# STUDIES ON BRONZE ARTIFACTS FROM THE BARLAD PLATEAU USING XRF AND CT METHODS

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The main purpose of the present study was to determine the elemental composition of some bronze artifacts using X-Ray Fluorescence spectrometry (XRF), but also to see the quality of casting by examining the pieces with the help of Computed Tomography (CT), which allowed obtaining some technological information.

These artefacts constitute prestige objects – social status, symbols of power, tools and weapons.

The analysis of bronze objects must take into account four important aspects: the metallurgy of bronze, the circulation of bronze objects, their typology and their cultural and chronological setting.

Some objects are only copper-based alloys consisting of two principal components, but most often there are situations where minor elements are present as can be seen from our results obtained first using the XRF method (see Figures 2a and 2b).

For the present study the artefacts come from a hoard discovered in 2010 at the Orthodox Cemetery of Oțeleni, Hoceni commune, Vaslui county, and contain 7 pieces - 5 sickles of Helesteni type (identified with the numbers - 18670,18671,18672,18673 and 18674), a spearhead of Krasnyj Majak type (no. 18676) and a knife fragment (no. 18675). In addition to the hoard of bronze objects from Oțeleni, a fragment of a bronze sword of the Krasnyj Majak type (no. 6702) discovered at Epureni was also studied (Figure 1).


Figure 1. Helesteni type sickles; Krasnyj Majak type spearhead; knife fragment and fragment of a bronze sword of the Krasnyj Majak type

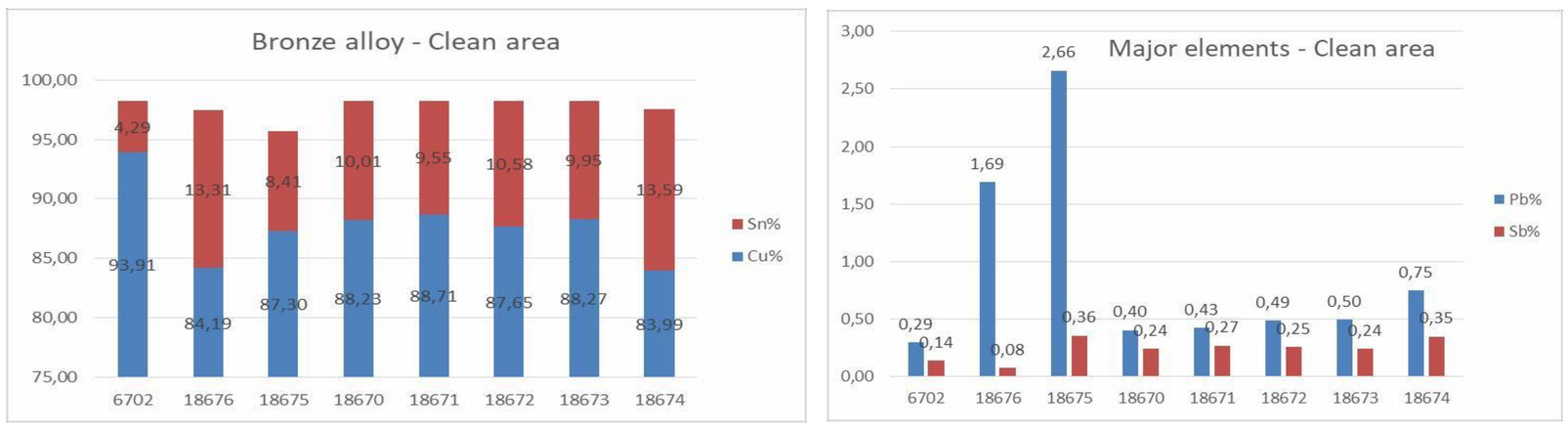


Figure 2. Elemental compozition on: a) clean area (bronz alloy component) and b) major elements

