FUNERARY FLASK VK_D_1783 - CU/AS/PB - MEDIEVAL TIMES - PERU

Artefact name Funerary flask VK_D_1783

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Url /artefacts/1649/

The object



Fig. 1: Funerary flask,

Credit HE-Arc CR, V.Ferati.

Description and visual observation

Description of the artefact Peruvian funerary flask, approximately 9.5 cm high, which consists of two hemispheres joined at their centers. They are held at the sides by stape-like fasteners and attached to a hollow, flared base. Two long, hollow cylindrical tubes rise from the top of the sphere (Fig. 1).

Type of artefact Funeral flask

Origin Lambayeque, Peru

Recovering date Date of excavation unkown, acquisition in 1932

Chronology category Medieval times

chronology tpq 100 A.D.

chronology taq 1400 A.D.

Chronology comment Could be from the Moche (100-700), Sicàn (700-1350) or Chimù (900-1450) civilization

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Burial conditions / environment	Unknown
Artefact location	Kulturmuseum St-Gallen
Owner	Kulturmuseum St-Gallen
Inv. number	VK_D_1783
Recorded conservation data	Ancient inventory informations

Complementary information

None.

Study area(s)



Credit HE-Arc CR, V.Ferati.

Fig. 2: The funerary flask showing the location of XRF analyses (white points), sampling areas for SEM-EDS (red points) and sampling area for examination on cross-section (red rectangle),

Binocular observation and representation of the corrosion structure

The schematic representation below gives an overview of the corrosion layers encountered on the funerary flask from the visual macroscopic observation.

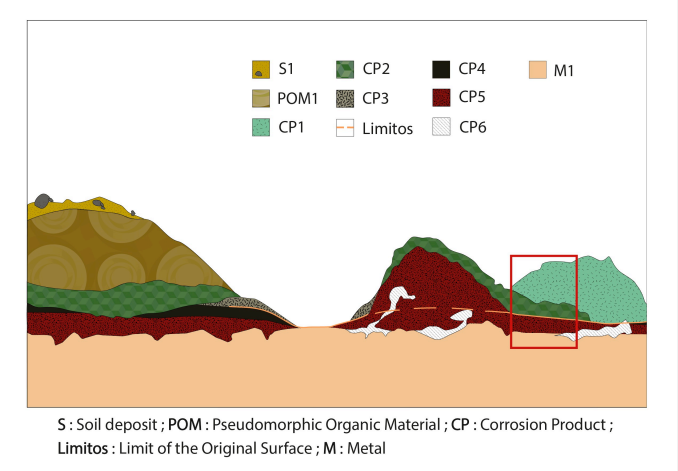


Fig. 3: Stratigraphic representation of the funerary flask by macroscopic and binocular observation,

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Credit HE-Arc CR, V.Ferati.

MiCorr stratigraphy(ies) – Bi

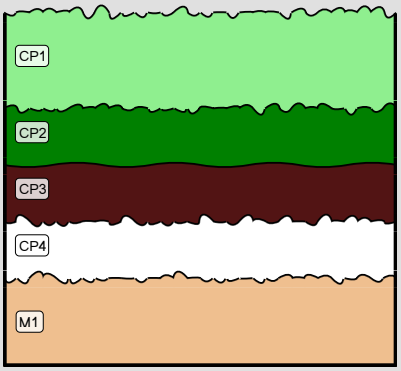


Fig. 4: Stratigraphic representation of the corrosion structure (red box on Fig.3) of the funerary flask observed macroscopically under binocular microscope using the MiCorr application. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation. CP5 and CP6 in Fig. 3 are CP3 and CP4, credit HE-Arc CR, V.Ferati.

Sample(s)

Description of sample	A polished cross-section was made from the already twisted damaged part on the flask (red square on Fig. 2) and embedded in resin. We can see the thin layer of corrosion mostly on the left side of the metal.
Alloy	Cu/As/Pb
Technology	Hammered
Lab number of sample	None
Sample location	Haute École Arc Neuchâtel, Neuchâtel
Responsible institution	Kulturmuseum St-Gallen
Date and aim of sampling	2026, metallography and chemical analyses

Complementary information

None.

