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The Challenge of Attribution: Technical Examination of a Bronze *Ding*

Abstract

There are many obstacles to the successful casting of a metal object. In antiquity, craftsmen in different cultures developed unique casting systems to overcome these obstacles, often resulting in culturally specific technologies. One such culturally linked casting method is the piece-mold process of the Shang and Zhou dynasties of ancient China, the mechanics of which are largely agreed upon by scholars after decades of technical examination and published research. An object resembling a ritual bronze vessel of the ancient Chinese tradition, donated to the Conservation Center at New York University, was examined by students to determine its method of manufacture using visual analysis, X-ray radiography, X-ray diffraction, X-ray fluorescence and metallography. The results of this technical examination show the Conservation Center vessel to be technically inconsistent with piece-mold cast vessels of ancient China. However, attributing the vessel to a particular later period proved difficult. The decoding of the Conservation Center vessel demonstrates that authentication is problematic and cannot be assigned to an object of cultural heritage by a single characteristic, but rather by a multiplicity of evidence gathered in reference to preceding research.

Introduction

In 2007 a copper-alloy vessel was donated to the study collection of the Conservation Center, Institute of Fine Arts, New York University, and catalogued as a Chinese *ding* (Figure 1). As students in a course entitled *Metalworking in Antiquity*, we were presented this object with the primary aim of establishing its manufacture. Examining the piece through radiography, elemental analysis, metallography, X-ray diffraction, and other relevant analyses, we reported our findings related to the manufacture of the vessel with reference to pertinent technical literature. Finally, we were asked to interpret our data as it related to the authenticity of the vessel.

Figure 1 Conservation Center *ding*

The Conservation Center *ding* is spherical with three bulbous, cabriole legs. A compact, powdery material is visible at the terminus of each leg. There are two U-shaped handles, both of which are open on the interior, and a raised line extending around the circumference of the body that is flanked above and below by registers of recessed geometric decoration. A horizontal, ring-shaped handle is joined to the center of the lid with six curved rods. The lid has identical decoration to the body in two registers. In form, the vessel resembles bronze ritual dings produced in China during the Zhou dynasty (ca. 1056 BCE-246 BCE), especially the Eastern Zhou dynasty, mid to late 6th century BCE, where a similar ding was catalogued in the Arthur M. Sackler (Figure 2).

In ancient China, as in other societies, ritualization was the mechanism that maintained social order (Rawson 1990). The material evidence of this lies with the numerous varieties of ancient Chinese ritual bronzes that have been uncovered archaeologically from tombs across China. Such vessels were central to ancestral ritual and state ceremony (Bagley 1993: 231), and although it is not known exactly how these vessels were used, their formal elegance and fine decoration affirm the artistic and technological achievements of the ancient Chinese.

Figure 2 Zhou dynasty ding (1050-221 BCE), Freer Gallery of Art, Arthur M. Sackler Collection (So 1995: 130).

Xia Dynasty	2205 to 1766 BCE
Shang Dynasty	1766 to 1122 BCE
Zhou: Western Zhou Dynasty	1122 to 771 BCE
Zhou: Eastern Zhou Dynasty	770 to 256 BCE
Zhou: Spring and Autumn	770 to 476 BCE
Zhou: Warring States	475 to 221 BCE
Qin Dynasty	221 to 206 BCE
Han: Western Han	206 to 9 CE
Han: Wang Mang Interregnum	9 to 25 CE
Han: Eastern Han	25 to 220 CE

Table 1 Chinese Dynastic Periods Before 220 CE (Allen 2001).

Technical Overview

There are many obstacles to the successful casting of a metal object. Flaws can result when there is not an even and ample supply of metal throughout the mold, when gases become trapped in the mold, or when the mold itself is shifted. In antiquity, craftsmen in different cultures developed unique casting systems to overcome these obstacles, often resulting in culturally specific technologies (Chase 1990; Lechtman 1977).

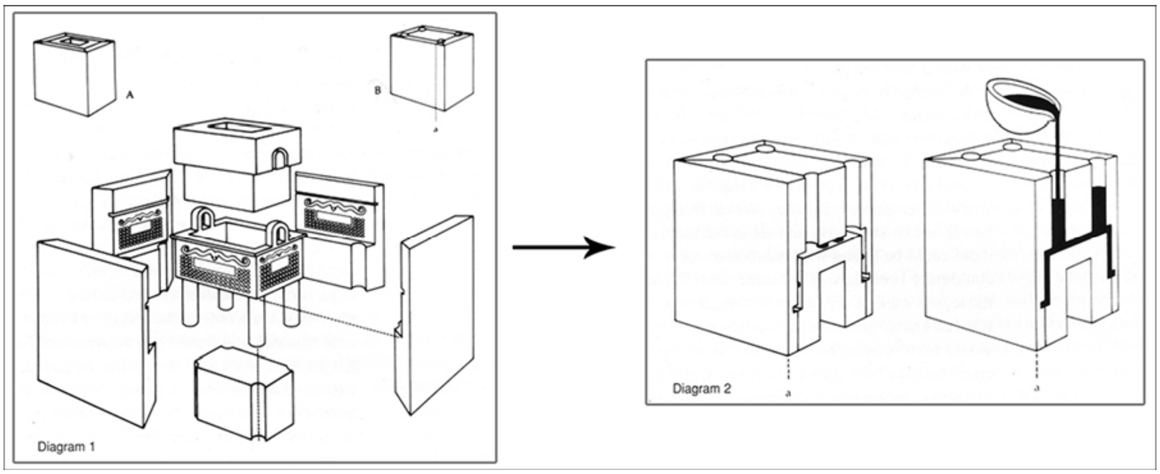

Figure 3 Diagrams of the piece-mold process of ancient China (Chase 1994: 88-89).

One such culturally linked casting method is the piece-mold process of the Shang and Zhou dynasties of ancient China, the mechanics of which are largely agreed upon by scholars after decades of technical examination and published research (Gettens 1969; Bagley 1990; Chase 1983; Meyers 1998; Rawson 1988; Rongyu 2003). This sophisticated technique has been described in the following sequence (Figure 3): The process began with the fabrication of a model in clay that served to define the shape and size of the final metal form. After the clay was dried or had been fired, a mold was made from the model using a fine, refractory material that could maintain the decoration and vessel shape. The mold was cut into sections, which were fired and incorporated into a casting assembly that included a ceramic core. The spacing between the mold sections and the core pieces was fixed with a series of bronze spacers (Gettens 1969: 119). A molten bronze alloy of copper, tin and lead was then poured into the casting assembly. After cooling, the casting assembly was broken, and the bronze was cleaned of casting skin and irregularities (Meyers 1988: 284).

