even if he is a goldsmith with a long experience, he is faced with problems never found in the creation of any jewelry complex.*

The jewel decorative components are, in fact, made with techniques that are not always handed down in full, because in addition to being the creations of the single craftsman, the precious alloys and other non-metallic materials undergo transformation with kinetics of more than 2000 years.

The gold metal does not show many alterations or corrosions, but it is prone to micro-structural evolutions such as recrystallization and discontinuous precipitation, hence it is rather fragile and may present mechanical damage, especially if it consists of thin sheets, connected to each other by welds, which may have been crushed or torn.

Clearly, the Castellani family was aware of the proliferation of fakes and did not want to be associated with them. Augusto Castellani, in the "Discourse on ancient goldsmiths"[13], talking about the activities conducted in the workshop by the goldsmith Sarno, who had a good reputation in the production of faithful reproductions of ancient jewelry, defines the falsification a reprehensible activity and takes the distances:

> *The artists who had been part of the Sarno bottega then set about restoring ancient works of art, and also applied their talent to their falsification. In this last reprehensible activity, they were so wonderfully skilled that Naples became famous for imitations, so astutely made with colored earths, acids and salts, so much to make it difficult and almost impossible to know if an object was ancient or not. Unless they were people who had a long experience in the field of art, and were very experienced in archeology.*

Their archaeological creations and the techniques involved, required a considerable amount of apprenticeship for their artisans, who were asked to apply maximum precision and quality in the execution of the models. This activity led to a revolutionary revival of local craftsmanship, which had its fulcrum in the Castellani bottega, where many Roman goldsmiths at the time carried out their apprenticeship: Fortunato Pio had created a sort of "Roman school" of goldsmiths.

A possible classification of the different types of nineteenth-century "falsification" can be expressed as follows:

1. Antique with modern reworking
2. Antique with modern additions
3. Pastiches of antique pieces
4. Pastiches of ancient and modern pieces
5. Modern with the addition of antique parts
6. Duplicates: pastiches as pendant of ancient pieces
7. Duplicates: modern copies as a pendant of antique pieces
8. Modern artifacts from ancient types
9. Pastiches or modern pieces sold together with antique pieces
10. Pastiches or modern pieces sold together ancient items (false documents)
11. Neoclassical or historicist pieces

Among these categories, the numbers 1, 2, 3 and 6 can be considered "good faith" restoration. Part of the artifacts, which fall into category 8 and those of n. 11 can be classified as imitations.

Categories 4, 5 and part of 8 have counterfeiting intentions. The works that belong to the categories 7, 9 and 10 are false in the strict and legal sense of the term.

According to Hilmeyer [14], the most difficult categories to be distinguished are 4 and 5, which require careful study of all the individual parts of the jewel, which also refers to the techniques of realization of the same. Considering all this, in the study of archaeological goldsmith's art, there is a need to circumscribe the category of "authentic" from that of "reworking".

If it is true that the "fakes", made in the nineteenth century, must be recognized and appreciated as a phenomenon of a specific historical period, it is also true that recognizing the falsifications is an act of honesty towards of visitors and scholars. At the same time, giving back the right identity to authentic works is a moral necessity rather than an historical requisite [15, 16].

From the above described, it is possible to understand how the identification of nineteenth-century reworking has to be considered as a complex study, especially in the specific case of the Castellani's family. In fact, by virtue of their authoritativeness, they could perform "copies", "complete" or "rework" precious objects starting from the direct observation of the authentic pieces, that they had the possibility to handle as long as they needed to study their characteristics and compare them directly with the jewels they reproduced.

If an initial critical observation can direct and help in the identification of originals /fakes, sometimes the stylistic and formal examination is uncertain and not always sufficient to grasp the differences between two objects, even if it is a question of discriminating in the same artifact, antique and modern decorative elements. These latter being formally identical copies of those already present on the original [16].

A useful tool, in this sense, can be provided by the scientific investigation, which, through chemical and physical analyses, allows the technological assessment of the jewel, identifying the details of the construction technique. If the overall system and the construction scheme of a jewel can be reproduced exactly and with relative ease, it will be more difficult to reproduce the original ancient techniques of decoration elements such as granulation and filigree with a resolution of the order of millimeters [17].