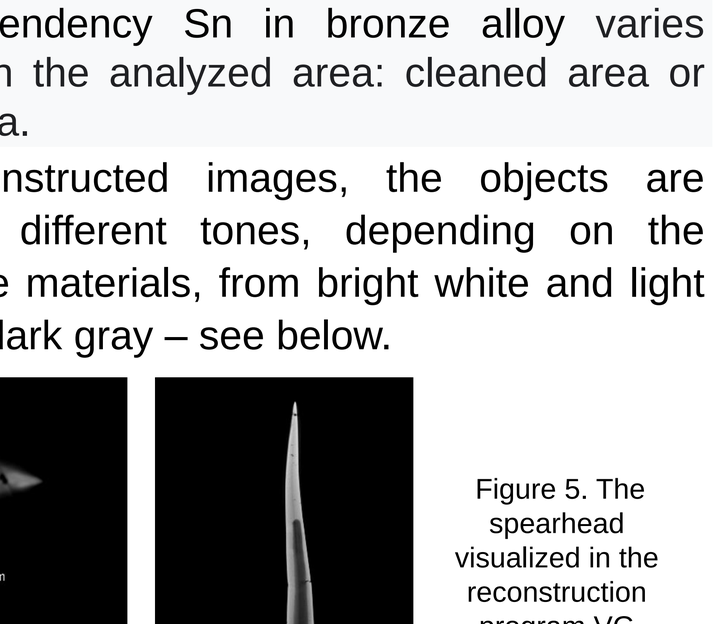


Figure 4. The tendency of Sn in bronze alloy – clean area and patina

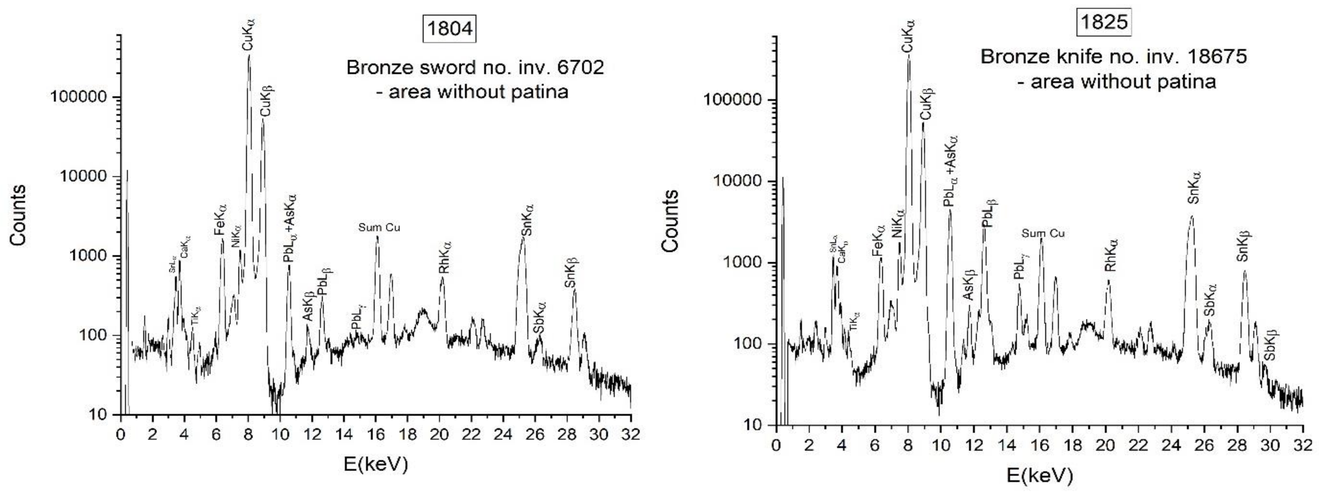


Figure 3. XRF spectra on: a) sword and b) knife - area without patina

Computed tomography consists of performing hundreds or thousands of projections of radiographic sections during the rotation of the object by 360º, ultimately resulting in a 3D image of the object, it works based on shades of gray.

Imaging technique is the only way to visualize the interior of objects, without them being affected in any way, preserving their integrity. Based on these images, information can be obtained about the density of objects, the presence of inclusions and voids, the latter often being the result of defective castings – see Fig.5.

Using X-Ray Fluorescence and Computed Tomography important informations was obtained regarding the alloy composition, the dimensions and appearance of the artefacts, their state of preservation and manufacturing technique.

The preservation status of the artefacts was established in two ways: fizico-chemically by comparing elemental content of each object's uncorroded core - Cu, Sn, Pb, Sb (see Fig. 3 a and b) and the other way - corroded surface (see Fig. 4) where the tendency Sn in bronze alloy varies depending on the analyzed area: cleaned area or corrosion area.

In the reconstructed images, the objects are rendered in different tones, depending on the density of the materials, from bright white and light gray to very dark gray – see below.

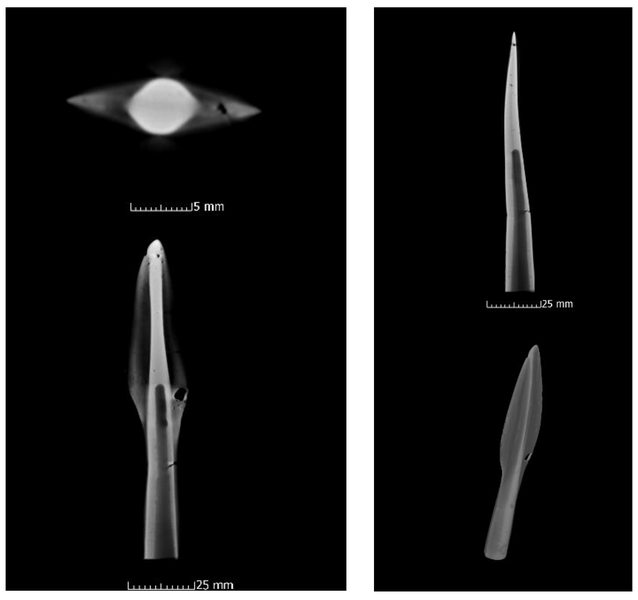


Figure 5. The spearhead visualized in the reconstruction program VG Studio Max 3.0 - in the 3 planes (longitudinal, horizontal and frontal), as well as 3D.

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