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# Try It Before You Buy It: A Non-Invasive Authenticity Assessment of a Purported Phoenician Head-Shaped Pendant (Cáceres, Spain)

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**Abstract**

Museums may acquire archaeological artefacts discovered by non-specialists or amateur archaeologists, holding the potential to promote the safeguarding of cultural heritage by integrating the local community in their activities. However, this also creates an opportunity for the fraudulent sale of modern forgeries presented as archaeological artefacts, resulting in the need for a critical assessment of the artefact's authenticity prior to acquisition by the museum. In 2019, the regional museum in Cáceres (Spain) was offered the opportunity to acquire a Phoenician-Punic head pendant, allegedly discovered in the vicinity of the city. The artefact's authenticity was assessed by traditional approaches, including typological analysis and analysis of manufacture technique, which raised doubts about its purported age. VP-SEM-EDS analysis of the chemical composition of the different glass portions comprising the pendant was used for non-invasive determination of glassmaking recipes, enabling the identification of glass components incompatible with known Iron Age glassmaking recipes from the Mediterranean. Further comparison with historical and modern glassmaking recipes allowed for the identification of the artefact as a recent forgery made from glasses employing modern colouring and opacifying techniques.

**Keywords:** glass; archaeometry; archaeological forgeries; Phoenician-Punic head pendants; VP-SEM-EDS

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## 1. Introduction

This work presents a case study of a non-invasive authenticity assessment of a head-shaped glass pendant of purported Phoenician origin brought to the Museum of Cáceres (Cáceres, Spain) in June 2019. The non-specialist discoverer stated that the Phoenician-Punic-style male head-shaped pendant (Figure 1), temporarily deposited in the Museum of Cáceres, originated from a location near the city of Cáceres in the Extremadura region. The pendant's state of preservation was considered to be exceptional, as no visible cracks, glass losses, or surface patinas typically characteristic of ancient glass were identified macroscopically; only the left ear was missing. Little is known of these head-shaped pendants that appear in the Phoenician-Punic contexts dated to the 6th to 3rd centuries BC. Made with multi-coloured glass and representing typical bearded male heads they could be representations of divinities or amulets against bad luck and curses such as the evil eye [1]. The pendant's exceptional preservation, the absence of a clear archaeological context, and the stylistic divergence from recognized typological examples raised doubts about its authenticity among the museum staff. However, even after consultation with external museums and experts, typological incongruities alone were not deemed sufficient evidence to exclude the pendant's archaeological age. The pendant was, therefore, analysed at the HERCULES Laboratory of the University of Évora (Évora, Portugal) during a day-long visit by the museum staff in order to evaluate the authenticity of the pendant and help the curators decide whether or not the artefact held the potential to be acquired by the museum.

**Figure 1.** Front, rear, right, and left side view of the investigated purported Phoenician head-shaped pendant. Scale section: 1 cm.

Museum acquisitions and donations of artefacts at a national level played an important role in the creation of prehistoric/early historic collections across Europe during the 19th and the early 20th century [2–5]. While most countries nowadays have a legal framework that classifies types of licit and illicit archaeological discoveries and dictates whose jurisdiction the discovered archaeological material falls under, as well as regulations on the reporting and deposition of, and the recompense for archaeological discoveries, the adherence to and the public awareness of said framework may depend on the available infrastructure, funds, and expertise, thus varying from one case to another [6,7]. In Spain, the reporting of chance archaeological finds is regulated under article 44 of the Ley del Patrimonio Histórico Español (LPHE) [8]. The finders are legally obliged to report chance finds to the administrative authority, upon which they are also entitled to a finder's compensation equal to half the estimated value of the artefact according to the LPHE. Article 44 strictly concerns the unintentional discovery of artefacts, i.e., during agricultural works, construction projects, or other activities, as opposed to looted artefacts which are all artefacts intentionally discovered—such as with the use of metal detectors or illicit excavations—outside of authorised archaeological activities and by a non-authorised person [8]. Specific implementations of the LPHE are further elaborated for each autonomous community of Spain. Relevant for this study is the case of Extremadura, whose Ley de Patrimonio Histórico y Cultural de Extremadura specifies public museums of the Autonomous Community of Extremadura designated by the Ministry of Culture and Heritage as the institution where chance archaeological finds should be delivered by finders [9]. Furthermore, article 32 of the Ley de Instituciones Museísticas de Extremadura lists different ways through which a museum may expand its collection, including purchase, donation, excavation, and chance archaeological finds [10]. Thus, in the Spanish Extremadura, public institutions may acquire sporadic finds of archaeological artefacts or whole private collections, either as donations or by purchasing them from the collector, or in exchange for the monetary recompense outlined in LPHE [8], for example, to ensure future collaboration of amateur archaeologists and the general public.

