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Prehistoric and Early Roman Period Goldwork from Northwestern Iberia: An Analytical Study of Artefacts from the Archaeological and Historical Museum of A Coruña

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Abstract: This article presents the results of a topographical and analytical study using hh-XRF of 22 gold and gilded objects from the Archaeological and Historical Museum of A Coruña (Galicia, Spain). They are highly representative of the northwestern Iberian goldwork from the Chalcolithic (third millennium BC) to the early Roman period (first century AD). This study contributes to our knowledge of the production techniques used in those periods, as well as their evolution over time. The collection includes some of the most representative types in this area, such as Early Bronze Age "sheet collars" and torcs from the Second Iron Age. In the case of torcs, new data are provided on one of the formally best-documented types (the Artabrian type) and on those known as "Baroque torcs" that are characteristic of the final moments of this goldsmith tradition. While pieces from the Chalcolithic and Early Bronze Age were made with alluvial gold, the torcs from the Late Iron Age contain variable amounts of silver and copper. Also detected is the frequent use of cores made of less precious metals, which were subsequently given a golden appearance using gilding techniques. The new data are discussed in light of our current knowledge of NW Iberian goldwork, one of the most representative of this craft tradition in Western Europe for those periods.

Keywords: gold; silver; gold technology; handheld XRF; archaeometallurgy; Chalcolithic; Early Bronze Age; Iron Age; early Roman period; Castro culture

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1. Introduction

An abundance of gold-bearing resources contributed to the early development of goldworking in the northwestern Iberian Peninsula, an area in which silver is a rare metal. It is currently accepted that pre-Roman communities obtained gold by means of the low-scale exploitation of secondary alluvial placers. Gold mining in galleries is not verified—at least intensively—until the Roman conquest [1,2].

These native northwestern gold nuggets can include varying contents of silver, generally between 10–25%, as well as copper (usually <1%) and trace elements such as Sn [3–6]. Guerra and Tissot [7,8] recently proposed that the native gold in the territory of present-day Galicia rarely has a Cu content higher than 0.2% and that, after an initial period of working with unalloyed gold, there is a phase, which we can place in the Late Bronze and the First Iron Age, when it coexisted with intentional Au-Cu alloys.

During the Second Iron Age, in the context of the so-called "Castro [hillfort] culture", we witness the consolidation of goldworking with a strong technical and formal personality, well differentiated from other goldsmithing traditions on the Iberian Peninsula. Formally, it consists of objects that can be considered items of prestige or personal adornment (torcs, earrings, bracelets, diadems, collars, pendants, etc.). However, some of them, such as torcs, are open to a more complex and polysemic interpretation [9,10], as indicated by their presence in representations of a ritual or symbolic nature [11]. The lack of contextual information on many of the preserved finds has made it difficult to properly place this goldwork in a refined chronological sequence. Nevertheless, it can be broadly stated that these productions have their roots in the goldsmithing developed in these regions beginning in the Late Bronze Age. Its period of greatest splendour appears to have been at the end of the Second Iron Age (2nd-1st centuries BC), at a stage that partially coincides with the protracted process of the Roman conquest of the territory (c. 138-19 BC).

Au-Ag-Cu ternary alloys predominate in the goldwork of the Second Iron Age, with many fewer objects made of silver being recorded [6,12]. Silver was, however, often intentionally added to alloys [12,13]. On a technical level, Castro-culture goldsmithing took on procedures well documented in the local tradition, such as lost-wax casting or embossing. Also of special importance were techniques of Mediterranean origin—e.g., welding, filigree and granulation—introduced to this area from the south of the Iberian Peninsula [14–16].

The technological variability of these productions, even in pieces of the same type, contrasts with the rigidity of their formal patterns. This could be due to their ritual nature [10,17]. The defining features of this goldworking tradition disappeared towards the end of the first century of the era, with the Roman presence in the territory already consolidated.

The archaeometric characterisation of the ancient goldwork has seen a remarkable boost in recent years, to which the progressive increase in the use of non-destructive analytical techniques and portable instrumentation has contributed significantly [18–23]. In particular, in the northwestern Iberian Peninsula, following Hartmann's [24] pioneering work, in the last 15 years, a significant dataset has been generated by means of XRF through the analysis of collections such as those of the Provincial Museum of Lugo [6,7], Castro de Viladonga Museum [25], National Archaeological Museum-Madrid [26,27], Mariñas Museum-Betanzos [28], National Archaeological Museum-Lisbon [29], Pilgrimage Museum-Santiago [11,12] and Asturias Archaeological Museum-Oviedo [30]. Although this task is far from finished, given the extensive repertoire of materials preserved in the museums of Spain and Portugal, these contributions have made it possible to study in greater depth the raw materials and technology of these productions, which, since the end of the 1990s, has provided an alternative to the typological approaches predominant until then.

This article aims to delve more deeply into these lines of research, presenting the results of the analytical study carried out on the goldwork finds in the Archaeological and Historical Museum of A Coruña (MAC), one of the most important collections in Galicia. It includes both outstanding examples of the first evidence of goldworking in the northwest, dated to the third millennium BC, and a rich representation of goldwork from the Second Iron Age and the first contact with the Roman world. Despite its importance, this repertoire of finds had not been the subject of a systematic archaeometric study.

This study is part of a broader project for the analytical characterisation of this collection, which also includes other relevant pieces not included here and which will be the subject of subsequent studies. This is the case, for example, of the Leiro helmet (Rianxo, A Coruña) [31] or what is known as the Elviña Hillfort hoard (A Coruña) [32–34].

The chronological diversity of the pieces in the MAC collection facilitates an approach to the study of the formal and technological changes undergone by these productions over time, since it includes some of the most representative types of northwestern Iberian goldwork, such as the sheet collars from the Early Bronze Age or the Castro-culture torcs from the Second Iron Age.

In the case of torcs, the collection includes both examples corresponding to the main typological groups proposed for these objects and pieces that, despite being less represented in this area, are of special interest to research. Among the former are those that form part of a broad group that Luis Monteagudo [35] defined as "torcs with coiled wires" (Figure 1). They incorporate hoops with a characteristic decoration based on wires or ribbons wound around their lateral thirds, delimiting the central area of said hoops with spiral-shaped elements. Monteagudo defined two variants depending on the profile of the terminals. The Asturian–North Galician type (Figure 1, A1) included the torcs with double-scotia profile terminals found in the territory of present-day Asturias and the provinces of A Coruña and Lugo, while the Artabrian type (Figure 1, A2) corresponded to examples with pyriform terminals (e.g., San Martiño do Porto, MAC-933; Orbellido, MAC-942; Xanceda, MAC-927).

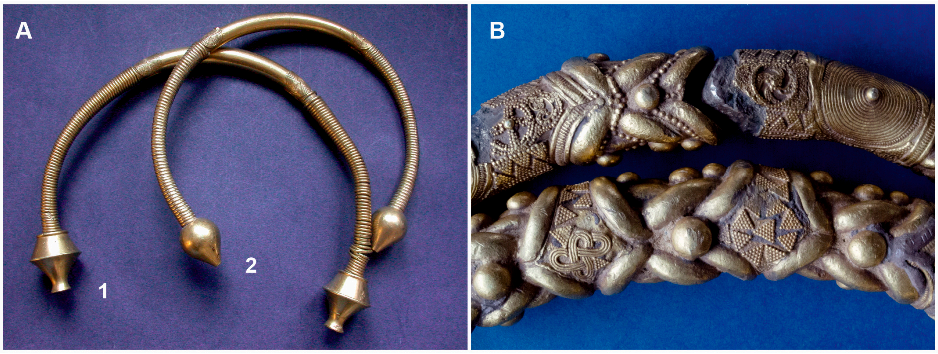

Figure 1. Castro-culture torcs. (**A**). Torcs with coiled wires from San Lourenzo de Pastor (A Coruña): 1. Asturian–North Galician type, 2. Artabrian type; (**B**). Torcs with "Baroque" decoration: detail of hoops of Xanceda torcs 1 and 2 (A Coruña) (MAC).

The Artabrian type would become one of the most representative of this area, with around 20 examples distributed in some 14 finds, with a special concentration in the province of A Coruña [36]. Although these torcs constitute an example of the formal rigidity of some types of Castro-culture goldsmithing, the MAC pieces confirm technological variability as one of their characteristic features.

Among the examples with the least representation are those that some scholars have defined as "transgressive" torcs [17] or with "Baroque" decoration [37] (p. 172), as they best reflect the changes in the rigid formal canons of such objects. These torcs are characterised by hoops with a plastic surface (Figure 1B), a tripartite ornamental scheme, and voluminous hollow terminals. Like some Artabrian examples, their hoops have a core obtained from alloys of less precious metals that were subsequently gilded. Only four or five specimens are known [38,39] and the MAC collection includes the best-preserved ones.

2. Materials and Methods

2.1. Materials

The items and fragments analysed belong to nine finds from Galicia, mostly from the province of A Coruña (Figure 2). Two of them can be placed in the early period of goldworking in this area (Chalcolithic and Early Bronze Age) and the remaining seven belong to Castro-culture goldsmithing (Table 1).

Table 1. List of analysed artefacts from the Archaeological and Historical Museum of A Coruña (all the geographic locations belong to the A Coruña province).