In fact, the ancient technologies used have peculiarities, such as the type of alloy, the execution procedure, the assembly, the welding, the traces left by specific instruments, to be used as *diagnostic markers* in the study of a modern example from an ancient one.

Starting from previous studies [18-22] the aim of the present work is to outline how the scientific investigative method, based on the recognition and the temporal and geographical attribution of a goldsmith working process, can be decisive in the attribution of authenticity of an ancient jewel.

MATERIALS AND METHODS

Dealing with jewels, it is right to start from the main metal, gold, that is considered *noble par excellence*, incorruptible, perpetually shining and therefore a symbol linked to the sphere of royalty and the sacred, a sign of power and unalterable wealth over the time.

The precious objects found in the archaeological excavations astonish for their unaltered appearance, even if, on a structural level, we must not neglect that gold, like all metals over time, tends to return to its more stable form, which, in the case of gold, is the metallic face centered cubic crystal structure. Its mechanical properties can be altered by micro and nano-structure modification.

The state of the structure on micro/nano scale becomes complex when alloyed gold is used instead of pure gold: e.g. alloys with silver, copper, often with traces of other metals coming from a possible re-use of metals, such as iron, lead, tin, zinc to cite the most frequent in ancient times. Besides, each of the alloyed metals may contain traces of minerals from which they were extracted by metallurgical processes. Furthermore, in addition to natural ageing, interaction with the environment, often hypogeal, should be considered in view of the function of jewelry in the funeral contexts.

What is described is the basis of archaeological research that aims to trace any clue that bring back to the authenticity of the artifact.

In the choice of the analytical method it is indispensable, in addition to the obvious application of non-destructive techniques, to take into account that it is required to go beyond the visible scale and therefore the dimension of the particular to be investigated is the key parameter for the selection of suitable methods.

The techniques most frequently used in the study of jewels, are based on X-ray radiography, scanning electron microscopy (SEM) coupled with energy dispersive X-ray micro-analysis (EDS) and X fluorescence (XRF), using instrumentations suitable to avoid any micro sampling on the object or surface pretreatment.

With the application of one or more of these techniques on a considerable number of ancient finds, in the

last years it has been possible to broaden the knowledge on the activity of goldsmith artisans but also indirectly on their scientific knowledge applied to metal processing [23-25]. From these studies it is possible to obtain a big amount of information that allows to compare technologies belonging to different cultures and to identify the processes linked to the creation of the object, establishing its own characteristics that consent us to trace the genuineness of a finding.

Specifically, each study includes the morphological analysis of the surfaces, by means of images acquired in the various SEM modalities, the elemental analysis of the composition of the pre-existing alloy, by EDS and /or XRF analysis. The critical discussion of the results made it possible to identify the technique of creating jewelry decoration elements such as: granulation, wire form, welding techniques up to the type of tools used and any non-metallic materials included in the artistic composition [26].

The thin border line among the various forms of jewelry remaking, more or less conforming to legal rules, can be highlighted considering the studies carried out on three types of reproduction of objects, from an evident falsification case, to an attribution of authenticity, the fibula Prenestina, passing through nineteenth-century remakes linked, above all, to models derived from studies on the Etruscan jewelry by Castellani's family.

RESULTS AND DISCUSSION

A case of falsification, appeared recently on an auction catalog, is represented by the pair of gold earrings (Fig. 1), consisting of an oval-shaped setting with a frame decorated with short radially engraved strokes, containing a blue-colored dark gem. In the back, on the lower side of the setting, a trapezium-shaped plate is welded to the edge, to which three fixed suspension eyelets are connected. Attached to them are three knurled wires, with the end folded to set three small blue-green beads. So many elements to be verified analytically, when stylistically perfectly consistent with the Roman Imperial jewelry, in particular the type refers to earrings diffused in many variants and defined by the classical sources with the name of "crotalia", a musical instrument that emits the sound from the tinkling of beads. The observation at SEM-EDS (Fig. 2a), highlights the short parallel lines engraved on the frame: they are irregular and imprecise, giving a scarce decorative effect. The central gem presents many imperfections and especially "bubbles" caused by a higher temperature than the glass transition. The glass components have been characterized by EDS analysis (Fig. 2b), showing a composition that can be associated with a modern glass, with a high content of lead and cobalt, the latter to impart the blue color to simulate lapis lazuli.