The decoration of the ancient Chinese ritual bronzes is a complicated issue, and there is little agreement in the literature as to the sequence of application (Bagley 1990; Chase 1983; Meyers *et al.* 1983; Meyers 2000). It could be stamped, carved or incised into either model or mold. Exceptions to this debate are the vessels produced at the Houma foundry, where ‘standard’ pattern blocks made of fired clay were pressed into the mold to create multiples (Meyers 2000: 65).

Internal Features

Two Chinese *ding* from the Asian collection of the Metropolitan Museum of Art, catalogued as Late Zhou dynasty vessels, were provided for comparative examination and radiography (Figure 4). Radiography proved a useful tool with which to observe the features of forming and joining that were described in relevant technical literature.

Figure 4 Late Zhou dynasty *ding* (New York, The Metropolitan Museum of Art, 13.100.6 and 49.135.1). Courtesy of The Sherman Fairchild Center for Objects Conservation.

The two vessels are smaller than the Conservation Center *ding*, but similar in general form with sphere shaped bodies, cabriole legs, inverted U-shaped handles, and domed lids. Closer inspection revealed extant mold-marks that are the result of molten metal seeping into the joins of the mold sections in the assembly. These are evident to the naked eye and in radiographs as thin, opaque lines. The spacers, which maintain the empty space between the core and the mold assembly, are visible as more radio-transparent, roughly rectangular features in the radiographs of both Metropolitan Museum *ding*, due to the difference of their alloy composition from the bulk material. In addition, they are visually evident because they corrode preferentially (Figure 5).

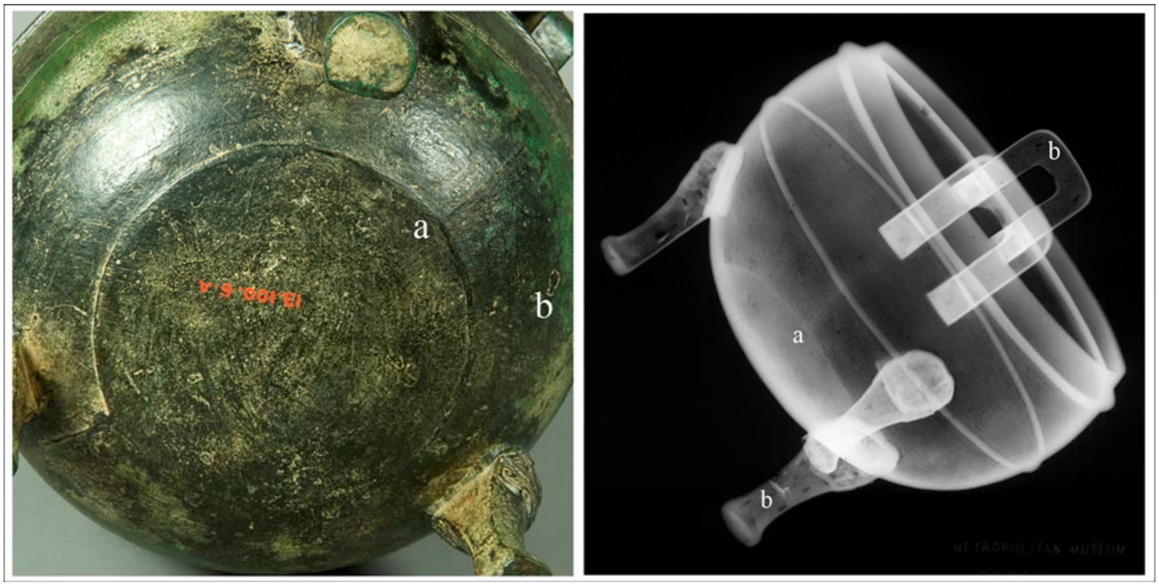

Figure 5 Visual and radiographic evidence of piece-mold casting process: (a) mold marks and (b) spacers (New York, The Metropolitan Museum of Art, 13.100.6). Courtesy of The Sherman Fairchild Center for Objects Conservation.

Ancient Chinese bronze casters employed a variety of joining solutions to manufacture vessels with legs. In the Eastern Zhou, legs were often cast separately and joined to the vessel. Pre-cast legs were incorporated into the mold assembly and the vessel was cast around them, creating a mechanical, interlocking join (Gettens 1969). The technique of casting-on appendages was illustrated in a 1965 study of a Zhou dynasty bronze from the special study collection of the Freer Gallery of Art, published by R.J. Gettens (Gettens 1965). In this examination, a detached leg of an Eastern Zhou vessel was sawn in half lengthwise, producing a cross-section of a cast-on leg that exhibits the interlocking join mechanism (Figure 6). Radiographs of the Metropolitan Museum of Art *ding* exhibit characteristic lines of transparency visible at the joins of the legs and the body that indicate this type of mechanical, interlocking join (Figure 6). The above features are what one would expect to see in an Eastern Zhou dynasty cast *ding* of this type.

