

COOKING POT HANDLE FRAGMENT V.008.2/2948.1. – LEADED BRONZE – ROMAN TIMES – SWITZERLAND

Artefact name Cooking pot handle fragment V.008.2/2948.1.

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∨ The object



Fig. 1: Cooking pot handle before and after treatment, front (a and c) and back (b and d),

Credit HE-Arc CR, L.Ruynat.

∨ Description and visual observation

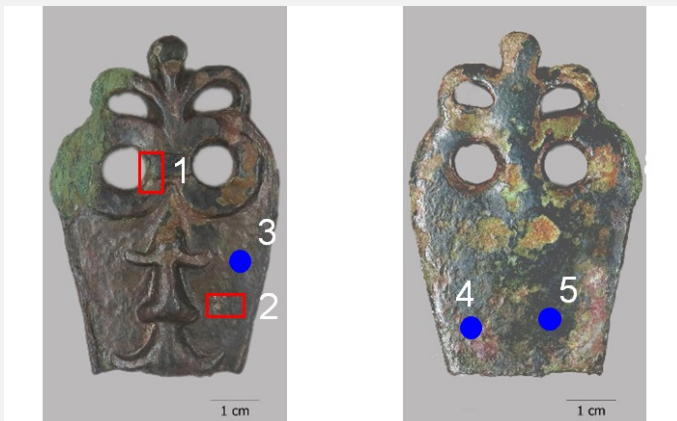
| | |
|------------------------------------|---|
| Description of the artefact | The object is the tip of a cooking pot handle representative of the Augustan age (100 AD), recognisable by the axial symmetry and the two orifices surrounded by prominent edging and flared shape. The upper part is composed of an openwork flower with three petals, comparable to the representation of the fleur-de-lis. A curved pattern frieze can be seen in the centre of the object. No decoration was found on the back. Before treatment, the object was covered with organic remains, most of which were mineralised (Figs. 1a and b). Dimensions : L = 73 mm ; W = 48 ; T = 9 mm ; WT = 80.8 g. |
| Type of artefact | Household implement |
| Origin | Romans legionnaires' camp of Vindonissa (present-day town of Windisch), Aargau canton, CH., Windisch, Aargau, Switzerland |
| Recovering date | 2008 |
| Chronology category | Roman Times |
| chronology tpq | <input type="text" value="1"/> A.D. ▾ |
| chronology taq | <input type="text" value="100"/> A.D. ▾ |
| Chronology comment | 1st century AD |

| | |
|--|---|
| Burial conditions / environment | Soil |
| Artefact location | Archaeological Service of the Aargau canton, Brugg, Aargau |
| Owner | Archaeological Service of the Aargau canton, Brugg, Aargau |
| Inv. number | V.008.2/2948.1. (Inv. Number at HE-Arc: 2001) |
| Recorded conservation data | 2008: Probably a first sediment clearing by archaeologists during the excavation. 2016-17: Lucile Ruynat, mechanical removal of the corrosion products over the limitos with ultrasonic scalpel. Conservation of wooden remains at the top right of the front of the object. Protective layer (varnish) with acrylic resin Paraloid B72®. |

Complementary information

The soil of Windisch is on the border between calcareous soil (Jura) and molasses-type (Swiss plateau). Calcareous soils tend to be alkaline whereas the molassic soil is generally more neutral. The Swiss climate is temperate, with the four marked seasons. It can have strong frosts in winter.

Study area(s)



Credit HE-Arc CR, L.Ruynat.

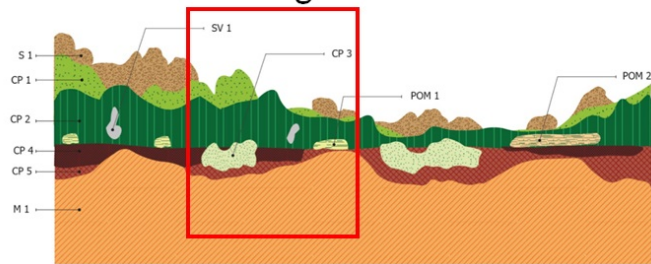
Fig. 2: Cooking pot handle after treatment: front (left) and back (right). Location of sampling for SEM-EDS and Raman (red square 1), XRD analyses (red squares 1 and 2), as well as XRF analyses (blue points 3, 4, 5),

Binocular observation and representation of the corrosion structure

The stratigraphy below gives an overview of the corrosion layers encountered on the object from visual macroscopic observation. The stratigraphy was created before treatment by observation under a binocular microscope and modified during the mechanical removal of corrosion products.

