Archaeologia Baltica 28, 2021, 25–38

NEW RESULTS ON HORSE TRAPPINGS FROM THE HUNNIC-PERIOD CARPATHIAN BASIN BASED ON NON-DESTRUCTIVE ARCHAEOMETRIC ANALYSES

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Keywords

Hunnic period, horse trapping, *Pressblechtechnik* horizon, Carpathian Basin, gilding, XRF method

Abstract

Objects manufactured from pressed gold, gilded silver or copper alloy plates are characteristic assemblages from the Late Hunnic period (5th century AD, 420/430). In this study, horse trappings that belong to the 'pressed gold plate horizon' from three archaeological sites in the Carpathian Basin (Léva, Nyíregyháza-Oros and Pécsüszög) were analysed non-destructively by using a handheld X-ray fluorescence spectrometer. The main aims were to determine the chemical composition and the gilding technique used, and to attempt to prove whether the groups in an assemblage are from the same set. The results of the chemical analyses give us the opportunity to confirm whether damaged or presumably lost objects of an assemblage were replaced or repaired. According to the results obtained, the objects were manufactured from gold (Pécsüszög), gilded silver (Nyíregyháza-Oros) or gilded unalloyed copper plates (Léva). Later, replacements can be distinguished based on their chemical composition and manufacturing quality. Two types of gilding were observed: fire gilding with the presence of mercury (Léva), and leaf gilding (Nyíregyháza-Oros).

Introduction

Of the known horse trappings from Late Antiquity and the Early Migration period, objects of the 'pressed gold plate horizon' are perhaps the ones that researchers have dealt with most comprehensively. However, 20th-century finds have only been mentioned in the last decade as parallels to newly discovered objects, and their individual study has been pushed into the background. In the course of our research, which so far concerned the archaeological examination of finds from the period mentioned, we considered it necessary to perform archaeometric investigations as well. In this study, three assemblages from the Carpathian Basin were examined: the 'ritual deposit' of Pécsüszög, the grave of Léva, and the ritual deposition of Nyíregyháza-Oros (Fig. 1). Our aim was to determine the chemical composition and the method of decoration, i.e. the gilding technique. After the analysis of the *Untersiebenbrunn*[1] horse trappings (Piros et al. 2021), another question arose: is it possible to prove whether the groups in an assemblage are from the same set? More specifically, can we use material composition data to conclude that certain items in an assemblage were made in another workshop, in the same workshop but perhaps by another goldsmith, or that they were replaced due to damage?

[1] Untersiebenbrunn horse trappings were decorated in the Sösdala style. Every horse trapping decorated with punching, dated to between the end of the 4th century and the first half of the 5th century AD, is classified as a Sösdala-style object. They feature elaborate stamped ornamentation, which usually covers the entire surface of the object. Recurring motifs are stars, multi-centric circles and semi-circles, filled triangles, and rectangles. Based on this style, experts have managed to date finds from the Baltic and Scandinavian regions, and from Central and Eastern Europe (Bitner-Wróblewska 2001, p. 89).

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DOI: http://dx.doi.org/10.15181/ab.v28i0.2280
Received: 21.04.2021; Revised: 13.08.2021; Accepted: 20.09.2021

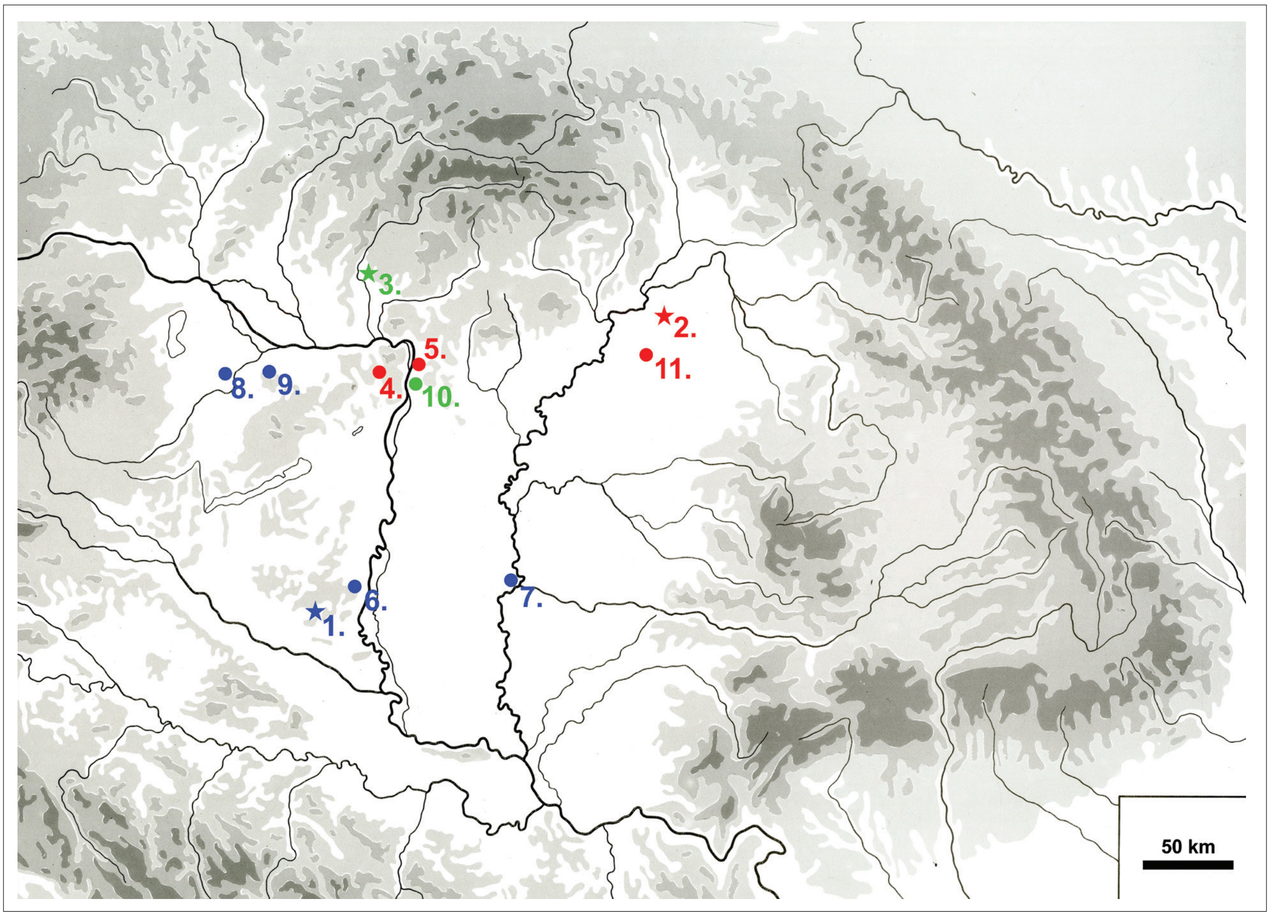

Figure 1. Assemblages of the *Pressblechtechnik* horizon: 1. Pécsüszög; 2. Nyíregyháza-Oros; 3. Léva; 4. Telki; 5. Göd-Bócsaújtelep; 6. Bátaszék; 7. Nagy-széksós; 8. Árpás; 9. Pannonhalma; 10. Budapest-Zugló; 11. Debrecen-Agrár park (blue, gold plates; red, gilded silver plates; green, gilded copper alloy plates). Assemblages from the localities indicated with a star were analysed in the present study.