Analyses and results

Analysis performed :

Non-invasive approach

- XRF, handheld device ***Thermo Scientific^{TM} Nixton XL3t Goldd +, general metal mode (20s Main / 20s Low / 20 s Light) and mining mode (20s Main / 20s Lw / 20s High / 20s Light),***
- X-radiography (44kV, 5 mA, 60s, d = 100cm).

Invasive approach

- SEM-EDS performed on individual samples and on the cross-section with an acceleration voltage of 20kV,
- Raman Spectroscopy (green laser).

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Non invasive analysis

The XRF analysis showed that the metal is probably a copper alloy, containing both lead (Pb) and Arsenic (As) in small concentrations (<1% mass).

X-ray radiography shows that the metal has been hammered repeatedly (Fig. 6).



Credit HKB, K.Wyss Heeb.

Fig. 6 : X-radiography image of the funerary flask. Fasteners are clearly visible all along the hollow cylindric tubes. The metal sheet between them is highly mineralised,

Metal

The metal consists of a copper-arsenic alloy (Table 1).

Elements	Cu	As
Mass %	98.8	1.2

Table 1: SEM-EDS analysis of the metal of the funerary flask (Fig. 7).

with lead and arsenic inclusions (Fig. 8).

The metal of this object is really thin and quite hard. Unfortunately the chemical etching that we tried on this cross-section did not give satisfactory results so we were not able to see the microstructure of the metal.

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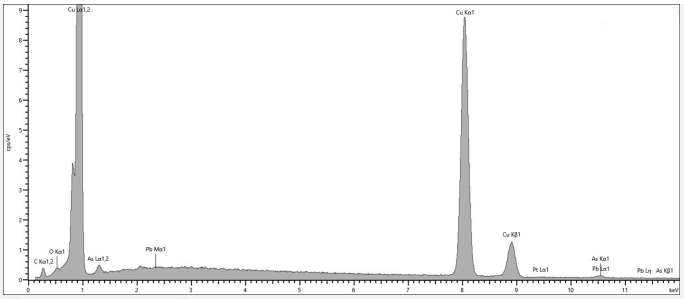


Fig. 7: EDS analysis of the metal. Mostly Cu and As with traces of Pb are found,

Credit HEI-Arc, S.Ramseyer.

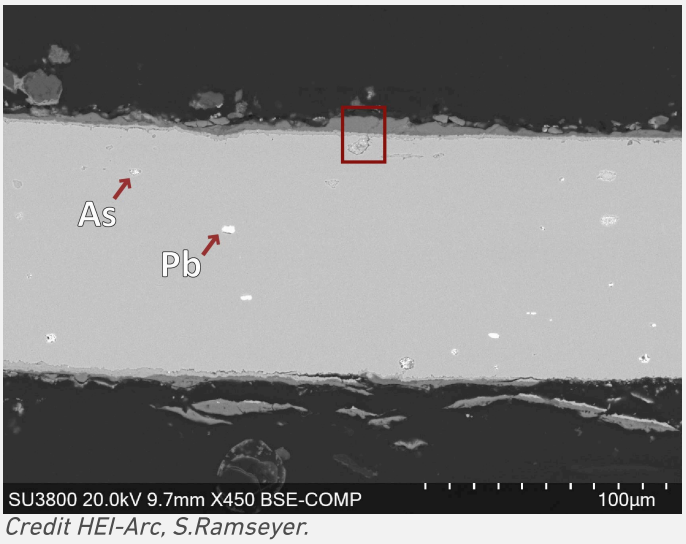


Fig. 8: SEM image, BSE-mode, of the metal sample from Fig. 2 with location of Fig. 9 (red square). Light-grey (As) and white (Pb) inclusions are distributed evenly,

Credit HEI-Arc, S.Ramseyer.

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

Complementary information

None.

Corrosion layers

Even though active corrosion could not be clearly visualised optically, the examination of the cross-section revealed the presence of chlorides in the whole corrosion structure (Figures 9-13). These chlorides become active upon contact with oxygen and high relative humidity.

