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Cat. XII - Preziosi Articoli d'Arte ed Antiquariato (18B, 18N)



Milano, 05.09.2025

Analysis report:
Object: Corean Goryeo bronze
Client: Marco Polo Auctions

Date of analysis: 04.09.2025
Type of analysis: XRF analysis
Number of pages:

The Corean Goryeo lost wax technique bronze was examined with XRF to determine the alloy composition. Several tests were done with an Olympus Vanta VCR series (serial number 823330) portable XRF analyzer., equipped with 40 kV X-ray tube with rhodium (Rh) anode and SDD (Silicon Drift Detector). Running for 60 seconds .3. mm spotsize. Profile used are Geochem(2), AlloyPlus and Precious Metals.

Results

1. Base alloy, "bulk" point on the metal
Cu 74.791%, Sn 12.533%, Pb 7.368%, Fe 1.384%, As 1.259%. Silver 0.618% by weight. Historically consistent traces of Bi, Sb, Zn, Ba, Ti, Ni. The data comes from the Chemistry page of the Geochem(2) profile.
2. Same point, "surface" reading with AlloyPlus
Cu 67.48%, Sn 10.159%, Pb 8.340%, with strong emergence of light surface elements, Si 6.237%, Al 2.52%, S 1.918%, P 0.863%. Silver 0.452%.
3. Visible gilding on the robe, left side
Precious Metals detects Au 10.676% on the surface, Cu 75.94%, Sn 7.29%, Pb 3.879%. Typical modern galvanic interlayers Ni and Cr are absent within the LOD. Silver 0.459%.
4. Black lacquered hair, back of the neck
Thick lacquer signature: LE 63.32%, S 2.825%, Si 2.822%, Ca 2.071%, K 0.594%, P 0.174%, with Cu 18.92%, Sn 3.047%, Pb 3.077% attenuated by the organic film. Silver 0.140% due to shielding effect.
5. Face, whitish area on the chin
Geochem shows Cu 53.312%, "W" 33.598%, Sn 7.737%, Pb 1.252%, Ag 0.427%. Here

the noble metal peak between 9.7 and 11 keV was labeled as W by the automatic fit. In light of test 3, it is actually Au residual from gilding.

Why silver matters here

Across independent profiles you consistently read silver around the half-percent level in the bronze matrix, for example 0.618 percent in the bulk test, 0.452 percent in AlloyPlus, 0.459 percent in the Precious Metals run, about 0.140 percent where lacquer is thick, about 0.427 percent on the gilded chin. This is the signature of preindustrial copper from argentiferous ores that was not fully desilvered by historic refining. In period, silver was precious and diverted to coinage and jewelry, so founders tried to remove as much as possible, yet residual Ag at the 0.3 to 0.7 percent level is common in older bronzes. With improved refining through the early modern period and the industrial 19th century, Ag in utility bronzes tends toward trace or below detection. Your readings, stable across methods and sites, are coherent with that older technology.

Alloy: a castable Cu–Sn–Pb bronze, Sn about 12 to 13 percent and Pb about 7 to 8 percent, with arsenic and bismuth in meaningful traces, fits a historic, not standardized, metallurgy.

Gilding: surface Au is present and widespread. No nickel or chromium interlayers typical of modern electroplating are detected.

Lacquer finishes: the black hair zone is a thick organic, mineral-charged coating that masks the substrate, exactly what you expect on an original finish

Dr. Andrea Ciaroni



bibliography:

Scott D A, Copper and Bronze in Art, Getty

Craddock P T, Early Metal Mining and Production, Edinburgh University Press

Oddy A, Gilding of Metals in the Ancient World, British Museum Technical Research Bulletin

Needham J, Science and Civilization in China, Chemistry and Chemical Technology

1) and 2) Chemistry of the rim under the base, test 1 and 2

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Geochem(2)
Sep 4, 2025, 6:03:02 PM



Chemistry	Spectrum	Notes	Map
Display nSigma : 1 Show Estimated LOD Show Uncertainty Show User Factor Name			
El	PPM	+/-	
Cu	74.791%	0.059	
Sn	12.533%	0.034	
Pb	7.368%	0.024	
Fe	1.384%	0.011	
As	1.259%	0.021	
Bi	6360	160	
Ag	6177	69	
Sb	3349	99	
Ba	3240	440	
Ti	2190	240	
Zn	1865	100	
Mn	1008	43	
Ni	671	38	
W	665	90	
Co	295	35	
Se	257	24	
Zr	181	11	

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AlloyPlus
Sep 4, 2025, 6:07:13 PM



Chemistry	Spectrum	Notes	Map
No grade to compare			Display nSigma : 1 Show Estimated LOD Show Uncertainty Show User Factor Name
EI	%	+/-	
Cu	67.48	0.17	
Sn	10.159	0.044	
Pb	8.340	0.033	
Si	6.237	0.098	
Al	2.52	0.20	
S	1.918	0.032	
Fe	1.512	0.014	
P	0.863	0.036	
Ag	0.452	0.006	
Sb	0.189	0.011	
W	0.117	0.010	
Bi	0.096	0.009	
Zn	0.046	0.008	
Ni	0.038	0.004	
Mn	0.023	0.004	
Mo	0.005	0.001	
< LOD			
EI	%	+/- 3σ	

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3) Lower left side, gilded vest

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Precious Metals
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Chemistry	Spectrum	Notes	Map
			Display nSigma : 1 Show Estimated LOD Show Uncertainty Show User Factor Name
El	%	+/-	
Cu	75.94	0.12	
Au	10.676	0.058	
Sn	7.290	0.044	
Pb	3.879	0.032	
Os	1.09	0.13	
Fe	0.655	0.013	
Ag	0.459	0.012	
Mn	0.018	0.006	
< LOD			
El	%	+/- 3σ	
Ti	ND	<0.038	
Cr	ND	<0.017	
Co	ND	<0.016	
Ni	ND	<0.013	
Zn	ND	<0.029	
Ga	ND	<0.022	
Ge	ND	<0.034	
Zr	ND	<0.005	



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4) Back side of the head, black hair

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Geochem(2)
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Chemistry	Spectrum	Notes	Map
			Display nSigma : 1 Show Estimated LOD Show Uncertainty Show User Factor Name
EI	PPM	+/-	
LE	63.32%	0.32	
Cu	18.92%	0.17	
Pb	3.077%	0.028	
Sn	3.047%	0.029	
S	2.825%	0.028	
Si	2.822%	0.040	
Ca	2.071%	0.019	
Fe	9830	110	
Al	7480	520	
K	5942	85	
As	3932	82	
W	2592	58	
P	1739	74	
Ba	1550	210	
Ag	1399	26	
Bi	1114	60	
Sb	939	38	

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5) Gilded face

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Geochem(2)
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Chemistry	Spectrum	Notes	Map
			Display nSigma : 1 Show Estimated LOD Show Uncertainty Show User Factor Name
EI	PPM	+/-	
Cu	53.312%	0.052	
W	33.598%	0.054	
Sn	7.737%	0.024	
Pb	1.252%	0.012	
Se	8959	93	
Bi	5110	130	
U	4986	65	
As	4882	88	
Rb	4329	39	
Ag	4273	52	
Ba	2420	320	
Fe	1858	53	
Sb	1814	74	
Ti	1040	160	
Mn	477	33	
Cr	423	37	
V	307	51	



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