Methodology

The chemical (elemental) composition of the finds was determined non-destructively by using hand-held X-ray fluorescence spectrometry (XRF)[2].

Therefore, our data can be compared with the results of previously examined finds[3] for which the same analytical method and mostly the same instrument was used[4].

A manual, digital VIS-UV microscope[5] was also used for the detailed observation of the manufacture techniques and decoration.

Results

Pécsüszög

The objects were found in January 1900, during a grape rotation, at a depth of 70 centimetres. During the systematic rotation, all objects were collected. József Hampel considered it possible that, due to their worthlessness, the workers ignored human and animal bone remains (Hampel 1900). However, based on the shallowness of the pit and the composition of the assemblage, it is likely that it was buried as a 'ritual deposition'[6].

2 SPECTRO xSORT Combi hand-held XRF (15–50 kV, 21–50 µA, Rh-anode, 'Light Elements' built-in calibration [based on the Fundamental Parameters (FP) method] designed specifically for alloys, three millimetres in diameter measurement area, 60-second acquisition time).

3 Horse trappings of Szeged-Nagyszéksós (Giumlía-Mair 2013), Bátaszék (Fodor 2018) and Telki (Szenthe et al. 2019). The XRF analysis of the finds from Bátaszék and Telki and from Göd (Mráv et al. 2021) was performed by Viktória Mozgai (Institute for Geological and Geochemical Research, RCAES, ELKH).

4 The assemblages of Árpás (Tomka 2001), Budapest-Zugló (Nagy 2003), Debrecen-Agrár park (Wieszner and Nagy 2021) and Pannonhalma (Tomka 1986), belonging to the 'gold plate horizon', will also be analysed in the near future using the same instrument.

5 Dino-Lite AM4113T–FVW digital UV/VIS LED USB microscope.

6 In addition to the horse trappings, sword grips, sword cases, plates to cover a bow and quiver, arrowheads and head tips were also found at the archaeological site. Based on the horse trapping and weapons, it can be concluded that objects of an elite warrior were placed in the sacrificial pit (Bóna 1993, pp. 248–249).

Figure 2. Objects from the Pécsüszög assemblage: 1. snaffle; 2–3. stone and garnet-inlaid bridle mounts; 4. saddle plate fragment (replacement of a D-shaped saddle plate or a fragment of a 'boomerang-shaped' saddle plate); 5. fragments of a D-shaped saddle plate (photographs: Janus Pannonius Museum, Pécs).