Active Corrosion (CP1 and CP6)

Chlorides from the environment entered the metal over centuries. They remain present throughout the metal and all corrosion layers. Upon excavation, exposure to oxygen and air humidity activated these chlorides. This activation is the root cause of the ongoing corrosion process. A white layer of nantokite (spectrum 42 - CP6, Fig. 9) was found near the sound metal and confirmed by EDS (Fig. 12), explaining the active corrosion. The powdery light green crystals on the top surface are atacamite (Fig. 9, CP1) a secondary corrosion product of nantokite. Its presence is confirmed by Raman spectroscopy (Fig. 13).

Mineralized Organic Remains (POM)

Circular micro-structures and a thicker corrosion layer identify mineralized organic remains on the vials. SEM analysis failed due to sample fragility during removal. Specialist examination ruled out textile and suggested mineralized leather instead. Traces appear on both faces, the sphere, and the transverse arch, indicating the object was likely entirely wrapped.

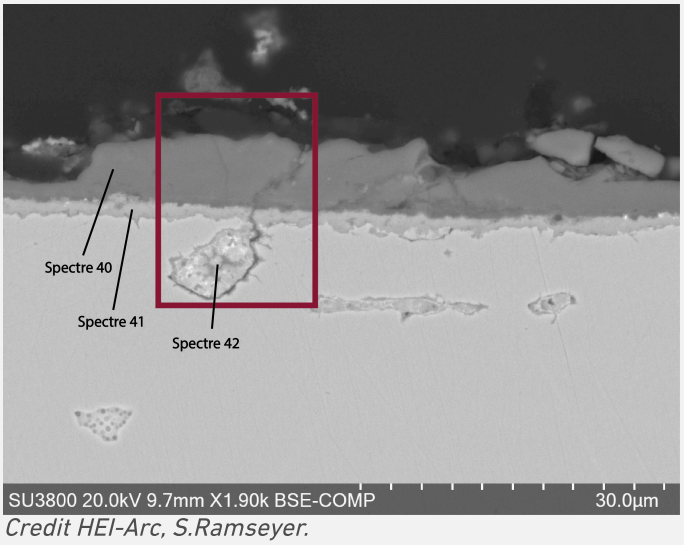
Black Corrosion (CP3 and CP4)

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Black tufted corrosion from copper sulfides affects the flask on large areas. It likely originated from sulfate-reducing bacteria in anaerobic burial sediments. Raman analysis seems to indicate the presence of covellite (CuS, Fig. 14). This sulfide appears powdery on outer layers and crystalline where oxygen was limited.

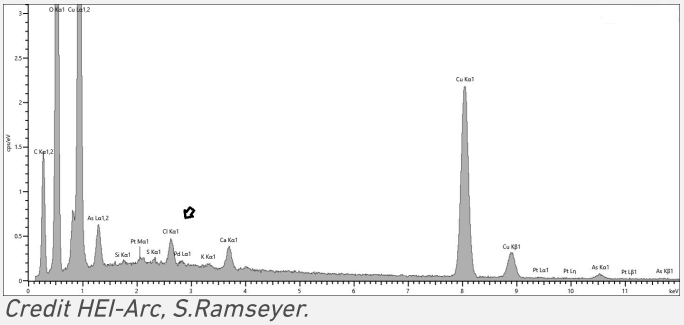
Stable Corrosion and Metal State (CP2 and CP5)

Cuprite (CP5, Fig. 11) and malachite (?, CP2, Fig. 10) layers are stable, classic alteration products that protect the metal core. Unlike active corrosion, these layers are not deteriorating further. X-ray radiography confirmed the underlying metal remains sound. Gray variations on the X-ray image reflect the object's thickness and 3D shape, not metal degradation.