Figure 1. Earrings attributable to the Roman Imperial period.

Besides, the SEM observations of the surface at microscale, revealed the presence of abrasive material with silicon and aluminum particles to antiquate the surface.

The trick to treat the surface for an antique appearance, is very common in counterfeiting. In another case Fig. 3, the filigree-decorated surface showed, at the SEM observation, a dense covering with a substance which displayed, by EDS analysis, a composition with anachronisms such as nickel and zinc dispersed in an organic matrix.

As written above, the knowledge of ancient jewelry technology through micro and nano diagnostic studies [27], is becoming fundamental for the recognition of counterfeits, but in the case of the 800's jeweler Fortunato Pio Castellani, this type of investigation becomes a discovery of a research method on the Etruscan jewelry that has left its mark on the jewel history.

The study of the Castellani goldsmiths, which include Etruscan jewelry restorations, copies for *experimental archeology*, to use a modern term, and Etruscan-inspired jewelry for sale, offers the possibility of discovering their secrets. The integrated study of a pair of "bauletto" earrings, belonging to the collection of "ancient golds" and another of the same type belonging to "modern gold" has

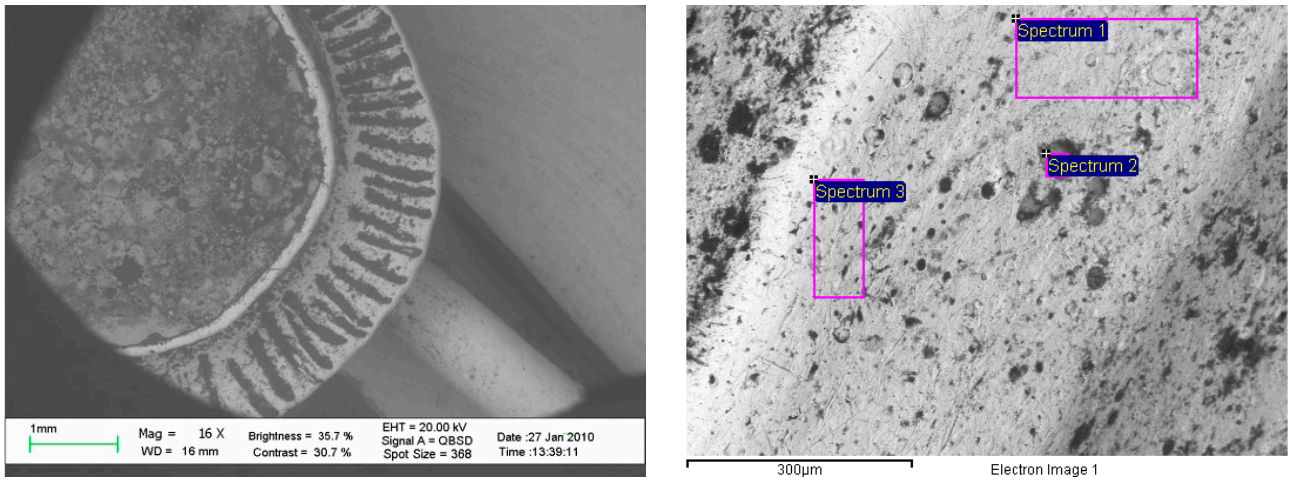


Figure 2. a) Backscattered electrons SEM image, of the part of the bezel with gem b) structure of the glass gemstone with indicated areas analyzed in EDS.