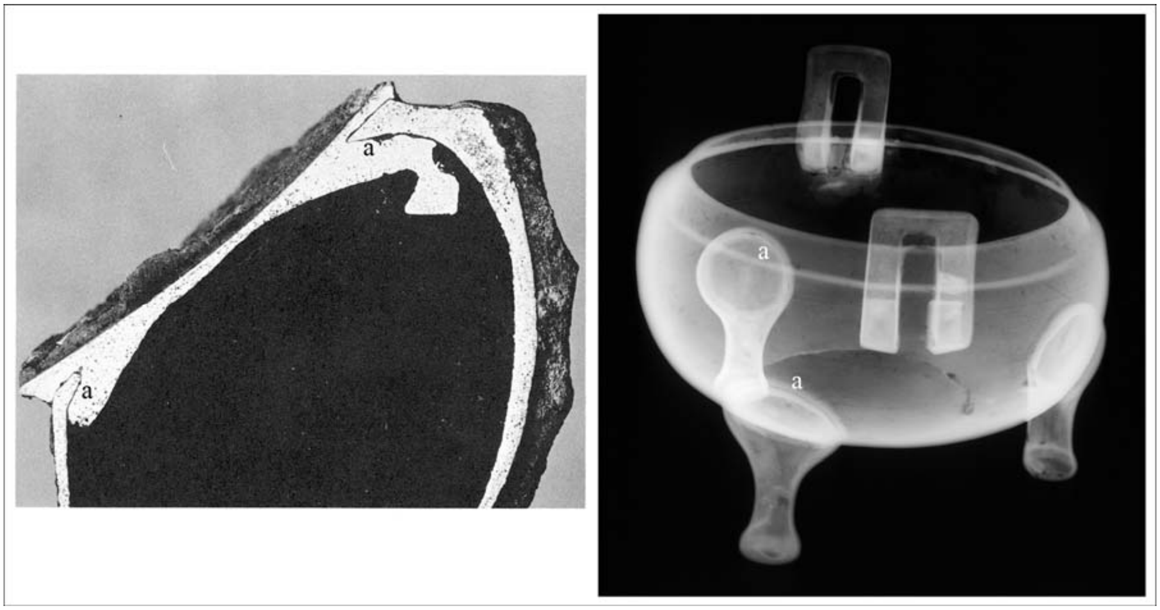

Figure 6 Interlocking join mechanism (a) illustrated by R.J. Gettens cross-section (Gettens 1965) and radiograph of Chinese *ding* (New York, The Metropolitan Museum of Art, 49.135.1). Courtesy of The Sherman Fairchild Center for Objects Conservation.

The Conservation Center *ding* does not exhibit these features: there are no mold marks, nor spacers, nor interlocking leg joins. However, the absence of a feature can be as informative as its presence. In the absence of characteristics that indicate the piece-mold casting technique, the radiographs for the Conservation Center *ding* do provide evidence that suggests the vessel was manufactured with the lost-wax process.

The lost-wax process begins with the fashioning of a wax model. This is then invested with a refractory material, the wax is melted out, and molten metal is poured in (Figure 7). There are several features in the radiographs of the Conservation Center vessel that suggest lost-wax casting as the method of manufacture. Irregular thickness variations seen in radiographs of the body may indicate areas where wax was pressed into a form. A seam line in the handle on the lid could possibly have resulted from an overlay of strips of wax when the model was being formed. Drip marks on the interior of the legs evident in the radiographs of the Conservation Center *ding* indicate that these appendages were fabricated with the indirect lost-wax process (Figure 8). In this technique, the wax model is formed in a slush-mold into which wax is poured, a thin skin is allowed to harden, and the excess is poured out. No other casting process provides the necessary conditions for the presence of a drip-mark on the interior of the hollow bronze appendages (Haynes 1962: 804).

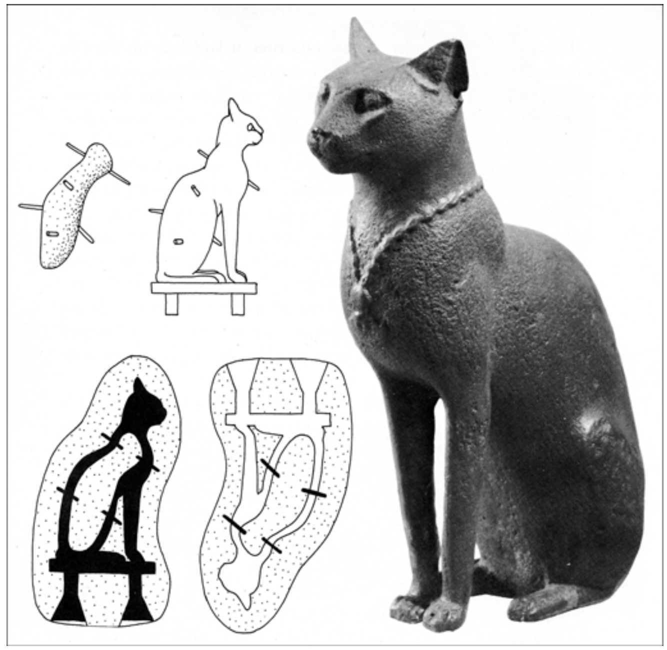

Figure 7 Diagram of the lost-wax casting technology from: Henry Hodges. *Technology in the Ancient World* (1970).

It should be noted that, although there are many ways to apply decoration to lost-wax cast vessels, there is no clear evidence to determine the process employed in the decoration of the Conservation Center *ding*.

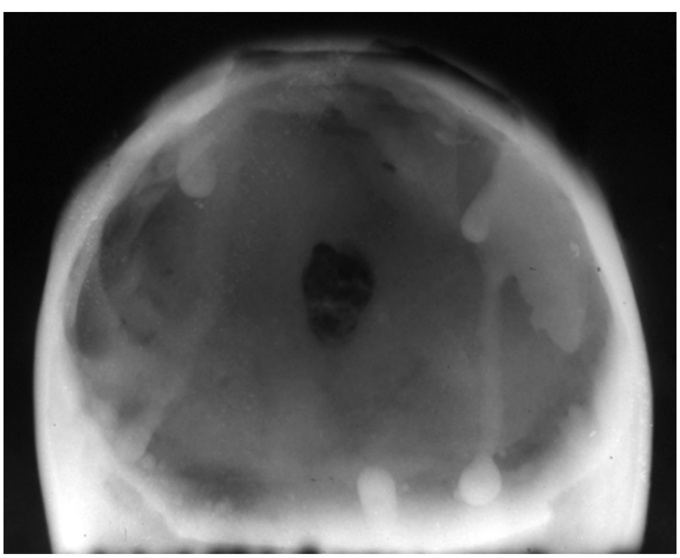

Figure 8 Radiograph of the Conservation Center *ding* leg; drip marks are evidence of indirect lost-wax process.

Alloy Composition

Visual and radiographic examinations revealed that the manufacture of the Conservation Center *ding* is not consistent with the established traditions of casting practiced during the Eastern Zhou dynasty. To explore this anomaly further, other analyses were carried out using similar technical studies as a reference point. The alloy composition and surface condition were of particular interest.