However, before the acquisition of an artefact, assessment of its authenticity is necessary to determine its relevance for the museum collection. At times, potential artefacts may be deemed of no archaeological value and are thus of no interest to the museum. In some cases intentional fraud may also present an opportunity for profit on the side of the "artefact" finder or a collection owner, and at the expense of the involved institution [11]. Museum staff may or may not be able to assess the authenticity of proposed acquisitions, depending on their area of expertise and the available resources. In some cases, external opinion on artefact typology, age, or authenticity of materials can be sought to help guide the decision-making process. Material characterisation is especially well-suited for establishing the authenticity of historic and archaeological artefacts based on discriminant characteristics such as the use of anachronous materials like pigments, alloys, binders, and dyes or identification of intentional ageing practices [12–21]. With the increasing availability of analytical methods for cultural heritage materials over the last few decades, there are now a number of techniques which can provide the compositional information necessary to assess the object's authenticity in a fast and non-invasive way, preserving the integrity of the potential artefact prior to transfer of ownership [12,13,20]. Among the many available techniques, variable pressure scanning electron microscopy with energy dispersive microscopy (VP-SEM-EDS) stands out as one of the most versatile—even if not the most readily available—combining high-magnification visual and textural analysis with quantitative and semi-quantitative elemental analysis while requiring no destructive sampling or sample coating due to the variable pressure analysis mode.

## 2. Materials and Methods

The purported Phoenician pendant is an anthropomorphic glass pendant in the shape of a male head, with a maximum height of 3.3 cm, maximum width of 2.3 cm, and a maximum thickness of 2 cm (Figure 1). The face features plastically formed eyes, a nose, eyebrows, ears (of which the left is missing), and mouth, all made of dark, black-appearing glass, with the eyes consisting of an additional layer of white glass representing the sclerae. The pendant also features a white beard with plastically accentuated texture and a type of headdress made of undulating black-appearing, white, and green glass. Due to the time-sensitive nature of the museum request, and to preserve the integrity of the object prior to the museum's decision on acquisition, the analyses were limited to visual examination with a stereomicroscope and textural and surface compositional analysis by VP-SEM-EDS.

The sample was visually examined with a Leica M205C stereomicroscope (Leica Microsystems, Mannheim, Germany) using a 10× apochromatic objective, a 1× eyepiece, and a 0.78× to 16× optical zoom, for a total magnification range of 7.8× to 160×. A mounted Leica MC170 HD camera (Leica Microsystems, Mannheim, Germany) was used for image acquisition. Tactile sensory inputs were observed during artefact handling to aid visual observation.

VP-SEM-EDS analyses were carried out using a Hitachi™ S3700N SEM (Hitachi High-Technologies Corporation, Tokyo, Japan) coupled to a Bruker™ XFlash 630M SDD EDS Detector® (Bruker Nano GmbH, Berlin, Germany). The sample was analysed at low vacuum (40 Pa) and with an accelerating voltage of 20 kV. The variable pressure approach allows imaging and chemical analysis without the need for coating. The semi-quantitative compositional data was acquired using the Bruker™ ESPRIT Compact software (version 2.3.1.1019) and manufacturer-provided standardless quantification procedure following peak identification in the EDS spectra. The resulting concentrations of identified elements were converted to oxides by stoichiometry and the final composition normalized to 100 wt.%. The limit of detection was considered to be 0.1 wt.% as per the manufacturer's specifications. The VP-SEM images were acquired in the backscattering (BSE) mode. Only the surface of the artefact was analysed, without any prior sample preparation, as the integrity of the artefact could not be compromised prior to acquisition.