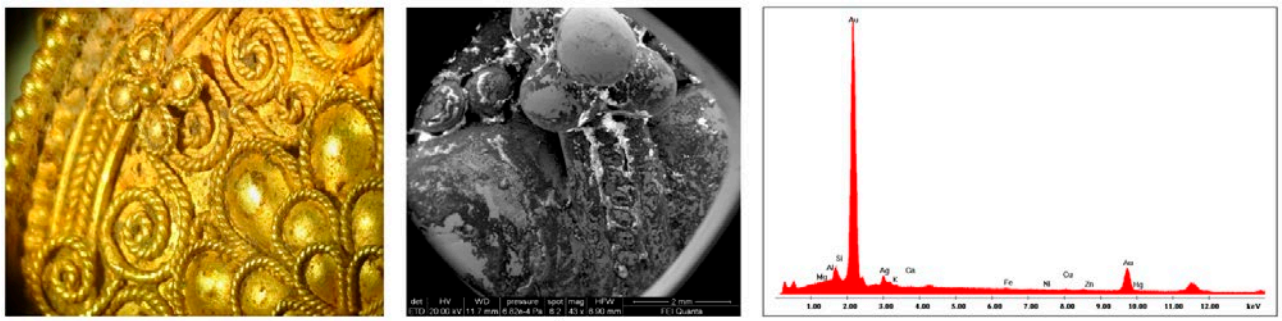


Figure 3. a) part of a modern jewel made of watermark; b) SEM image in secondary electrons of a part of the decoration; c) EDS analysis of the substance distributed on the surface.

been the subject of an experimental thesis and chemical-physical research [28]. This study gave the opportunity to compare the technologies of execution and realization of the overall plane, and the decoration details of the Castellani work with those of the ancient Etruscan goldsmiths. First of all, the study of the modern earring has been undoubtedly an opportunity to fine-tune the observations and analyses on the technological details used by the Castellani. In the analytical determinations, all the processing technologies related to all the decorative elements of the earring, such as granulation (grain shapes, three-dimensionality, welding), watermark (realization of the threads) and tools traces have been considered. Each particular of the modern production, is to be considered as anachronistic elements in the subsequent study of the so called "Etruscan Collection".

The impossibility of subjecting jewels to invasive instrumental investigations, taking into account the exceptional value of jewels, has led to the selection of appropriate diagnostic techniques. A new type of analytical approach, aimed at highlighting structural differentiations on micro / macro scale between the "hand" of the Castellani and Etruscan goldsmiths has been employed by using modern data processing systems. In fact, the modest variations in composition and the imperfect localization of the Castellani's interventions on a micrometric scale, led to the elaboration of the numerous data obtained from the EDS micro-analysis through the statistical method of the Classification Analysis, allowing to identify correlation areas between elements.

The evaluations of the percentage of the elements constituting the Au-Ag-Cu gold alloy trough EDS is extremely difficult, as the elements are not homogeneously bound, and therefore minimal variations are not immediately observable in order to characterize, for example, one of the various welding processes. The

variables selected to discriminate the various soldering techniques have been: brazing agents, Cu salts, silver or other paillons, and the presence of the elements: Cu, Ag, Cd, Au. To avoid undermining the final result, before each classification analysis, their degree of Bivariate Correlation has been calculated using the Pearson Correlation Coefficient, which measures the degree of linear association between two variables.

The values of the coefficient vary between -1 and +1. The sign of the coefficient indicates the direction of the relationship between the two variables: directly proportional in the positive case, inversely proportional in the negative case.

The results made it possible to define the use of Au-Ag alloy for the welding, as traditionally used in the 800s, but there are traces of cadmium that cannot be ignored.

On the use of cadmium in Castellani's work, much has been written [29] and having found it on the pair earrings of Castellani manufacture, it certifies its use.

The skills acquired on Etruscan jewelry and on Castellani's production allow us to recognize the parts subjected to modern intervention with the aim to give the jewel back its original aspect.

This is the case of the "bauletto" earrings Fig. 4, decorated with numerous and dense filigree and granulation motifs.

At first glance they appear identical, but a more expert observation reveals several elements of differences. That's why the first studies concluded that they are original Etruscan, but one (N. Inv. 53582) presents many subsequent works, while the other (N. Inv. 53580) has only a few alterations.

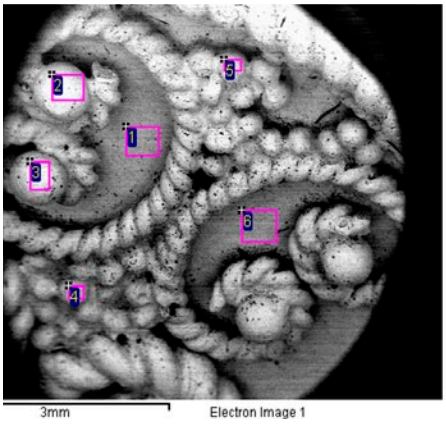
If we observe the two earrings at micro/nano scale, many contradictory elements with the Etruscan jewelry

Figure 4. Pair of earrings, Museum of Villa Giulia N.Inv. 53580 and 53582.

are evident. This pair of earrings then falls into the category of antique piece with modern rework.