X-ray fluorescence (XRF) spectra were generated on a Jordan Valley Ex-3600 open architecture x-ray fluorescence spectrometer based on a Rhodium (Rh) anode and a Si (Li) solid-state detector located at the Metropolitan Museum of Art Objects Conservation Laboratory to characterize the surface and to infer the alloy composition of the Conservation Center and Metropolitan Museum of Art *ding.* The spectra generated were similar, and although not quantitative, showed significant peaks for copper, tin, and lead that are consistent with the expected ternary copper-tin-lead system of ancient Chinese bronzes. Arsenic is consistently present in the spectra; however, this peak is also consistent with *the k-alpha* line of lead.

Spectrum #1	Area of exposed metal on handle	Peaks present for Cu, As, and Sn; peak identified as Kr likely represents Pb instead; weak Fe peak also present
Spectrum #2	Area of exposed metal on body, upper half, in area of decoration	Peaks present for Cu, As, and Sn; peak identified as Kr likely represents Pb instead; weak Fe peak also present
Spectrum #3	Area of exposed metal on body, under rim	Peaks present for Cu, As, and Sn; peak identified as Kr likely represents Pb instead; weak Fe peak also present
Spectrum #4	Area of exposed metal on shoulder of leg	Peaks present for Cu, As, Sn and Pb; weak Fe peak also present
Spectrum #5	Area of exposed metal on lid, just above rim	Peaks present for Cu, As, Sn and Pb; weak Fe peak also present

Table 2 Overview of XRF spectrum analysis of the CC ding.

Features that indicate the manufacture of a cast tin bronze can be seen in a metallographic section. Such an examination necessitated the removal of two samples, one from the body and one from the lid of the Conservation Center vessel. These samples were embedded in an epoxy resin, and polished to view through a metallographic microscope at the Metropolitan Museum of Art.

When tin bronzes (10-17% Sn) are cast, the alloy becomes segregated with cored dendritic growth of a copper-rich alpha phase surrounded by a matrix of the eutectoid phase of alpha and tin-rich delta (Scott 1991: 25). Typically in the copper-tin-lead system, the lead does not alloy with the copper or tin, but rather it occurs as small globules throughout the structure (Scott 1991: 27). The sample from the body of the Conservation Center *ding* exhibits segregation of the alpha and delta phases. The microstructure reveals cored dendrites of alpha phase surrounded by a continuous delta phase eutectoid (Figure 9).

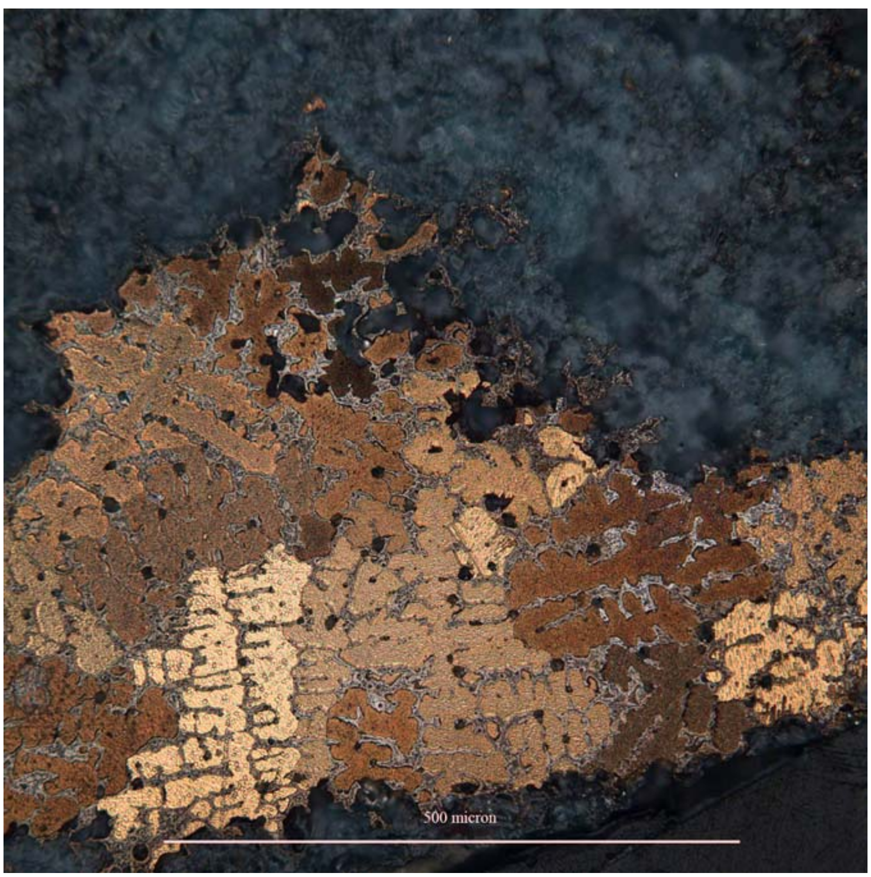

Figure 9 Metallographic cross-section of the Conservation Center ding photographed at 200 times magnification.

The bulky layer of green corrosion visible around the perimeter of the sample appeared loosely adhered, a property unusual for corrosion products formed in a burial environment. Below the green corrosion, at the interface with the metal, is a discontinuous cuprite layer. It should be noted that this layer is generally reported to be evenly distributed across the surface of archaeological bronzes (Chase 1994: 97). Intergranular corrosion can be identified in a metallographic sample as a disruption of the metal by a corrosion layer along the grain boundaries and is generally associated with archaeological bronzes (Figure 10). The metallic surface of the Conservation Center *ding* has been similarly penetrated by embayments of corrosion that resemble this classic intergranular corrosion (Figure 11).

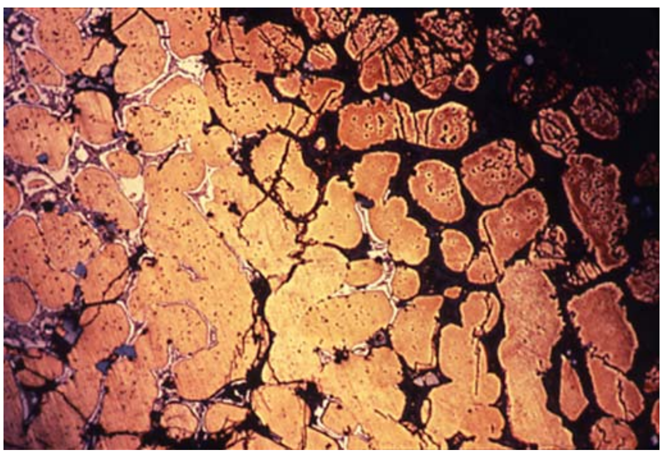

Figure 10 Intergranular corrosion seen in a cross-section from a cast bronze figure of *Avalokishvara* (New York, The Metropolitan Museum of Art, 67.234.1). Courtesy of the Sherman Fairchild Center for Objects Conservation.