Fig. 3: Stratigraphic representation of the cooking pot handle fragment in cross-section based on macroscopic global observation and indication of Fig. 4. S = structural void, CP = corrosion product, POM = pseudomorph of organic material, M = metal,

Fig. 4



| | |
|------|---|
| S1 | Sediments with sand forming isolated and highly porous ochre-colored clusters |
| CP1 | Scattered clusters of highly porous medium green corrosion product |
| CP2 | Continuous layer of compact dark green corrosion product |
| SV1 | Structural voids within CP2 |
| POM1 | Pseudomorphs of organic remains |
| POM2 | Pseudomorphs of wood remains |
| CP3 | Scattered clusters of highly porous light green corrosion product |
| CP4 | Discontinuous layer of compact dark-red corrosion products |
| CP5 | Discontinuous layer of compact red corrosion product |
| M1 | Continuous and compact metal |

Credit HE-Arc CR, L.Ruynat.

∨ MiCorr stratigraphy(ies) – Bi

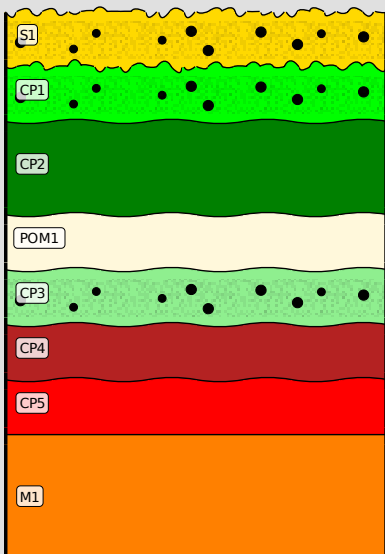


Fig. 4: Stratigraphic representation of the cooking pot handle fragment in cross-section using the MiCorr application (to be compared to Fig. 3). The stratum SV1 is missing because it is integrated in CP2 and it was not possible to represent it in MiCorr while POM1 and POM2 are merged as POM1. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation, Credit HE-Arc CR, L.Ruynat.

∨ Sample(s)

Description of sample

No sample from the metal was possible. Only a few invasive samples were taken for analysis of corrosion products, as indicated on figure 2 (red squares 1 and 2).

Alloy

Leaded Bronze

Technology

As-cast

Lab number of sample

Sample location

None

Responsible institution Archaeological Service of the Aargau canton, Brugg, Aargau

Date and aim of sampling 2017, chemical analyses

Complementary information

Nothing to report.

∨ Analyses and results

Analyses performed:

XRF with portable X-ray fluorescence spectrometer (NITON XL3t 950 Air GOLDD+ analyser, Thermo Fischer®). XRD of powder samples using Stoe Mark II-Imaging Plate Diffractometer System (Stoe & Cie, 2015) equipped with a graphite-monochromator. Mo-K α radiation ($\gamma = 0.71073\text{\AA}$, beam diameter 0.5 mm, exposure time: 10 min). SEM/EDS on the object. Raman on powder samples of corrosion products. SEM on sample of organic remains, as well as X-ray picture not presented in this report.

∨ Non invasive analysis

∨ Metal

The mechanical removal of corrosion products stopped at the limitos, so the metal was not directly observed. XRF analysis carried out after the cleaning process (Fig. 2, blue dot 3) showed that the metal is a leaded bronze (Table 1). Theoretically the metal is as-cast and should present a dendritic structure.

| Elements mass % | Cu | Sn | Pb | Sb | Si | P | Ti | Fe |
|-----------------|------|------|------|-----|-----|-----|-----|-----|
| M1 | 61.1 | 21.1 | 14.2 | 0.9 | 0.9 | 0.4 | 0.2 | 0.1 |

Table 1:

Chemical composition of the metal. Method of analysis: XRF, mode General metals, 60s (filters M20/Lo20/Li20). Located at point 3 Figure 2, credit MiCorr_HE-Arc CR, C.Degrigny.

Microstructure Dendritic structure

First metal element Cu

Other metal elements Sn, Pb

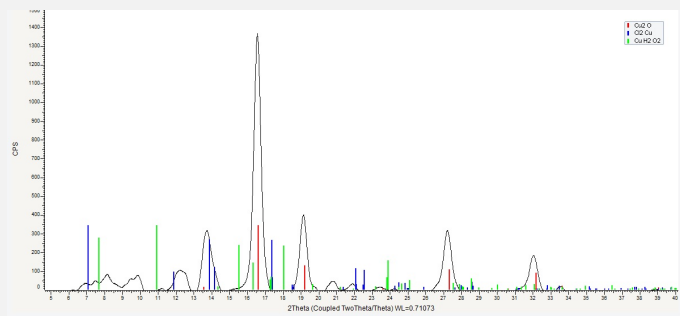
Complementary information

Nothing to report.

Above the well-preserved metal core, CP4 is discontinuously interlocked in CP5. The XRD analysis done on a sample (Fig. 2, red square 2) of both corrosion products, shows that they are mainly constituted of cuprite (Cu₂O), (Fig. 5). The colour difference can be explained by a tin enrichment in the darker CP4, as measured by XRF. XRF analyses of CP4 (Fig. 2, blue dot 5) and CP5 (Fig. 2, blue dot 4) are given in Table 2. The EDS analysis of the light green CP3 (red square 1 Fig. 2) layer did not reveal the presence of chlorides (Fig. 6). Complementary XRD analysis validated the absence of nantokite. Indeed the XRD and Raman indexing was not successful probably because the compound has a large amorphous part. The other layers were not analysed, we expect CP1 and CP2 to be malachite (copper carbonate hydroxyde) because of the green colour and absence of chlorides. Organic remains were mineralised and preserved by the corrosion process.