As an example of the analysis carried out in each part of the jewel, we report the representative elements of the Etruscan jewelry, granulation, watermark and knurled thread, are, as highlighted in Fig. 5. As regards the identification of the gold material composition, the SEM investigation has been undertaken by selecting an appropriate focused electron probe and by observing the surface in the backscattered electrons mode. Based on these results, it has been possible to select micro-areas which were homogeneous for morphology and atomic contrast, for the EDS microanalysis. The obtained data are shown in the table of Fig. 5, following the criterion of imposing on the system the evaluation of all the chemical element mentioned in the "probable" Castellani's recipes.

EDS data immediately highlighted the presence of cadmium that, considering only the elements of the gold alloy, ranges from 0.2 to 1.3 wt%.



	Cu	Ag	Cd	Au
1	-	0.9	-	99.1
2	0.3	1.4	1.3	97.0
3	0.4	0.2	0.6	98.8
4	0.8	0.6	0.2	98.4
5	-	6.3	1.3	92.4
6	-	-	-	100.0

Figure 5. Earring N.Inv. 53582 SEM image in backscattered electrons with indicated the areas investigated by EDS method. The table shows the values of the chemical elements in percentage by weight (±0.2%).

The SEM observation, in secondary electrons, of some areas of the jewel, highlighted the welds, whose realization caused an excessive filling of the spaces between the wires and between the granulation spheres.

Focusing on the use of metal wires for the filigree decoration, thanks to SEM (Fig. 6), it is possible to make morphological comparisons that highlight heavy differences between the ancient and the modern parts, certainly not known at the time of the Castellani.

It is possible to observe that the numerous threads do not all have the same technical execution. Some of them show the typical helical grooves, characteristic of the Etruscan construction technique that makes use of a twisted foil strip.

Others, instead have the characteristic parallel streaking, signs that have been produced through the use of a modern wire drawing die.

The excessive heat applied has melted part of the original substance in the upper part and in the external side, making it difficult to locate the welding. In fact, the heating allowed diffusion and or local fusion of the metallic elements.

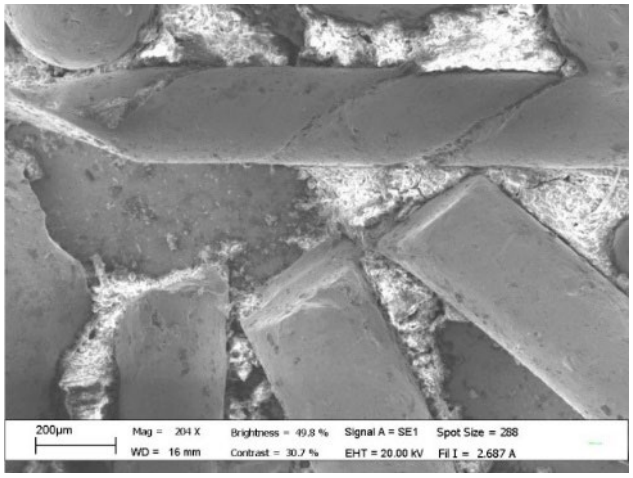


Figure 6. Original wires and threads added during the Castellani restoration.

Therefore, the pair of earrings belonging to the collection of "ancient gold", given the complexity of the work, have been analyzed by considering each decorative element, in order to obtain more specific information and allow a comparison between them.

The application of Person's analysis for each earring allowed the creation of correlation matrices (Fig. 7).

The most significant evidence derived from the analysis of elemental composition and correlation of the variables is that the Au concentration decreases in jewel N. Inv. 53580 depends, in equal weight, on the presence of both Cu and Cd. This indicates the presence of welding with Cu salts and addition of modern processing with use of Cd, while, in N. Inv. 53582, it depends primarily on Ag (Ag welding) and then on Cu (copper salts welding).

