Archeometallurgical Examination of Bronzes from the Second Iron Age

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ABSTRACT

The present paper is part of an archaeometallurgic examination of Vaccei bronzes from the archaeological place of Las Ruedas (Padilla de Duero, Valladolid, Spain). A sample of 6 objects is discussed here as representative of the main results from the metallographic examination, showing high skill in the forge work compensating foundry problems. It is observerd that those problems for melting bronze decrease gradually being still important till the begining of the Roman Conquest, when a real advance in the casting techniches can be recorded.

The pictures shown here can be regarded as examples of the technical problems arising when handing archaeological material. As there was no authorization for cutting or mounting the objects for metallographic examination due to legal restrictions, they had to be hold by hand and polished only on their outer surfaces, the consecuence being that pictures show many scratches and marks left during the polishing process.

INTRODUCTION

All the objects considered here come from modern archaeological excavation **(1)** of cremation graves found in Las Ruedas (Padilla de Duero, Valladolid, Spain), placed by the river Duero **(2)**. It is dated in the Iron Age II, during the last five centuries BC, and it is related to the Vaccei, a well known Celtiberic nation **(3)** settled down on the central part on the North Meseta.

During the burial ritual **(4)**, the corpse (fully dressed up) was burnt, and the resulting ashes kept in a vessel and buried. Therefore, some bronzes may show recristalization structures due to the cremation, but most of the objects still kept their original metallographic structures.

METHODOLOGY

The metallographic preparation of ordinary bronzes is well known **(5)**. But archaeological bronzes are actually very different: they should be regarded as a short of composite (an anhomogeneous mixture of different metals and oxidation products) so, when mounted in plastic material, a very slow six steps process has been found as the best: four grinding steps (grits 250, 500, 750 and 1000) and another two for polishing (with 7 μm and 3 μm diamond). But, as we were not allowed to cut or mount our speciments due to Spanish law restrictions dealing with archaeological finds, we were forced to hold the objects at necked hand while preparing their outer surfaces for examination. In this case, only two steps were followed: one for grinding (grit 500) and one for polishing (3 μm diamond). The result is a very bad picture with plenty of scratches and marks left by the polishing process, but which let us got, at least, an approach to the metal structure.

Alcoholic ferric cloride was used a etching material ($FeCl_3$+C_2H_6O+HCL).

Objects were analized using XRF-EDS and ICP.

SUBJECT

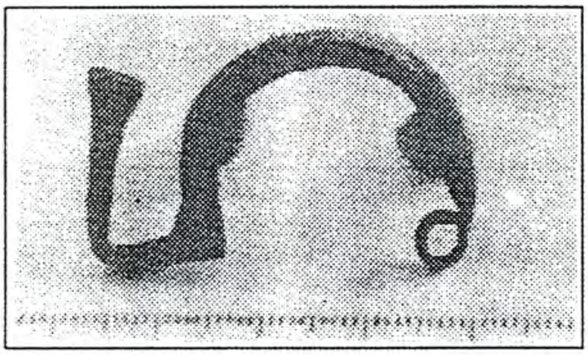

Figure 1. PD/LR/II-C/76.

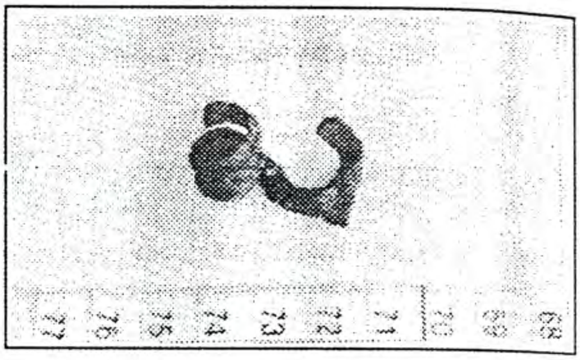

Figure 2. PD/LR/II-H/56.