Inv.	Find	Location	Object Type	Dimensions (mm)	Weight (g)	Main Reference
MAC 4121	Dombate	Borneiro, Cabana de Bergantiños	Laminar bead	6.3 × 5.4 × c. 0.2	0.116	[40,41]
MAC 3780/1	Cícere	O Mato de Cícere, Sta. Comba	Sheet collar	350 × 21.5 × 1.4–0.5	102.4	[42]
MAC 3780/2	Cícere	O Mato de Cícere, Sta. Comba	Rolled band (1) (diadem?)	390 × 71 × 0.3	44.7	[42]
MAC 3780/3	Cícere	O Mato de Cícere, Sta. Comba	Rolled band (2) (diadem?)	170 × 73 × 0.48	26.5	[42]
MAC 3780/4	Cícere	O Mato de Cícere, Sta. Comba	Gold sheet	130 × 35 × c. 0.45	4.8	[42]
MAC 3780/5	Cícere	O Mato de Cícere, Sta. Comba	Brass sheet	57 × 8.5 × c. 0.3	0.7	[42]

Table 1. *Cont.*

Inv.	Find	Location	Object Type	Dimensions (mm)	Weight (g)	Main Reference
MAC 3780/6	Cícere	O Mato de Cícere, Sta. Comba	Sheet collar?	49 × 11 × c. 0.5	2.1	[42]
MAC 3780/7	Cícere	O Mato de Cícere, Sta. Comba	Sheet collar?	55 × 2 × c. 1	1.4	[42]
MAC 3780/8	Cícere	O Mato de Cícere, Sta. Comba	Gold sheet	35 × 12 × c. 0.4	1.1	[42]
MAC 3780/9	Cícere	O Mato de Cícere, Sta. Comba	Gold sheet	23.5 × 16.5	0.5	[42]
MAC 3780/10	Cícere	O Mato de Cícere, Sta. Comba	Gold sheet	24 × 12	0.4	[42]
MAC 3780/11	Cícere	O Mato de Cícere, Sta. Comba	Gold sheet	22 × 5	0.3	[42]
MAC 1211	Baroña	Castro de Baroña, Porto do Son	Earring	17 × 9 × 14	1.43	[43,44]
MAC 2205 -1-2	Os Castros de Ferreirías	Vilarrube, Valdoviño	Laminar bead (2 Frags.)	Length: 17 × 15 × 0.5	c. 1	[45]
MAC 942	Orbellido	Santoiño de Baiñas, Vimianzo	Torc (Artabrian type)	Hoop: c. 124 × 132.7 × 7.5–6/Terminals: 22 × 18	150.3	[46]
MAC 993	S. Martiño do Porto	Cabanas	Torc (Artabrian type)	Hoop: c.128 × c. 135 × c. 12–9/Terminals: 27 × 21	354/ (3 main frags.: 340)	[35]
MAC 842	Xanceda	S. Salvador de Xanceda, Mesía	Torc 1 (2 Frags.) (Baroque type)	Hoop: c. 190 × c. 170 × 24–12/Terminals: c. 50 × 36	722.98 (408.8 + 314.18)	[39]
MAC 925/926/1385	Xanceda	S. Salvador de Xanceda, Mesía	Torc 2 (3 Frags.) (Baroque type)	Hoop: lenght: 146–98–74 × -- × 25–c. 11/Terminals: 49 × 36	697.3 (452.12 + 139.80 + 105.38)	[39]
MAC 1386/1387	Xanceda	S. Salvador de Xanceda	Torc 3 (2 Frags.) (Baroque type?)	Hoop: c. 110 × -- × c. 10–12/Terminal fragment.: 20 × 12 × 1	81.40 (80.20 + 1.20)	[39]
MAC 927	Xanceda	S. Salvador de Xanceda, Mesía	Torc 4 (1 Frag.) (Artabrian type)	Hoop: 110 × c.140 × c. 9–8	71.57	[39]
MAC 3245	Unknown	Unknown (NW Iberia)	Bronze gilded torc (Baroque type)	Hoop: c. 132 × c. 139; × 13–8/Terminal: 45 × 29/rattle element: 6.4 × 5.8	262.5	[38]
MAC 119	Elviña	Castro de Elviña, A Coruña	Bracelet or torc?	27 × 8 × c. 4	6.1	[47,48]

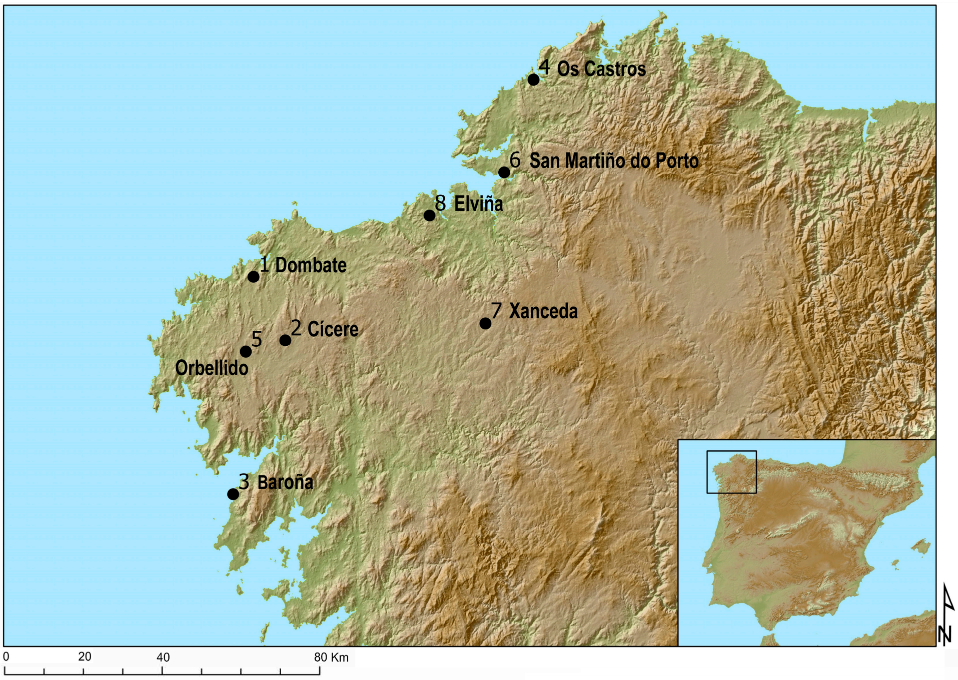

Figure 2. Geographic location of the analysed artefacts (numbers cited in the text) (map: J.L. Pecharromán, Labtel, IH–CSIC).

2.1.1. Chalcolithic–Early Bronze Age

Dolmen of Dombate (Borneiro, Cabana de Bergantiños, A Coruña) (MAC-4121). Crushed laminar bead on the edges of which cut marks can be seen (Figure 3A,B). It was found in one of the best-known dolmens of northwestern Iberia, in the 2002 excavation campaign, in a context corresponding to the reuse phase of the monument in the Bell Beaker period, towards the second half of the third millennium BC [40,41].

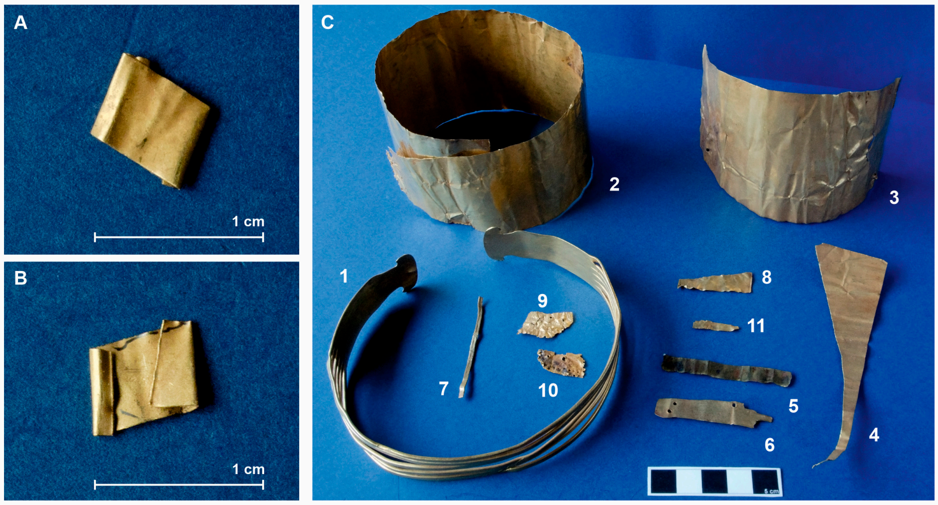

Figure 3. Chalcolithic–Early Bronze Age analysed artefacts: (**A**,**B**). Dombate laminar bead; (**C**). Cícere's assemblage. See text for details.

Cícere (O Mato de Cícere, Sta. Comba, A Coruña) (MAC-3780/1-11). An incomplete assemblage whose exact original composition is unknown (Figure 3C). It is currently made up of a sheet collar (MAC-3780/1) and 10 laminar fragments, of which four would have corresponded to two bands that can be interpreted as diadems (MAC-3780/3-4 and MAC-3780/2 y 10), and another two to another possible sheet collar (MAC-3780/6-7) [42,49] (pp. 101–104). The objects were discovered by chance, perhaps at different times, and were altered after discovery. Around 1935, they were acquired by a family who kept them until they were deposited in the museum in 1999 [42] (pp. 174–176). They were unveiled more than fifteen years after that acquisition, indicating their origin from a burial mound [50] (p. 292). The set has been dated to the Early Bronze Age, mainly due to the presence of a sheet collar or strip band (Figure 3C, 1 and 6).

2.1.2. Late Iron Age–Early Roman Period (Castro-Culture Goldwork)

Earring from the Baroña hillfort (Porto do Son, A Coruña) (MAC-1211) (Figure 4B,C). Example with a penannular body that formally corresponds to the type called "labyrinth" or IB by Pérez Outeiriño [43], characterised by concentric partitions on both sides of the piece. It was found during the 1982 excavation campaign, an isolated find in an area of the hillfort interpreted to have been of public use. Its context was dated to the Phase IIB proposed for this site, around the 1st century AD [44] (pp. 19–20, 26).

Laminar bead from the Os Castros de Ferreirías hillfort (Vilarrube, Valdoviño, A Coruña) (MAC-2205, 1–2) (Figure 4A). Gold bead with a laminar structure and a bitroncoconical profile, broken into two parts. It was found in the 1989 excavation campaign in a context dated to between the mid-1st century BC and the mid-1st century AD [45].

Figure 4. (**A**). Os Castros bead fragments; (**B**). Baroña earring; (**C**). detail of filigree decoration on the external edge of the earring (the threads used were made with the wrapping wire technique, as can be seen in the helicoidal traces on its surface).

Torc from Orbellido (Santoiño de Baiñas, Vimianzo, A Coruña) (MAC-942) (Figure 5A). Artabrian-type torc with filigree spirals; one of its terminals was found separated from the hoop. It was discovered by chance at the Orbellido site in 1979 when a foundation trench was being dug [46].