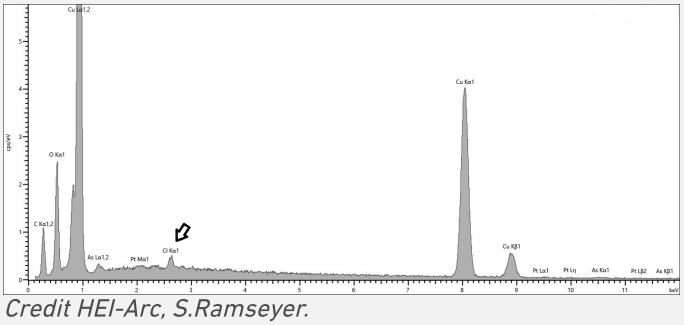
Credit HEI-Arc, S.Ramseyer.

Fig. 9: SEM image of Chlorid corrosions roots, BSE-mode (detail of Fig. 8), spectrum 40 is detailed in Fig. 10, spectrum 41 is detailed in Fig. 11 and spectrum 42 is detailed in Fig. 12. Powdery compounds on top might be atacamite but were not analysed by EDS,



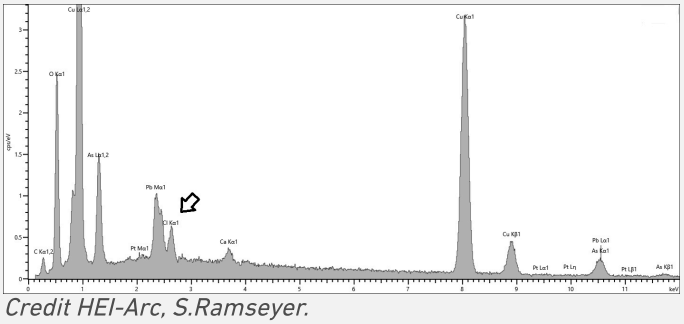
Credit HEI-Arc, S.Ramseyer.

Fig. 10: EDS analysis corresponding to spectrum 40 - CP2 (Fig. 9),



Credit HEI-Arc, S.Ramseyer.

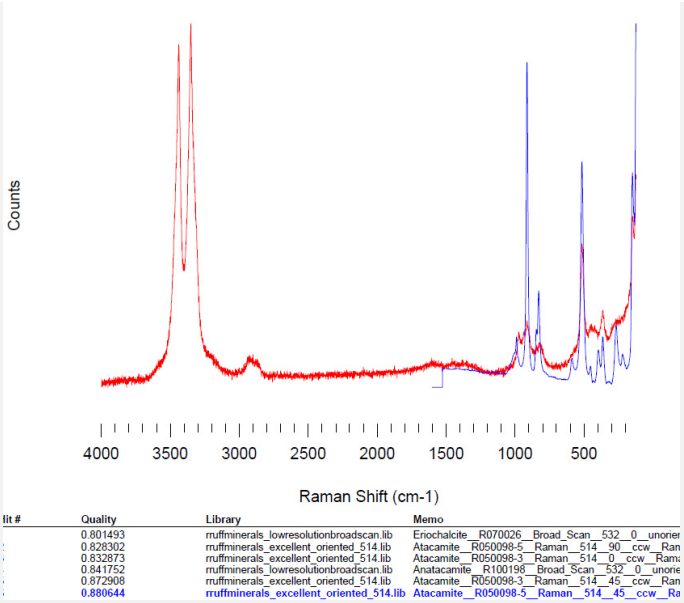
Fig. 11: EDS analysis corresponding to spectrum 41 - CP5 (Fig. 9),



Credit HEI-Arc, S.Ramseyer.