## 3. Results and Discussion

### *3.1. Artefact Typology*

The typology and style of the pendant evoke Phoenician-Punic examples in the form of human or animal heads, which are especially found in funerary contexts throughout the Mediterranean from the late 8th century BCE to the early 3rd century BCE, and particularly in the Iberian Peninsula during the 5th and 4th centuries BCE. Not far from Cáceres, in the Extremadura region of Spain, two examples are known: one from Pajares (Villanueva de la Vera, Cáceres) [22] and another from Cancho Roano (Zalamea de la Serena, Badajoz) [23]. Additionally, other examples have been found in funerary assemblages across the Iberian Peninsula, such as in Albufereta (Alicante) [24], Ampurias (Girona), La Osera (Ávila) [25], Villaricos (Almería) [26], and numerous pieces discovered in the necropolises of Puig des Molins on the island of Ibiza [1,27], as well as the mask bead from Pintia (Valladolid) [28]. Other pendants of this typology have been found in different contexts such as Colvalta [29], Turó del Mongrós (Barcelona) [30], and Castellones del Ceal (Jaén) [31,32].

However, from a stylistic standpoint, it is very difficult to find strong similarities between the piece in this study and the types described by Seefried [1]. The piece temporarily deposited in the Museum of Cáceres features a large attachment ring on the hat, similar to some ancient examples, such as the type D II specimens from Ibiza [1] (no. 37, Figure 11, pp. 78) and Copenhagen [1] (no. 91, Figure 32, pp. 130). However, the wavy hairstyle or headdress, along with the polychrome green and white design, does not correspond to any of the specimens described by Seefried. The beard of the purported Phoenician pendant is sharper than those found in archaeological contexts and does not match the specimens described by Seefried, none of which exhibit heads with such defined and regular shapes.

By comparing it to known examples of Phoenician-Punic pendants, it is evident that the head pendant from the Museum of Cáceres displays significant stylistic differences from authentic examples, such as those catalogued by Seefried [1]. The results of a typological analysis suggest that, at least from an archaeological perspective, the pendant from the Museum of Cáceres is likely a forgery. Moreover, the scarce number of similar examples found in the region raised further doubts about the authenticity of this discovery in an archaeological context, prompting further study of the pendant's manufacture technique and chemical composition.

### *3.2. Observations on Manufacture Technique and Use-Wear*

The head, the headdress base, and the facial features of the pendant are made of translucent brown glass which mostly appears black and opaque due to the artefact thickness and morphology. A thinner mass of glass forming the left earlobe overlying a part of the beard allowed for the observation of its true hue (Figure 2A). The bulk of the pendant was made by gathering a mass of translucent brown glass on a mandrel, forming the head. The facial features were subsequently added by attaching viscous brown glass—three elongated strands for the eyebrows and the nose and drops for the mouth, ears, and eyes. The ears and the mouth were further elaborated by impression of the still viscous glass in order to shape the outer ear and to separate the upper and lower lip of the mouth. The eyes were made by layering three drops of glass: brown, white, and then brown again. The use of the same glass colour for the face and the first layer of the eye is uncharacteristic among attested Phoenician head pendants and beads, which rely on the use of contrasting colours to emphasise the outer circle of the eyes [27,33–35]. The beard—white and technologically simple in design, made of a glass thread with incisions—was formed by applying a thick strand of white glass around the lower half of the face prior to adding the ears. Sections or locks of the beard were emphasised by incision.