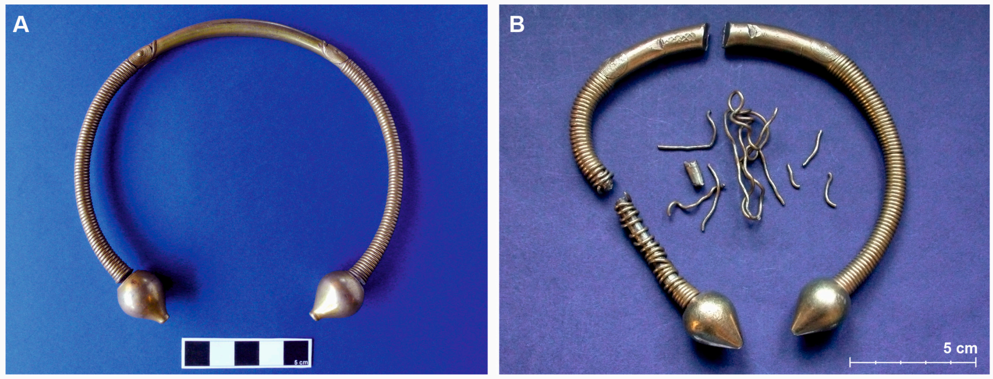

Figure 5. Artabrian torcs: (**A**). Orbellido; (**B**). San Martiño do Porto.

Torc from San Martiño do Porto (Cabanas, A Coruña) (MAC-933) (Figure 5B). Artabrian-type torc with pairs of filigree spirals delimiting the central area. It features a triangular motif stamped on the hoop, interpreted as an ownership or artisan's mark (see below). These types of marks are not frequent in Castro-culture goldwork and have so far only been identified on torcs [10,51]. It was cut into pieces with a chisel after its discovery, and the imprint of the clamping tool used could be seen on its hoop (Figure 5B), which was mistakenly interpreted as a second ownership or artisan's mark [35] (p. 287). The exact location of the find is unknown, with a possible origin of the As Modias hillfort being suggested [52] (pp. 152–153) [36] (pp. 78–79). It was acquired by the A Coruña Provincial Government in 1868 after having had several owners [35] (p. 288, note 3) and later entered the museum.

Torcs from Xanceda (O Castro, S. Salvador de Xanceda, Mesía, A Coruña) (MAC-842, 925, 926, 927, 1385, 1387) (Figure 6). Consisting of eight fragments, probably belonging to four torcs, with a total weight of 1758.68 g [39] (p. 110), the pieces appear to correspond to a single hoard, although they could have been found during agricultural work at different times in the mid-1970s [39] (pp. 93–95). They were acquired for the museum between 1982 and 1985.

Xanceda 1 (MAC-842) (Figure 6, A). Torc divided into two fragments. Hoop made with the lost-wax casting process and gilded, with plastic decoration that differentiates the central part from the lateral thirds. It also incorporates applied ornamental elements made with lost-wax casting, filigree and granules. The terminals have a pyriform bell-shaped profile and are hollow with internal elements that act as a rattle.

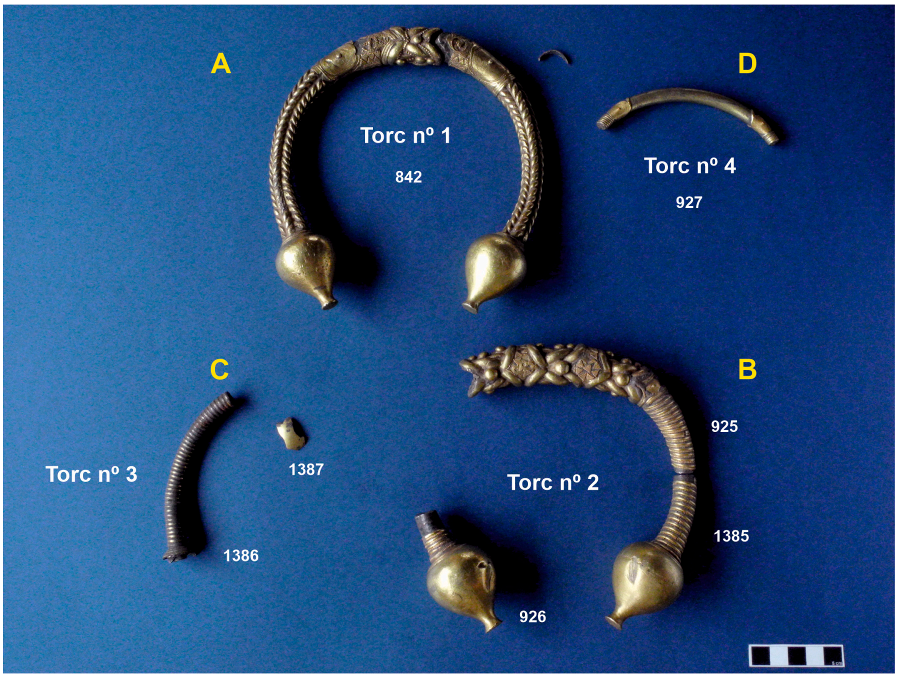

Figure 6. Xanceda hoard: 1–3. Baroque-type torc fragments; 4. Artabrian-type torc fragment.

Xanceda 2 (MAC-925; MAC-1385) (Figure 6, B). Incomplete, deformed torc divided into three fragments. Hoop made with lost-wax casting and gilded, with plastic decoration in the central area, which also includes areas with applied decoration of stamped plates and filigree. Lateral thirds of the circular section covered with moulded rings worked on a grooved anvil. Hollow pyriform terminals with rattle.

Xanceda 3 (MAC-1386; MAC-1387) (Figure 6, C). Two fragments of a torc of dubious typology corresponding to the end of the lateral third of a hoop with the remains of a terminal and a terminal fragment. The hoop fragment presents a decoration in the form of a ribbon-coiled wire that could have been obtained from the lost-wax casting process. However, corrosion makes a suitable examination difficult. Its surface was originally gilded but has now lost much of its coating. The piece included terminals of the same type as those documented in Examples 1 and 2.

Xanceda 4 (MAC-927) (Figure 6, D). Fragment of an Artabrian-type torc corresponding to the central area of the hoop and part of the lateral sections. On the smooth central area, gold leaf was apparently applied to cover a hoop made of an alloy of less precious metals), visible in the section of the ends (see below). On the interior face, a joint area can be seen in that sheet, affected by the segregates of the base material.

Gilded bronze torc (unknown provenance) (MAC-3245). Incomplete hoop with plastic decoration made with the lost-wax casting process (Figure 7A). It preserves a hollow pyriform terminal obtained with the same technique, which has the peculiarity of being able to separate from the hoop, which ends in a spike. The terminal contains a metal fragment inside which acts as a rattle, on which traces of chisel cutting can be seen (Figure 7B). The entire surface of the torc had a thin layer of gold, now very worn [38]. It entered the museum together with other bronze pieces, without a reliable relationship being established between them. From a formal point of view, we know of a parallel in a small gold torc fragment from Punta do Castro (Barreiros, Lugo), which until now has not been analysed [53] (p. 99). Added to this is a bronze bracelet recently discovered in the Armeá hillfort (Ourense), still in the study phase.

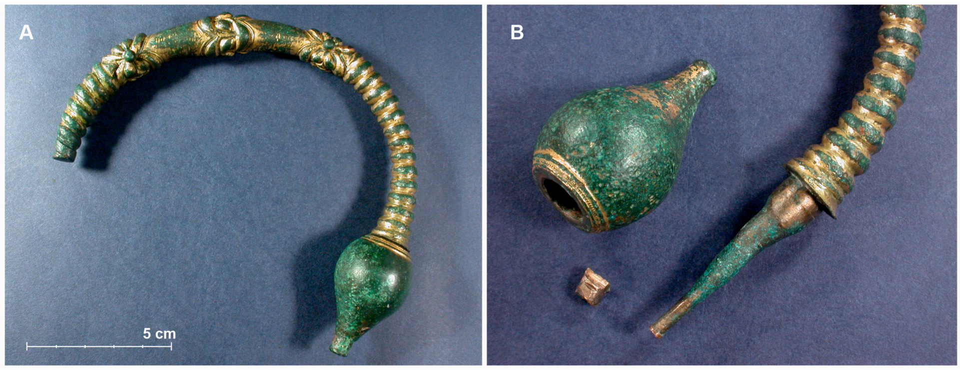

Figure 7. Baroque-type gilded torc of unknown provenance (Galicia). (**A**). General view; (**B**). the terminal contains a metal fragment inside which acts as a rattle.

Bracelet or torc fragment from the Elviña hillfort (A Coruña) (MAC-119) (Figure 8). Corresponding to a gilded hoop consisting of a circular section bar on which another bent one is placed, with a globule at the intersection between the two [47] (p. 98). It was found in the 1947 excavations directed by Luis Monteagudo. According to this author, it was found inside the collapse level of a tower that also contained sherds of Castro-culture and Roman pottery, a sherd of Campanian pottery and a coin from Tiberius [48] (p. 25). A well-known hoard was recovered in the hillfort in 1953. It consisted of a diadem/belt, a collar and an articulated pendant with 13 beads, all of them made of gold, and one glass bead [32–34]. Recent excavations have yielded a helicoidal gold strip and a touchstone [54] (pp. 193–194).

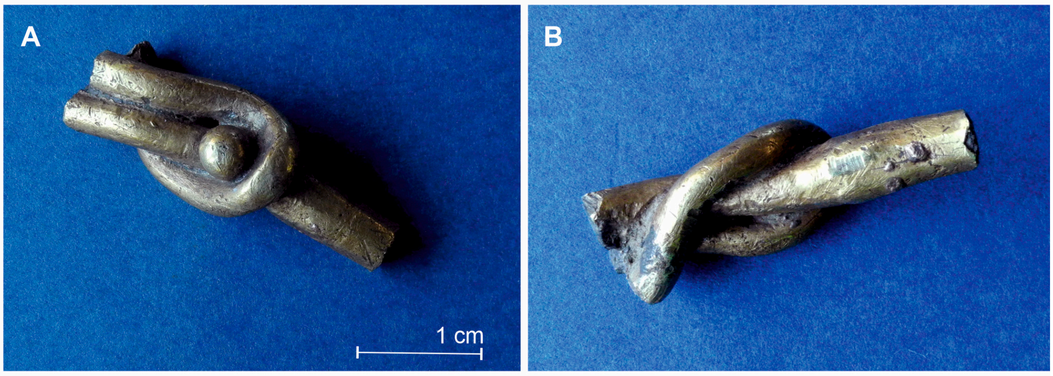

Figure 8. Bracelet or torc fragment with plastic surface from the Elviña hillfort. (**A**). External face; (**B**). inner face.