Moreover, a direct proportionality link between Ag and Cu cannot be found in Inv. No. 53580: this means that in the analyzed areas, the two elements are not correlated and therefore a use of an Ag-Cu alloy is to be excluded. Cadmium is present independently of the Cu in equal measure in the two objects analyzed. Compared to Ag, on the other hand, the Cd has a null bond for Inv. No. 53580, while it becomes important in the case of Inv. No. 53580, a sign that probably Cd has been used in addition to the welds by Ag.

The studies here reported demonstrate how the margin of separation between an attribution of authenticity or falsification is inconsistent, if one does not consider the complexity of chemical-physical information drawn from the study of ancient technological processes.

What has been described, even if it can not necessarily be exhaustive, indicates however an obligatory route for the attribution or for "re-assigning" the authenticity grade to an ancient finding.

A demonstration of this may be the case of the recent restitution of authenticity to a precious object, considered false and deprived of its important historical significance for a long period, the Fibula Prenestina Fig. 8 [30]. The fibula is datable around 670-650 BC and containing the signature of the "Manius" artisan, as well as that of the client. The formula employed is that of the

Matrice di Correlazione N. Inv. 53580

	Cu	Ag	Cd	Au
Cu	1.000	-0.190	0.115	-0.664
Ag	-0.190	1.000	0.282	-0.521
Cd	0.115	0.282	1.000	-0.612
Au	-0.664	-0.521	-0.612	1.000

Matrice di Correlazione N. Inv. 53582

	Cu	Ag	Cd	Au
Cu	1.000	0.283	0.107	-0.704
Ag	0.283	1.000	0.071	-0.877
Cd	0.107	0.071	1.000	-0.173
Au	-0.704	-0.877	-0.173	1.000

Figure 7. Correlation matrices for each of the pair's earrings in Fig. 4.

Figure 8. Fibula Prenestina 670-650 bC. Pigorini Museum Rome.

"speaking object" by reporting the sentence "Manios fecit for Numasio". These indications have represented the fundamental element used by the legendary etruscologist and archaeologist Raymond Bloch, to fix the birth of the Latin alphabet to the VII century BC.

The writing proceeds from right to left and uses the letters of the Latin archaic alphabet; its wording is influenced by Etruscan, Sabellian and Faliscan languages [31].

So the fibula is considered the oldest document of the Latin language but its authenticity, disputed for years, has been proved not only by linguistic data but also by recent chemical and physical analysis.

It was officially presented for the first time by the German archaeologist Wolfang Helbig, in 1887.

The scholar claimed to have purchased it from a friend in 1876, and indicated the place where it was found as the Bernardini tomb. A princely tomb, discovered in 1851 and excavated from 1871, near the ancient city of Prenestae, the current Palestrina. After years of academic and judicial disputes over its authenticity in 2009, the application of the integrated epigraphic and archaeometric study has demonstrated its authenticity.

The application of the analytical method, to prove the consistency of the techniques used in the construction of the fibula with the ancient working methods, has revealed inconsistencies due to a modern process. However, the real importance of the finding focuses on the verification that the writing has not been performed post-recovery. This has induced studies on the microstructure of the metal, in order to derive useful information for understanding the transformations undergone [32].

As known in its fundamental state, the gold metal has a face-centered cubic crystalline structure (fcc). The specific properties of course are modified when Au is alloyed with other metals such as Cu or Ag. However, while silver is completely soluble in gold at any temperature, copper is soluble in gold only above 410 C, below this temperature Au-Cu intermetallic compounds are formed. It is therefore clear that in the ternary alloys, the parameters and the mechanism of the recrystallizations after the various treatments that the metal undergoes for the realization of the object, are complex [33]. However, the overall process can be reduced to the following general scheme: a) nucleation of crystalline grains, b) growth of crystals, c) irregular grains form more or less regular structures that grow together d) increase of crystalline grains dimensions observable by optical microscope.

Recrystallized structures are clearly identifiable in the SEM image of one of the traces left by the tip used for the inscription (Fig. 9).

