Elemental Analysis of Etruscan Loom Weights and Roman Mortars using X-Ray Fluorescence

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Loom Weights

Abstract:
During the summer of 2018 loom weights excavated from Cavitá 254 in Orvieto, Italy were analyzed by x-ray fluorescence (XRF) spectrometry. This study identified the elements present in these Etruscan loom weights and the statistical differences in the composition of the materials used to make the weights. Significant statistical differences were found in the composition of loom weights based upon color and inscription. These differences were found in the relative abundances of iron (Fe), calcium (Ca), and manganese (Mn). The different visually identified loom weight colors were related to elemental composition and fell into categories of red (high Fe), white (high Ca), black (high Mn), and black-spotted (mid-range Mn).

Anthropological Background and Theory:
- Loom weights were used by the ancient Etruscans to hold tension on thread while weaving textiles on a warped-weighted loom (Figure 1).
- Loom weights were likely made locally and sometimes marked with an inscription
- Loom weights may have been passed down from mother to daughter to keep in the family and may have travelled with brides to their new homes after marriage
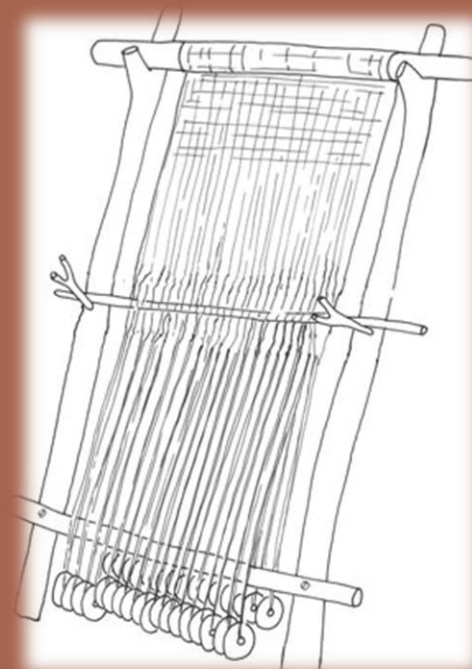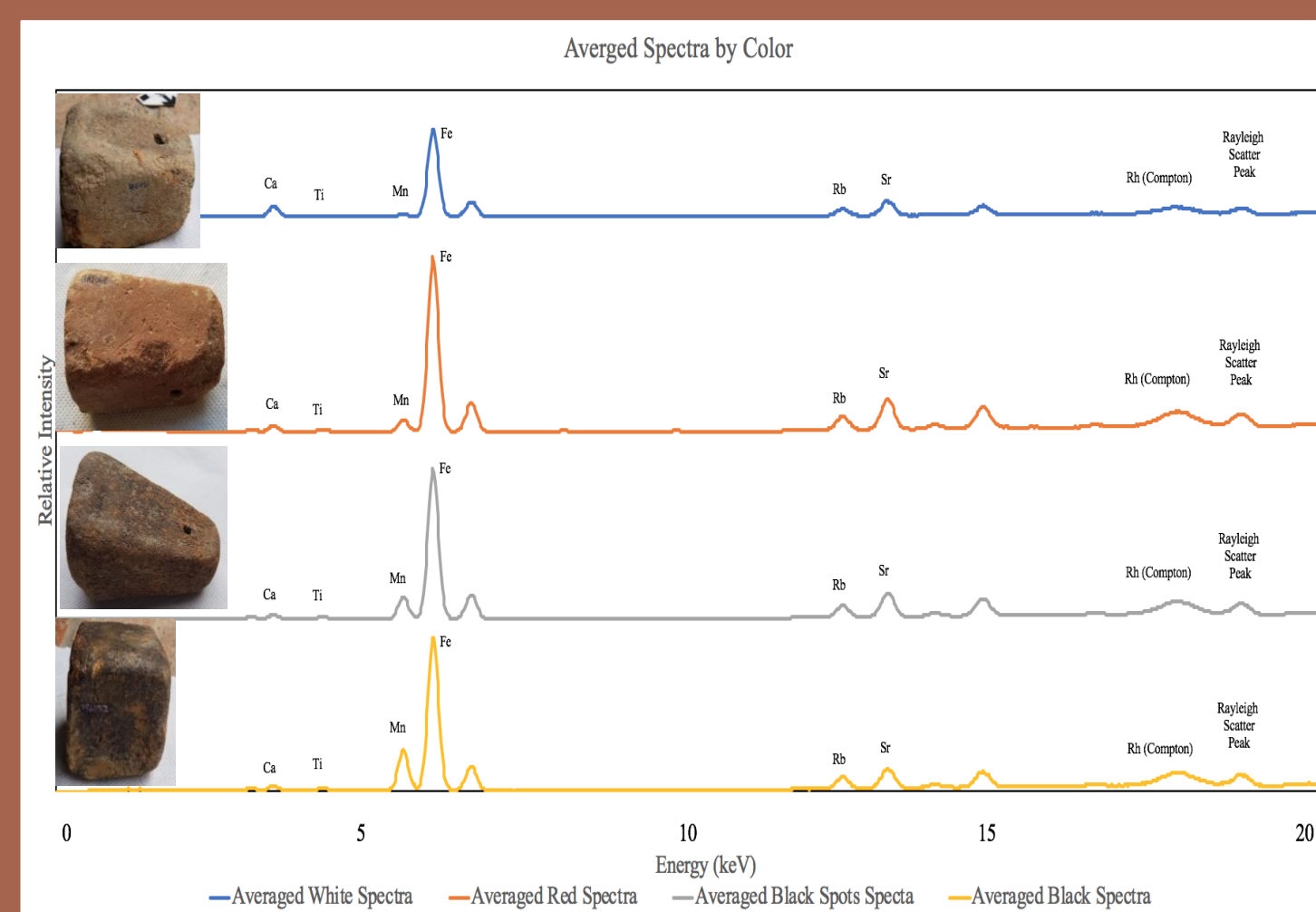

