LADLE WITH COCKEREL IIB 4016 - LEADED BRONZE - LATE BRONZE AGE - THAILAND

Artefact name Ladle with cockerel IIb 4016

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Url /artefacts/1643/

The object

Fig. 1: Ladle, front view, before conservation interventions, *Credit HE-Arc CR, C.Foessel.*

Fig. 2: Ladle, rear view, before conservation interventions, *Credit HE-Arc CR, C.Foessel.*

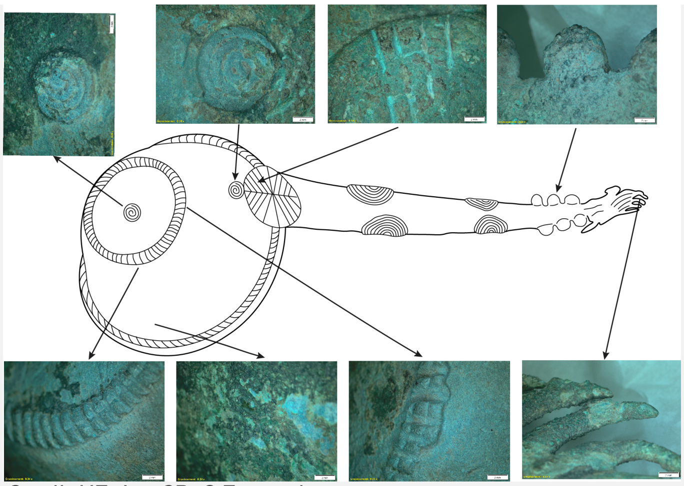


Fig.3: Detailed decorations of the ladle, before conservation interventions,

Credit HE-Arc CR, C.Foessel.

Fig.4: Ladle, front view, after conservation interventions,

Credit HE-Arc CR, C.Foessel.

Fig.5: Ladle, rear view, after conservation interventions,

Credit HE-Arc CR, C.Foessel.

Description and visual observation

Description of the artefact	Ladle with long, slightly curved handle topped with a rooster and ending in a round bowl. It is covered with green corrosion products mixed with sediment (Figs. 1 and 2). The handle features decorative ornamentation and has two breaks (Figs. 4 and 5). Dimensions: Length = 30cm, bowl diameter = 10.6cm.
Type of artefact	Ladle

Origin	Ban Chiang archaeological site, Udon Thani, Changwat Udon Thani, Thailand
Recovering date	Date unknown
Chronology category	Late Bronze Age
chronology tpq	500 B.C.
chronology taq	300 B.C.
Chronology comment	The proposed time frame is an estimate
Burial conditions / environment	Soil
Artefact location	Museum der Kulturen, Basel
Owner	Museum der Kulturen, Basel
Inv. number	IIb 4016
Recorded conservation data	N/A

Complementary information

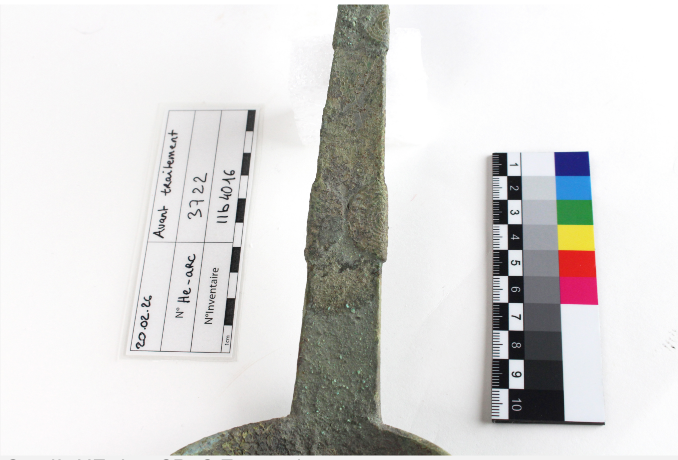
There is no information available regarding the archaeological context. In 2008, Elsbeth Walder-Bachmann donated this object to the museum. Previously, the object was likely on the post-excavation art market. The fractures are old and were repaired with an adhesive mixed with corrosion products and pigments.

The object was made using the lost-wax casting technique. This technique allowed for the creation of highly detailed decorations.

Study area(s)

Credit HE-Arc CR, C.Foessel.

Fig.6: Closer view of the top of the handle with the rooster, before conservation interventions. The fracture zone (Fig. 15) is covered by an adhesive mixed with corrosion products and pigments,



Credit HE-Arc CR, C.Foessel.