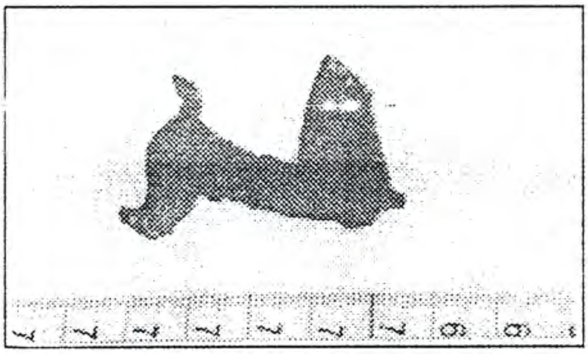

Figure 3. PD/LR/II-AA/17.

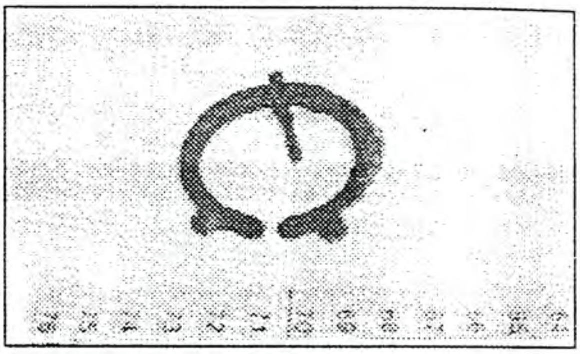

Figure 4. PD/LR/II-AU/34.

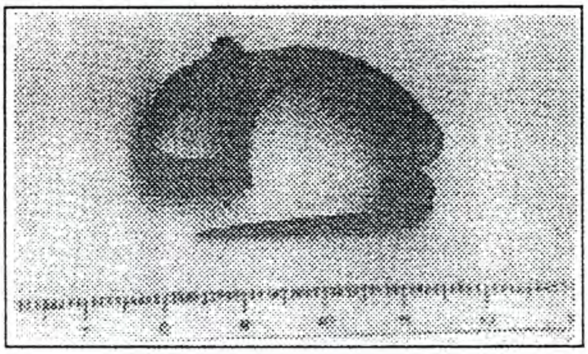

Figure 5. PD/LR/IIAG/45.

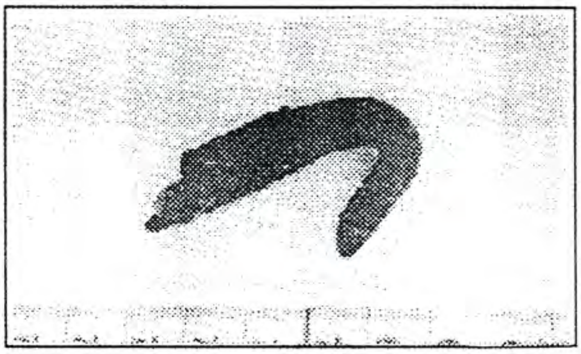

Figure 6. PD/LR/III-E/51.

The six objects considered here are:

Figure 1. Arch. reference: PD/LR/II-C/76. Tower type fibula (400-350 BC). Composition: 95.24 %Cu, 1.86 %Pb, 2.51 % Sn.

Figure 2. Arch. reference: PD/LR/II-H/56. Top end of cross type fibula with double spring (400-300 BC). Composition: 93.12 %Cu, 0.98 %Pb, 5.07 % Sn.

Figure 3. Arch. reference: PD/LR/II-AA/17. Central part of horse type fibula (300-100 BC). Composition: 92.92 %Cu, 1.66 %Pb, 2.71 %Sn.

Figure 4. Arch. reference: PD/LR/II-AU/34. Ω type buckle (200-100 BC). Composition: 87.55 %Cu, 10.66 %Zn, 0.20 %Pb, 0.92 %Sn.

Figure 5. Arch. reference: PD/LR/II-AG/45. La Tène type fibula (100-50 BC). Composition: 80.06 %Cu, 11.92 %Pb, 7.07 %Sn.

Figure 6. Arch. reference: PD/LR/III-E/51. Hook from horse fitting (100-0 BC). Composition: 86.88 %Cu, 2.07 %Pb, 4.75 %Sn.

