Table 42.1. Results of the ICP-AES analyses made at the C2RMF on the bronze parts of the Piombino Apollo. Results in wt% or wt. ppm. X = base metal (not quantified). nd = below the limit of detection.

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Analysis No.** | **Sample location** | **Casting type** | **Cu** | **Sn** | **Pb** | **Ag** | **As** | **Fe** | **Ni** | **S** | **Sb** | **Zn** |
|  | (wt.%) | (wt.%) | (wt.%) | (wt.%) | (wt.%) | (wt.%) | (wt.%) | (wt.%) | (wt.%) |
| FZ20669-a | Head (curl) | PC | X | 6.3 | 21 | 0.046 | 0.16 | 0.045 | 0.075 | 0.15 | 0.059 | nd |
|  | ±0.6 | ±2 | ±0.005 | ±0.02 | ±0.005 | ±0.008 | ±0.01 | ±0.006 | <0.00069 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-b | Welding: head - body (left basin) | SC (welding) | X | 6.5 | 21 | 0.047 | 0.17 | 0.041 | 0.076 | 0.15 | 0.061 | nd |
|  | ±0.7 | ±2 | ±0.005 | ±0.02 | ±0.004 | ±0.008 | ±0.01 | ±0.006 | <0.00080 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-c | Body (right flank) | PC | X | 5.1 | 20 | 0.043 | 0.17 | 0.12 | 0.068 | 0.13 | 0.055 | nd |
|  | ±0.5 | ±2 | ±0.004 | ±0.02 | ±0.01 | ±0.007 | ±0.01 | ±0.006 | <0.00079 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-d | Welding: right arm - body | SC (welding) | X | 9.3 | 13 | 0.081 | 0.51 | 0.11 | 0.071 | 0.26 | 0.11 | 0.047 |
|  | ±0.9 | ±1 | ±0.008 | ±0.05 | ±0.01 | ±0.007 | ±0.03 | ±0.01 | ±0.005 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-e | Right arm | PC | X | 6.5 | 21 | 0.045 | 0.16 | 0.043 | 0.073 | 0.19 | 0.059 | nd |
|  | ±0.6 | ±2 | ±0.005 | ±0.02 | ±0.004 | ±0.007 | ±0.02 | ±0.006 | <0.00096 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-f | Pinkie finger | PC | X | 6.0 | 19 | 0.042 | 0.15 | 0.035 | 0.069 | 0.13 | 0.054 | nd |
|  | ±0.6 | ±2 | ±0.004 | ±0.02 | ±0.003 | ±0.007 | ±0.01 | ±0.005 | <0.00096 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-g | Welding: pinkie finger - right arm | SC (welding) | X | 8.1 | 7.4 | 0.051 | 0.35 | 0.00081 | 0.031 | 0.051° | 0.078 | nd |
|  | ±0.8 | ±0.7 | ±0.005 | ±0.03 | ±0.00008 | ±0.003 | >0.020 | ±0.008 | <0.00070 |
|  |  |  |  |  |  |  | <0.067 |  |  |
| FZ20669-h | Left leg | PC | X | 5.1 | 16 | 0.040 | 0.18 | 0.13 | 0.068 | 0.13 | 0.053 | nd |
|  | ±0.5 | ±2 | ±0.004 | ±0.02 | ±0.01 | ±0.007 | ±0.01 | ±0.005 | <0.00066 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-i | Welding: left foot - left leg | SC (welding) | X | 6.0 | 19 | 0.044 | 0.17 | 0.025 | 0.075 | 0.13 | 0.056 | nd |
|  | ±0.6 | ±2 | ±0.004 | ±0.02 | ±0.003 | ±0.007 | ±0.01 | ±0.006 | <0.00073 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-j | Left foot (forefoot) | PC | X | 6.3 | 21 | 0.047 | 0.16 | 0.056 | 0.075 | 0.15 | 0.060 | nd |