2.2. Methods

The study was carried out in situ and was based on a prior formal and technical review of the pieces with the support of a binocular loupe. The chemical composition was determined with Energy-Dispersive X-ray Fluorescence (EDXRF) on the surface of the artefacts, as it was not possible to conduct invasive sampling analysis. The pieces were analysed using an Innov-X Alpha Series 2000 handheld spectrometer with an X-ray tube (35 kV, 20 μA, Ag anode) and a SiPiN detector (Res < 230 eV FWHM at 5.95 keV Mn Kα line) belonging to the Museo Arqueológico Nacional (MAN) and regularly used in the Archaeometallurgy of the Iberian Peninsula Project [55]. The spot area of this spectrometer is 1 cm. It was calibrated in advance to analyse 100% metallic objects using the fundamental parameters technique; furthermore, the accuracy of the quantitative results was validated with an analysis of a set of certified standards. The standard with a composition closest to the alloys studied here (Fischer 603–681) (Au 58.15%, Ag 30.05%, Cu 11.90%) shows a slight overquantification of silver (c. 1.2%), placing copper at c. 0.5% below the certified value (Table S1). These slight differences can be explained by the material used in the anode of the X-ray tube (Ag), which contributes to the overquantification of this metal, and by the different beam size (10 × 10 mm in the Innov-X Delta analyser compared to 2 × 2 mm in the central part of the standard in the measurements made for its certification). The spectral acquisition times were established at between 30 and 40 s and the results were processed using Innov-X Systems software and are presented in % by weight, with the three main elements (Au, Ag, Cu) normalised to 100%. The detection limit of copper in gold-based alloys was established at 0.2%.

The analyses were carried out with the spectrometer mounted on a workstation and placing the pieces in a sample chamber, ensuring optimal conditions in terms of excitation/detection geometry in flat zones in direct contact with the spectrometer. In order to evaluate the quality of the results, between two and three analyses were obtained in most of the areas of interest, although we only reported one of them if the data obtained coincided. In the complex pieces, a sketch of the situation of the analyses carried out is attached (Supplementary Material S4).

3. Results and Discussion

Table 2 shows 74 pXRF analyses corresponding to c. 22 objects included in this study. Only five of them (the bead from Dombate, torcs from San Martiño do Porto and Orbellido, a torc or bracelet fragment from Elviña and an earring from Baroña) had been the subject of previous analyses, which we take into account for comparison purposes (Table S2).

Due to the relative exceptionality and conservation requirements of gold pieces, compositional analyses are usually performed at the surface. Handheld-XRF is one of the most used techniques, since it combines the good penetration capacity of XRF (8–60 µm), superior to that of other techniques such as SEM-EDS or µPIXE, with the possibility of obtaining extensive analytical series in museums [17,56–58]. In our case, the use of this technique has the additional advantage of allowing direct comparisons with much of the analytical information available to date for northwestern Iberian goldwork, obtained with similar equipment and work protocols [6–8,25–30,51]. On the other hand, although a superficial analysis with XRF presents limitations in some studies that require greater quantitative accuracy and precision, it is valid for the objectives of this paper, which is focused on determining the trends seen in the major elements, identifying the use of nuclei in less noble metals or obtaining a preliminary characterisation of surface gilding techniques. To date, comparison with results obtained using other techniques does not require the modification of interpretations based on analytical information obtained with XRF [7,8,12,59]. However, the study of enrichment phenomena and other surface alterations, through the combined use of analytical techniques or the comparison between the intensity of spectral lines [59–62], constitutes an objective for the future.

Table 2. List of analysed artefacts from the Archaeological and Historical Museum of A Coruña (all the geographic locations belong to the A Coruña province) (bdl = below detection limit; tr = traces). (*) The analysis may also detect the signal of the core; (**) The analysis may also detect the signal of the gilded surface.

Lab. Code	Inventory No.	Find	Object Type	Area	Cu (%)	Cu +/−	Ag (%)	Ag +/−	Au (%)	Au +/−	Other Elements
PA25647 B	MAC 4121	Dombate	Laminar bead		bdl		9.78	0.11	90.22	0.37	
PA25684	MAC 3780/1	Cícere	Sheet collar	Laminar strip	bdl		9.20	0.24	90.80	0.8	
PA25684 D	MAC 3780/1	Cícere	Sheet collar	Laminar strip	bdl		9.49	0.22	90.51	0.72	
PA25683 C	MAC 3780/2	Cícere	Rolled band (diadem?)	External surface	bdl		10.34	0.1	89.66	0.32	
PA25682	MAC 3780/3	Cícere	Rolled band (diadem?)	External surface	bdl		8.05	0.09	91.95	0.32	
PA25682 B	MAC 3780/3	Cícere	Rolled band (diadem?)	External surface	bdl		8.11	0.09	91.89	0.32	
PA25657 B	MAC 3780/4	Cícere	Gold sheet		bdl		8.27	0.09	91.73	0.33	As

Table 2. *Cont.*

Lab. Code	Inventory No.	Find	Object Type	Area	Cu (%)	Cu +/−	Ag (%)	Ag +/−	Au (%)	Au +/−	Other Elements
PA25659 B	MAC 3780/5	Cícere	Brass sheet		72.7	0.18	bdl		bdl		Ni; Zn: 28.63; Pb: 0.31
PA25656	MAC 3780/6	Cícere	Sheet collar?		bdl		25.21	0.14	74.79	0.28	
PA25660	MAC 3780/7	Cícere	Sheet collar?		bdl		24.81	0.24	75.19	0.49	
PA25658 B	MAC 3780/8	Cícere	Gold sheet		bdl		8.56	0.09	91.44	0.33	As
PA25662	MAC 3780/9	Cícere	Gold sheet		bdl		10.72	0.1	89.28	0.33	
PA25661	MAC 3780/10	Cícere	Gold sheet		tr		10.88	0.09	89.12	0.3	As
PA25663 B	MAC 3780/11	Cícere	Gold sheet		bdl		8.34	0.13	91.66	0.48	
PA25654 C	MAC 1211	Baroña	Earring	External edge	2.99	0.07	45.65	0.2	51.36	0.26	
PA25649	2205 (1)	Os Castros	Laminar bead	Frag. 1	2.56	0.06	42.06	0.17	55.38	0.23	
PA25650 B	2205 (2)	Os Castros	Laminar bead	Frag. 2	2.56	0.06	41.62	0.19	55.82	0.26	
PA25676	MAC 942	Orbellido	Torc (Artabrian-type)	Hoop (central area)	10.19	0.11	32.93	0.17	56.88	0.28	
PA25677	MAC 942	Orbellido	Torc (Artabrian-type)	Hoop (coiled wire, lat. 1)	5.99	0.09	28.48	0.18	65.53	0.33	
PA25678	MAC 942	Orbellido	Torc (Artabrian-type)	Hoop (coiled wire, lat. 2)	5.21	0.11	27.77	0.23	67.02	0.43	
PA25679 B	MAC 942	Orbellido	Torc (Artabrian-type)	Terminal 1	9.24	0.09	31.19	0.15	59.56	0.26	Ni
PA25680 C	MAC 942	Orbellido	Torc (Artabrian-type)	Terminal 2	8.39	0.09	31.12	0.15	60.50	0.26	
PA25681	MAC 942	Orbellido	Torc (Artabrian-type)	Hoop (spiral 1)	6.05	0.1	28.49	0.19	65.46	0.35	
PA25681	MAC 942	Orbellido	Torc (Artabrian-type)	Hoop (spiral 2)	5.46	0.1	27.71	0.21	66.83	0.38	
PA25664 B	MAC 933	S.M.Porto	Torc (Artabrian-type)	Frag. 1. Hoop (central area)	1.92	0.05	20.71	0.13	77.37	0.3	
PA25665	MAC 933	S.M.Porto	Torc (Artabrian-type)	Frag. 1. Hoop (spiral plate)	1.75	0.06	18.23	0.13	80.02	0.33	
PA25667	MAC 933	S.M.Porto	Torc (Artabrian-type)	Frag. 1. Hoop (coiled wire)	1.96	0.07	18.21	0.17	79.84	0.42	
PA25668	MAC 933	S.M.Porto	Torc (Artabrian-type)	Frag. 2. Hoop (frag. without coiled wire)	5.85	0.09	25.13	0.16	69.02	0.32	
PA25669 B	MAC 933	S.M.Porto	Torc (Artabrian-type)	Frag. 3. Terminal A	1.94	0.05	21.54	0.12	76.52	0.27	Ni
PA25670	MAC 933	S.M.Porto	Torc (Artabrian-type)	Frag. 4. Terminal B	3.13	0.06	22.90	0.12	73.97	0.26	Pb
PA25671	MAC 933	S.M.Porto	Torc (Artabrian-type)	Frag. 4. Hoop (coiled wire)	1.76	0.06	17.76	0.14	80.48	0.35	
PA25672	MAC 933	S.M.Porto	Torc (Artabrian-type)	Frag. 4. Hoop (spiral)	1.97	0.08	19.07	0.19	78.96	0.44	
PA25673	MAC 933	S.M.Porto	Torc (Artabrian-type)	Frag. 5. Hoop (central area)	2.18	0.1	18.85	0.23	78.97	0.54	
PA25616	MAC 842	Xanceda	Torc 1 (Frag. A) (Baroque-type)	Terminal	0.98	0.05	18.08	0.13	80.94	0.32	
PA25618	MAC 842	Xanceda	Torc 1 (Frag. A) (Baroque-type)	Hoop (lateral third)	0.63	0.05	22.06	0.16	77.31	0.36	
PA25619	MAC 842	Xanceda	Torc 1 (Frag. A) (Baroque-type)	Hoop (spiral)	1.16	0.05	23.78	0.15	75.07	0.32	Pb
PA25620	MAC 842	Xanceda	Torc 1 (Frag. A) (Baroque-type)	Hoop (triangular motifs)	1.11	0.04	23.13	0.13	75.76	0.28	
PA25621 B	MAC 842	Xanceda	Torc 1 (Frag. A) (Baroque-type)	Hoop (central area, plastic decoration)	1.70	0.05	23.46	0.14	74.84	0.3	
PA25622	MAC 842	Xanceda	Torc 1 (Frag. B) (Baroque-type)	Terminal	0.79	0.04	27.23	0.13	71.82	0.05	Ni; Pb
PA25623	MAC 842	Xanceda	Torc 1 (Frag. B) (Baroque-type)	Hoop (lateral third)	0.59	0.06	22.10	0.17	77.31	0.38	
PA25624 B	MAC 842	Xanceda	Torc 1 (Frag. B) (Baroque-type)	Hoop (spiral plate)	0.67	0.04	22.74	0.14	76.60	0.3	Pb
PA25625	MAC 842	Xanceda	Torc 1 (Frag. B) (Baroque-type)	Hoop (central area, globules, circular motifs)	0.96	0.05	18.88	0.13	80.16	0.31	
PA25626	MAC 842	Xanceda	Torc 1 (Frag. B) (Baroque-type)	Hoop (core)	18.74	0.12	51.00	0.17	30.26	0.17	Ni; Zn