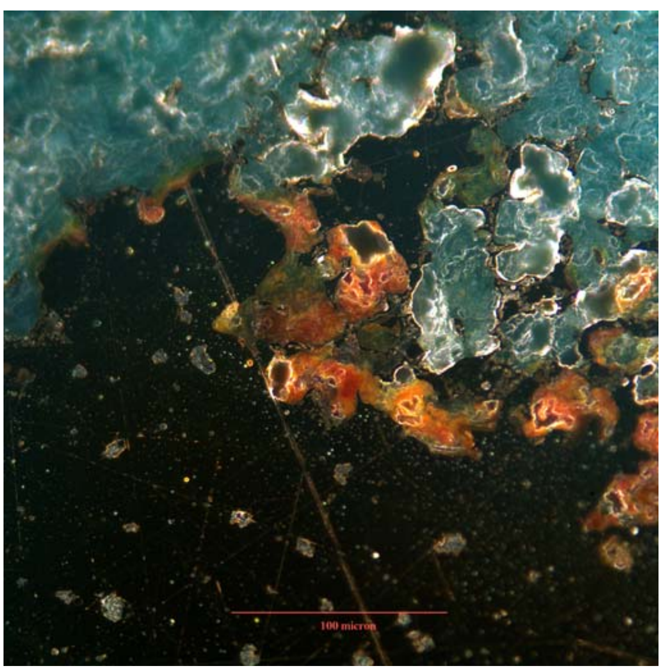

Figure 11 Metallographic cross-section of Conservation Center ding photographed at 500 times magnification.

Surface Condition

After determining the alloy composition and microstructure of the vessel, we investigated the post-manufacture history of the Conservation Center *ding* through an in-depth examination of its surface. The surface corrosion on archaeological bronzes generally has a characteristic morphology that includes red or black oxides in combination with green carbonates or chlorides (Table 3). The surface of the Conservation Center *ding* is layered with corrosion products that are matte in appearance, finely divided and range from red to bluish-green to black in color. Several samples were taken and analyzed at the American Museum of Natural History with a Rigaku D/max-RAPID microdiffraction unit using Cu-K-alpha radiation with an incident-beam graphite monochromator (Table 4).

Oxides	Cuprite Tenorite	Cu_2O CuO	Red Black	Occur widely Seldom reported
Carbonates	Malachite Azurite Chalconatronite	$CuCO_3{*}Cu(OH)_2$ $2CuCO_3{*}Cu(OH)_2$ $Na_2Cu(CO_3)_2{*}3H_2O$	Dark green Dark blue Bluish-green chalky	Common Less abundant Rare
Chlorides	Atacamite, paratacamite Nantokite	$Cu_2(OH)_3Cl$ Differing crystal structures $CuCl$	Dark green Pale grey waxy	Common to archaeological material In association with atacamite
Sulphates	Brochantite	$Cu_4SO_4(OH)_6$	Green	Polluted atmospheres in urban environments
Sulphides	Chalcocite Chalcopyrite Bornite	Cu_2S $CuFeS_2$ Cu_5FeS_4	Black	Forms in oxygen-deficient, aqueous environments and from museum pollutants
Nitrates	Gerhardtite	$Cu_2(NO_3)(OH)_3$	Dark or emerald Green	Rare: only reported in a tomb of the mound at Gordion in Anatolia

Table 3 Copper corrosion products common on archaeological metals (Gettens 1963; Scott 2002).

Samples of the red corrosion layer were composed predominantly of cuprite [Cu_2O] whereas samples of the black material were composed of both cassiterite, tin oxide [SnO_2], and tenorite [CuO]. Tenorite typically forms on copper alloys that are heated in air (Gettens 1970; Scott 2002) but is a less common component of natural patinas, while cuprite is the predominant oxide of copper.