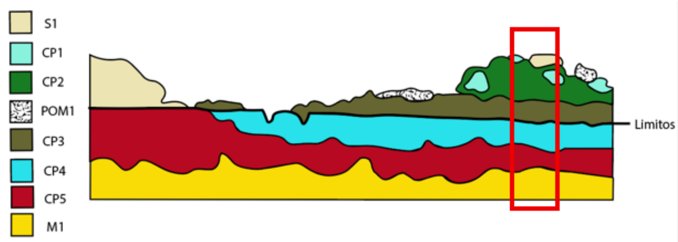
Fig.7: Fracture zone at the bottom of the handle (Fig. 14) covered by an adhesive mixed with corrosion products and pigments, before conservation interventions,

Credit HE-Arc CR, C.Foessel.

Fig.8 : Location of XRF analyses on the front and rear faces of the handle,

Binocular observation and representation of the corrosion structure

The schematic diagram below provides an overview of the corrosion layers observed on the ladle following an initial examination under a binocular microscope.



Layer	Reasons	Color	Description
S1		Yellow ochre, orange	Powdery yellow sediment
CP1		Turquoise Blue	Turquoise powdery corrosion pustule
CP2		Dark green	Hard spongy corrosion
POM 1 (Fig.10)		-	Vegetable fibers, mineralized rice grains
CP3		Green, Brown/Olive Green	Copper corrosion with a mat and quite powdery appearance
CP4		Light Green / Turquoise	Dense copper corrosion
CP5		Brown / Red	Matte, dense
M1		?	The metal is not visible (yellow -> bronze)

Credit HE-Arc CR, C.Foessel.

Fig. 9: Stratigraphic representation of the corrosion structure of the laddle by macroscopic and binocular observation with reference to Fig. 10, The red rectangle represents the MiCorr stratigraphy (Fig. 11),

Credit HE-Arc CR, C.Foessel.

Fig.10: Mineralized rice grain impressions, exterior of the bowl,

MiCorr stratigraphy(ies) – Bi

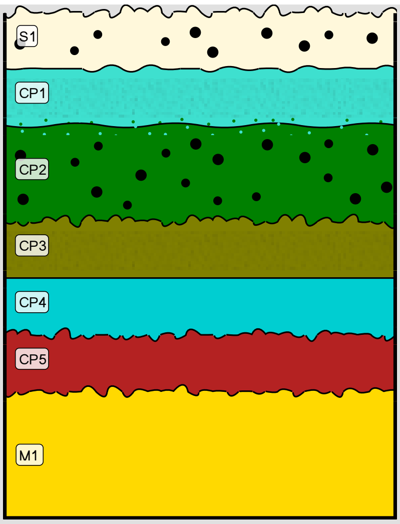


Fig. 11: Stratigraphic representation of the corrosion structure of the ladle, as observed under a binocular microscope (Fig. 9, the red rectangle) using the MiCorr application. The characteristics of the layers can only be accessed by clicking on the image, which redirects you to the stratigraphic search tool. Credit HE-Arc CR, C.Foessel.

Sample(s)

Credit HE-Arc CR, C.Foessel.

Fig.12: Sample 1 - turquoise powdery corrosion (CP1),

Description of sample	Only one sample (Sample 1) was taken. It corresponds to the powdery turquoise-blue corrosion product found on the handle of the ladle, near a semicircular decoration.
Alloy	Leaded Bronze
Technology	casting and cold working
Lab number of sample	1
Sample location	None
Responsible institution	None
Date and aim of sampling	18.03.2026, chemical analysis

Complementary information

None.

Analyses and results

Analyses performed:

Non-invasive approach

- XRF with handheld portable X-ray fluorescence spectrometer (NITON XL5). General Metal mode, acquisition time 60s (filters: Li20/Lo20/M20).
- X-radiography (142 kV, 5 mA, 40s, d = 100cm).
- Raman (spectral range 54-1633cm^{-1}).

Invasive approach

- Scanning electron microscopy /Energy Dispersive X-ray Spectrometry (SEM-EDS) on sample 1. Analysis was performed with a Jeol JSM-6400 device, 20,0 kV, x5k.
- Raman (spectral range 633-1800cm-1, 10mW, 5 accumulations of 20s, objective x50).

Non invasive analysis

Ten zones were analysed with XRF (Fig. 8). Fig. 13 gives the details of the results. The metal is a leaded bronze containing a small percentage of antimony (Sb). Table 1 is summarising them.

Elements	Cu	Sn	Pb	Sb
Mass %	38.5 - 85	6 - 39.5	5.5 - 21	<1

Table 1: Chemical composition of the metal. Method of analysis: HE-Arc portable XRF.

Except for the ornementation, the concentrations of tin (Sn) and lead (pb) are high (Sn>15% and Pb>10%).

X-radiography image revealed two fractures on the ladle's handle. These fractures, covered with adhesive and pigments/corrosion products, indicate that the object has undergone a previous restoration. The decorative motifs are also clearly visible, and the porosity suggests that the object was cast (Fig. 14). At the end of the handle, a loop beneath the rooster is visible (Fig. 15), although it is filled with corrosion products when viewed in visible light (Fig. 6).

