BUST OF AN APPLIQUE 2005.054.F00265.1 – QUARTERNARY BRONZE ALLOY – ROMAN TIMES – SWITZERLAND

Artefact name	Bust of an applique 2005.054.F00265.1
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Url	/artefacts/337/

The object



Credit HE-Arc CR, M.Arnautou.

Fig. 1: Bust of an applique as found (left picture) and the bust (right picture),

Description and visual observation

Description of the artefact	Bust representing a love figure from a bronze applique (Fig. 1), covered by a thin dark-grey patina and scattered green corrosion products. Dimensions: L = 6 cm; W = 3.5 cm; T = 3 cm.
Type of artefact	Applique
Origin	Augst BL, Augusta Raurica, Insula 27, Roman villa, Avenches, Vaud, Switzerland
Recovering date	Excavation 2005
Chronology category	Roman Times
chronology tpq	753 B.C.
chronology taq	476 A.D.
Chronology comment	Roman Times

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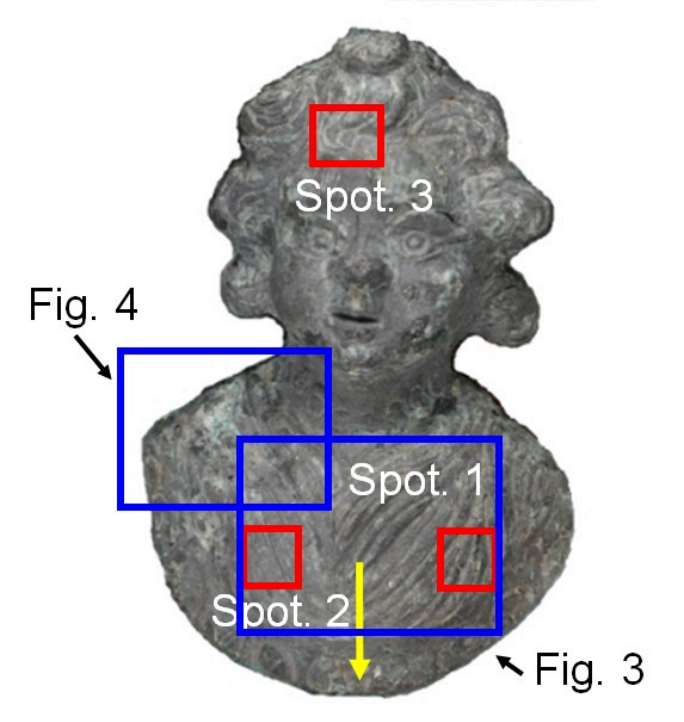
Burial conditions / environment	Soil
Artefact location	Museum Augusta Raurica, Avenches
Owner	Museum Augusta Raurica, Avenches
Inv. number	2005.054.F00265.1
Recorded conservation data	Not conserved

Complementary information

Nothing to report.

Study area(s)



Credit HE-Arc CR, M.Arnautou.

Fig.2: Location of areas of visual observation in blue, of sampling in yellow and of analyses (XRF) in red,



Credit HE-Arc CR, M.Arnautou.

Fig. 3: Dark patina located on Fig. 2 (blue square),

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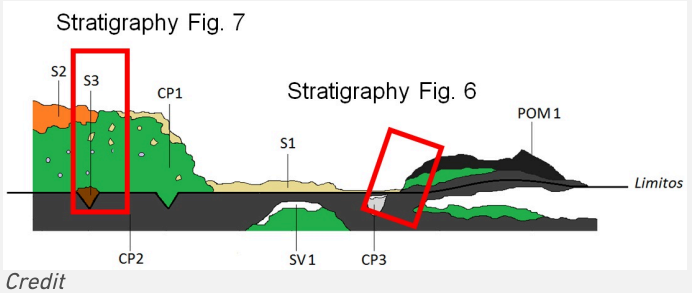
Fig. 4: Porous zone located on Fig. 2 (blue square),

Binocular observation and representation of the corrosion structure

The schematic representation below gives an overview of the corrosion layers encountered on the bust from a first visual macroscopic observation.



Credit

Fig. 5: Stratigraphic representation based on visual observation and visualization of the stratigraphies of Figs. 6 and 7.

MiCorr stratigraphy(ies) – Bi

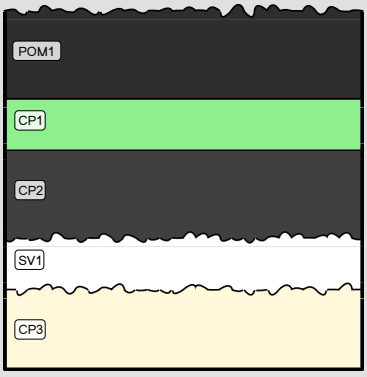


Fig. 6: Stratigraphic representation of the object in cross-section using the MiCorr application. This representation can be compared to Fig. 5.