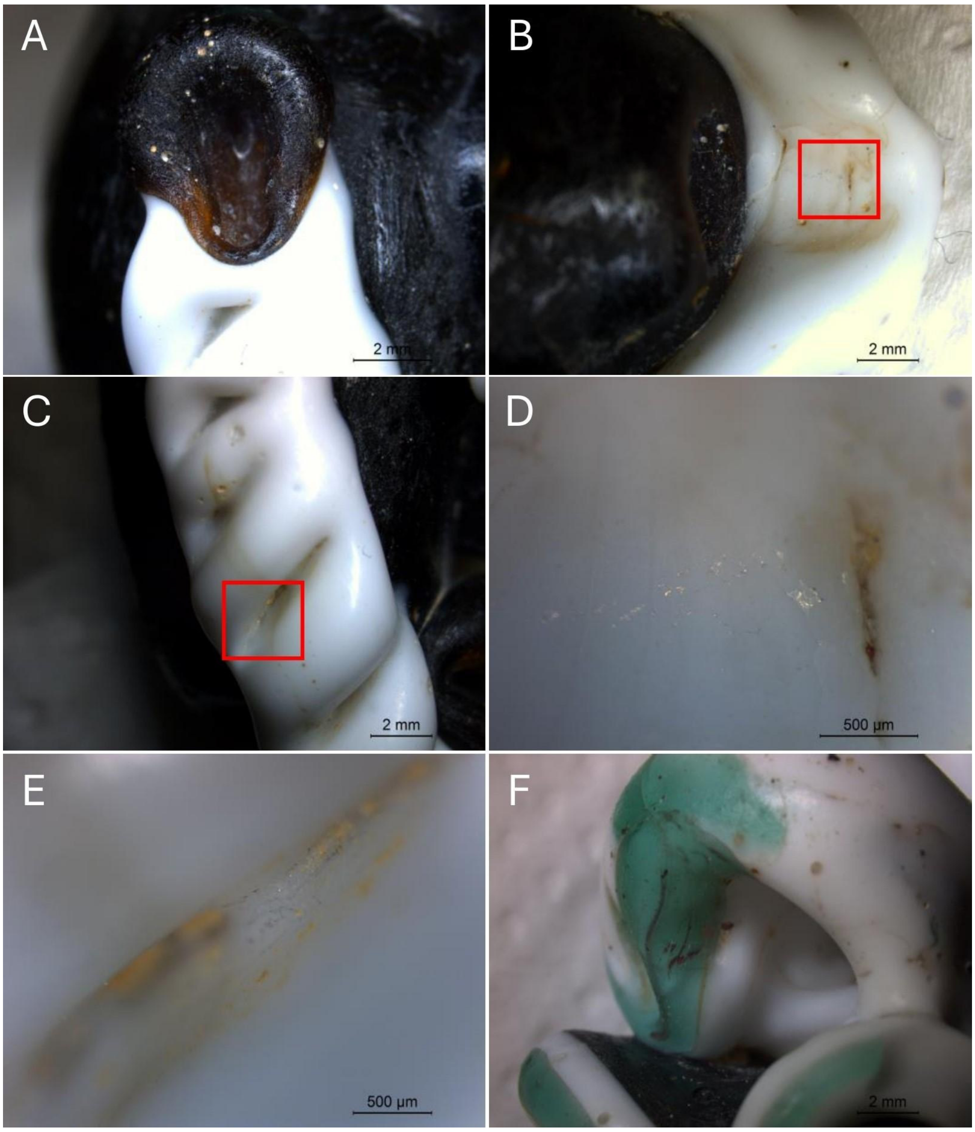


**Figure 2.** Stereomicroscopy images of manufacture and use-wear observations of the pendant: (**A**) brown hue of the "black" glass visible in the thin layer forming part of the ear of the pendant; (**B**) area of the mandrel perforation behind the beard decoration with silver-coloured metallic traces highlighted by the red square; (**C**) incision in the beard with silver-coloured metallic traces highlighted by the red square; (**D**) close-up image of the metallic traces from the red square in (**B**); (**E**) close-up image of the metallic traces from the red square in (**C**); (**F**) suspension ring showing a well-preserved surface without visible traces of use-wear.

No traces of bead release agent or deposition sediment were recorded in the mandrel perforation (Figure 2B), indicating either cleaning of the sample or removal of the coating agent. The mandrel perforation itself is narrow and elongated, oriented vertically on the bottom part of the pendant, in contrast to the wide and shallow mandrel impressions documented on archaeological examples [1] (Pl. I–II). Furthermore, silver-coloured metallic traces were noted on the white glass portion forming the beard of the head-shaped pendant (Figure 2B–E). The traces are present in concavities on the lateral portions of the beard and on the mandrel negative at the back of the lower portion of the beard. The shiny appearance of metallic traces is more in accordance with the use of modern lampworking tools, such as stainless steel or tungsten rods, than what might be the expected range of materials available in the 1st millennium B.C., such as copper alloys or iron, the traces of which after more than two millennia would be either completely missing or show signs of oxidative damage. The presence of traces linked to glassworking tools hints that the age of the pendant is significantly younger than suggested by the finder. Surface damage or loss of mass associated to use-wear may be present in ancient glass artifacts. While use-wear traces on glass objects are still relatively poorly understood [36], glass wear resulting from friction with the stringing medium and hertzian fractures resulting from contact with other strung beads were not recorded on the stringing ring (Figure 2F), indicating the pendant was not strung for a prolonged period.

### 3.3. State of Preservation

The glass, regardless of its hue, also appears to be exceptionally well-preserved, which is noteworthy considering naturally aged glass artefacts from the Iron Age often display noticeable signs of weathering. Common signs of glass weathering include surface roughness and porosity, presence of glass alteration layers, presence of a network of fractures, accumulation of deposition sediment in concavities and in the perforation, detachments of thin glass layers, and opalescence [34,36–43]. While the state of preservation of glass is not necessarily a direct testament of its age, the surface of the white glass portions forming the beard show a smooth appearance both under the stereomicroscope (Figure 2B–F), as well as under tactile examination, inconsistent with the suggested age of the artefact. A slight degree of surface roughness was noticed on the green and black glass portions (Figure 3) compared to the white glass, possibly indicating significant differences in the composition of the three glasses which resulted in different susceptibility to chemical deterioration.

