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Supplementary Materials: An Ancient Egyptian Multilayered Polychrome Wooden Sculpture Belonging to the Museo Egizio of Torino: Characterization of Painting Materials and Design of Cleaning Processes by Means of Highly Retentive Hydrogels

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Analysis on Painting Materials

Supplementary materials are related to the results on the characterization of painting materials. In Figure S1 the SEM-EDX maps of the layer sequence in the case of the wig are shown. The OM image of a similar region is shown in Figure 5 (paragraph 3.1) in the main paper. In particular are clear the outer layer made of an iron rich material attributed to red ochre, the white intermediate preparation layer made of calcite and the green layer made of Egyptian green.

About the composition of blue and green crystals, a quantitative SEM-EDX analysis was carried out on some grains. In Figure S2 are shown the results on three blue grains. The grains number 60 and 70 are homogeneous in BSE images and they present a composition very similar to cuprorivaite ($CaCuSi_4O_{10}$), i.e., Egyptian blue. The grain number 75 is not uniform. It shows a part with low quantity of calcium and the presence of other elements, in particular sodium (c75b and c75c), and a significant amount of quartz (c75a), that is coherent with available literature.

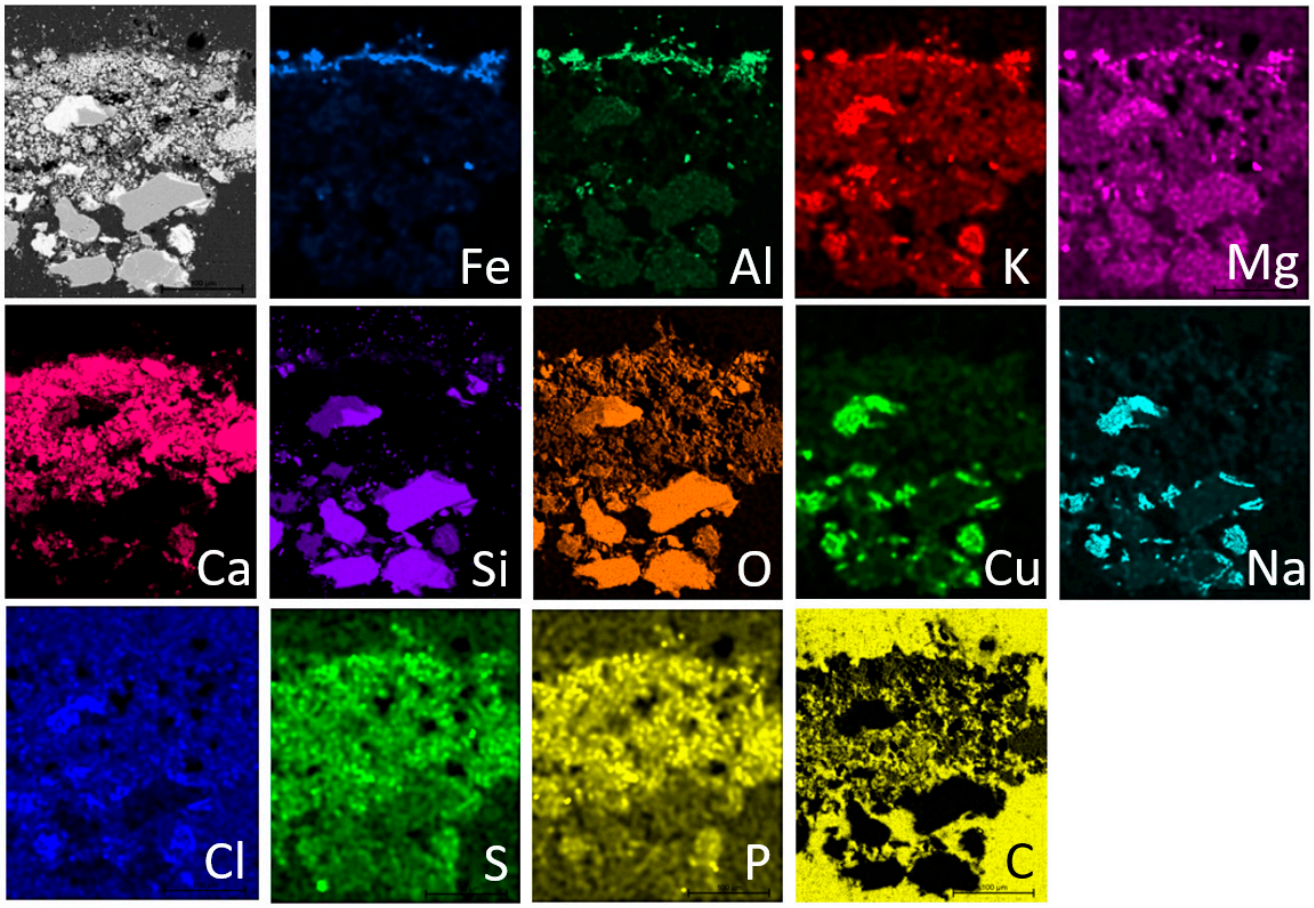
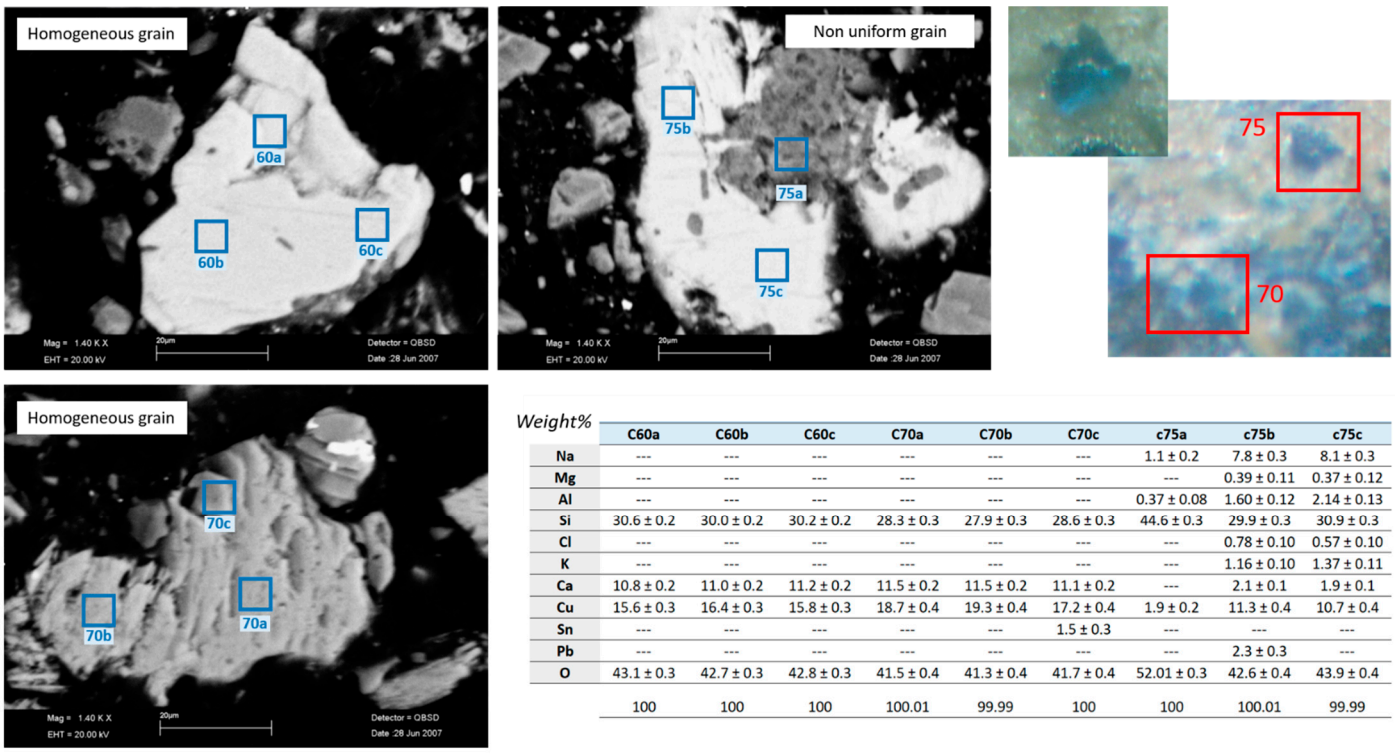