Table 2. *Cont.*

Lab. Code	Inventory No.	Find	Object Type	Area	Cu (%)	Cu +/−	Ag (%)	Ag +/−	Au (%)	Au +/−	Other Elements
PA25626 B	MAC 842	Xanceda	Torc 1 (Frag. B) (Baroque-type)	Hoop (core)	20.65	0.13	50.67	0.18	28.68	0.18	Ni, Zn
PA25627 C	MAC 925	Xanceda	Torc 2 (Frag. A) (Baroque-type)	Hoop (central area, plastic decoration)	1.60	0.05	24.19	0.14	74.20	0.3	
PA25628	MAC 925	Xanceda	Torc 2 (Frag. A) (Baroque-type)	Hoop (filigree, intertwined motif 1)	0.65	0.06	27.52	0.19	71.83	0.37	
PA25628 B	MAC 925	Xanceda	Torc 2 (Frag. A) (Baroque-type)	Hoop (filigree, intertwined motif 2)	0.98	0.05	28.26	0.16	70.76	0.29	
PA25629	MAC 925	Xanceda (*)	Torc 2 (Frag. A) (Baroque-type)	Hoop (plate with triangular motifs	0.87	0.04	48.24	0.18	50.89	0.22	
PA25630	MAC 925	Xanceda	Torc 2 (Frag. A) (Baroque-type)	Hoop (lateral third)	0.45	0.04	59.41	0.21	40.13	0.21	
PA25631	MAC 925	Xanceda	Torc 2 (Frag. A) (Baroque-type)	Hoop (core)	17.77	0.11	59.60	0.17	22.63	0.14	Ni; Zn; Bi; Pb
PA25632	MAC 926	Xanceda	Torc 2 (Frag. B) (Baroque-type)	Terminal (frontal disc)			8.87	0.08	91.13	0.3	Ni
PA25633 B	MAC 926	Xanceda	Torc 2 (Frag. B) (Baroque-type)	Terminal (intermediate area)	0.95	0.04	20.76	0.12	78.29	0.28	As
PA25634	MAC 926	Xanceda	Torc 2 (Frag. B) (Baroque-type)	Hoop fragment (core)	22.61	0.12	53.28	0.16	24.11	0.14	Ni; Zn; Bi; Pb: 0.1
PA25635	MAC 1385	Xanceda	Torc 2 (Frag. A) (Baroque-type)	Terminal (frontal disc)			11.87	0.09	88.13	0.28	As
PA25636 B	MAC 1385	Xanceda	Torc 2 (Frag. A) (Baroque-type)	Terminal (intermediate area)	0.77	0.04	21.93	0.12	77.30	0.27	Ni, As
PA25637	MAC 1385	Xanceda	Torc 2 (Frag. A) (Baroque-type)	Hoop (core)	13.33	0.11	68.06	0.2	18.61	0.13	Ni; Zn; Bi; Pb
PA25638	MAC 1385	Xanceda (*)	Torc 2 (Frag. A) (Baroque-type)	Hoop (lateral third)	0.24	0.04	57.94	0.21	41.83	0.22	
PA25639 B	MAC 1387	Xanceda	Torc 3 (Baroque-type?)	Terminal (fragment, external surface)	0.85	0.04	27.45	0.14	71.69	0.27	Sn
PA25639 C	MAC 1387	Xanceda	Torc 3 (Baroque-type?)	Terminal (fragment, internal surface)	5.09	0.09	63.61	0.25	31.30	0.21	Bi
PA25640 B	MAC 1386	Xanceda (*)	Torc 3 (Baroque-type?)	Hoop (coiled wire)	0.52	0.03	86.62	0.25	12.86	0.12	Bi
PA25641	MAC 1386	Xanceda (*)	Torc 3 (Baroque-type?)	Hoop (frag. Ag section in contact with terminal)	4.57	0.07	62.80	0.22	32.63	0.19	As; Bi; Pb
PA25642 D	MAC 927	Xanceda	Torc 4 (Artabrian-type)	Hoop (central area)	0.87	0.05	27.99	0.17	71.13	0.33	
PA25643	MAC 927	Xanceda	Torc 4 (Artabrian-type)	Hoop (spiral)	1.30	0.06	19.59	0.14	79.10	0.34	
PA25644	MAC 927	Xanceda	Torc 4 (Artabrian-type)	Hoop (spiral, opposed side)	0.41	0.04	18.21	0.14	81.38	0.34	
PA25645	MAC 927	Xanceda (*)	Torc 4 (Artabrian-type)	Hoop (lateral third, coiled wire)	1.30	0.07	35.94	0.25	62.77	0.39	
PA25646	MAC 927	Xanceda (**)	Torc 4 (Artabrian-type)	Hoop (core)	14.49	0.12	60.57	0.21	24.94	0.17	Ni; Zn
PA25651	MAC 3245	Unknown prov.	Torc (Baroque-type)	Metal frag. (rattle inside the terminal)	89.38	0.26			bdl		Sn: 10.02; Pb: 0.38
PA25652	MAC 3245	Unknown prov.	Torc (Baroque-type)	Terminal	71.64	0.21			bdl		Sn: 27.39; Pb: 0.8
PA25653	MAC 3245	Unknown prov.	Torc (Baroque-type)	Hoop (central area, plastic decoration)	49.18	0.23			31.86	0.21	Sn: 22.41; Pb: 0.53; Hg: 4.43
PA25653 B	MAC 3245	Unknown prov.	Torc (Baroque-type)	Hoop (central area, plastic decoration)	42.06	0.21			34.12	0.19	Sn: 31.06; Pb: 0.74; Hg: 3.98
PA25653 C	MAC 3245	Unknown prov.	Torc (Baroque-type)	Hoop (lateral third)	43.22	0.2			38.98	0.21	Sn: 24, 13; Pb: 0.51; Hg: 4.36
PA25653 D	MAC 3245	Unknown prov.	Torc (Baroque-type)	Hoop (lateral third)	39.79	0.2			38.61	0.2	Sn: 30,72; Pb: 0.59; Hg: 3.63
PA25648 C	MAC 119	Elviña	Bracelet/Torc?	Section (core)	13.15	0.16	55.29	0.29	31.56	0.28	Bi
PA25648 E	MAC 119	Elviña	Bracelet/torc?	Hoop (central bar)	8.18	0.11	24.46	0.18	67.36	0.36	

3.1. Chalcolithic–Early Bronze Age

The pieces from these periods present Ag and Cu values compatible with unalloyed gold. The analysis of the Dombate laminar bead (PA25647B) (Table S2) (Figure 3A,B) indicates a Ag value of 9.78%, placing Cu below the detection limit. This result is consistent with the previously published Atomic Absorption Spectroscopy analysis, which also reports several trace elements (Sn, As, Sb and Ni) [40].

Although they are typologically different, in Galicia and northern Portugal, analyses have been published for the gold beads from Chaos de Barbanza (Boiro, A Coruña) and Buraco da Pala (Mirandela, Bragança). The former show a high Ag content (23.2–26.1%), with Cu at around 0.2% [6]; in another analytical series, this element shows higher percentages of between c. 0.2% and 0.6% in the different specimens [63]. The Portuguese examples have silver contents of between 6.89% and 7.89%, with copper below the detection limit (1% in the case of the instrument used) [64].

Other regions on the Iberian Peninsula have also provided gold laminar beads of similar chronology. Among those with compositions analysed using XRF, we can cite those of Camino de las Yeseras (Alcalá de Henares, Madrid) [65], Humanejos (Parla, Madrid) [66] and Convento de Carmo and Almonda (Torres Novas, Portugal) [5]. In the south of Spain, examples from Loma de Belmonte I (Almería) and the La Pastora Dolmen (Sevilla) have been analysed using SEM-EDS [67]. In general, the results are compatible with alluvial golds, although there are variations in the Ag and Cu percentages, partly associated with the geographical origin of the raw material and the detection limits of the instrumentation used.

Cícere's analytical sampling (Supplementary Material S4) included all the elements of the assemblage. Fragment 3780/5 (Figure 3C, 5) is brass with a Zn content of 28.6%. This composition rules out it being contemporary with the rest of the finds. Although there are Roman and early medieval brasses with these amounts of Zn, it is more likely that we are looking at a modern alloy, rather than ancient brass obtained by cementation [68–70] (pp. 401–406), and, therefore, an intrusion produced after the discovery. This circumstance is not unusual if we take into account the aforementioned vicissitudes undergone by the pieces following their discovery.

The rest of the fragments mainly present Ag percentages of between 8.01% and 10.7% and Cu values below the detection limit, except for the MAC 3780/10 fragment in which the presence of Cu (0.4%) could be explained by contamination or dirt visible to the naked eye. Trace elements are barely detected in most cases. The fragments identified as originally belonging to the same object (3780/2-10 on the one hand and 3780/3-4 on the other) [42] show similar percentages of Ag that support these associations. Another two fragments (3780/6 and 3780/7) differ from the majority tendency since they present Ag percentages of c. 25%. Their similar composition suggests they could be part of the same piece, perhaps another sheet collar [50]. The other specimen of this type in this set (Figure 3C, 1 and Figure 9) fits compositionally with the majority group.