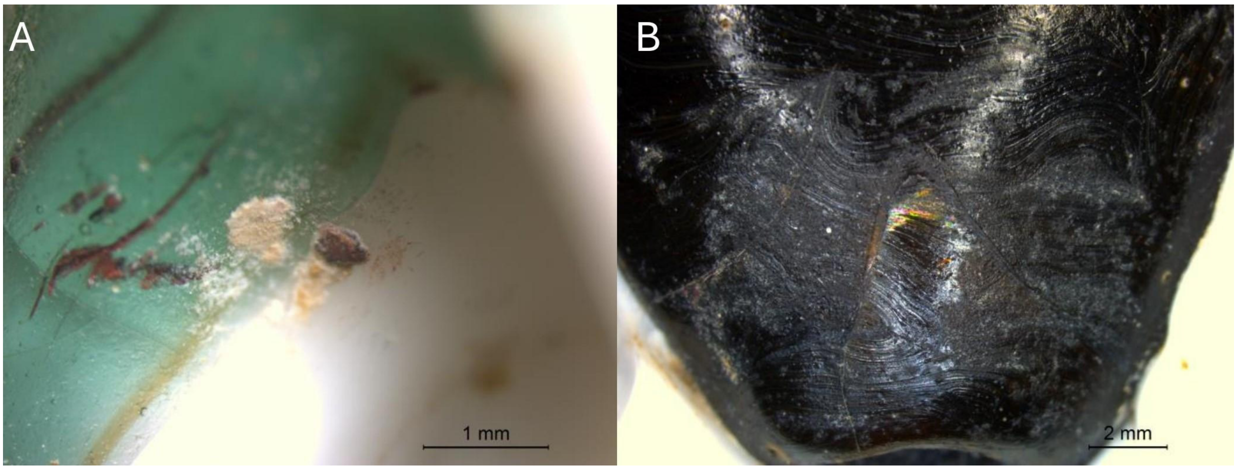


**Figure 3.** Close-up image of the green (**A**) and black (**B**) glass exhibiting a slight degree of surface roughness compared to the white glass.

The microstructural observation of the pendant using VP-SEM revealed a homogeneous reticulate network of slight ridges and indentations indicative of initial stages of glass dissolution. However, the overall degree of weathering was low, as there was no presence of alteration layers, impact fractures, flaking or cracking detected in any section of the glass pendant (Figure 4), in contrast to some confirmed examples of Iron Age glass beads [37,41,43].