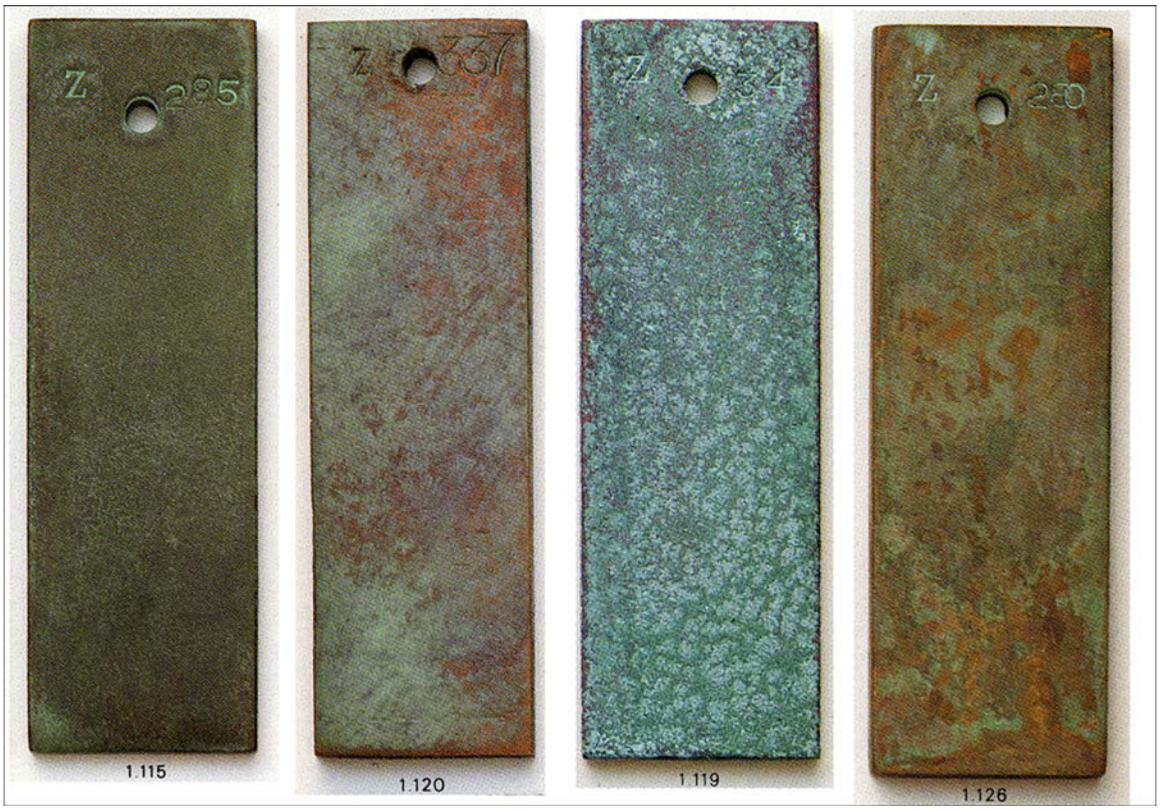

Figure 12 Bronze coupons with applied nitrate patinas (Hughes *et al.* 1991).

Three of the samples of the green corrosion were composed predominantly of gerhardtite [$Cu_2(NO_3)(OH)_3$] and its polymorph, rouite. Gerhardtite is a relatively rare copper nitrate mineral found largely in arid climates, and although a few examples of copper nitrate corrosion have been noted on archeological objects, it rarely occurs in burial due to the high solubility of nitrate salts in water (Scott 2002: 250-251). It is, however, a commonly occurring component of artificially patinated copper alloys (Figure 12). A large number of empirical recipes for green patinas based on copper nitrate have been published (Hayez *et al.* 2006; Hughes 1991, 1993; Untracht 1968). Both copper carbonates and copper chlorides, the green corrosion products most typically found on archaeological bronzes, were conspicuously absent from the samples.

Sample A	Core material from interior of leg	Sample appears to be composed mainly of quartz and calcite
Sample B	Beige/off-white powdery material from lip of vessel body	Sample appears to be composed mainly of quartz
Sample C	Brownish-orange powdery accretion from interior of vessel body	Essentially quartz; additional peaks may represent small quantities of calcite, gypsum and gadolinite;
Sample D	Green corrosion from interior surface of lid	Results inconclusive due to small sample size
Sample E	Red corrosion from exterior surface of lid	Sample contains two phases: cuprite and anglesite
Sample F	Green corrosion from interior surface of lid	Sample contains essentially two phases: gehardtite and rouaite
Sample G	Black corrosion product from rim of lid	Sample consists of essentially two phases: cassiterite and tenorite
Sample H	Pale green corrosion from interior or lid	Sample appears to be a mixture of corrosion products; predominant phases appear to be cassiterite and gerhardtite with possibly small amounts of rouaite and anglesite present
Sample I	Core material from interior of handle	Sample appears to be composed predominantly of quartz; additional peaks possibly represent small amounts of calcite or gypsum; presence of cuprite likely due to proximity of sample location to handle wall
Sample J	Green corrosion product from body, area directly above leg	Sample appears to essentially composed of three phases: gerhardtite, calcium sulfate and quartz
Sample K	Blue-green corrosion from one of the U-shaped handles	Sample is essentially gerhardtite or its polymorph, rouaite
Sample L	Red corrosion just above leg on body	Sample appears to be predominantly cuprite; some cassiterite may also be present

Table 4 Rigaku micro-diffraction analysis results of samples taken from the CC ding.

Analysis

The first task of this student project was to determine the method of manufacture of the Conservation Center vessel. This was accomplished, somewhat superficially, through the technical examination just presented. The data that we generated was comprehensive, yet the evidence still left open questions during analysis. The continuing problem with which we were faced was the task of establishing the object's authenticity. This required an alternative methodology of research that led us in interesting directions.

The technical analysis led to no clear conclusions as to the authenticity of the vessel, however several important questions regarding the manufacture of the Conservation Center *ding* were answered:

- Radiographic examination indicated that the object was cast using a lost-wax method. The date of introduction of the lost-wax process to China is still debated, however, by the dawn of the Han dynasty (206 BCE-226 CE), objects were certainly being produced using the lost-wax method (Chase 1983: 110). By this time, however, ritual ceremonial vessels of the Shang and Zhou dynasties were no longer being produced (So 1980: 308).
- X-ray fluorescence spectroscopy provided a rough estimate of the bulk alloy composition. This data informed us that the Conservation Center *ding* is not inconsistent with Shang and Zhou dynasty bronzes. However, copper-tin-lead alloys are ubiquitous, and cannot be used as markers for bronzes of these periods.
- X-ray diffraction defined the corrosion products on the surface. Two factors suggest that the object did not experience long-term burial: (1) the presence of gerhardtite, a compound not typically associated with archaeological corrosion, and (2) the absence of typical archaeological corrosion products. However, the presence of intergranular corrosion is generally considered evidence of an archaeological context.

We considered many postulates to account for the contradiction in the evidence. The only conclusion that we were able to make definitively for the object was that its manufacture was not consistent with the published technical literature concerning early

Chinese ceremonial bronze vessels. The continuing goal of this research project was to determine the authenticity of the object. However, we discovered that the challenge of authenticity is really the challenge of attribution. If the Conservation Center *ding* is not an Eastern Zhou dynasty bronze, where does it come from and when was it made?

Interpretation

Zhou dynasty *ding*, 1050-221 BCE
Freer Gallery of Art, Arthur M. Sackler Collection

Conservation Center *ding*

Archaistic *ding*, Qing dynasty, 18th century
(Goedhuis 1989)

Figure 13

It might seem logical, when one first considers the evidence, to define the object as a forgery of an Eastern Zhou dynasty *ding*. However, this assertion gives rise to conceptual concerns that would be of worth to explore further. It is necessary to first establish the terminology. The following definitions come from *The Getty Art and Architecture Thesaurus Online*:

- Forgeries, or fakes, are objects made or altered with the intent to deceive. Deception is a critical element in determining whether or not an object is a forgery.
- Reproductions are objects made to copy an original without the intent to deceive.
- Adaptations are defined as works that are modifications of other works done for a purpose, use or medium other than that for which the original was intended.