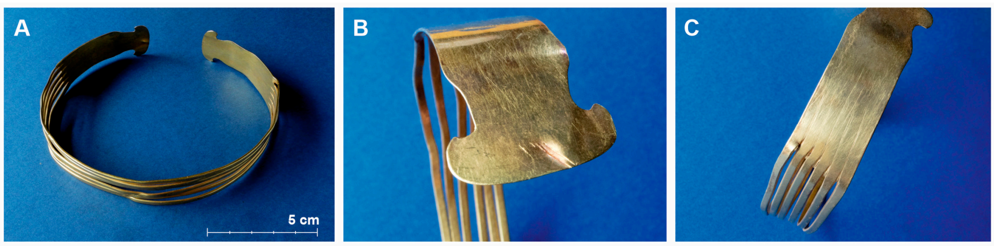

Figure 9. Sheet collar from Cícere: (**A**). general view; (**B**,**C**). details of the external surface.

These collars are part of an assemblage of jewellery with laminar strips with a concentration located above all in Galicia and northern Portugal. However, one example is known from Vale dos Moinhos (Santarém, Portugal), another (interpreted as a ring) from Mata'l Casare (Asturias) and six from western France: two in Rondossec (Plouharnel, Morbihan), two in Saint-Laurs (Deux-Sèvres), one in Saint-Père-en-Retz (Loire Atlantique) and another doubtful one in Saint-Méme (Charente) [49] (pp. 103–105) [71].

If the identification of Fragments 3788/6-7 is correct, with the analyses we provide in this article there are a total of 10 strip jewels with published composition data (Table S3). The specimens from NW Iberia show an interesting compositional variability: the complete collar from Cícere and the two from Monte dos Mouros show Ag percentages of between 9.2% and 18–19.5%, depending on the analytical series we consider, and Cu percentages of 0.2% [6,7]. The fragments from Cícere 3780/6-7 show higher Ag concentrations (c. 20–25%), with Cu at <0.2%, compositional characteristics they share with a fragment from Caldas de Reis [24] (pp. 90–91). These Ag concentrations above 20% in the first goldwork productions, which, as we have seen, are also detected in the Chaos de Barbanza beads, are specific to the territory of present-day Galicia. In contrast, the strip jewellery located around this territory has lower Ag percentages: in the Braga example (2.5%) [71] and the Mata'l Casare example (8.6%) [72] (p. 92). As for those located outside the Iberian northwest, that of Saint-Père-de-Retz has only one early reference to its composition (Ag c. 12.5%) [73] (p. 26), probably obtained by wet chemistry analysis, while those of Rondossec and Vale dos Moinhos were analysed by Hartmann, offering in both cases Ag percentages of c. 15% and Cu percentages of <0.2% [24] (pp. 88–91), compositions similar to those of other specimens from the northwest. However, it should be kept in mind that, while the values of Cu and Sn reported by Hartmann continue to be useful, those of Ag must be considered qualitative in nature [74,75]. In the case at hand, this affects the three sheet collars analysed by that scholar, as well as other data we will comment on later.

3.2. Late Iron Age–Early Roman Period (Castro-Culture Goldwork)

The items of Castro-culture goldwork included in this study are highly representative of the productions of that period, confirming in all cases the use of ternary Au-Ag-Cu alloys.

3.2.1. Baroña Earring and Os Castros Bead

The results of the analyses corresponding to these two pieces are characterised by their high Ag (>40%) and Cu (>2.5%) contents. These compositions are not uncommon in Castro-culture goldsmithing. However, in the case of the earring (Figure 4B,C), the percentages of both elements are above those seen in other examples with a penannular body from this area, such as those from the Recouso treasure (Oroso, A Coruña) [11].

The Baroña piece was previously analysed at the University of Santiago de Compostela [44]. There are significant differences between our analyses and the published results, especially in the case of silver (Table S2). As with the Orbellido torc analysed in the same laboratory [46], the absence of data on the equipment and the protocol used prevents an adequate assessment of these differences. The discrepancies between these analyses, carried out in the 1980s, and those reported later by us and other scholars have already been commented on in a previous work [12].

3.2.2. Artabrian-Type Torcs

Regarding the torcs, we will first deal with the Artabrian-type pieces, which, as we have mentioned, are among the most characteristic productions of Castro-culture goldwork. Our analytical study included three specimens: Orbellido, S. Martiño do Porto and Torc 4 from Xanceda. The Orbellido example (Figure 5A) was made using at least two different Au-Ag-Cu alloys. The analysis of the central area of the hoop shows a Ag concentration of c. 32.9%, with Cu at 10.2%. In the sections of coiled wires or in the spiral motifs (Figure 10C) these elements are situated at c. 27.7–28.5% (Ag) and c. 5.2–6% (Cu). The terminals (Figure 10D) show values close to those identified in the central area of the ring, although with slightly lower amounts of Ag and Cu, with the analysis result similar to one of those reported by Acuña and Casal [46] (Table S2).

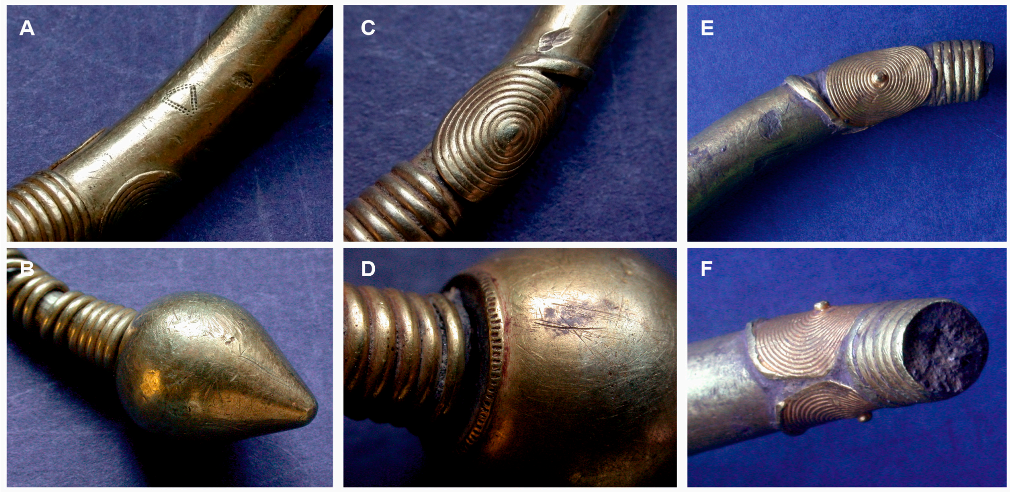

Figure 10. Artabrian-type torcs: (**A**). triangular motif stamped on the hoop of the San Martiño do Porto torc; (**B**). pyriform terminal of the same piece; (**C**). spiral-shaped decoration on the Orbellido torc; (**D**). chiselled decoration on the back of a terminal of the same torc; (**E**). decoration on the hoop in Torc 4 from Xanceda; (**F**). silver core at the end of the hoop of the same torc.

The torc from S. Martiño do Porto (Figure 5B) also reveals differences in the composition of the elements that make it up. The two analyses in the central zone of the hoop (Figure 10A) show Ag concentrations of c. 18.8–20.7% and Cu values of c. 1.9–2.2%. In the fragment corresponding to the lateral section of the hoop, previously covered with coiled wire, Ag and Cu values of c. 25% and 5.8%, respectively, are recorded. The only analysis published by Hartmann [24] of this example (Table S2) also offers high Ag and Cu values, although it is not specified at which point the sample was obtained [76] (p. 241, nº 74, Taf. 18.11). The remains of coiled wires present lower percentages of silver (c. 18%), as well as lower Cu content (c. 1.7–2%). The spirals that delimit them maintain similar values, while intermediate values are recorded in the terminals (Figure 10B), with a Ag content of c. 21–23% and Cu around 2–3%.

Finally, the example from Xanceda 4 (Figure 6, D) stands out. Its hoop has a core made of a Ag-Au-Cu alloy (Figure 10F) with percentages of c. 14% Cu and 24% Au. A superficial plating applied in its central area is documented, observing on the inner face the joint between the edges of the applied gold plate, in which Ag and Cu values of c. 27.6% and 0.85%, respectively, were obtained. The spirals that delimit this area (Figure 10E) were made with a different alloy, with maximum values of Ag lower than 20%, and Cu not exceeding 1.5%. The composition of the coiled wire sections is also apparently different (Ag 34.93%); although, as with Torcs 2 and 3, the results are affected by the core metal of the hoop.

Prior to this study, analytical information was published on a total of 12 Artabrian-type torcs. Using specific gravity and Optical Emission Spectroscopy (OES), Hartmann [24] obtained the composition of five of them: the three from Foxados (Curtis, A Coruña), the one from the Flores hillfort (Aranga, A Coruña) and the one from S. Martiño do Porto studied here [76]. Another seven have been analysed more recently using XRF: the three from Viladonga (Castro de Rei, Lugo) and those from Bardaos (Tordoia, A Coruña), Centroña (Pontedeume, A Coruña), Portochao or nearby Viveiro (Lugo) (MPL 2015/600) and Croa de Riotorto (Riotorto, Lugo) [6,25,77]. While Hartmann analysed a single sample per piece without indicating to which part it corresponded, the most recent studies include the sampling of the different elements that make up the torcs. In total, the available analytical repertoire amounts to 38 analyses for these 12 examples. They all indicate the use of intentional alloys, both in the gold elements and the nuclei made with less precious metals. The Ag values are between c. 18% and 80% and those of Cu between c. 0.5% and >50% (high Ag and Cu values correspond to the analysis of cores). The high Ag contents stand out in particular, with an average of c. 46% and a median of 44.5%, if we consider only the analyses obtained with XRF. The three examples we analysed present lower values of this metal, except for the Xanceda 4 torc core. In terms of Cu, the XRF analyses corresponding to the aforementioned seven examples give an average of c. 6.5% and a median of 2.8%. The three torcs of this study also show a notable variability of this element, ranging between 0.85% in the central part of the Xanceda 4 hoop and 10.2% in the same area of the Orbellido example, or 14% in the Xanceda 4 hoop core.