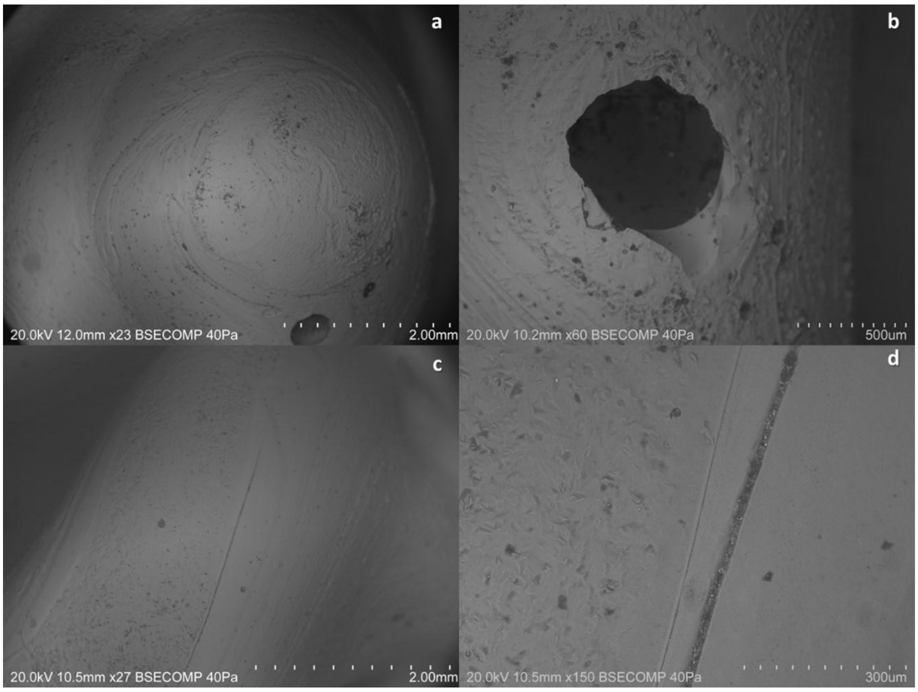


**Figure 4.** VP-SEM images of the glass head pendant. (**a**) Eye decoration with a large gas bubble visible on the bottom in the white glass; (**b**) a large gas bubble present on the nose of the head; (**c**) white and green decoration; (**d**) detail of the green (left) and white (right).

### *3.4. Chemical Composition*

#### 3.4.1. Brown (Black-Appearing) Glass

The brown to black-appearing glass used for the face and pupils of the pendant is a soda-lime-silica glass whose alkali, lime, silica, and alumina concentrations fall within the known range of Iron Age natron-fluxed glass (Tables 1 and 2) [42–51], as well as modern-day soda-lime-silica glass [52,53]. The detection of a relatively high concentration of $Na_2O$ (14.7 wt.%) on the surface of the artefact argues against its alleged age since the surface of archaeological glasses is practically always leached, resulting in low $Na_2O$ values, especially when surface-sensitive analysis like the EDS is undertaken [41,43,54,55]. Alumina (2.9 wt.%) and FeO (0.6 wt.%) are suggestive of the use of sand as the silica source, as well as the lime fraction (8.3 wt.%). However, given the dark colour of the glass, the detected FeO values are lower than those typically reported for iron-coloured "black-appearing" glass produced during the early 1st millennium BCE (>2%), including black-appearing natron-fluxed glass [41,43,49,51,56–58]. On the other hand, in brown-coloured natron glass examples from the 1st millennium BCE with low FeO content, the content of ZnO does not exceed trace amounts [49]. The sample also has no compositional parallels among later Roman black-appearing soda-lime-silica glasses which routinely exhibit higher iron (group BG2) or manganese (group BG3 with subgroups) concentrations than detected in the sample [59], suggesting the use of a more recent glass. In this case, the deep colour of the glass probably derives from the presence of iron and sulphur coupled with the thickness of the glass, rather than simply a high concentration of iron. A brown or amber colour occurs due to the $S^{2-}$—$Fe^{3+}$ charge transfer transition when glass is melted under reducing conditions, with the total concentration of either sulphur or iron not playing a critical role since even low concentrations (<0.1 wt.% $SO_3$, <0.5 wt.% $Fe_2O_3$) are sufficient to produce a dark brown to black-appearing colour in modern bottle glass [60,61].

**Table 1.** Chemical composition of the different glasses used in the manufacture of the pendant obtained by VP-SEM-EDS (n.d.—not detected). All data normalized to wt.100%. All results in wt.%.

| | F | $Na_2O$ | MgO | $Al_2O_3$ | $SiO_2$ | $SO_3$ | Cl | $K_2O$ | CaO | $TiO_2$ | $Cr_2O_3$ | MnO | FeO | CuO | ZnO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| White | 7.4 | 16.7 | 0.5 | 6.7 | 60.8 | n.d. | 0.1 | 3.5 | 2.5 | 0.3 | n.d. | n.d. | 0.2 | n.d. | 1.1 |
| Brown | n.d. | 14.7 | 0.3 | 2.9 | 70.7 | 0.3 | 0.1 | 0.9 | 8.3 | n.d. | n.d. | 0.5 | 0.6 | n.d. | 0.6 |
| Green | n.d. | 4.8 | 0.4 | 1.5 | 84.6 | n.d. | 0.1 | 3.0 | 3.4 | n.d. | 0.5 | n.d. | n.d. | 1.7 | n.d. |