Hu, Shang dynasty, 12th c. BCE
Freer Gallery of Art,
Arthur M. Sackler Collection

Hu, Late Western Zhou dynasty
Freer Gallery of Art,
Arthur M. Sackler Collection

Figure 14

Consider the historical practice of copying objects of antiquity. The production of copies is likely motivated by a desire to maintain or revive traditional cultural forms or by a reverence for the past (Chase 2008; Jones 1990: 29). In China, a long history of deep regard for the past meant that as early as the Western Zhou dynasty, copies of Shang dynasty bronzes were being produced (Figure 14) (Rawson 1990: 21, 62). Bronzes designated as ‘later’ were produced beginning in the Song dynasty, around the eleventh century CE. These vessels referred in form and decoration to the ancient Shang and Zhou dynasty vessels. The archaized form suggests a veneration for the classical past, and such vessels were produced to satisfy the demands of collectors (Goedhuis 1989). The Qing dynasty (1662-1722 CE) of the eighteenth century represents another antiquarian age in Chinese history (Figure 15). During this time, vessels similar to the ancient ritual bronzes were produced to indulge the subtle tastes of cultured patronage (Goedhuis

1989). This trend has continued into this century, when the growing Western market for Chinese antiquities has exercised its own influence (Jones 1990: 100). So, although we determined that the Conservation Center *ding* was not produced in the Eastern Zhou dynasty, it may have been possible to attribute it to the Song dynasty, the Qing dynasty, or to modern times (Figure 13).

Fang hu, Early Eastern Zhou dynasty, 8th c. BCE, Freer Gallery of Art, Arthur M. Sackler Collection

Archaistic *hu*, Song Dynasty (Kerr 1990)

Archaistic *hu*, Qing dynasty (Goedhuis 1989)

Figure 15

The difficulty of placing this object in time problematizes its value as cultural heritage. Reproductions and adaptations that are not understood as such may distort our understanding of the past, presenting us with a false history (Jones 1990: 16). Recognizing a copy is essential when objects are being used to interpret the culture to which they are assumed to belong. If the Conservation Center *ding* had been produced in the Song or Qing dynasty, it would serve as an important document. In this manner, copies are historical evidence of the culture that supplied and demanded them, and therefore have didactic value, illustrating history as a process of change and not a static event. In this case, because we had no clear evidence concerning the attribution of the

Conservation Center *ding*, we decided to continue the investigation from another standpoint: that of exploring the provenance of the vessel.

The traditional casting technology of early China flourished in part because of the exploitation of the fine soil, or loess, that is native to the northern part country (Chase 1994: 88). Loess is a fine-grained, un-stratified accumulation of silt deposited by wind, and although it is not unique to China, Chinese loess is considered characteristic because of its bimodal distribution with a course and fine component (Donghuai *et. al* 2004). We prepared a thin section of the core material that was extant in the legs of the Conservation Center *ding*. This core material showed both angular and rounded grains co-existing in a calcite-rich clay matrix. Transmitted light microscopy revealed quartz minerals, larger grains of feldspar, micas, and amphibole as an accessory mineral (Figure 16). The relative abundance of quartz, feldspar, and especially amphibole shows a strong similarity to reference samples from the Houma region (Figure 17). Although this analysis is not diagnostic, it suggests that the vessel is from China (Figure 18).

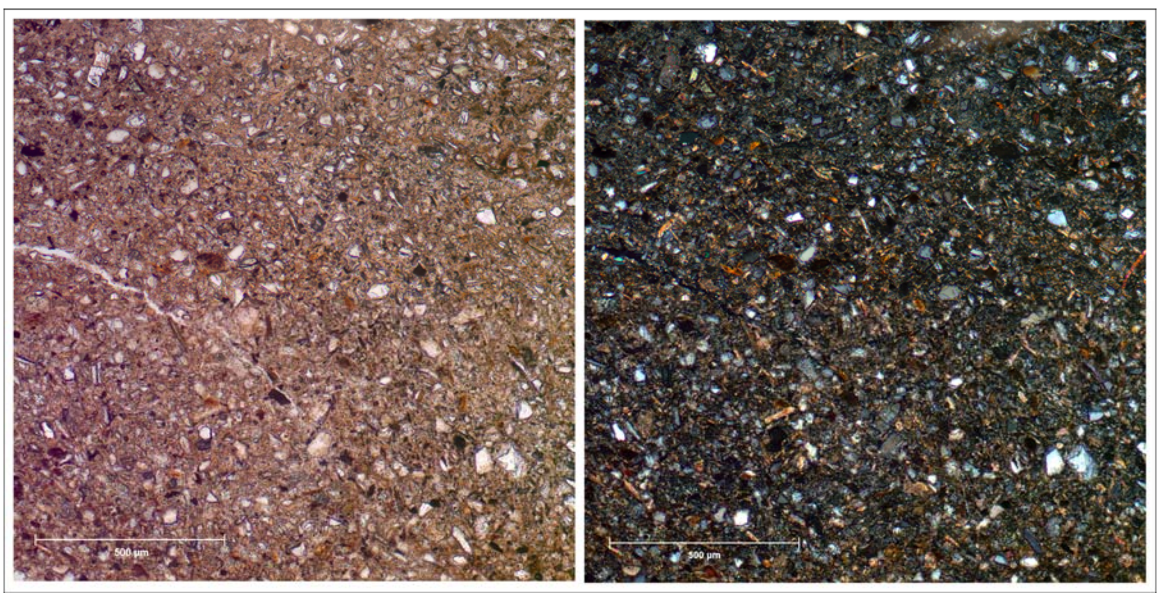

Figure 16 Core sample from the Conservation Center *ding*, prepared as a thin-section and viewed under plane polarized light.