These high Ag values and, to a lesser extent, those of Cu, are explained by the tendency shown by the NW Iberian goldsmiths in a period close to the turn of the era to use this type of ternary Au-Ag-Cu alloy, as well as the use of cores in less precious materials [12]. Thus, although Artabrian torcs have often been described as gold objects, the example from Xanceda 4 attests to the production of hoops with Ag-based cores covered with gold elements, such as coiled wires, spirals or sheaths. These features are also observed in other torcs. An example from the Viladonga hillfort (A.70-606) presents a Ag-Cu hoop gilded with mercury amalgam [77], while in the one known as Viladonga II (A.74.4) (Figure 11B) [6] or that of the Troña hillfort (Ponteareas, Pontevedra) (Figure 11A) [36] the gilded surface was achieved through plating and/or covering the core of the hoop with sections of coiled wires.

Figure 11. Artabrian-type torcs (**A**,**B**) and plano-convex ingots (**C**): (**A**). hoop fragment with a silver core from the Troña hillfort (Ponteareas, Pontevedra); (**B**). torc with a Cu-based core from the Viladonga hillfort (Castro de Rei, Lugo); (**C**). Au-Ag-Cu plano-convex ingots from the Recouso hillfort (Oroso, A Coruña).

This trend cannot be extrapolated to all the Artabrian torcs, since Au-based alloys are observed in the sections of some fractured examples of solid hoops (Centroña, Croa de Riotorto and S. Martiño do Porto). However, in several of those that are preserved completely (Bardaos, Castro de Flores, Viladonga I. . .) it is not possible to determine whether they have this type of nuclei in less precious metals, and it cannot be ruled out that, if so, some of the surface analyses also detect the signal of the alloy below the gilded layer.

Another aspect to comment on has to do with the use of different castings or alloys to produce the different parts of the same torc. Factors such as the geometry of the analysis or surface alterations (corrosion, enrichment) can explain some of the differences in the analytical data. However, along with the aforementioned presence of rings in less precious metals, in some cases, the compositional variations in the different parts of the torc could point to the use of at least two alloys. This is the case of the three examples included in our study, as well as in the torcs from Bardaos, near Viveiro/Portochao, Viladonga I or Centroña, with compositional Ag differences that range from between 5.4% (Viladonga I) and 15.8% (Bardaos), and between 1.8% (Centroña) and 5% (vicinities of Viveiro/Portochao) in the case of Cu. In other torcs of the Artabrian type, such as those from Croa de Riotorto or the gold parts of Viladonga II, these variations are less noticeable. Other types of torcs also present a variety of cases regarding the degree of compositional homogeneity/heterogeneity [27,28].

3.2.3. Torcs with Plastic Decoration and a Fragment from Elviña

As has been noted, the rest of the torcs studied are among the least represented in the Castro-culture area, although they constitute outstanding examples of the formal and technical transformations undergone by these pieces at advanced moments in their production.

Examples 1 and 2 from Xanceda (Figure 6, A–B) show differences in their typology, although they share many similarities on a technical level. As with the rest of the pieces in this assemblage, its hoops were made with lost-wax casting using Ag-Au-Cu alloys. The two pieces incorporate hoops whose surfaces form plastic decorations. In Torc No. 1, these decorations (Figure 12A,B,E, 2) affect the entire length of the hoop, although they are limited to the central part in No. 2 (Figure 12C–E, 1). Both examples received a superficial gilding treatment that was applied to the entire ring of Torc No. 1 and only the central part of No. 2. The two torcs also incorporate other ornamental elements made with gold in their central part, documenting the use of manufactured plates, lost-wax casting, and the application of filigree and granulated motifs (Figure 12A–D).

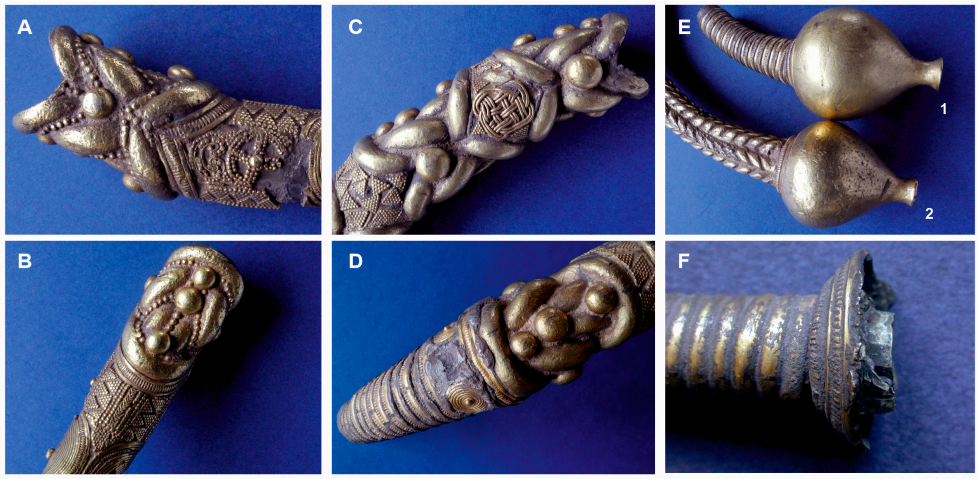

Figure 12. Baroque-type torcs from Xanceda: (**A**,**B**). plastic and applied decoration in the central part of the hoop of torc 1 (lateral view and external edge, respectively); (**C**,**D**). plastic and applied decoration in the central part of the hoop of Torc 2 (lateral view and external edge, respectively); (**E**,**F**). terminals and lateral thirds of the hoops (E1: torc 2; E2: torc 1; F: torc 3).

Unlike other Castro-culture torcs, the gilding was also applied to their terminals (Figure 12E) made from the welding of at least two parts manufactured by lost-wax casting and which, as mentioned, included rattle elements inside. The superficial gilding is also clearly observed in the terminal fragment MAC-1287, attributed to Example 3 of the assemblage (Figure 6, C), of which part of the hoop is preserved, including its end with remains of the associated terminal. It could have corresponded to a piece of a similar typology to that of Example 2, also including sections of rolled moulded strips (Figure 12F).

In Torc 1, the composition of the hoop core reaches 50% Ag, with maximum Au and Cu values of c. 30% and 20.3%, respectively. The Ag values recorded in the gilding layer remain at c. 20%, with values of c. 17–26% in the terminal. As in the rest of the pieces of the assemblage, it cannot be ruled out that the results are affected by the penetration of the beam below the gilded layer.

It should also be noted that the alloys used in the ornamental elements added to the central third of the hoop generally show a Ag content slightly higher than those documented in the gilding layer, with values that do not exceed 24%, and a low presence of Cu of between c. 1% and 1.5%. However, due to issues related to beam size and penetration, these data must be considered with caution.

These problems are also manifested in the analyses of Example 2. In that piece, the Ag values are below 25% in the gold layer of the hoop and c. 20% in the body of the terminals, whose front discs present a lower content of that element (c. 11%). For its part, the hoop core offers a Ag content that exceeds 50% and reaches maximum values of c. 68%. The maximum Au and Cu values are situated at c. 24% and c. 22.5%, respectively. This variability could be due to the fact that the area analysed includes part of the Au-based external surface.

As can be seen in Example 1, the ornamental elements added to the hoop present a slightly higher proportion of Ag than the gold layer. Due to the size of the beam, a detailed analysis of the coiled wire turns could not be provided, and Ag values greater than 50% were recorded, partly corresponding to those segregated from the core which affect this area (Figure 12A,D).

Torc 3 could correspond to a piece of the same type, but the results obtained in the hoop core are different, with a slightly lower Ag content, a higher gold value and a lower presence of Cu. Also in this case, the analyses corresponding to the coiled wire sections are affected by the partial loss of the gilding layer and the presence of segregates from the core (Figure 12F). As already indicated, the terminal was also gilded, presenting Ag rates that varied from 63.61% to 27.45% between the interior and the exterior. For its part, Cu, which exceeds 5% on the interior face, appears in very low quantities on the exterior (0.85%).

Both the alloys documented in Torcs 1 and 2 and the exceptional nature of their morphology suggest that they come from the same workshop. Considering the similarities between the hoops of Torcs 2 and 3, the proposal could also be extended, at least, to this third example.

One of the aspects to highlight in the pieces of this assemblage is the composition of the hoop cores. Ag-Au-Cu or Ag-Cu alloys are rare in Castro-culture manufactures, although they have been documented in some plano-convex-type ingots, such as those from the Recouso (Figure 11C) or Zoñán (Mondoñedo, Lugo) hillforts. Among the torcs, in addition to Example 4 from Xanceda and the two already mentioned from Viladonga (Figure 11B), we can cite the Ag-Au-Cu alloy identified in the hoop core of an example from Asturias, now in the National Archaeological Museum (Inv. 33. 133, 137, 138) [30] (p. 102). The piece from the Elviña hillfort we study in this article (Figure 8) can also be included in this list.

From a technological point of view, it is also worth mentioning the use of gilding or plating in the four examples of the assemblage, without the presence of Hg having been documented in any of them. The Xanceda pieces also highlight the problem posed by the physical-chemical alterations of the objects (segregation, loss of gilding, etc.) when evaluating the results of the superficial analytical study.

Significant differences are observed in the bronze torc (MAC-3245) (Figure 7) with respect to the Xanceda examples. In this case, no ornamental elements welded or superimposed on the hoop are documented. The partial loss of the gilding layer facilitated the determination of the base alloys used in both the hoop and the preserved terminal (Figure 13), identifying in the latter the use of a binary bronze with a high percentage of Sn (27.39%).

