



# BRACELET WITH DRAGONFLIES IIB 4025.01 - LEADED BRONZE - LATE **BRONZE AGE**

Artefact name Bracelet with dragonflies IIb 4025.01

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Url /artefacts/993/

#### ☐ The object



Fig. 1: Bracelet with zoomorphic decorations before conservation interventions,

Credit HE-Arc CR, E.Perret-Gentil.



Fig. 2: Bracelet with zoomorphic decorations after conservation interventions,

#### Description and visual observation

Credit HE-Arc CR, E.Perret-Gentil.

**Description of the artefact** 

Decorated bracelet with zoomorphic extensions looking like dragonflies (Fig. 1 and 2), covered with dark green corrosion layers and sediments. Dimensions:  $\emptyset$ = 60mm, Lmax = 24mm, WT =

40.82 g (Figs.1 et 2).

Type of artefact Jewellery

Origin Thailand, Udon Thani, Siam, Nong Han, Ban Chiang archaeological site

Recovering date Date unknown

Chronology category Late Bronze Age

chronology tpq 300 B.C. ▶

chronology taq 200 A.D. ✓

**Chronology comment** 

Burial conditions / environment

Soil

Artefact location Museum der Kulturen, Basel

Owner Museum der Kulturen, Basel

Inv. number IIb 4025.01

Recorded conservation data N/A

# Complementary information

No information on the archaeological or historical context before 2008 (year of donation to the museum). The artefact was brought to HE-Arc CR in 3 fragments. Preliminary information on corrosion structures could be observed on cross-sections exposed.

#### ∃ Study area(s

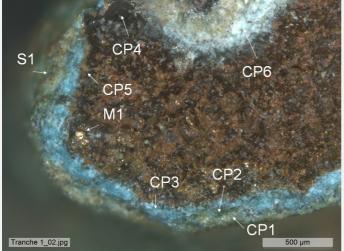


Fig. 3 : Broken fragment of Fig. 1 without zoomorphic extensions and location of the cross-sections observed on Figs. 4 and 6,

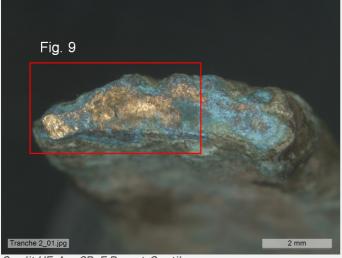
Fig. 4: Visual observation on cross-section of section 2 of the broken fragment (Fig. 3),



Credit HE-Arc Ingénierie, S.Ramseyer.



Credit HE-Arc Ingénierie, S.Ramseyer.



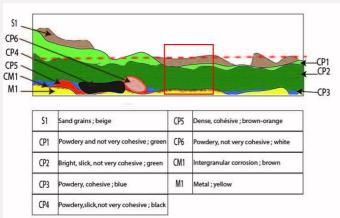
Credit HE-Arc CR, E.Perret-Gentil.

Fig. 5 : Detail of Fig. 4 with indication of the different strata represented on Fig. 7,

Fig. 6: Visual observation on cross-section of section 1 of the broken fragment (Fig. 3) with location of Fig. 9,

#### $\;\;\square\;$ Binocular observation and representation of the corrosion structure

The schematic representation below gives an overview of the strata encountered on the bracelet from a first visual macroscopic observation under a binocular microscope both on the surface and section 2 exposed (Fig. 5).



Credit HE-Arc CR, E.Perret-Gentil.

Fig. 7: Stratigraphic representation of the fractured cutting edge of the bracelet in cross-section by macroscopic observation with indication of strata of Fig. 5 and the MiCorr stratigraphy in the red rectangle (Fig. 21) built from the polished surface of section 1.

# ☐ MiCorr stratigraphy(ies) – Bi

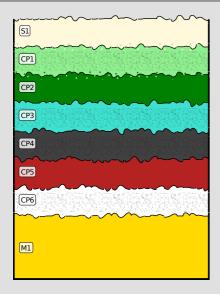
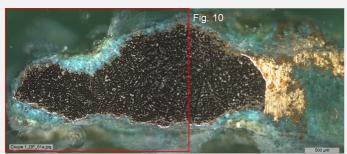


Fig. 8: Stratigraphic representation of the corrosion structure of the bracelet observed macroscopically under binocular microscope from Fig. 5 (cross-section of section 2) using the MiCorr application. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation, Credit HE-Arc CR, E.Perret-Gentil.