|  | ±0.6 | ±2 | ±0.005 | ±0.02 | ±0.006 | ±0.007 | ±0.02 | ±0.006 | <0.00068 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-k | Right leg | PC | X | 6.3 | 19 | 0.045 | 0.18 | 0.024 | 0.072 | 0.12 | 0.057 | nd |
|  | ±0.6 | ±2 | ±0.005 | ±0.02 | ±0.002 | ±0.007 | ±0.01 | ±0.006 | <0.00089 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-l | Welding: right foot - right leg | SC (welding) | X | 5.5 | 17 | 0.041 | 0.16 | 0.025 | 0.075 | 0.13 | 0.051 | nd |
|  | ±0.5 | ±2 | ±0.004 | ±0.02 | ±0.003 | ±0.008 | ±0.01 | ±0.005 | <0.00072 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-m | Right foot (forefoot) | PC | X | 6.5 | 19 | 0.046 | 0.17 | 0.060 | 0.077 | 0.16 | 0.061 | nd |
|  | ±0.7 | ±2 | ±0.005 | ±0.02 | ±0.006 | ±0.008 | ±0.02 | ±0.006 | <0.00078 |
|  |  |  |  |  |  |  |  |  |  |
| FZ20669-n | Fourth toe of the right foot | SC (repair) | X | 4.2 | 13 | 0.18 | 0.40 | 0.0082 | 0.087 | 0.15 | 0.28 | 0.69 |
|  | ±0.4 | ±1 | ±0.02 | ±0.04 | ±0.0008 | ±0.009 | ±0.02 | ±0.03 | ±0.07 |
|  |  |  |  |  |  |  |  |  |  |

Table 1 (continued)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Analysis No.** | **Au** | **Ba** | **Bi** | **Cd** | **Co** | **Cr** | **Ge** | **Hg** | **In** | **Mg** | **Mn** | **Mo** | **P** | **Se** | **Te** | **Ti** | **U** | **V** | **W** |
| (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) | (wt. ppm) |
| FZ20669-a | 55 | nd | 140 | nd | 228 | nd | nd | 4.1 | 10 | nd | nd | 2.6° | nd | 12 | 27 | nd | nd | nd | nd |
| ±5 | <0.2 | ±14 | <0.2 | ±23 | <0.9 | <3.3 | ±0.4 | ±4 | <3.1 | <0.0 | <8.4 | <24 | ±2 | ±5 | <0.3 | <9.3 | <0.2 | <2.2 |
|  |  |  |  |  |  |  |  |  |  |  | >2.5 |  |  |  |  |  |  |  |
| FZ20669-b | 42 | nd | 138 | nd | 227 | nd | nd | 4.1 | 8.2 | nd | nd | nd | nd | 9.9 | 31 | nd | nd | nd | nd |
| ±4 | <0.3 | ±14 | <0.3 | ±23 | <1.0 | <3.9 | ±0.4 | ±1.7 | <3.6 | <0.1 | <2.9 | <28 | ±1.1 | ±3 | <0.3 | <11 | <0.3 | <2.6 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| FZ20669-c | 37 | nd | 63 | nd | 204 | nd | nd | 4.2 | 5.5° | nd | nd | nd | nd | 12 | 32 | nd | nd | nd | nd |
| ±4 | <0.3 | ±6 | <0.3 | ±20 | <1.0 | <3.8 | ±0.5 | <8.0 | <3.6 | <0.1 | <2.9 | <28 | ±1 | ±9 | <0.3 | <11 | <0.3 | <2.5 |
|  |  |  |  |  |  |  |  | >2.4 |  |  |  |  |  |  |  |  |  |  |
| FZ20669-d | 27 | nd | 122 | nd | 40 | nd | nd | 4.2 | 9.6 | nd | nd | nd | nd | 24 | 26 | nd | nd | nd | nd |
| ±3 | <0.3 | ±12 | <0.3 | ±4 | <1.1 | <4.3 | ±1.3 | ±4.8 | <4.0 | <0.1 | <3.3 | <31 | ±2 | ±9 | <0.4 | <12 | <0.3 | <2.9 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| FZ20669-e | 27 | nd | 138 | nd | 228 | nd | nd | 4.0 | 9.4° | nd | nd | nd | nd | 9.1° | 28 | nd | nd | nd | nd |
| ±3 | <0.3 | ±14 | <0.3 | ±23 | <1.2 | <4.6 | ±0.4 | <9.7 | <4.3 | <0.1 | <3.5 | <34 | <11.5 | ±3 | <0.4 | <13 | <0.3 | <3.1 |
|  |  |  |  |  |  |  |  | >2.9 |  |  |  |  | >3.4 |  |  |  |  |  |