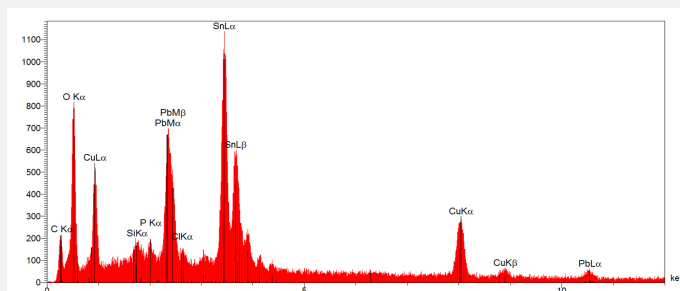
| Elements mass % | Cu | Sn | Pb | Sb | As | Ag | Fe | P | Cl | S | BAL |
|----------------------|------|------|------|-----|-----|------|------|-----|-----|-----|------|
| Dark-red layer (CP4) | 24.9 | 18.2 | 11.2 | 0.7 | 0.1 | 0.09 | 0.1 | 0.3 | 0.4 | 7.2 | 36.1 |
| Red area layer (CP5) | 33.5 | 14.5 | 16 | 0.5 | 0.8 | 0.1 | 0.05 | 1.3 | 0.6 | 1.5 | 30.5 |

Table 2: Chemical compositions of the dark-red and the red layers. Method of analysis: XRF, mode mining Cu/Zn, 180s (filters M30/Lo30/H60/Li60). BAL corresponds to the elements not analysed: O and C, credit MiCorr_HE-Arc CR, C.Degrigny.



Credit Empa, A.Neels.

Fig.5: XRD spectrum of CP4 and CP5, Method of analysis: XRD, Center for X-ray Analytics, Empa,



Credit HEI, S.Ramseyer

Fig. 6: EDS spectrum representative of the light green corrosion product (CP3). Method of analysis: SEM-EDS, Lab of Electronic Microscopy and Microanalysis, IMA (Néode), HEI Arc,

Corrosion form None

Corrosion type

Mostly type I with locally type II (Robbiola)

Complementary information

Nothing to report.

∨ MiCorr stratigraphy(ies) – CS

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

The schematic representation of corrosion layers of Fig.3 integrating additional information based on the analyses carried out is given in Fig. 7.

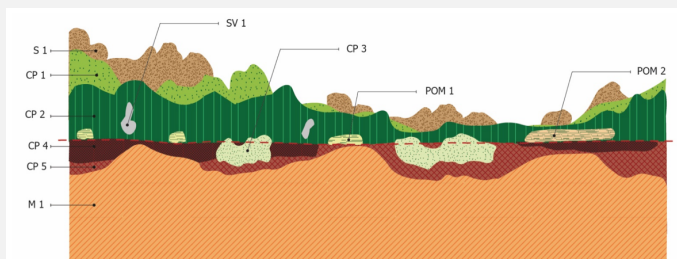


Fig. 7: Improved stratigraphic representation of the cooking pot handle fragment from visual observations and analyses,

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|---|--|
| S1: Sediments | Soil and sand |
| CP1: Outer light green corrosion clusters | Malachite? |
| CP2: Outer dark green corrosion layer | Malachite? |
| SV1 | Structural voids within CP2 |
| POM1: Pseudomorphs of organic remains | Stems, grass within CP2 |
| POM2: Pseudomorphs of organic remains | Wood within CP2 |
| CP3: Outer/inner isolated light green corrosion product | No Nantokite, No Malachite |
| CP4: Inner black-dark red corrosion layer | Main phase: Cuprite Tin enrichment |
| CP5: Inner red corrosion layer | Main phase: Cuprite |
| M1: Orange Metal | Bronze with high lead content, probably with dendrites (as-cast) |

Credit HE-Arc CR, L.Ruynat.

∨ Conclusion

The object is a leaded bronze with a well-preserved metal core. Covering the metal are two strata (CP4 and CP5) composed of cuprite, the darker (CP4) appears enriched in tin. The superior interface of these layers represents the limitos. In areas the limitos, CP4 and CP5 have been replaced by a light green porous corrosion product (CP3). The following layers CP2 and CP1 are probably malachite.

The powdery green corrosion layer CP3 has frequently been observed on bronzes of Vindonissa where it can be located within cuprite or malachite layers. It is typically developed below the limitos and renders the latter extremely fragile. The nature of this corrosion product has not yet been determined. However, the absence of chlorine indicates that it is not a chlorinated corrosion product such as atacamite or paratacamite. The aggressive urban soil could be a reason for the transformation of these naturally grown and stable corrosion layers.

∨ References

References on object and sample

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