Figure 1: Warped Loom
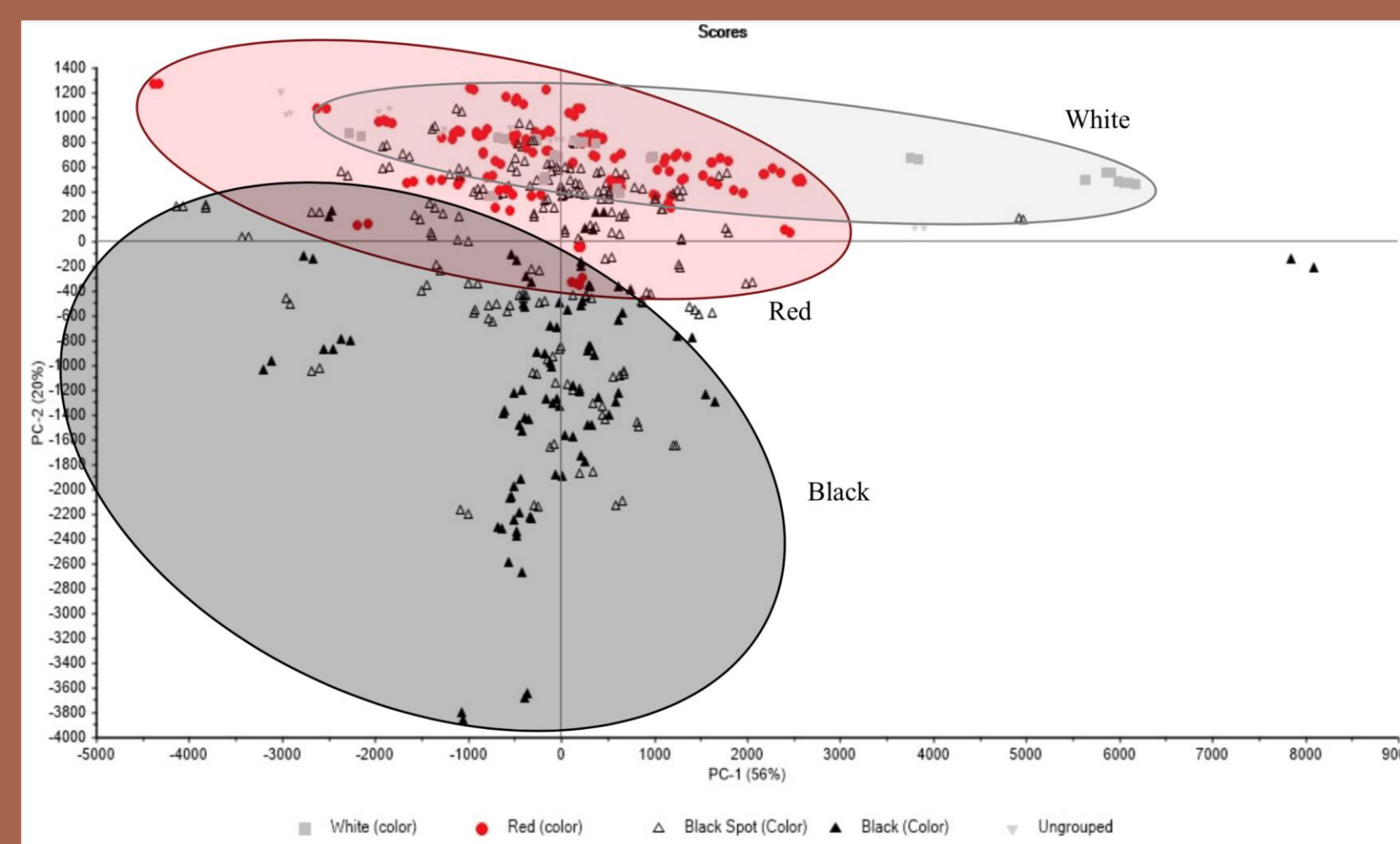

Figure 2: Averaged Spectra Comparison by Color

Figure 3: Scores Plot of Color Analysis

Instrumentation:
- Bruker Tracer III-V+ Handheld X-Ray Fluorescence Spectrometer (Figure 4)
- Instrument settings: 3 μA current at 40 kV x-ray tube energy
- Analysis time: 120 seconds in duplicate
- Analyses conducted at 5 locations on 47 loom weights
- Analyses conducted at 2 locations on 23 mortar samples
- Filter: Yellow (12 mm Al and 1 mm Ti filters)

Figure 4: XRF in Benchtop mode with Loom Weight

Conclusions (Figures 2 and 3):
- Red loom weights were found to have high Fe content
- Black loom weights were found to have high Mn content
- White loom weights were found to have high Ca content

Mortars

Abstract:
X-Ray fluorescence (XRF) spectrometry was used to analyze mortar samples collected from the Coriglia excavation site located in Orvieto, Italy. Mortar created for three different uses were analyzed: exhedra, well, and trench wall mortars. Data collected was analyzed by principle component analysis (PCA) to show relationships among the chemical compositions of the different kinds of mortars. The PCA showed that the elements that vary the most are Ca, Fe, and Mn. Exhedra mortar has the highest Fe concentration. Well mortar has the highest Mn concentration. Trench wall mortar has the highest Ca concentration.