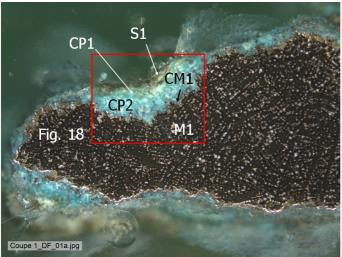
# □ Sample(s)



Credit HEI Arc, S.Ramseyer.

Fig. 9 : Polished cross-section of section 1 (detail of Fig. 6) with location of Fig. 10, unetched, dark field,

Fig, 10: Detail of Fig. 9 with indication of the strata represented in Fig. 21,



Credit HEI Arc, S.Ramseyer.

**Description of sample**After section 1 of the fragment of Fig. 3 has been consolidated with Technovit 5071

(bicomponent resin (powder+liquid) from Dibenzoylperoxid and Methymethacrylate NN, N-dimethyl-p-tolviol), it was embedded, polished and observed on cross-section (Figs. 9 and 10) to build the MiCorr stratigraphic representation (Fig. 21). Once examined the fragment was extracted, the consolidant was dissolved in acetone and the fragment could be reintegrated on

the artefact.

Alloy Leaded Bronze

**Technology** Cast and cold worked

Lab number of sample 1

Sample location Museum der Kulturen, Basel

**Responsible institution** Museum der Kulturen, Basel

**Date and aim of sampling** 14.05.2019, chemical and structural analyses

### Complementary information

Nothing to report.

# ☐ Analyses and results

#### Analyses performed:

Metallography (etched with ferric chloride reagent), SEM-EDS (Jeol JSM-6400 device), XRD.

#### $\sqcap$ Non invasive analysis

None.

The remaining metal is a porous leaded bronze (Fig. 11) with a high concentration of Sn and Pb (Table 1 and Fig. 12). The 9% Pb concentration is due to the area analysed where Pb nodules false the result which should be more around 5%.

Elements	Cu	Sn	Pb
mass%	76	15-16	9

Table 1: Chemical composition (mass %) of the metal (from Fig. 12). Method of analysis: SEM/EDS. HE-Arc Ingénierie. In bright field, the etched alloy shows a dendritic structure (Fig. 13). Therefore, the metal is as-cast. Fig. 14 shows that the yellow inner dendrite phase is richer in Cu (A; Fig. 15) while the orange-brown interdendritic phase is richer in Sn (B; Fig. 16) with lead nodules (C; Fig. 17).

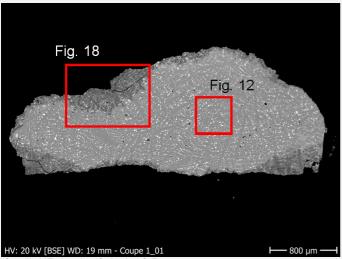
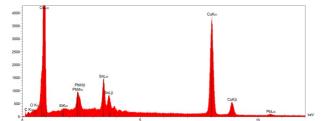


Fig. 11: SEM image of the cross-section similar to Fig. 9, BSE-mode. The area selected for elemental chemical analysis (Fig. 12) is marked by a rectangle. Fig. 18 is similarly indicated,

Credit HE-Arc Ingénierie, S.Ramseyer.



Credit HE-Arc Ingénierie, S.Ramseyer.

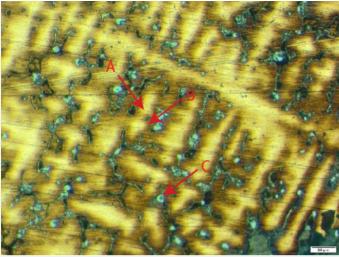
Fig. 12: EDS spectrum of the alloy of the bracelet,



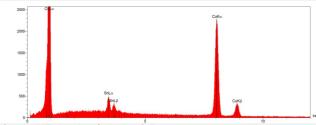
Credit HE-Arc CR, E.Perret-Gentil.

Fig. 13: Micrograph showing the dendritic microstructure (reversed picture of Fig. 12), etched, bright field,

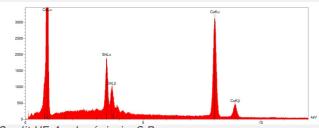
Fig. 14: Micrograph of a selected area of Fig. 13, etched, bright field, showing the dendritic (A), interdendritic (B) phases and lead nodules (C),



Credit HE-Arc CR, E.Perret-Gentil.