| FZ20669-f | 24 | nd | 128 | nd | 208 | nd | nd | 3.7 | 3.7° | nd | nd | nd | nd | 6.5° | 21 | nd | nd | nd | nd |
| ±2 | <0.3 | ±13 | <0.3 | ±21 | <1.2 | <4.6 | ±0.7 | <9.7 | <4.3 | <0.1 | <3.5 | <34 | <11.5 | ±4 | <0.4 | <13 | <0.3 | <3.1 |
|  |  |  |  |  |  |  |  | >2.9 |  |  |  |  | >3.4 |  |  |  |  |  |
| FZ20669-g | 18 | nd | 57 | nd | 25 | nd | nd | 3.9 | 2.2° | nd | nd | nd | nd | 36 | 16 | nd | nd | nd | nd |
| ±2 | <0.2 | ±6 | <0.2 | ±3 | <0.9 | <3.4 | ±0.4 | <7.0 | <3.1 | <0.0 | <2.5 | <24 | ±4 | ±6 | <0.3 | <9.3 | <0.2 | <2.2 |
|  |  |  |  |  |  |  |  | >2.1 |  |  |  |  |  |  |  |  |  |  |
| FZ20669-h | 29 | nd | 57 | nd | 220 | nd | nd | 4.5 | 9.7 | nd | nd | nd | nd | 12 | 28 | nd | nd | nd | nd |
| ±3 | <0.2 | ±6 | <0.2 | ±22 | <0.8 | <3.2 | ±0.6 | ±1.1 | <3.0 | <0.0 | <2.4 | <23 | ±2 | ±3 | <0.3 | <8.9 | <0.2 | <2.1 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| FZ20669-i | 63 | nd | 66 | nd | 112 | nd | nd | 4.0 | 4.3° | nd | nd | nd | nd | 12 | 35 | nd | nd | nd | nd |
| ±6 | <0.3 | ±7 | <0.2 | ±11 | <0.9 | <3.6 | ±0.6 | <7.4 | <3.3 | <0.0 | <2.7 | <26 | ±2 | ±7 | <0.3 | <9.9 | <0.3 | <2.3 |
|  |  |  |  |  |  |  |  | >2.2 |  |  |  |  |  |  |  |  |  |  |
| FZ20669-j | 39 | nd | 141 | nd | 224 | nd | nd | 4.0 | 6.9 | nd | nd | nd | nd | 10 | 33 | nd | nd | nd | nd |
| ±4 | <0.2 | ±14 | <0.2 | ±22 | <0.9 | <3.3 | ±0.7 | ±1.7 | <3.1 | <0.0 | <2.5 | <24 | ±2 | ±6 | <0.3 | <9.2 | <0.2 | <2.2 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| FZ20669-k | 40 | nd | 60 | nd | 110 | nd | nd | 4.4 | 4.8° | nd | nd | nd | nd | 13 | 30 | nd | nd | nd | nd |
| ±4 | <0.3 | ±6 | <0.3 | ±11 | <1.1 | <4.3 | ±0.4 | <9.0 | <4.0 | <0.1 | <3.3 | <31 | ±2 | ±4 | <0.4 | <12 | <0.3 | <2.9 |
|  |  |  |  |  |  |  |  | >2.7 |  |  |  |  |  |  |  |  |  |  |
| FZ20669-l | 35 | nd | 54 | nd | 114 | nd | nd | 4.4 | 6.2° | nd | nd | nd | nd | 9.8 | 29 | nd | nd | nd | nd |
| ±4 | <0.2 | ±7 | <0.2 | ±11 | <0.9 | <3.5 | ±0.7 | <7.3 | <3.2 | <0.0 | <2.6 | <25 | ±1.0 | ±9 | <0.3 | <9.7 | <0.3 | <2.3 |
|  |  |  |  |  |  |  |  | >2.2 |  |  |  |  |  |  |  |  |  |  |
| FZ20669-m | 31 | nd | 135 | nd | 229 | nd | nd | 4.0 | 9.0 | nd | nd | nd | nd | 9.8 | 33 | nd | nd | nd | nd |
| ±3 | <0.3 | ±14 | <0.3 | ±23 | <1.0 | <3.8 | ±0.4 | ±3.5 | <3.5 | <0.0 | <2.8 | <27 | ±3.7 | ±13 | <0.3 | <10 | <0.3 | <2.5 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| FZ20669-n | 52 | nd | 393 | nd | 103 | nd | nd | 5.3 | 9.3 | nd | nd | nd | nd | 21 | 31 | nd | nd | nd | nd |
| ±5 | <0.3 | ±39 | <0.3 | ±10 | <1.0 | <3.9 | ±0.5 | ±3.3 | <3.6 | <0.1 | <3.0 | <28 | ±3 | ±6 | <0.3 | <11 | <0.3 | <2.6 |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

° = below the limit of quantification. PC = primary casting. SC = secondary casting.