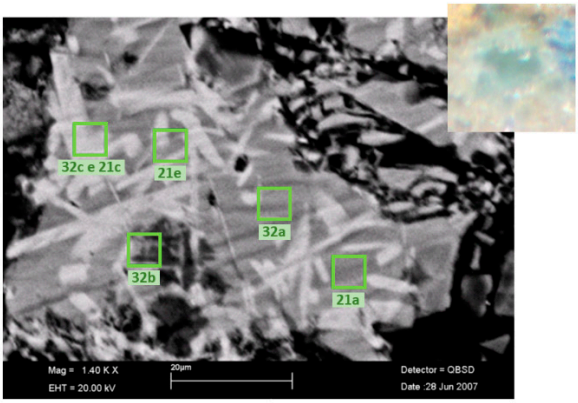
Figure S1. SEM-EDX maps of the main elements in the sample A. The first image in gray scale is the SEM-BSE image.



Weight%	C60a	C60b	C60c	C70a	C70b	C70c	c75a	c75b	c75c
Na	---	---	---	---	---	---	1.1 ± 0.2	7.8 ± 0.3	8.1 ± 0.3
Mg	---	---	---	---	---	---	---	0.39 ± 0.11	0.37 ± 0.12
Al	---	---	---	---	---	---	0.37 ± 0.08	1.60 ± 0.12	2.14 ± 0.13
Si	30.6 ± 0.2	30.0 ± 0.2	30.2 ± 0.2	28.3 ± 0.3	27.9 ± 0.3	28.6 ± 0.3	44.6 ± 0.3	29.9 ± 0.3	30.9 ± 0.3
Cl	---	---	---	---	---	---	---	0.78 ± 0.10	0.57 ± 0.10
K	---	---	---	---	---	---	---	1.16 ± 0.10	1.37 ± 0.11
Ca	10.8 ± 0.2	11.0 ± 0.2	11.2 ± 0.2	11.5 ± 0.2	11.5 ± 0.2	11.1 ± 0.2	---	2.1 ± 0.1	1.9 ± 0.1
Cu	15.6 ± 0.3	16.4 ± 0.3	15.8 ± 0.3	18.7 ± 0.4	19.3 ± 0.4	17.2 ± 0.4	1.9 ± 0.2	11.3 ± 0.4	10.7 ± 0.4
Sn	---	---	---	---	---	1.5 ± 0.3	---	---	---
Pb	---	---	---	---	---	---	---	2.3 ± 0.3	---
O	43.1 ± 0.3	42.7 ± 0.3	42.8 ± 0.3	41.5 ± 0.4	41.3 ± 0.4	41.7 ± 0.4	52.01 ± 0.3	42.6 ± 0.4	43.9 ± 0.4
	100	100	100	100.01	99.99	100	100	100.01	99.99

Figure S2. Elemental analysis (weight %) by means of SEM-EDX of three representative blue grains. The blue squares are the areas of analysis. On top right are shown the optical images of the grains.

Figure S3 shows the result on a representative green grain. In the SEM-BSE image the two-phase microstructure is clear. In particular it was detected that the light grey part of the crystal is made of wollastonite (area 21c and 32c) with the addition of sodium and copper, whereas the dark grey part is a silica-rich amorphous phase (c21a and c32a) with calcium, sodium and copper. On average, in the two samples, the green portion has a lower copper content and a higher sodium content than the blue portion. These differences are imputable to the different production processes.



Weight%	c21a	c32a	c21e	c32b	c21c	c32c
Na	9.0 ± 0.4	6.0 ± 0.3	6.4 ± 0.3	6.4 ± 0.3	2.1 ± 0.3	0.8 ± 0.2
Mg	---	0.32 ± 0.09	---	0.27 ± 0.09	---	---
Si	29.5 ± 0.3	30.1 ± 0.3	29.5 ± 0.3	29.0 ± 0.2	25.9 ± 0.3	24.5 ± 0.2
Cl	1.0 ± 0.3	1.0 ± 0.3	1.0 ± 0.3	0.8 ± 0.3	0.3 ± 0.3	---
K	0.28 ± 0.10	0.19 ± 0.08	---	---	---	---
Ca	12.3 ± 0.2	14.3 ± 0.2	16.0 ± 0.3	15.9 ± 0.2	28.5 ± 0.3	32.6 ± 0.2
Cu	5.0 ± 0.3	4.4 ± 0.3	3.7 ± 0.3	4.6 ± 0.3	1.3 ± 0.3	0.7 ± 0.2
O	42.9 ± 0.4	43.6 ± 0.3	43.2 ± 0.4	43.0 ± 0.3	41.9 ± 0.4	41.4 ± 0.3
	100.07	100.02	100.01	100.01	100	100

Silica-rich amorphous phase (darker in BS image) ⟷ Wollastonite ($CaSiO_3$) (lighter in BS image)

Figure S3. Elemental analysis (weight %) by means of SEM-EDX of a representative green grain. The green squares are the areas of analysis. In the center is shown the optical images of the grain.