Fig. 12: EDS analysis corresponding to spectrum 42 - CP6 (Fig. 9),

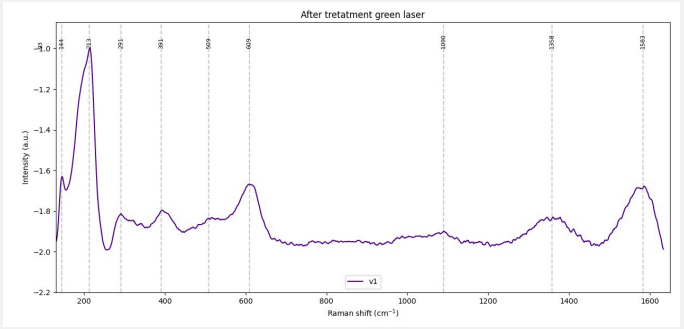
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lit #	Quality	Library	Memo
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	0.828302	rruffminerals_excellent_oriented_514.lib	Atacamite__R050098-5__Raman__514__90__ccw__Ran
	0.832873	rruffminerals_excellent_oriented_514.lib	Atacamite__R050098-3__Raman__514__0__ccw__Rama
	0.841752	rruffminerals_lowresolutionbroadscan.lib	Anatacamite__R100198__Broad_Scan__532__0__unorie
	0.872908	rruffminerals_excellent_oriented_514.lib	Atacamite__R050098-3__Raman__514__45__ccw__Ran
	0.880644	rruffminerals_excellent_oriented_514.lib	Atacamite__R050098-5__Raman__514__45__ccw__Ra

Credit HKB, N.Scherrer.

Fig. 13: Raman spectrum of CP1 and comparison with Ruffminerals database,



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

Fig. 14: Raman spectrum of CP3 and CP4,

Corrosion form Multiform

Corrosion type Unknown

Complementary information

None.

MiCorr stratigraphy(ies) – CS

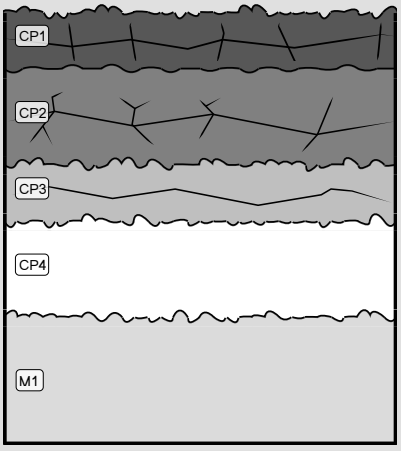


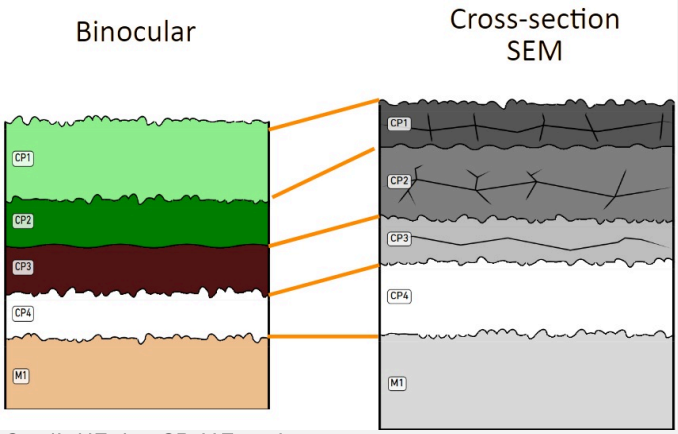
Fig. 15: Stratigraphic representation of the sample from the funary flask in cross-section (SEM) using the MiCorr application. The characteristics of the strata are only accessible by clicking on the drawing that redirects you to the search tool by stratigraphy representation. This representation was build according to Fig. 9, credit HE-Arc CR, V.Ferati.

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

The observation under binocular microscope and cross-section both identified 4 similar CPs with different widths though.

Using a binocular microscope, it is possible to distinguish the strata based on texture and color variations, whereas in cross-section (SEM), these strata exhibit different shades of gray, even though they are composed of similar elements at varying concentrations.



Credit HE-Arc CR, V.Ferati.

Fig. 16: Stratigraphic representation side by side of binocular view and cross-section (SEM),

Conclusion

The metal is arsenical copper containing some lead inclusions. It appears to have been hammered repeatedly. The corrosion layers are typical of buried archaeological metal: cuprite, sulfides, and hydroxycarbonates. Chlorides have been detected and could trigger active corrosion.

References

References on object and analytical methods

- Scott, D. A. (1992) ***Metallography and microstructure in ancient and historic metals***. Getty publications.
- Scott, D. A. (2002) ***Copper and bronze in art: corrosion, colorants, conservation***. Getty publications.

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