#### 3.4.2. White Glass

The white glass of the pendant is a sodic glass (16.7 wt.% $Na_2O$) with a significant amount of $K_2O$ (3.5 wt.%) (Table 1). A visually good state of preservation of the white glass portions, coupled with the high concentration of alkali oxides, show that, similarly to the brown glass, no leaching has occurred, raising doubts about its archaeological age. Alkali—lime ratios of the analysed section correspond to the plant ash glass range [50], but fall outside of the range of recorded values for the Mediterranean Iron Age glass recipes (Table 2) [49,51,54,56]. Unusually low calcium oxide (2.5 wt.%) is not consistent with the use of sand as the silica source, nor can it be explained by the use of cobaltiferous alums [56,62] since the glass is not blue, despite the limitations of VP-SEM-EDS when it comes to detection of trace amounts of Co. A highly anomalous characteristic is the presence of 1.1 wt.% ZnO, which only appears in trace amounts in Iron Age glass, and should therefore not be detectable by EDS. Zinc oxide is a component of modern glasses, known to have been used from the 16th century AD onwards as a glass stabilizer [63], and is also used to improve the whiteness and opacity of enamels and glazes containing zinc sulphide as an opacifier [64]. For example, high zinc oxide values have been detected in modern Murano glass [65]. The colouring technology is equally anachronous. In archaeological glass, white colour is usually achieved either by inducing the formation of antimony-based or tin-based opacifier crystals in the melt, the addition of already formed opacifiers, or by allowing for bubble formation [66–68]. No opacifying bubbles were observed under stereomicroscope, with the exception of a couple of large bubbles linked to accidental trapping of air during the manipulation of the molten glass, seen in the eye decoration and the nose of the pendant (Figure 4a–b), and opacifier crystals were not visible on the surface of the sample under SEM, in accordance with low CaO and a complete lack of Sb in the analysed spectrum. Fluorine, which was detected as a major component in the analysed sample, was not in use as a white opacifier before the production of Chinese cloisonné enamels in the 15th century AD [69], having been introduced to European glass production even later [70]. Considering the colour of the glass, the texture observed by VP-SEM, and the composition obtained by EDS, the white glass could be an example of modern-day opal glass. Opal glass is a modern type of glass-ceramic in which opacity is achieved by the formation of NaF, $CaF_2$, and $BaF_2$ crystals, commonly used in tableware production [53,71]. In fact, the analysed white glass from the purported Phoenician pendant shows remarkable compositional similarities to modern opal-crystallized glass tableware [71]: 2.5% CaO, 6.7% $Al_2O_3$, 3.5% $K_2O$, and 7.4% F. In our case, the absence of $CaF_2$, $BaF_2$, and NaF crystals is consistent with the observation on the sub-surface presence of these nanometre-scale opacifier crystals in modern opal glass [71].

**Table 2.** Summary table of expected compositions of the glass types from the 1st millennium BCE contexts in Europe (n.r.—not reported). All values expressed in wt.%.

| Glass Type | F | $Na_2O$ | MgO | $Al_2O_3$ | $SiO_2$ | $SO_3$ | Cl | $K_2O$ | CaO | $TiO_2$ | $Cr_2O_3$ | MnO | FeO | CuO | ZnO | Refs. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| natron glass/ LMG | n.r. | 10–20 | <1.5 | <4 | 45–75 | <0.1–0.6 | 0.1–1.9 | <1.5 | c. 2–10 | <0.1–0.3 | <0.1 | <0.1–1.5 | 0.1–15 | <0.1–3 | <0.1 | [42–51,54,56] |
| High-Al natron glass | n.r. | 13–20 | <1.5 | c. 2–4 | 45–75 | <0.1–0.6 | ~1 | <1.5 | generally 5–10; as low as 3 | <0.1–0.3 | <0.1 | <0.1–1.5 | 0.3–1.7 | <0.1–3 | <0.1 | [42,43,45–51] |
| Low-Al natron glass | n.r. | 10–20 | <1.5 | <1.5 | 45–73 | <0.1–0.6 | 0.5–1.2 | <1.5 | generally 5–10; as low as 2 | <0.1–0.2 | <0.1 | <0.1–1.5 | 0.1–8 | <0.1–2 | <0.1 | [42–51,54,56] |
| Fe-rich black natron glass | n.r. | 13–21 | <1.5 | <1.5 | 64–73 | <0.1–0.2 | 0.5–1.5 | 0.1–1 | 0.9–8 | 0.1–0.3 | <0.1 | <0.1–0.2 | 3.5–15.5 | <0.1–0.1 | <0.1–0.1 | [41,43,44,49, 51,56–58,62] |
| Plant ash glass | n.r. | 15–21 | c. 2–7; >K2O | 0.2–10 | 55–72 | 0.2–0.7 | 0.7–1.3 | 2–4; <MgO | 3–10 | <0.1–0.4 | <0.1 | <0.1–0.3 | 0.2–2 | <0.1–2 | <0.1 | [49–51,54,56] |
| Mixed-alkali glass LMHK | n.r. | 4–12 | 4–18 | 1–10 | 75–80 | <0.1 | <0.1 | 4–10 | <4 | <0.1–0.2 | <0.1 | <0.1 | 0.6–1.8 | 0.2–4.3 | <0.1 | [44,50,54] |
| Iron Age "wood ash" black glass | n.r. | <1 | 2–5 | 1.3–37 | 55–61 | <0.1–0.2 | <0.1–0.2 | 5–14 | 5–10 | <0.1–0.2 | <0.1 | 0. 3–0.8 | 12–16 | <0.1–0.2 | <0.1 | [57] |