EXPERIMENTAL

PD/LR/II-C/76, **figure 7**, shows the usual structures for 4th century BC objects: very small equiaxial grains with twin grains and, here, bending lines, all comming from a pocess of sucesive annealing and forging to form the object. **Figure 8**, top end of fibula, shows the same structure with greater damage from corrosion where stress from hammering was bigger, in the same way clearer shown in **figure 9**, a Danish head of a rivet from the Bronze Age. **Figure 10**, PD/LR/II-H/56, shows better recristalization, as care had to be taken to forge the spring, so longer annealing times were used for this type.

The very complicated in shape fibula PD/LR/II-AA/17, **figure 11**, is as cast, but shows many casting holes due to overheating of the bronze in the crucible.

Later, all this problems desappear. PD/LR/II-AU/34, **figure 12**, is as cast, probably in hot mold or slightly annealed. PD/LR/II-AG/45, **figure 13**, very similar to the first object, was cast in a cold mold. PD/LR/III-E/51, **figure 14**, was cast and slightly annealed.

DISCUSSION

It has been shown that during a first period bronze work went from casting of simple figures which were later forged to get the final object towards bad casting of almost finished pieces. After this, together with the beginning of the Roman conquest, an improvement in casting technics has been demonstrated.

This fits with other analytical results. Brass is only recorded after the 2nd. century BC, together with a change in the copper smelting technology used for the copper imported by the Vaccei, as shown by the Fe and As content (7): iron increases with time, and arsenic has both very low or very high percentages till the 2nd century BC, which can be due to very low smelting technology, and later becomes homogeneous just bellow 1 %As, suggesting the generalization of the shaft furnace.

ACKNOWLEDGMENTS

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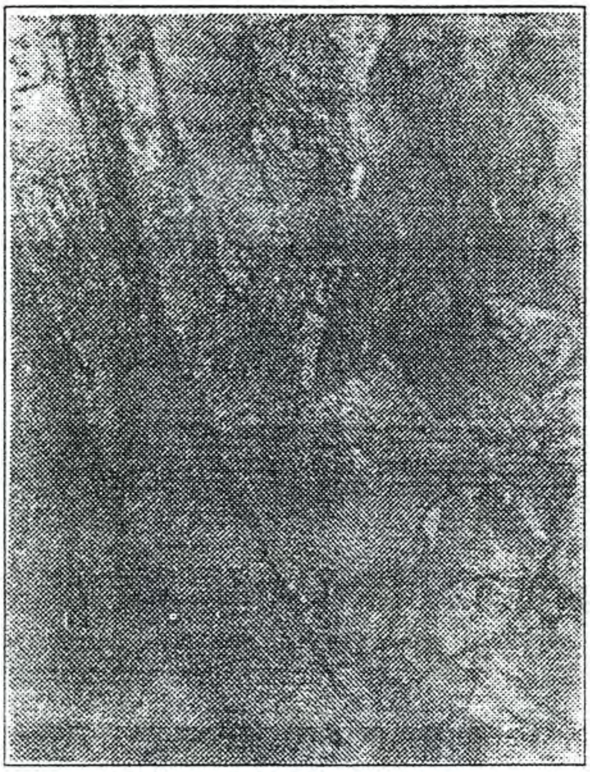

Figure 7. PD/LR/II-C/76. 80x.