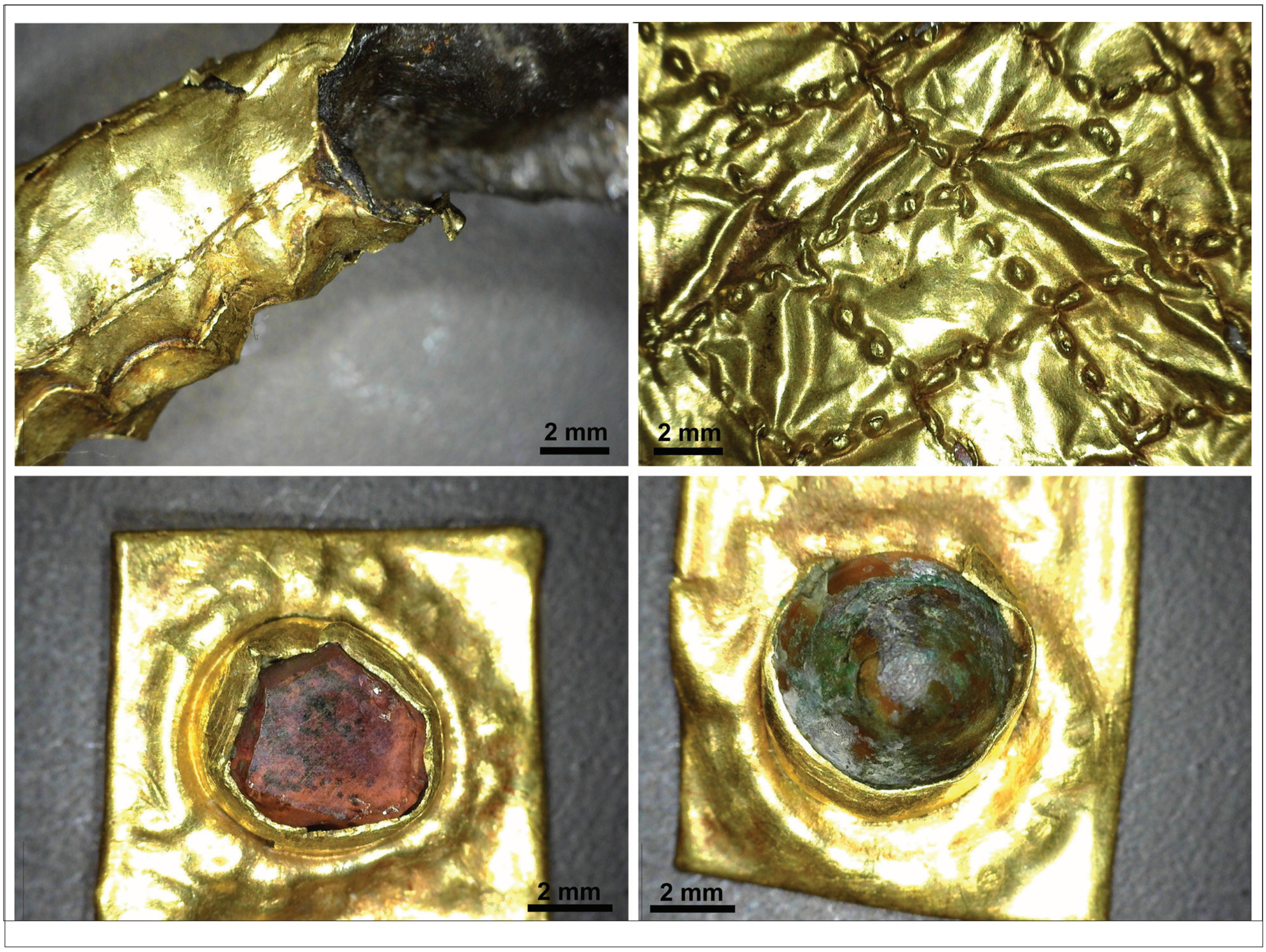

Figure 3. Digital microscopic images showing the gold plates of the snaffle (upper left), the net-pattern decoration of the saddle plate (upper right), and the garnet inlays of the stone-inlaid bridle mount from Pécsüszög (lower left and right; the garnet inlay in the lower right is covered with copper corrosion products).

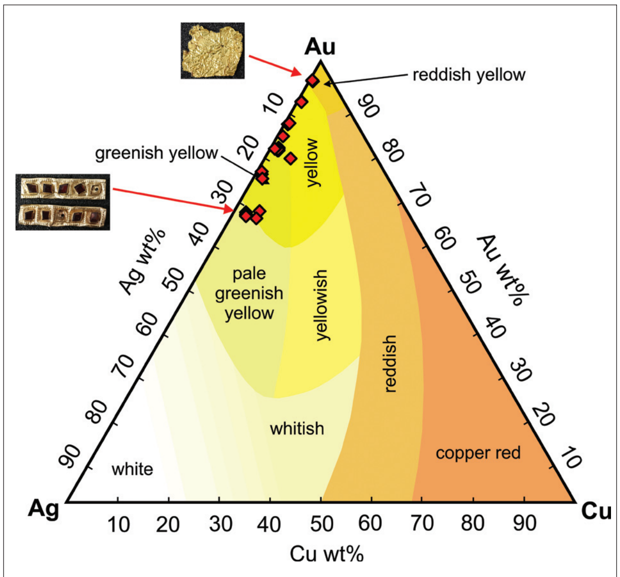

Figure 4. The chemical composition of the objects from Pécsüszög depicted on the gold-silver-copper ternary diagram based on XRF measurements (after Leuser 1949).

The pressed gold plate of the iron bit with cheek-pieces is finely ribbed (Fig. 2.1), and the microscopic images reveal the method of folding the plate (Fig. 3.1). The composition of the gold plates covering the two iron bits is the same within analytical error. The objects were made of relatively low-quality gold: 74.0% to 74.2 % gold, 23.7% to 24.2% silver, 0.8% to 1.0% copper (Figs. 4 and 5; Table 1).

The bridle mounts can be classified in two groups. Objects without gemstone inlays include two rhomboid-shaped pendants depicting a stylised leaf, three crescent-shaped pendants with a hanger, seven shorter and two longer rectangular mounts, three strap ends, and a small fragment which, based on its pattern, may be a remnant of a longer rectangular mount (Fig. 6). The stone-inlaid objects were decorated with the *en cabochon* technique. This group includes rectangular mounts inlaid with square-shaped garnets (two pieces) (Fig. 2.3), and one mount decorated with two round-shaped garnets and a round-shaped white stone, presumably some quartz variant (Fig. 2.2). In this mount, it seems as if three different-coloured stones were used; however, based on the microscopic observations,

Table 1. The chemical composition of the objects from Pécsüszög, measured by the XRF method. The results are given in weight% (LOD = limit of detection).

Description	Au	Ag	Cu	Pb	Bi	Fe	S
Snaffle							
956/2a	74.0	24.2	1.0	< LOD	< LOD	0.1	< LOD
956/2b	74.2	23.7	0.8	< LOD	< LOD	0.3	< LOD
Bridle mounts							
Rhomboid-shaped pendants							
956/5/a1	80.4	18.1	1.5	< LOD	< LOD	< LOD	< LOD
956/5/a2	80.6	18.0	1.3	< LOD	< LOD	< LOD	< LOD
Crescent-shaped pendants							
956/5/b1	91.1	8.2	0.6	< LOD	< LOD	< LOD	< LOD
956/5/b2	73.6	24.7	1.7	< LOD	< LOD	< LOD	< LOD
956/5/b3	91.0	8.3	0.6	< LOD	< LOD	< LOD	< LOD
Rectangular mounts (shorter)							
956/7/b1	65.4	32.0	2.5	< LOD	< LOD	< LOD	< LOD
956/7/b2	65.9	31.8	2.3	< LOD	< LOD	< LOD	< LOD
956/7/b3	79.9	18.5	1.5	< LOD	< LOD	< LOD	< LOD
956/7/b4	65.3	32.1	2.5	< LOD	< LOD	< LOD	< LOD
956/7/b5	65.4	32.1	2.5	< LOD	< LOD	< LOD	< LOD
956/7/b6	80.0	18.4	1.6	< LOD	< LOD	< LOD	< LOD
956/7/b7	65.1	32.2	2.7	< LOD	< LOD	< LOD	< LOD
Rectangular mounts (longer)							
956/7/d1	80.2	18.3	1.5	< LOD	< LOD	< LOD	< LOD
956/7/d2	80.3	18.3	1.4	< LOD	< LOD	< LOD	< LOD
Strap ends							
956/7/c1	80.2	18.4	1.4	< LOD	< LOD	< LOD	< LOD
956/7/c2	80.3	18.2	1.4	< LOD	< LOD	< LOD	< LOD
956/7/c3	80.2	18.3	1.4	< LOD	< LOD	< LOD	< LOD
Rectangular mounts with garnets							
956/6/f1	66.2	29.0	4.8	< LOD	< LOD	< LOD	< LOD
956/6/f2	64.5	30.5	4.9	< LOD	< LOD	< LOD	< LOD
Rectangular mount with two round-shaped garnets and one white stone							
956/7/g	78.0	16.9	4.9	< LOD	< LOD	< LOD	< LOD
Small fragment of a mount							
956/7/e	80.3	19.0	0.7	< LOD	< LOD	< LOD	< LOD
Saddle mounts							
Saddle plates							
956/6/a1	95.7	3.8	0.5	< LOD	< LOD	< LOD	< LOD
956/6/a2	95.8	3.8	0.4	< LOD	< LOD	< LOD	< LOD
956/6/a3	83.2	15.9	0.9	< LOD	< LOD	< LOD	< LOD
956/6/a4	95.9	3.7	0.4	< LOD	< LOD	< LOD	< LOD
Stiffener bands							
956/9/d1	0.6	81.7	10.3	0.3	0.1	3.0	1.3
956/9/d2	0.7	90.2	4.6	0.2	0.1	0.3	4.0
956/9/d3	0.9	94.6	2.5	0.3	0.1	0.9	0.8
956/9/d4	1.1	96.2	1.5	0.3	0.1	0.5	< LOD