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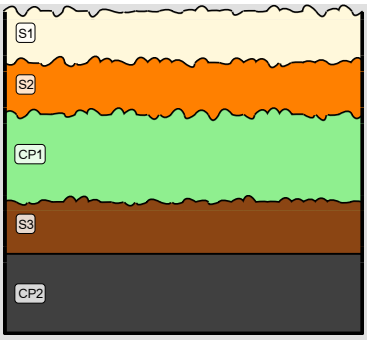

Fig. 7: Stratigraphic representation of the object in cross-section using the MiCorr application. This representation can be compared to Fig. 5.

Sample(s)

Description of sample	The sample is a scale (1 x 1 mm) of the dark-grey patina taken from the bottom part of the bust (Fig.2).
Alloy	Quarternary bronze alloy
Technology	Hollow cast, chiselled
Lab number of sample	None
Sample location	None
Responsible institution	None
Date and aim of sampling	2013, study of the corrosion layer

Complementary information

Nothing to report.

Analyses and results

Analyses performed:
XRF, SEM/EDS. XRF was carried out with portable X-ray fluorescence spectrometer (NITON XL3t 950 Air GOLDD+ analyser, Thermo-Fischer®, mode "General metal", acquisition time: 20/20/20s).

Non invasive analysis

Metal

The metal has not been examinated.

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Microstructure	None
First metal element	Cu
Other metal elements	Zn, Sn, Pb

Complementary information

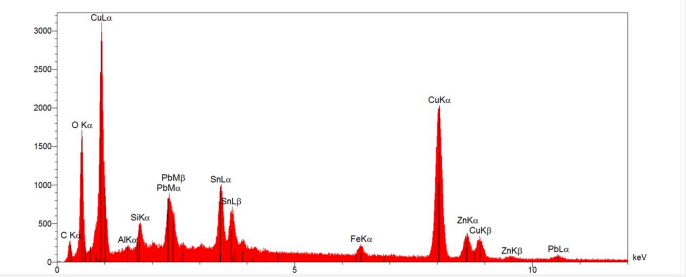
Nothing to report.

Corrosion layers

The entire surface of the bust is covered by a dark grey layer directly attached to the remaining metal (CP2) (Fig. 3). The surface analyses (Table 1) performed on the bust have revealed a high amount of Cu, as well as Pb, Sn and Zn. These are elements which can be constituents of the alloy, while elements in minor amount such as Al, Si and Fe are likely to originate from the environment. The qualitative analysis carried out on the dark patina by SEM/EDS (Fig. 6) confirms the XRF results (Table 1), showing the same elements and the presence of O, which probably correspond to copper oxide (cuprite Cu2O or tenorite CuO). The dark patina is covered by an adherent green corrosion layer (CP1) which has developed in scattered clusters (probably copper carbonate). The clusters have a surface area of 2 mm2 to 2 cm2, and have a thickness of 0.5 to 5 millimeters. In some places, the green corrosion layer has formed in the porous blisters of the dark layer (Fig. 5). Charcoal might be found locally (POM1) as well as different sediments: S1 (discontinuous and brown), S2 (mixed with fine and coarse sand grains) and S3 (scattered homogeneous brown layer).

Table 1: Chemical composition of the dark-grey patina of the selected areas of Fig.2 (red squares). Method of analysis: HE-Arc portable XRF.

	Elements	Cu	Pb	Sn	Zn	Si	Al	Fe
Spot 1	mass%	43	24	13	8	5	3	3
Spot 2	mass%	52	23	11	6	4	2	2
Spot 3	mass%	69	17	5	4	2	2	1



Credit HE-Arc CR, M.Arnautou.

Fig. 6: EDS spectrum of sample 1 located in Fig. 2 (yellow arrow),

Corrosion form	Multiform
Corrosion type	Type I (Robbiola)

Complementary information

Nothing to report.

MiCorr stratigraphy(ies) – CS

Synthesis of the binocular / cross-section examination of the corrosion structure

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No modification.

Conclusion

The metal is probably a quaternary bronze (Cu-Pb-Sn-Zn) according to the qualitative XRF analysis performed on the surface of the bust. The high amount of lead is probably due to its diffusion towards the metal surface caused by exposure to high temperatures. The dark patina (CP2) has developed from a smooth layer to voluminous green crusts (CP1) corresponding to a type 1 corrosion according to Robbiola and al. 1998. The artefact has been excavated from a burial context characterized by burnt soil, which could explain the formation of the black patina (tenorite will form at temperatures above 300/400°C). A green corrosion has developed in the porous blisters of the dark layer. The limit of the original surface is located at the interface of the dark smooth corrosion and the green adherent corrosion product. In certain areas the limit of the original surface has been elevated from its original position.

References

References on object and sample
References object
1. B. Pfäffli : Ausgrabungen in Augst im Jahre, 2005.
2. E. Künzl, S. Künzl, Das römische Prunkportal von Ladenburg, Stuttgart, 2003.
References on analytic methods and interpretation
3. L. Robbiola, J.M.Blengino and C. Fiaud, Morphology and mecanisms of formation of natural patinas on archeological Cu-Sn alloys, in Corrosion science. Vol. 40, n° 12, pp. 2083-2111, 1998.
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