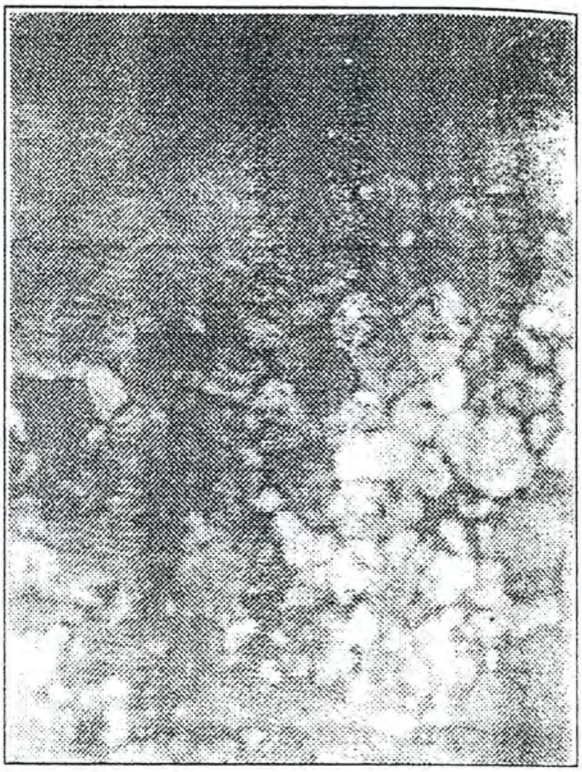

Figure 8. PD/LR/II-C/76. 80x.

Figure 9. Head of bronze rivet. 140x.

Figure 10. PD/LR/II-H/56. 100x.

Figure 11. PD/LR/II-AA/17. 80x.

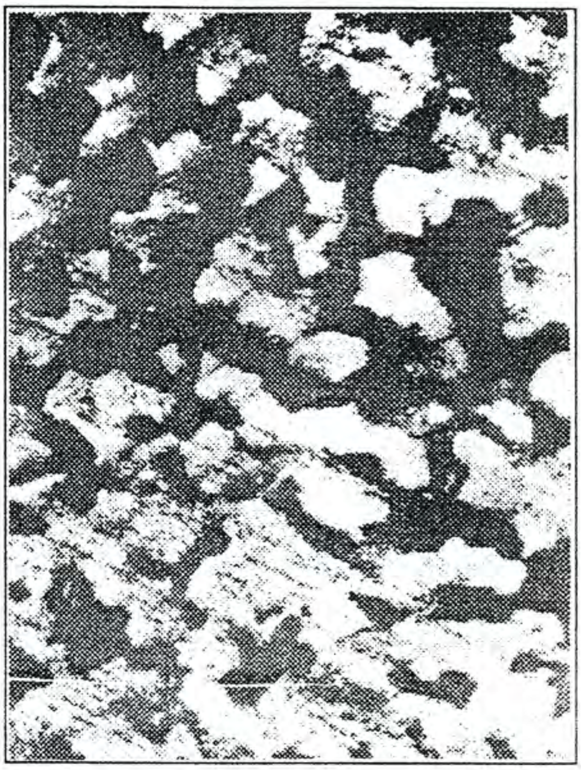

Figure 12. PD/LR/II-AU/34. 100x.

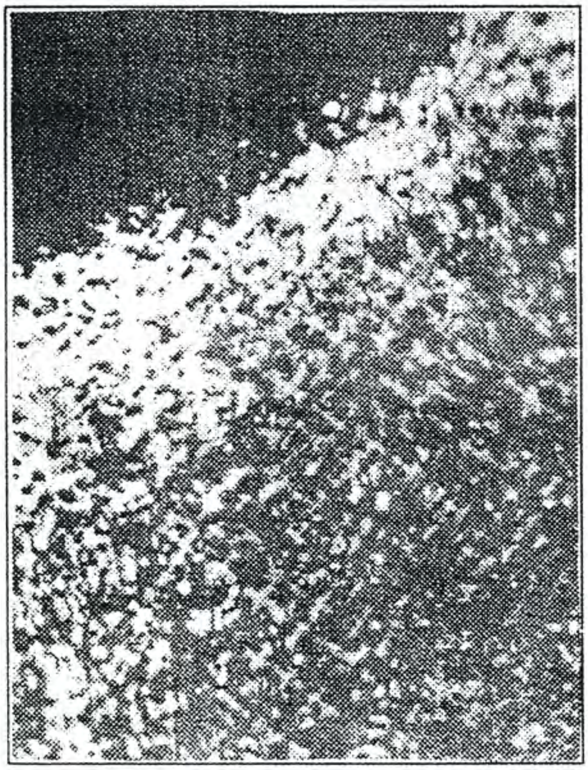

Figure 13. PD/LR/II-AG/45. 250x.

Figure 14. PD/LR/III-E/51. 100x.