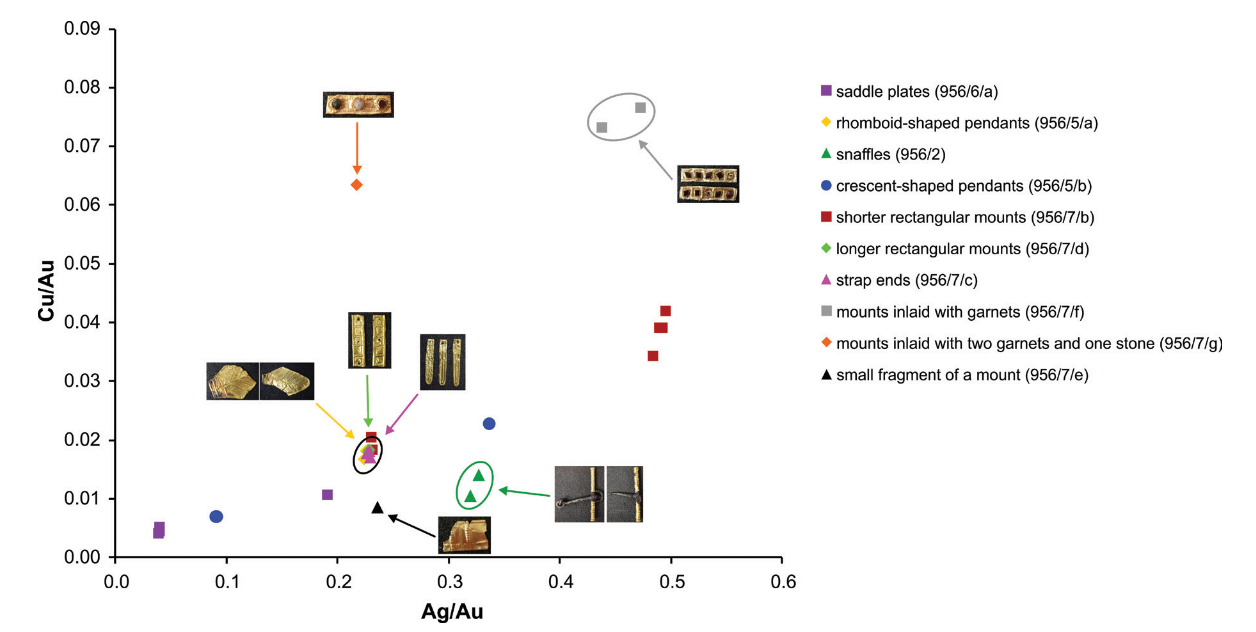

Figure 5. The chemical composition of the objects from Pécsüszög based on XRF measurements; snaffle and bridle mounts are highlighted.

one of the red garnets is covered with a green copper corrosion product (Fig. 3.3, 4).

In his report, Hampel wrote that a copper-based back-plate was still visible at the bottom of the rhomboid-shaped pendant, and that there were four crescent-shaped pendants, the number of which has now been reduced to three. A fragmented strap end is also missing (Hampel 1900, pp. 103, 105, 107). We can conclude that each object type in the assemblage, replenished with the lost mounts, could have entered the ground in pairs. In addition, it can be assumed that each bridle mount may have had some kind of copper-based back-plate, which is now missing.

All the objects were made using the ‘pressed gold plate technique’ (*Pressblechtechnik*), and it is usually visible both macroscopically and microscopically which mounts are ones that can be identified as replacements. The quality of one of the crescent-shaped pendants and five of the shorter rectangular mounts apparently differs from that of the better-quality ones (Fig. 7). The chemical compositions confirmed the optical observations.

Stone-inlaid objects can be easily distinguished from other objects, not only by their decoration but also by their composition, as their copper content is the highest among the analysed objects (4.8% to 4.9% copper) (Fig. 5; Table 1). Although their copper content is the same, based on their gold and silver content, the garnet-inlaid rectangular mounts and the stone-inlaid mount are very different from each other (Fig. 5; Table 1).

The chemical composition of two of the strap ends, the longer rectangular mounts, the rhomboid-shaped pendants, and the shorter rectangular mounts, is the same within the analytical error: 79.9% to 80.6% gold, 18.0% to 18.5% silver, 1.4% to 1.6% copper (Figs. 5 and 7; Table 1). Based on this, we can assume that these objects were presumably made in the same workshop, and at the same time. The other shorter rectangular mounts are made of lower-quality gold: 65.0% to 65.9% gold, 31.8% to 32.2% silver, 2.3% to 2.7% copper (Table 1). The difference is also reflected in the quality of the decoration of the objects (Fig. 7). Diverse, lower-quality pieces may be replacements for damaged or lost specimens.

The small fragment, based on its pattern, assumed to be a remnant of a longer rectangular mount, is completely different in its chemical composition (80.3% gold, 19.0% silver, 0.7% copper) from the other rectangular mounts (Fig. 5; Table 1).

The crescent-shaped, pressed pendants show a similar picture. Two of them have the same composition (91.0% gold, 8.2% to 8.3% silver, 0.6% copper), but the third one was made of lower-quality gold (73.6% gold, 24.7% silver, 1.7% copper) (Fig. 7; Table 1). On this basis, we can assume that the third piece was a later replacement.

Among the pressed gold plates decorating the saddle board, the collection of the Janus Pannonius Museum in Pécs today contains a fragmentary but matching D-shaped plate (three pieces) and a smaller fragment (Fig. 2.4, 5). Instead of the ‘*scale pattern*’ which is characteristic of the Hunnic period, all of them are decorated with a mesh pattern (Fig. 3.2). In Hampel’s time, the currently fragmented D-shaped plate was still whole, and the description includes another more damaged, fragmented one. In addition, part of the assemblage was a ‘boomerang-shaped’ mesh-patterned

Figure 6. Objects from the Pécsüszög assemblage: 1. rectangular-shaped bridle mounts; 2. rhomboid-shaped pendants; 3. strap ends; 4. fragment of a rectangular-shaped bridle mount; 5. crescent-shaped pendants; 6. saddle stiffener bands (photograph: Janus Pannonius Museum, Pécs).