Credit HE-Arc Ingénierie, S.Ramseyer.



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Credit HE-Arc Ingénierie, S.Ramseyer.

Fig. 15: EDS spectrum of the dendritic phase,

Fig. 16: EDS spectrum of the interdendritic phase,

Fig. 17: EDS spectrum of Pb nodules,

Microstructure Dendritic structure with inclusions

First metal element Cu

Other metal elements Sn, Pb

# Complementary information

Traces of As have been found locally in some phases of the metal.

Corrosion layers

Interdendritic corrosion is visible at the interface metal/corrosion product (Fig. 18) and peudomorph of dendritic structure is visible in CP2 (Figs. 10 and 18). EDS analysis of CP2 and CP1 indicates the presence of higher concentration of Sn in CP2 than CP1 and the presence of P in both layers, validating the funeral context where the object was found. The results of the XRD analysis were irrelevant due to the instability of fragment of Fig. 3 on the support of the device.

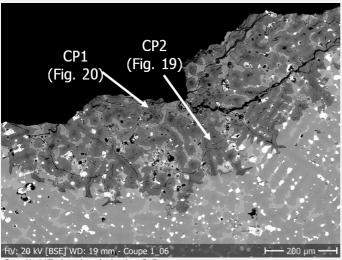


Fig. 18: SEM picture showing interdendritic corrosion with locations of Figs. 19 and 20,

Credit HE-Arc Ingénierie, S.Ramseyer.

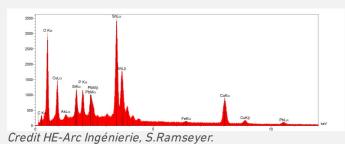


Fig. 19: EDS spectrum of the area (CP2) located in Fig. 18,

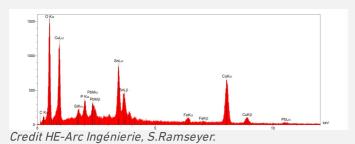


Fig. 20: EDS spectrum of the area (CP1) located in Fig. 18,

Corrosion form Other

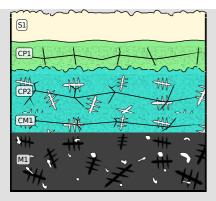
Corrosion type Mostly type I with locally type II (Robbiola)

# Complementary information

None.

# ☐ MiCorr stratigraphy(ies) – CS

Fig. 21: Stratigraphic representation of the bracelet in cross-section (dark field) using the MiCorr application with reference to Fig. 10. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the



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

The schematic representation of corrosion layers of Fig. 7 integrating additional information based on the analyses carried out is given in Fig. 22. Strata CP1 and CP2 in the stratigraphy of Fig. 8 are merged into CP1 in Fig. 21. Similarly, strata CP3 to CP6 in Fig. 8 are merged into CP2 and CM1 in Fig. 21.



Description Interpretation 51 Sand and soil of the archaeological context Sand grains ; beige CP1 Powdery and not very cohesive; green Copper carbonate: malachite Cu2CO3(OH)2 (?) Copper carbonate : malachite Cu2CO3(OH)2 (?) CP2 Bright, slick, not very cohesive; green CP3 Copper carbonate: azurite Cu3(CO3)2(OH)2 (?) Powdery, cohesive; blue CP4 Powdery, slick, not very cohesive; black (?) CP5 Dense, cohesive ; brown-orange Copper oxide, Cuprite Cu2O (?) CP6 Powdery, not very cohesive; white Copper chloride, nantokite CuCl (?) Copper oxide, Cuprite Cu20 (?) CM1 Intergranular corrosion : brown M1 Leaded bronze with a high concentration of Sn

Credit HE-Arc CR, E.Perret-Gentil.

# Fig 22: Improved representation of the stratigraphy of corrosion layers of the bracelet from visual observations and analyses,

## ☐ Conclusion

The metal of the bracelet is a leaded bronze with a high concentration of Sn et Pb. The object was cast and certainly cold-worked to smooth the surface. The metal is heterogeneously corroded with Robbiola types I and II. The limit of the original surface is at the CP1 and CP2 interface. Both layers contain high amounts of Sn and P, validating in the latter case, the funeral context where the object was found.

# ☐ References

# References on object and samples

- 1. Scott, 1991: Scott, David A. Metallography and Microstructure of Ancient and Historic Metals. Getty Publications, Los Angeles, 1991
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