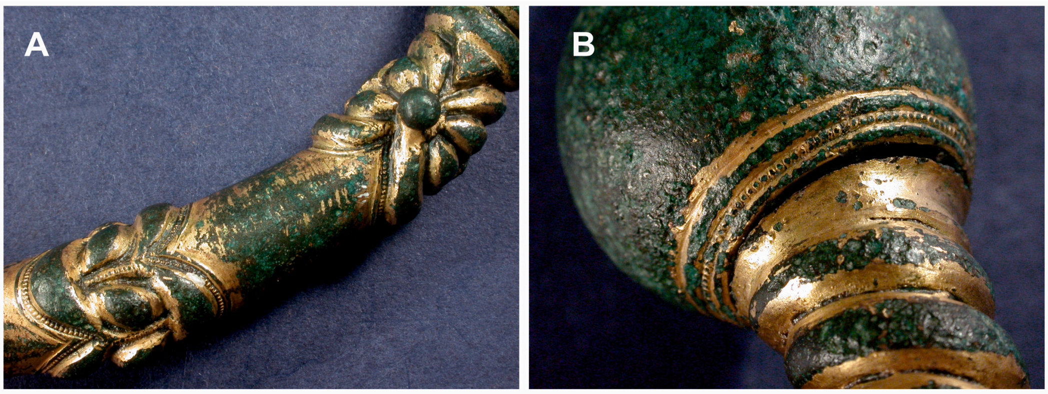

Figure 13. Gilded bronze torc of unknown provenance: (**A**). detail of the plastic decoration in the central part of the hoop; (**B**). details of gilding and decoration at the end of the hoop and terminal.

The fragment of a chisel-cut bronze bar inserted into the terminal, apparently used as a rattle element (Figure 7B), presents a different alloy (Sn 10.02%) to the rest of those documented. In the gold layer of the hoop, percentages of Au ranging from between 31.86% and 38.98% and Hg between c. 3.5% and 4.5% have been recorded, placing silver below the detection limit. These results indicate that the technique used to cover the hoop was mercury gilding or fire gilding, a gilding technique we refer to elsewhere in this article.

From the formal and technological point of view, it can be considered that both the Xanceda and the MAC-3245 torcs probably reflect the products of an advanced phase of Castro-culture goldsmithing. This, as we will see, could be placed in a later period of this artisanal tradition, probably around the turn of the era.

The data obtained from the Elviña fragment (MAC-119), identifiable as the remains of a possible torc or bracelet that, due to its characteristics could be linked to the previous group, differ from the previously published analysis [24] (pp. 116–117, Au2983) (Table S2). Although the values of the two series are not directly comparable, the Cu value obtained with pXRF (8.16%) is lower, roughly coinciding with the presence of Ag identified in the lateral surfaces (c. 25%). However, in the body sections, the amounts of Ag and Cu increase to 55.29% and 13.15%, respectively, and significant values of Br are recorded and can be interpreted as the result of corrosion. The results suggest that the piece was made from a Ag-Cu alloy that was subsequently subjected to surface gilding/plating. However, due to the beam size used, the data presented should be considered qualitatively, pending a more detailed analytical review.

3.3. Some Interpretative Questions

The study carried out adds new information of special interest to research into the transformations produced in goldsmithing technology at the end of the Iron Age and the beginning of the Roman period. These would be reflected both in changes in the formal canons of the objects and the techniques and raw materials used for their manufacture.

In this respect, particularly noteworthy is the information provided by the study of processes aimed at giving the surface of objects the appearance of gold, thus concealing the use of less precious metals. They have been documented mainly in torcs, with good examples among those belonging to the Artabrian group [77]. To a lesser extent, they have been confirmed in other groups of finds such as hair adornments [78] or, recently, earrings [79]. The use of cores in less noble materials, whether metals, wax, wood or clay, is attested in the goldsmithing of Atlantic Europe at least since the Late Bronze Age, as shown by the lock-rings (c. 1000–750 BC) typical of Britain, Ireland and France [49,80]. The study of the Snettisham torcs (Norfolk, UK) has also allowed the use of wood inside some torcs to be identified by optical microscopy [81]. In the northwest of Iberia, in chronologies similar to the pieces studied in this article, the Recouso earrings have a filling material consisting of sediment with a high content of diatoms [82]. This use of less noble materials inside the pieces may be due to technological reasons related to their production and use, but also to the saving of a valuable raw material such as gold.

Among the pieces studied here, the identification of a new example of the use of fire gilding (torc MAC-3245) stands out. This technique is based on the propensity of mercury to amalgamate with gold, forming a paste that is applied to the surface of the metal to be gilded and subsequently heated to a moderate temperature (around 250–350º), causing the partial evaporation of mercury; the resulting porous surface is finished by burnishing [70,77,83–85]. It went unnoticed for years in studies on Castro-culture goldwork, but in recent years it has been increasingly documented, both in torcs [77] and in hair adornments [78] or ornamental overlays [30]. There is still a debate about the origin of this technique in the goldsmithing of northwest Iberia, whose adoption and development were surely favoured by the presence of cinnabar (HgS) in several areas of the Iberian Peninsula, including the north of the province of León, very near the study area at hand [86,87]. However, no mercury has been detected in Torcs 1 and 2 from Xanceda, which indicates that the Castro-culture goldsmiths knew other procedures to obtain thin layers of gilding on surfaces with plastic decoration.

To the use of these procedures and the incorporation of non-gold raw materials into the pieces, we must add, as noted above, the documentation of significant changes in the formal patterns and ornamental elements.

Even maintaining part of the defining features of the Castro-culture torcs, such as the tripartite ornamentation of the hoop or the voluminous terminals, both the MAC-3245 torc (Figure 7) and the Xanceda pieces (Figure 6) are good examples of these transformations. To the use of subsequently gilded Ag-Au-Cu hoop cores, features have been added such as the simulation using plastic surfaces made with the lost-wax casting process of characteristic elements in Castro-culture torcs, such as the "coiled wire" decoration (torc MAC-3245) (Figure 14A) or pairs of filigree spirals. Less frequent characteristics using the same technique are also incorporated, such as the composition of twisted wires on the hoop of Xanceda Torc 1 (Figure 14B).

Figure 14. Baroque-type torcs. (**A**). Simulation with lost-wax casting of a coiled wire decoration on the hoop of MAC-2345 gilded torc. (**B**). Simulation (with the same process) of filigree spirals and twisted wires on the hoop of Xanceda Torc 1.

All these characteristics define a variation with respect to the Castro-culture torc canon and probably also reflect changes in the significance of goldwork for those communities [17]. In that respect, we could also note the incorporation into the MAC-3245 or Xanceda Torcs 1 and 2 of rare ornamental elements and symbolic connotations that are difficult to determine (Figure 12A–D). The structural rigidity manifested in these torcs could also indicate a different type of use, perhaps limited to specific or ritual occasions [11,30].

As has been pointed out, the combination of both aspects—technology and changes in the formal structure—constitute arguments to defend the late dating of the Xanceda and MAC-3245 examples. This could probably be placed in a context of greater control of raw materials and a gradual transformation of the formal and symbolic codes of Castro-culture goldwork related to the Roman presence in the northwestern Iberian Peninsula.

Finally, it can be suggested that not only these "Baroque" torcs—with which the morphology of the possible Elviña torc or bracelet could also be related—appear to account for these transformations. As we have already seen, the available analytical repertoire allows us to propose that Artabrian-type torcs also underwent changes that could be reflected in both the amount and purity of the raw materials used, while retaining, however, their strict formal pattern. In this respect, the contrast between torcs with solid gold hoops and those that incorporate cores made with less precious metal alloys could be mentioned. The association of an example of this type with "Baroque" torcs at Xanceda is significant in this regard.

4. Concluding Remarks

This study constitutes a further step in the technological characterisation of pre- and protohistoric goldwork in northwestern Iberia. From a methodological point of view, our work confirms the need to carry out a detailed analytical sampling of objects. As has been seen, the pieces often integrate structural or ornamental elements made with different alloys, meaning that a specific analysis is not representative of the entire object.

At the same time, this study should be completed in the future. The spectrometer used has not allowed us to study in greater depth the characterisation of certain technical procedures, such as welding, nor to carry out an individualised characterisation of all the ornamental elements identifiable in these materials. Carrying out analytical sampling with smaller beam sizes, using techniques such as SEM-EDX, SEM-XRF or micro-XRF, will allow progress to be made in these areas. At the same time, and as we have already pointed out, the study of surface enrichment and other alterations, through the combined use of analytical techniques or the intensity of spectral lines [59–62], constitutes an objective for the future. In the collection at hand, it is also an important challenge to explain the presence of several fractured pieces, which in some cases, such as the Elviña fragment, seem to be due to amortisation processes prior to deposition. However, in others, as happens in the torcs of S. Martinho do Porto and Xanceda, the fractures seen in this pieces make it necessary to deepen the knowledge of the manipulations and vicissitudes after their discovery, which are poorly documented, and require the use of other archaeometric techniques such as SEM-EDS for the study of phenomena that could have influenced its state of conservation, such as the intergranular corrosion. These tasks, which exceed those applicable in an in situ study of the materials such as the one presented here, will be considered in future studies.

Nevertheless, the information presented here expands on that previously available for the Iberian northwest, both in regard to the first metallurgical stages and to some of the most characteristic materials that define goldworking during the Second Iron Age and the early Roman presence. For this latter period, of particular importance was the study of less represented materials that to date did not have an archaeometric characterisation. This has provided new data for a more detailed assessment of the transformations produced in Castro-culture goldwork at chronologically advanced moments of its production, close to the turn of the era.

Although our research is still in progress, the data presented here are fully comparable with the analytical repertoires obtained through XRF in the last two decades on goldwork production in that geographical area. These works, already mentioned, have contributed to renewing research by providing fresh data on findings that had not been reviewed in decades. Once this problem is resolved, these studies will together facilitate an improved characterisation and a social and chronological interpretation of pre- and protohistoric goldwork in the northwest of the Iberian Peninsula. The data obtained will also allow a suitable comparative analysis on both an Iberian and a European level, an aspect that only a few studies have focused on to date, e.g., [49], and one that will undoubtedly constitute one of the research lines to be developed in the future.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/heritage7040101/s1: Table S1: Elemental composition (wt.%) obtained by XRF for Fischer standard 603-681 (code CDMZK) (Std. = certified value; M = measured value); Table S2: Previous analytical data of materials from the MAC collection studied in this article; Table S3: Analytical data of gold sheet collars from Atlantic Europe; and Supplementary Material S4: Sketches of the situation of pXRF analyses carried out in complex objects.

Author Contributions: Ó.G.-V.: conceptualisation, methodology, investigation, data curation, writing—original draft, and writing—review and editing; X.-L.A.: conceptualisation, methodology, investigation, data curation, writing—original draft, writing—review and editing, project administration, and funding acquisition. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: Data generated and analysed during this study are available from the authors upon reasonable request.

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