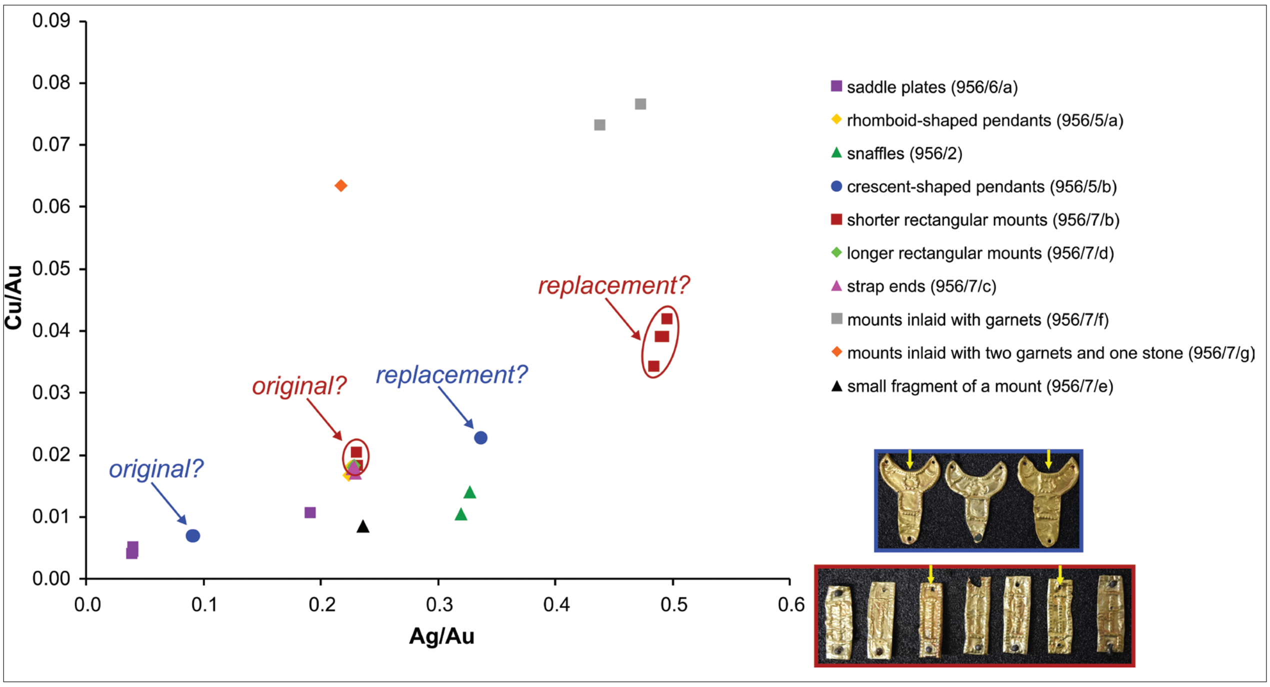

Figure 7. The chemical composition of the objects from Pécsüszög based on XRF measurements; crescent-shaped pendants and shorter rectangular-shaped mounts are highlighted (yellow arrow: original pieces).

plate, which presumably decorated the pommel of the saddle. Nowadays, this plate is not present in the collection in its published form (Hampel 1900, pp. 102–103). Microscopic examination revealed that the mount, interpreted as a fragment of a D-shaped plate (Figs. 2 and 4)[7], differs in its colour and in its curved edge from the other.

The D-shaped saddle plates are made of the highest-quality gold of all the items: 95.7% to 95.9% gold, 3.7% to 3.8% silver, 0.4% to 0.5% copper (Fig. 8; Table 1). Based on the same composition, the former inhesion of the fragments can be verified. The fragment of plate differs from the others chemically: 83.2% gold, 15.9% silver, 0.9% copper (Fig. 8; Table 1). Therefore, it could either be a contemporaneous replacement or it could have been a fragment of the former boomerang-shaped plate, but in the absence of a comparable piece, this cannot be stated with absolute certainty. Four fragments of a silver stiffener band also belong to a saddle, and their silver content was also determined (Fig. 6.6). The stiffener bands were made of good-quality silver (Table 1), alloyed with copper. The elevated sulphur, iron and silicon content indicates the presence of corrosion products and surface contaminants. Thus, it is not possible to determine whether the four fragments were indeed made of the same material.

Nyíregyháza-Oros

In 2004, fragments of gilded silver plates, which clearly decorated a saddle, were found in the fill of pit 207 of the Sarmatian age settlement, a few centimetres above the trodden surface (Fig. 9). The oval pit was oriented NE–SW. Wooden remains were found on the back of the two D-shaped plates, in which a silver rivet is clearly visible. A thin bronze band (stiffener) was also found in the pit, which may have belonged to the saddle plate. The find may have been some kind of sacrifice, and can be dated to the early 5th century (Istvánovits and Kulcsár 2013, pp. 117–118).

Microscopic images reveal that a punch needle with a rather elongated pattern was used for decoration, which differs from the punches of Léva (Figs. 9 and 10). The appearance of the gilding is also different, which may indicate the use of another gilding technique.

The exact chemical composition of the saddle plates cannot be determined due to the extensive corrosion, during which possibly the entire material recrystallised to silver chloride and silver bromide. Based on the lack of copper corrosion products, they could presumably be made of good-quality silver (Fig. 11). The saddle plates are gilded; their analysis did not show the presence of mercury (Fig. 12), referring to the use of a different gilding technique other than fire gilding. It can be clearly seen in the microscopic images that the gilding, unlike the gilding on the plates from Léva, did not wear out, but curled up (Fig. 10.1). We also checked for possible overlapping, but we did not observe any. It seems that one single foil was used to cover the object. Based on this, the goldsmith could have used the 'leaf gilding' technique.

[7] The gold alloy of the plates was already described as being different, lighter in colour (Hampel 1900, p. 103).