Anthropological Theory:
Mortar composition changes based on the time period, use, and raw materials available at the time of construction. Due to this there should be differences in the chemical composition of the mortars at each locus for walls constructed at different times. These differences can be identified through XRF spectrometry.
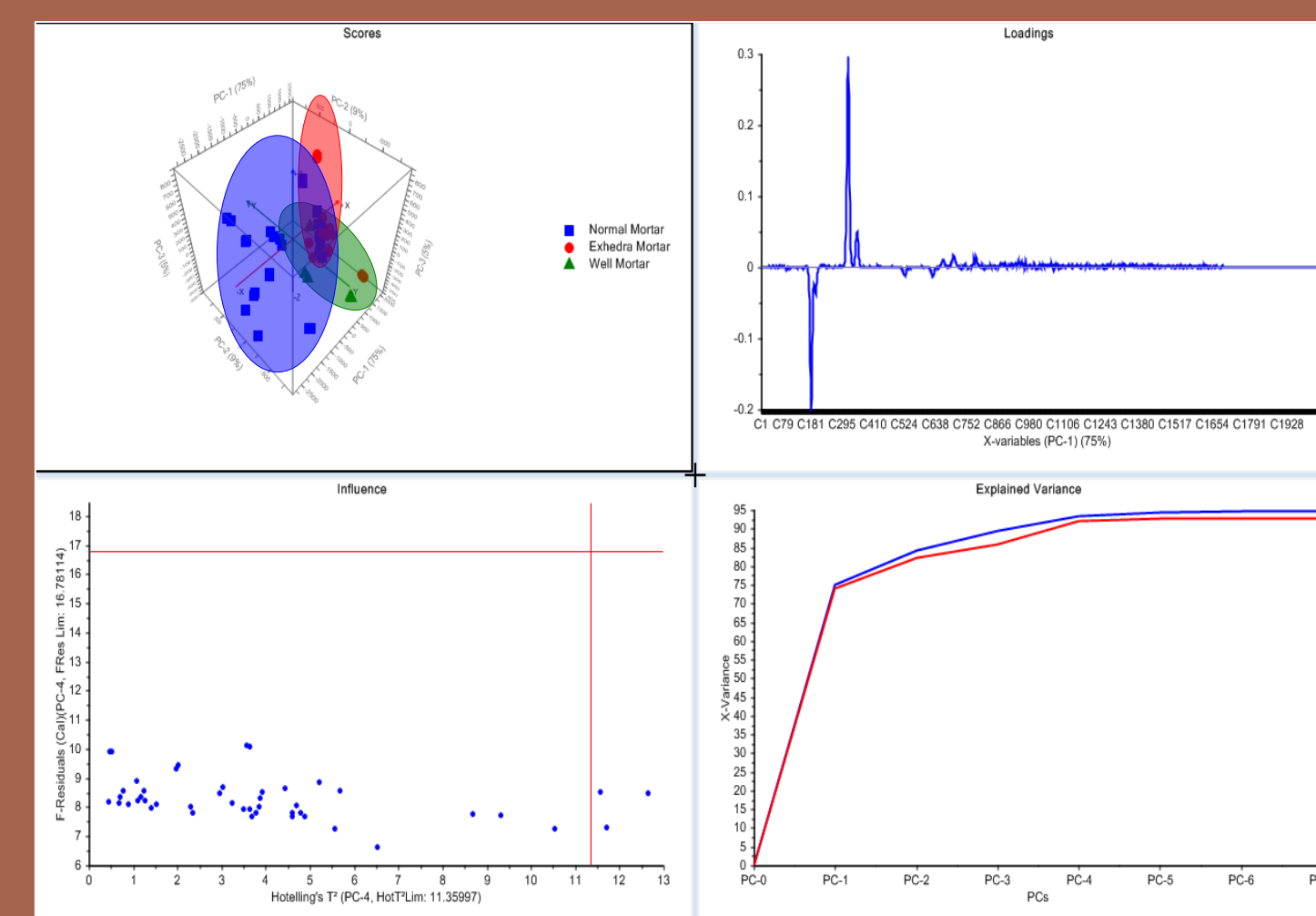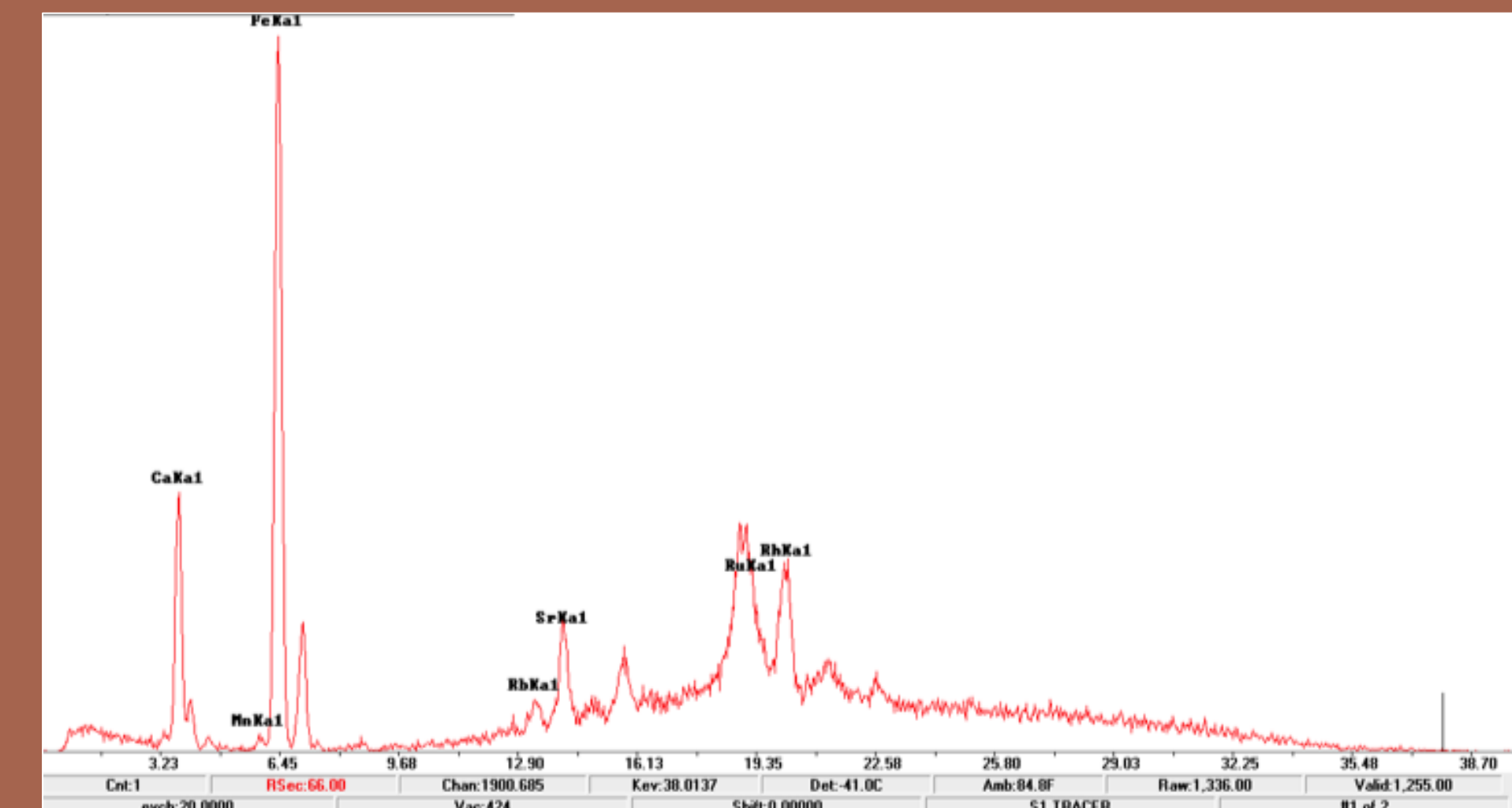

Figure 5: PCA Analysis of Mortar Data

Figure 6: Sample XRF Spectrum of Mortar

Conclusions:
- Mortars collected at Coriglia are different based on their use
- Mortar used to construct the Exhedra at Coriglia contained the highest concentration of Fe
- Mortar used in the construction of the Well contained the highest concentration of Mn.
- Data collected on the mortar of Trench walls yielded the highest concentration of Ca.