To obtain information on the chronology of the layer sequence, a preliminary study of trace and minor elements was carried out by means of PIXE analysis. In particular, green and white preparation layers in samples from the wig (sample A) and from the body (sample B) were taken in account. In Figure S4 are shown the results in the two cases for PIXE analysis in areas of about 100 × 100 µm^2. Some differences in trace elements composition were observed, in particular in potassium content, for the green sectors from sample A and sample B (i.e., the green pigment that forms the first buried layer in the wig and the green pigment below the brown layer in the body), even though counting statistic is low and further analyses are necessary to confirm the observation and to correlate it to the chronology of the layer sequence. No particular differences were observed in minor and trace elements in the intermediate and first white preparation layers, even though the result is not sufficient to hypothesize a contemporaneity of the two layers. PIXE analyses will be enhanced in future.

Finally, for what concerns the decorative elements, FT-IR analysis carried out on a sample from the white belt (Figure S5) has shown the presence of huntite, $Mg_3Ca(CO_3)_4$, a carbonate mineral which provides a brighter white than calcite.

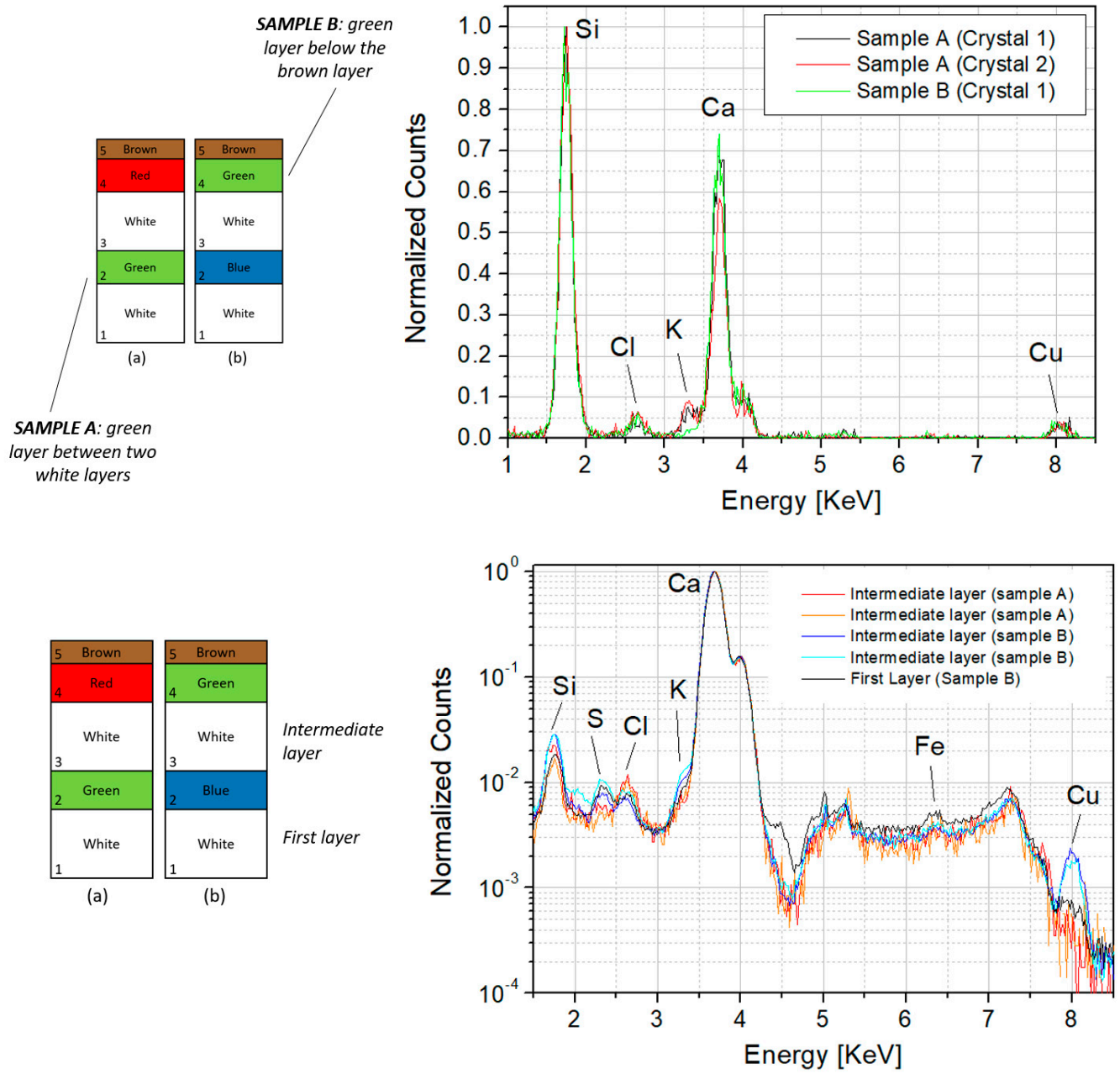


Figure S4. Semi-quantitative **e**lemental analysis by means of PIXE of different green (top) and white preparation (bottom) layers.

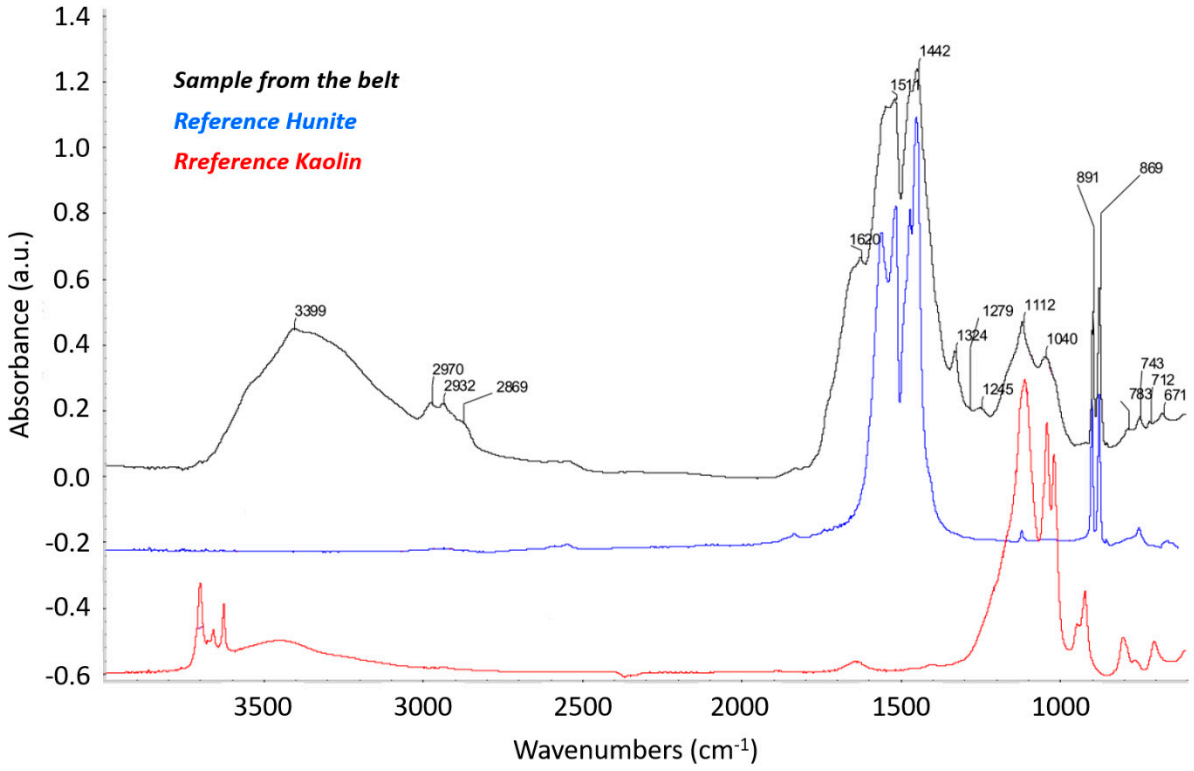


Figure S5. FT-IR analysis carried out on a sample from the white belt has shown the presence of huntite.