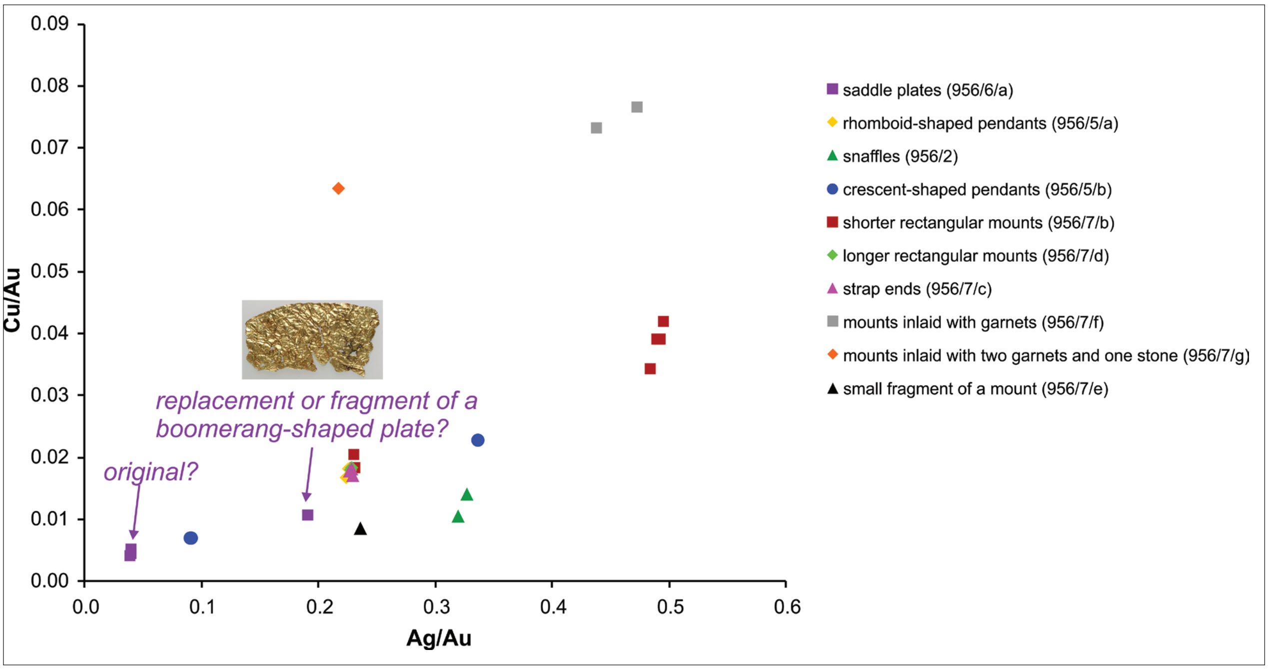

Figure 8. The chemical composition of the objects from Pécsüszög based on XRF measurements; saddle plates are highlighted.

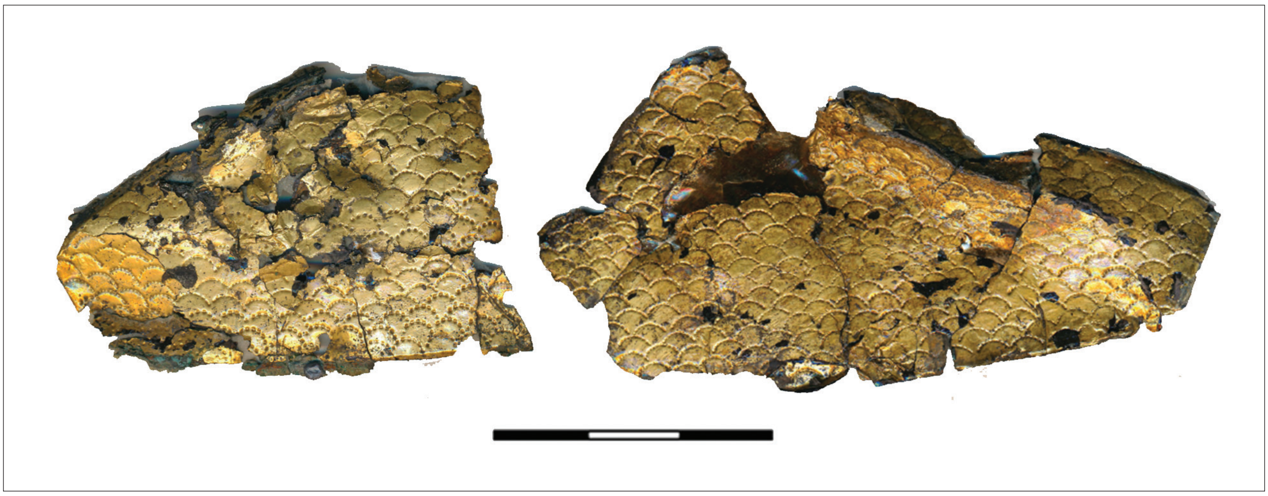

Figure 9. Saddle plates from Nyíregyháza-Oros (after Figs. 5–6 from Istvánovits and Kulcsár 2013).

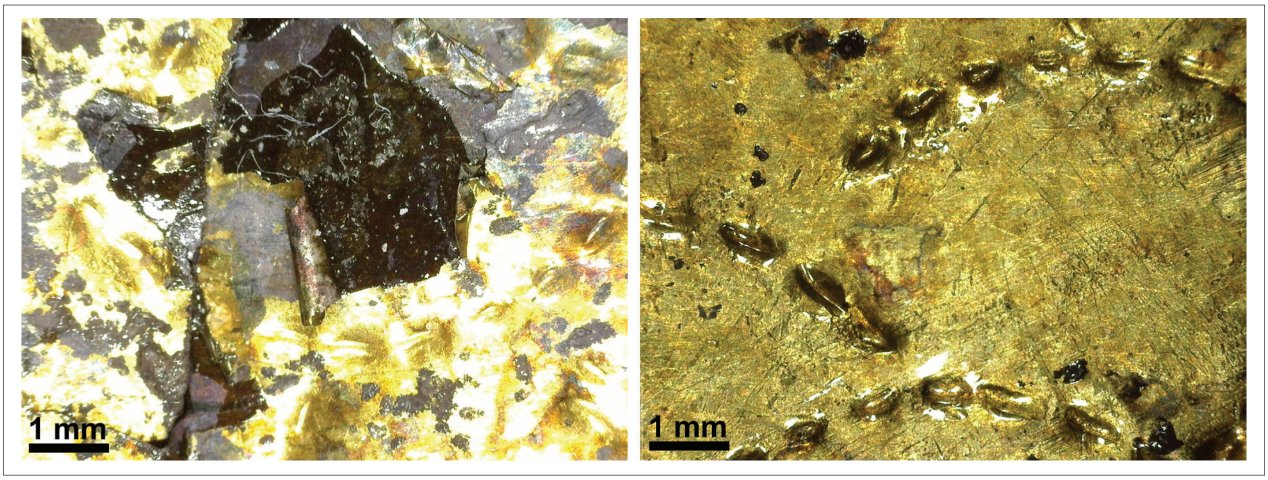

Figure 10. Digital microscopic images showing the decoration of the saddle plates from Nyíregyháza-Oros.