### 3.4.3. Green Glass

The alkali content of the decorative strip made of green glass is low (4.8% $Na_2O$, 3.0% $K_2O$), suggesting extensive leaching occurred. Low stabilizer—1.5% $Al_2O_3$, 0.4% MgO, and 3.4% CaO—content could have contributed to its comparatively lower chemical durability than the other glass sections of the pendant. Because of the altered composition, it is difficult to draw conclusions about the glassmaking recipe used for the production of the green glass. In this case, evaluation of the colouring technology provided key information for assessing the age of the artefact. The glass was coloured by the addition of copper and chromium ions, evidenced by the elevated concentrations of CuO (1.7%) and $Cr_2O_3$ (0.5 wt.%). Copper was a common glass colourant during the 1st millennium BCE and was used to achieve hues ranging from blue to green, either alone or in conjunction with other transition metal ions [54]. Chromium oxide, however, is only known to have been used as a colourant since the mid-19th century AD, with possible earlier uses of Cr-bearing garnet (pyrope) as a colouring component since the 16th century AD [63,72,73]. When it comes to glass artefacts dating from the 1st millennium BCE circulating in Europe and the Mediterranean, Cr is only present in trace concentrations [42,45,46,51,56,57]. Furthermore, the use of Cr-bearing pyrope can be excluded, as the MgO and $Al_2O_3$ concentrations of the green glass (Table 1) are significantly lower than would be expected for a pyrope-coloured glass—around 5% of MgO and $Al_2O_3$ each [72]. Instead, unusually high $Cr_2O_3$ content of the green glass portion of the pendant should be taken as an indication of its recent production since chromium is a widespread colourant in modern green glass, for example in bottle production [52,60,74–76].

## 4. Conclusions

The presented typological characteristics of the studied pendant and the chemical composition of its different glass colours do not conform to the known typology of Phoenician head pendants or glass types circulating across the Mediterranean during the 1st millennium BCE. While the manufacturing technique is similar, it lacks the typical details of those ancient products. The texture being indicative of some chemical deterioration, contrasting with the lack of evidence of surface leaching of the brown and white glass, suggests an attempt to deliberately age the artefact with chemical agents. The detection of chronologically discriminant components, such as ZnO in both the white and brown glass sections, $Cr_2O_3$ in the green glass, and F in white glass, attests to the fact that the pendant could not have been created prior to the 16th century AD, and was used as an argument against artefact acquisition. The green glass showed compositional similarities with modern bottle glass, which suggests this artefact may have been made from reutilized bottle scrap. A detailed study of the chemical composition of the white glass revealed remarkable similarities between the white glass portions and modern, commercially produced opal glass, possibly plate scrap, solidifying the conclusion that the allegedly discovered Iron Age pendant was a modern-day forgery of no archaeological value, akin to other similar pieces found in private collections [15]. Since the pendant was deemed to be a modern-day forgery, the Museum of Cáceres (Cáceres, Spain) ultimately refused to acquire the artefact from the discoverer.

This study also demonstrated how visual examination in conjunction with surface analysis by VP-SEM-EDS can be employed as a quick, non-destructive, and effective workflow for differentiating archaeological glass artefacts from modern-day forgeries.

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J.M.G.B.; writing—review and editing, V.L., J.M.G.B., P.B. and M.C.; visualization, V.L. and J.M.G.B.; supervision, M.C. and P.B.; project administration, M.C.; funding acquisition, M.C. and V.L. All authors have read and agreed to the published version of the manuscript.

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## Abbreviations

The following abbreviations are used in this manuscript:

| | |
|---|---|
| AD | Anno Domini |
| BCE | Before the Common Era |
| LPHE | Ley del Patrimonio Histórico Español |
| Ref. | reference |

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