Three situations are related to the alloy modification over time and consequently to the observed alteration of the inscription:

1. In the furrow, the marks left by the roughness of the tracer tool are partially interrupted by recrystallization marks (indicating that recrystallization took place after the inscription was traced).
2. If the inscription had been made recently, i.e. after recrystallization of the alloy, the engraving lines would have appeared jagged, following the intergranular lines of lower mechanical resistance: such a feature was not observed.
3. Internal areas of the inscription paths were investigated, using backscattered electron observation with appropriate modifications of the detector operation mode, in order to simulate the effects of grazing light. In this mode, the differences in height between the grooves impressed by the incisor tool and the natural alterations of the metal are high-

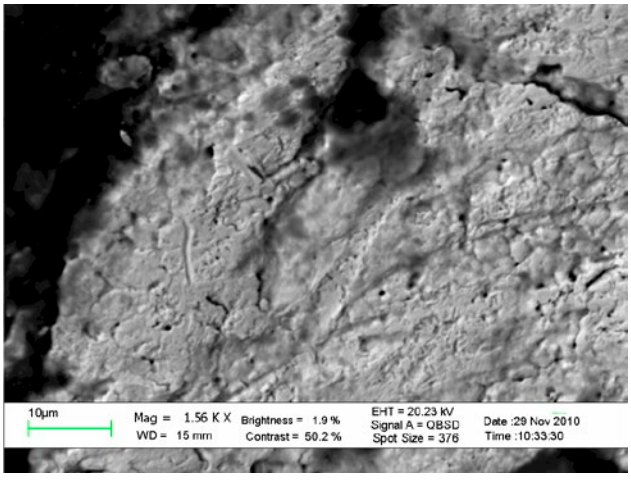


Figure 9. Modification of the metal microstructure (due to recrystallization) inside the incision groove.

lighted. Therefore, SEM observation of the surface in the furrow area confirmed that recrystallization (i.e. natural evolution of the precious alloy over a very long time) took place after tracing the inscription.

This aspect, together with the other scientific information collected with an analytical procedure tailored for the Fibula Prenestina [32], demonstrated that the ancient find contains so many historical, artistic and technological information that we can never say we know everything about it.

This affirmation is particularly true in this case, for which the new investigations, carried out after twenty years of analytical studies on ancient jewelry in general and the Etruscan one in particular, have been able to restore its historical credibility.

CONCLUSIONS

The jewel is the only one among the ancient finds, that contains all the practical and scientific knowledge of the craftsman who has to create a unique work each time. Relying on procedures more or less attested in the period and in the geographic area where it operates, the antique jeweler brings stylistic and technological innovations that gradually become established, and their recognition together with historical artistic elements, allows their chronological collocation. The other important aspect is that the metal, whatever it is, keeps both the information of the operations that have allowed its transformation into a work of art, both of the action of time. The recognition of such transformations provides useful elements for defining its antiquity. The story of ancient gold working is not only related to metallurgical studies, because in the past each object contained meanings and symbolisms, but, at the same time, from another point of view, it is also full of technical and scientific knowledge. Translations, interpretations, hypotheses, assumptions: how many times before an old jewel we met the difficulty to understand it, as well to know its history, the technology used in its realization, the scientific knowledge that led to the manipulation of its constituent material, its origin and so on. However, there is only one universal language, that always existed and always will exist and that is translatable in any language: chemistry. The identification of products and chemical processes that led to the physical realization of wondrous works of art, provides important data to complete the history of the work of art itself, allowing to define also the cultural grade of the contexts in which the object was manufactured.

Someone wrote:

The work of art is born from the idea of form and search for technical means to realize the minimal details. In this sense the artist is at the same time, scientist and technologist.

From this point of view, research turns its attention to the problems of the past with the knowledge of today, trying to identify the chemistry and physics concepts and applications, which, obviously on empirical basis, the ancients had and which we can interpret through scientific laws, now. The treated argument covers the research carried out in recent years on archaeological items in precious metals. The investigation on micro/nano scale is essential for the identification of diagnostic markers that yield the knowledge of particular processes applied to precious metals workings. The collected data on the smallest details of the production procedure of jewels, provide completely objective comparison of the specific techniques adopted in the creation of the artistic object. In fact, as well known, the precious items were always object of treasuring, trades, spoils of war, reaching places far from the original provenance. In this view each jewel contains information on particular geographical areas and/or different socio-cultural situations. Different examples of the described cases studies help to understand the mismatch between scientific investigation and historical knowledge. But the more immediate goal is the transfer of enthusiasm for a research that helps us to appreciate more of our cultural heritage and to suggest that it is not enough to see an object but is much more interesting to know how to see it.

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