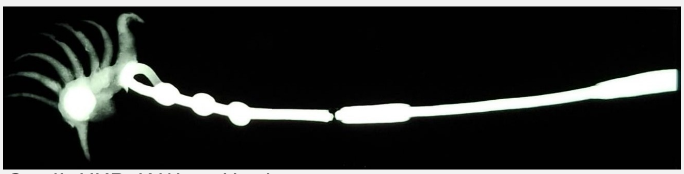
Measurement	Location	Cu %	Sn %	Pb %	Sb %
Footnote 1	Bowl	38,5	39,5	16,3	0,7
2	Sleeve	65,5	19,2	9,7	0,3
3	Medallion	60,9	15	19,2	0,3
4	Cracked handle	60,6	15,2	20,9	< LOD (Limit of detection)
5	Semi-Circle Ornament 2	81,7	6,1	10,6	0,1
6	Sleeve incision - Front side	64,3	22,1	11,7	0,4
7	Semi-Circle Ornament 4	58,2	30,2	9	0,3
8	Decorative Knob	85	7,9	5,6	0,1
9	Rooster	53,5	27,3	16,3	0,5
10	Bottom Bowl	48	28,9	20,9	0,5

Credit HE-Arc CR, C.Degrigny.

Fig. 13: XRF analyses with rounded results,

Credit HKB, K.Wyss Heeb.

Fig. 14: X-radiography image of the handle of the ladle showing the two fractures,



Credit HKB, K.Wyss Heeb.

Fig. 15: X-radiography image of the cockerel of the side of the handle showing the top fracture,

Metal

The metal itself has not been analysed. By questioning MiCorr database based on the MiCorr stratigraphy of Fig. 11, we found a similar object in the database: bracelet with dragonflies IIb 4025.01 coming from the same archaeological site, which core composition is in the range of the compositon indicated in table 1.

Microstructure	Unknown
First metal element	Cu
Other metal elements	Sn, Pb

Complementary information

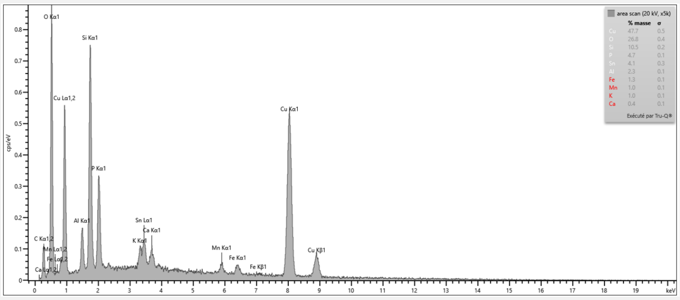
As the object was presumably produced using the lost-wax casting process (cast metal), a dendritic microstructure is to be expected, similar to that of the metal in bracelet IIb 4025.01.

Corrosion layers

The turquoise-blue sample (Fig. 12) was analyzed using SEM-EDS, which identified the following significant elements: copper, tin, magnesium, and phosphorus (Fig. 16).

Raman spectroscopy performed on this sample revealed the presence of copper hydroxide phosphate, identified as libethene ($Cu_2(OH)(PO_4)$) (Fig. 17). The presence of phosphates on buried metals often indicates the proximity of a burial site, as the decomposition of bones releases phosphorus. This marker, which is also associated with cremation sites and arid climates, supports the hypothesis that the ladle is a funerary object. Similar results were obtained for bracelet IIb 4025.01.

Malachite was also identified on the medallion of the ladle (Fig.18) using Raman spectroscopy.



Credit HEI-Arc, S.Ramseyer.

Fig. 16: EDS spectrum of sample 1,

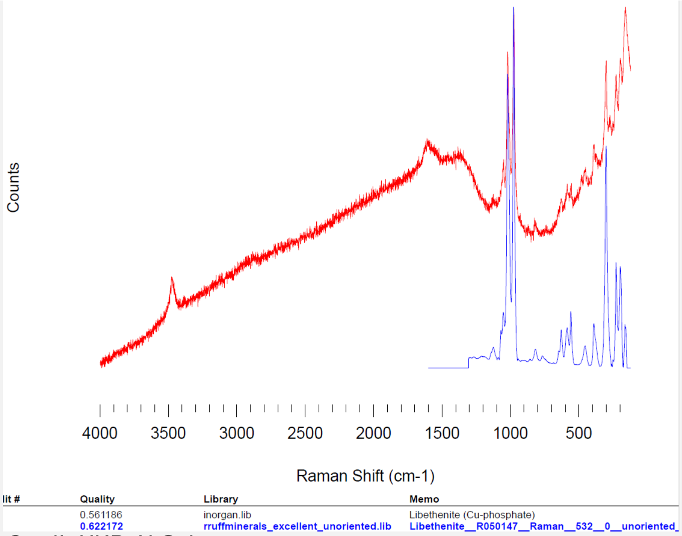


Fig. 17: Raman spectrum of sample 1 showing the presence of libethenite $Cu_2(OH)(PO_4)$,

Credit HKB, N.Scherrer.