Table 42.2. Results of the PIXE analyses made at the C2RMF on the copper and silver inlays of the Piombino Apollo. Results in wt%.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Analysis No.** | **Location** | **Cr** | **Mn** | **Fe** | **Co** | **Ni** | **Cu** | **Zn** | **As** | **Se** |
| 07mai006 | Cu - right eyebrow | *< 0.3* | *< 0.05* | 0.33 | *< 0.0058* | 0.067 | **98.3** | *< 0.017* | 0.032 | *< 0.0071* |
| 07mai007 | Cu - left eyebrow | *< 0.26* | *< 0.066* | 0.28 | *< 0.0026* | 0.077 | **99.1** | *< 0.018* | *< 0.021* | *< 0.0023* |
| 07mai008 | Cu - upper lip | *< 0.32* | *< 0.048* | 0.42 | *< 0.012* | 0.066 | **97.6** | *< 0.025* | 0.19 | *< 0.0084* |
| 07mai010 | Cu - lower lip | *< 0.21* | *< 0.077* | 0.47 | *< 0.017* | 0.072 | **98.8** | *< 0.024* | 0.20 | *< 0.005* |
| 07mai011 | Cu - right nipple | *< 0.29* | *< 0.057* | 0.28 | *< 0.014* | 0.093 | **98.9** | *< 0.018* | 0.14 | *< 0.0042* |
| 07mai012 | Cu - left nipple | *< 0.28* | *< 0.065* | 0.46 | 0.097 | 0.095 | **98.7** | *< 0.018* | 0.20 | *< 0.0049* |
| 07mai013 | Ag - left foot | *< 0.36* | *< 0.039* | 0.33 | *< 0.013* | 0.067 | **9.8** | *< 0.011* | 0.085 | *< 0.0036* |
| 07mai014 | Ag - left foot - no scan | *< 0.35* | *< 0.059* | 0.024 | *< 0.0086* | 0.054 | **3.1** | *< 0.0059* | *< 0.014* | *< 0.0036* |

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Analysis No.** | **Mo** | **Ag** | **Cd** | **In** | **Sn** | **Sb** | **Te** | **Au** | **Hg** | **Pb** | **Bi** |
| 07mai006 | *< 0.0098* | 0.071 | *< 0.015* | *< 0.009* | *< 0.022* | *< 0.021* | *< 0.02* | *< 0.0085* | *< 0.0094* | 0.96 | *< 0.0099* |
| 07mai007 | *< 0.0053* | 0.076 | *< 0.0087* | *< 0.0073* | *< 0.013* | 0.07 | *< 0.0091* | *< 0.011* | *< 0.0041* | 0.098 | *< 0.0063* |
| 07mai008 | *< 0.0052* | 0.055 | *< 0.019* | *< 0.0053* | *< 0.045* | *< 0.016* | *< 0.029* | *< 0.013* | *< 0.0094* | **1.7** | *< 0.014* |
| 07mai010 | *< 0.011* | 0.029 | *< 0.0098* | *< 0.0032* | *< 0.031* | *< 0.031* | *< 0.024* | *< 0.014* | *< 0.0079* | 0.18 | *< 0.0086* |
| 07mai011 | *< 0.011* | 0.056 | *< 0.026* | *< 0.008* | *< 0.016* | *< 0.051* | *< 0.021* | *< 0.012* | *< 0.0082* | 0.17 | *< 0.0064* |
| 07mai012 | *< 0.0048* | 0.048 | *< 0.018* | *< 0.0069* | *< 0.0059* | *< 0.029* | *< 0.025* | *< 0.01* | *< 0.004* | 0.07 | *< 0.0066* |
| 07mai013 | *< 0.0024* | **85.8** | *< 0.036* | *< 0.084* | **2.9** | *< 0.047* | *< 0.031* | 0.45 | *< 0.0051* | **2.1** | *< 0.0072* |
| 07mai014 | *< 0.0021* | **95.9** | *< 0.027* | *< 0.074* | *< 0.59* | *< 0.04* | *< 0.023* | 0.48 | *< 0.0026* | 0.41 | 0.029 |