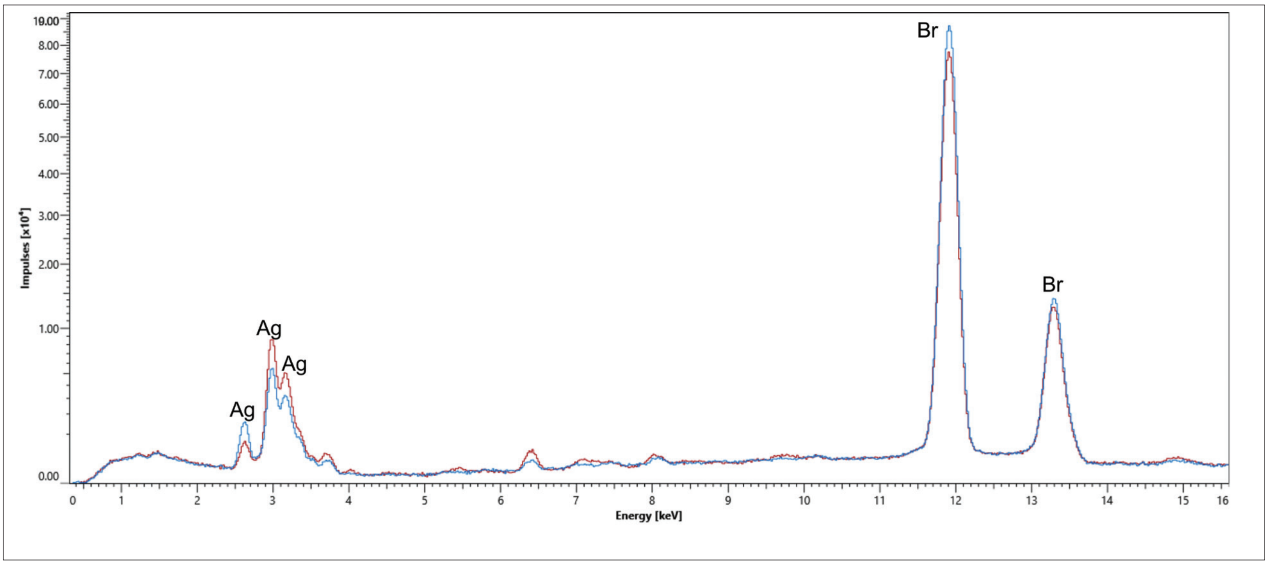

Figure 11. XRF spectra of the saddle plates from Nyíregyháza-Oros, showing the emission lines of the characteristic elements (red, lighter part; blue, darker part).

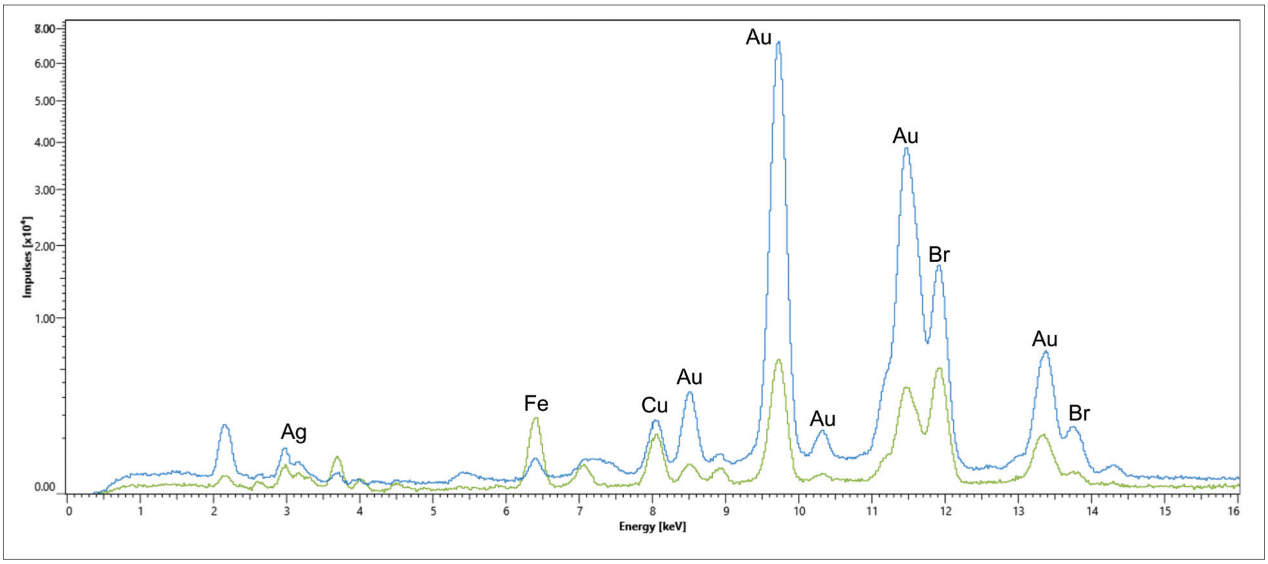

Figure 12. XRF spectra of the gilding of the saddle plates from Nyíregyháza-Oros, showing the emission lines of the characteristic elements (green, saddle plate 1; blue, saddle plate 2).

Table 2. The chemical composition of the objects from Nyíregyháza-Oros, measured by the XRF method. The results are given in weight% (LOD = limit of detection). Numbers against a grey background indicate surface contamination or gilding, and not the elements originally present in the alloy.

Description	Ag	Cu	Au	Pb	Bi	Hg	Fe	Zn
Saddle plate 1 rivet	65.5	11.3	1.1	< LOD	0.2	< LOD	18.5	1.3
Saddle plate 1 stiffener band 1	56.5	2.9	31.4	< LOD	0.2	< LOD	8.5	< LOD
Saddle plate 1 stiffener band 2	84.3	7.2	4.5	< LOD	0.4	< LOD	3.2	0.04

Figure 13. Objects from the Léva assemblage: 1. phaleras; 2. cicada-shaped bridle mounts; 3. rectangular-shaped bridle mounts; 4. D-shaped saddle plates (photographs: Hungarian National Museum, Budapest).

One piece of the stiffener band was preserved in a highly corroded piece of iron, while the other was a very small, detached piece. A silver rivet and wooden remains were also preserved in the iron. The exact chemical composition of the stiffener bands and the silver rivet cannot be determined, due to the extensive gilding and iron corrosion products present on the surface (Table 2), but the stiffener bands were made of silver-copper alloy similar to those from Pécsüszög.