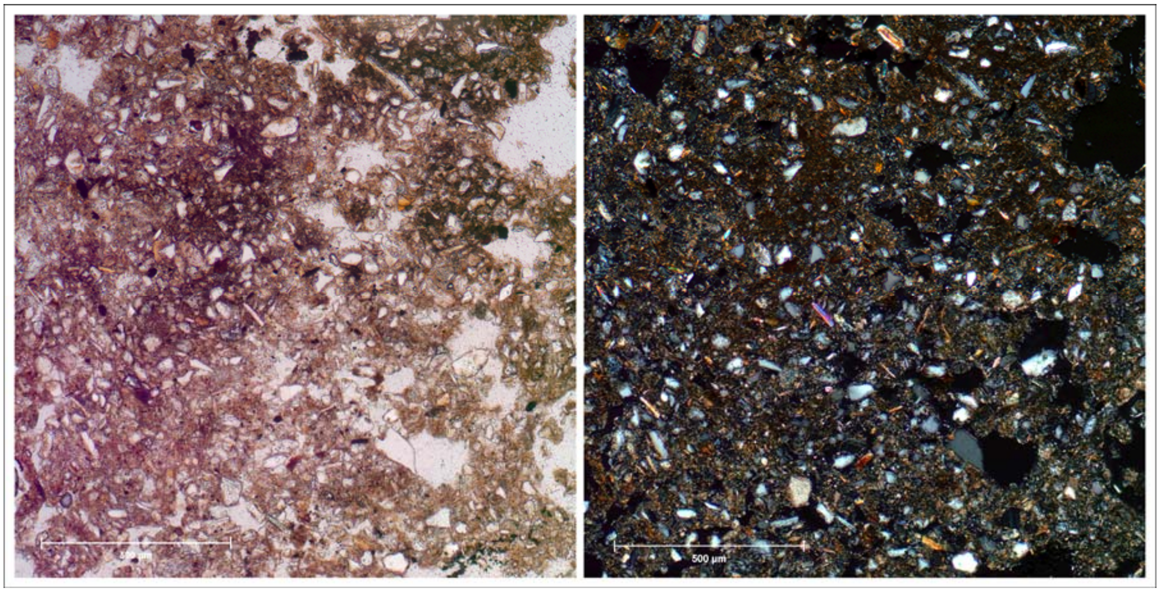

Figure 17 Sample of loess soil from Houma, China, prepared as a thin section and viewed under plane polarized light. Courtesy of Donna Strahan and Federico Carò.

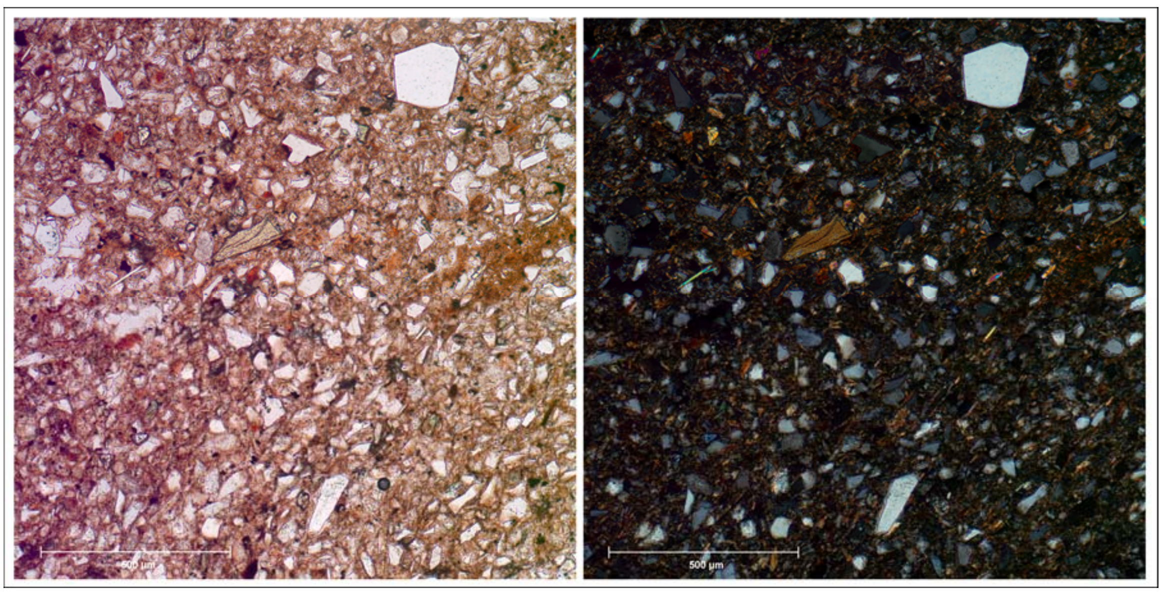

Figure 18 Core sample from Chinese bronze Buddha (New York, The Metropolitan Museum of Art, 26.123) prepared as a thin section and viewed under plane polarized light. Courtesy of The Sherman Fairchild Center for Objects Conservation and the Department of Scientific Research.

We explored the origin of the vessel further through limited provenance documentation available to us. The object was donated to the Conservation Center in early 2007 and catalogued as a "Chinese *ding*", so we contacted the donor to gain a better idea of its history. He had purchased the vessel on a whim for a nominal sum and directed us to the seller of the vessel in mid-town Manhattan, who is the owner of an encyclopedic storehouse of non-Western antiquity reproductions (Figure 19). They were having a 50% off sale. When asked about an object on the shelves that resembled an ancient Shang dynasty incense burner, the dealer stated that it would cost $200. In the end, he would have sold it for $100. There was never any mention of its age or origin. In other words, the incense burner was not being purported as an ancient object, and therefore it was not a forgery, it is a reproduction. Judging intuitively after this research, we were also able to extrapolate that the Conservation Center *ding* was not likely a product of the Song or Qing dynasties because it was patinated to look archaeological. Indeed we concluded that the Conservation Center *ding* was never more than a reproduction produced in China to supply the demand of modern collectors.

Figure 19 Seller of the Conservation Center *ding* in Midtown Manhattan.

<u>Conclusion</u>

Over the course of our study, the assignment to authenticate the Conservation Center vessel became the question of attribution. We realized that is our responsibility as scholars to recognize an object as an adaptation or a reproduction in order to interpret it in its appropriate historical context. The decoding of the Conservation Center vessel supports our assertion that attribution cannot be assigned to an object of cultural heritage by a single characteristic, but rather by a multiplicity of evidence gathered from previous research on similar objects. We also learned that legitimate paths of research might still leave open questions. For example the inconsistency between the presence of a nitrate patina in conjunction with intergranular corrosion warrants further investigation. In the end, the *ding* served us greatly as a didactic tool demonstrating the value of problematizing the interpretation of data. The lessons learned speak to the essence of our roles as stewards of cultural heritage.

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