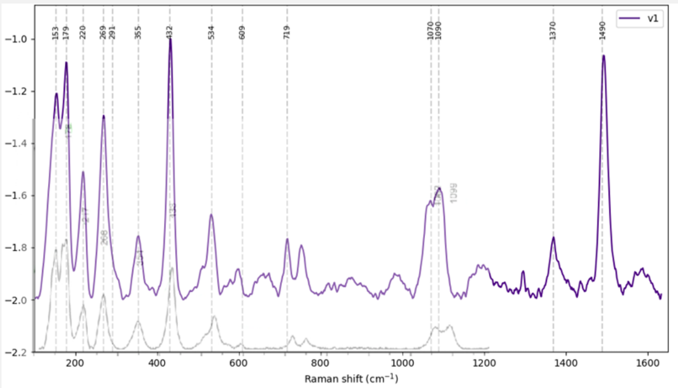


Fig. 18: Raman spectrum of the corrosion layer covering the medallions of the ladle. Spectrum in grey is standard malachite $Cu_2CO_3(OH)_2$,

Credit HE-arc CR, P.J.Petrasz.

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

Complementary information

None.

MiCorr stratigraphy(ies) – CS

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

All information concerning corrosion products is shown in the final stratigraphic profile (Fig. 19).

The boundary of the original surface (limitos) lies at the interface between the CP4/CP5 layers and the CP3 layer. However, the pseudomorphs of organic matter (POM) have been preserved. In particular, impressions of rice grains were identifiable.

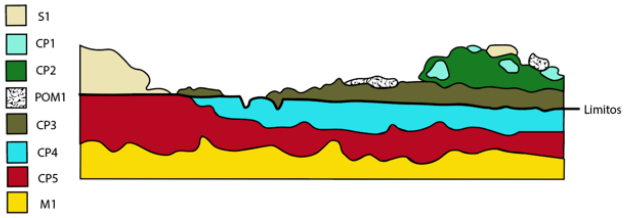


Fig. 19: Final stratigraphic representation of ladle,

Layer	Reasons	Color	Markers	Description
S1		Yellow ochre, orange	Superior : Earth sediments and sand grains	Powdery yellow sediment
CP1		Turquoise Blue		Turquoise powdery corrosion pustule identified by the Raman as libethenite $Cu_2(PO_4)(OH)$, copper hydroxide phosphate
CP2		Dark green		Hard spongy corrosion (Malachite, $Cu_2CO_3(OH)_2$?)
POM 1 (Fig.10)		-	Superior : Mineralized Organic Products	Vegetable fibers, mineralized rice grains
CP3		Green, Brown/Olive Green	Superior : corrosion	Copper corrosion with a matt and quite powdery appearance (Malachite, $Cu_2CO_3(OH)_2$?)
CP4		Light Green / Turquoise	Corresponding : Smooth surface and incised decorations	Dense copper corrosion identified by Raman as Malachite, $Cu_2CO_3(OH)_2$
CP5		Brown / Red	Matching: Surface Smooth	Matte, dense (cuprite Cu2O ?)
M1		?	Lower	The metal is not visible but was hit during the clearing

Credit HE-Arc CR, C.Foessel.

Conclusion

The ladle is a leaded bronze containing small amount of antimony. The object was probably cast using the lost-wax technique. The analysis of corrosion products has provided insight into the nature of the object (funeral?) and the context in which it was buried (burial site?), and the mechanisms of its deterioration by comparison to an object from the same archaeological site, from MiCorr database (bracelet IIb 4025.01). No active corrosion was identified.

References

References on object and analytical methods

Reference on object

1. MiCorr_Bracelet IIb 4025.01
2. Higham C., Higham T., Ciarla R., Douka K., Rispoli A., Rispoli K., and Rispoli F. (2011), The Origins of the Bronze Age of Southeast Asia. Springer Science+Business Media.
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4. White J.C. and and Hamilton E.G. (2019) Ban Chiang, Northeast Thailand, Volume 2B: Metals and Related Evidence from Ban Chiang, Ban Tong, Ban Phak Top, and Don Klang. Philadelphia : University Museum Publications.

Reference analytical methods

5. Scott D.A. (2003) Copper and bronze in art: corrosion, colorants, conservation. Getty Publications, Los Angeles.