Léva

In 1904, during clay extraction, the skeletal remains of a partial horse burial were found in Léva. The horse skull lay on the man's skeleton. Only a little information has survived about the circumstances of the excavation of the Léva assemblage[8].

The horse trappings include an iron bit, bridle mounts and saddle plates. The pressed, gilded copper alloy ornaments of the bridle are all worn out, some are fragmented, and back-plates made of yellow brass were attached to all their backs by the conservator (Fig. 13). Both the rectangular (six pieces) and the cicada-shaped (three pieces) mounts, as well as the phaleras (three pieces) are gilded, and the microscopic images show clearly the extent to which the gilding has worn off (Fig. 14.1, 2). It seems that there is no difference in their material and method of manufacturing.

The exact chemical composition of the mounts cannot be determined, due to the disturbing effect of extensive gilding and surface contamination; however, the analysis of the worn areas did not show the presence of alloying elements (tin, lead, zinc), suggesting that the objects were made of unalloyed copper (Table 3). In the gilding, we detected the presence of mercury, referring to the use of fire gilding (Fig. 15).

The two pieces of fragmented D-shaped saddle plate, also made of gilded copper alloy, differ in their style of decoration from the bridle mounts, in that the 'scale pattern' was punched by the goldsmith (Fig. 14.2). The cannulated, hemmed edges of the plate survived in better condition. Based on chemical analyses, the saddle plates, like the bridle mounts, were made of unalloyed copper, decorated with fire gilding, as is proven by the presence of mercury (Fig. 15; Table 3). There are also saddle stiffener bands that were made of copper alloys containing tin, lead and zinc (Table 3).

The appearance of the two-piece side cover of the whip (*nagaika*) suggests that the two pieces differ in their material, which may indicate a replacement (Figs. 14.3, 4). The difference is also reflected in their chemical composition: one piece was made of unalloyed copper, whereas the other was made of good-quality silver (Table 3). No traces of gilding were detected, but traces of tin-lead solder appear on the silver piece.

Conclusion

After examining the three assemblages, it can be stated that the material analysis of the objects is essential, as it can be used to determine which mounts, different in colour or decoration, could have been manufactured at the same time and in the same workshop. It also shows which ones were made later, possibly as replacements. This question can be examined very successfully in the case of

[8] Thin fragments of bronze belt mounts were also unearthed at the site, gilded on one side and embossed with pearl motifs on them. They were presumably fastened with a bronze clasp (Alföldi 1932, p. 72).

Table 3. The chemical composition of the objects from Léva, measured by the XRF method. The results are given in weight% (LOD = limit of detection). Numbers against a grey background indicate surface contamination or gilding, and not the elements originally present in the alloy.

Description	Cu	Ag	Au	Sn	Pb	Zn	Fe	Si	S
BRIDLE MOUNTS									
Phaleras									
1.1924.d1	97.2	< LOD	0.3	< LOD	0.4	< LOD	0.05	0.6	0.2
1.1924.d2	52.1	0.1	47.3	< LOD	< LOD	< LOD	0.01	0.3	< LOD
1.1924.d3	72.3	0.03	26.3	< LOD	< LOD	< LOD	0.02	0.5	0.2
Cicada-shaped mounts									
1.1924.c1	91.7	0.2	7.3	< LOD	< LOD	0.1	< LOD	< LOD	< LOD
1.1924.c2	96.5	< LOD	0.9	< LOD	< LOD	0.2	0.03	0.3	0.2
1.1924.c3	93.7	0.3	4.7	< LOD	< LOD	< LOD	< LOD	0.2	0.1
Rectangular mounts									
1.1924.b1	84.8	0.5	11.3	< LOD	< LOD	< LOD	0.04	< LOD	< LOD
1.1924.b2	95.7	< LOD	1.2	< LOD	< LOD	0.02	0.01	0.7	0.4
1.1924.b3	97.0	< LOD	1.1	< LOD	< LOD	< LOD	0.04	0.8	0.4
1.1924.b4	89.3	< LOD	8.9	< LOD	< LOD	< LOD	0.02	< LOD	< LOD
1.1924.b5	94.3	< LOD	2.9	< LOD	< LOD	0.2	0.03	0.4	0.2
1.1924.b6	90.0	< LOD	8.4	< LOD	< LOD	0.04	0.03	1.1	< LOD
SADDLE PLATES									
1.1924.a	69.6	0.05	23.7	< LOD	< LOD	< LOD	< LOD	< LOD	< LOD
1.1924.a2 rim	91.0	0.5	0.2	0.8	1.4	1.8	0.1	1.7	2.1
1.1924.a2 rivet	84.7	0.9	1.8	1.3	< LOD	1.6	0.3	3.5	3.8
Stiffener bands									
1.1924.a_1	83.6	0.2	0.2	1.0	8.7	1.8	0.4	2.7	< LOD
1.1924.a_2	80.3	< LOD	< LOD	0.9	6.1	1.7	0.6	7.9	< LOD
WHIP (*nagaika*)									
1.1924.e1	96.2	< LOD	< LOD	< LOD	0.1	< LOD	0.1	0.9	1.2
1.1924.e2	2.5	96.3	0.5	< LOD	0.3	0.04	0.04	< LOD	0.3
1.1924.e2 solder	2.7	85.4	0.4	3.1	5.4	0.1	1.1	< LOD	0.9

assemblages including several objects, as in the case of Pécsüszög.

Thanks to the XRF analysis, it was possible to determine the purity of the gold (Pécsüszög) and the different gilding techniques (fire gilding, Léva; 'leaf gilding', Nyíregyháza-Oros), and to specify the material composition of copper alloy plates (Léva).

Previously analysed assemblages, such as the horse trappings from Bátaszék, Göd-Bócsaújtelep, Nagy-széksós and Telki, can also be classified according to defined groups. In terms of material and gilding, three main groups can be distinguished: gold plates (Bátaszék, Pécsüszög, Szeged-Nagyszéksós), gilded silver plates (Göd-Bócsaújtelep, Nyíregyháza-Oros, Telki), and gilded copper alloy plates (Léva). The assemblages of Árpás, Budapest-Zugló, Debrecen-Agrár park and Pannonhalma, belonging to the 'gold plate horizon' as well, will be analysed in the near future, and so they can be compared to each other. Consideration should be given to the analysis of garnets/stones from stone-inlaid mounts, as it can provide evidence of their provenance. For this reason, it is worth re-analysing the horse trappings from Szeged-Nagyszéksós.

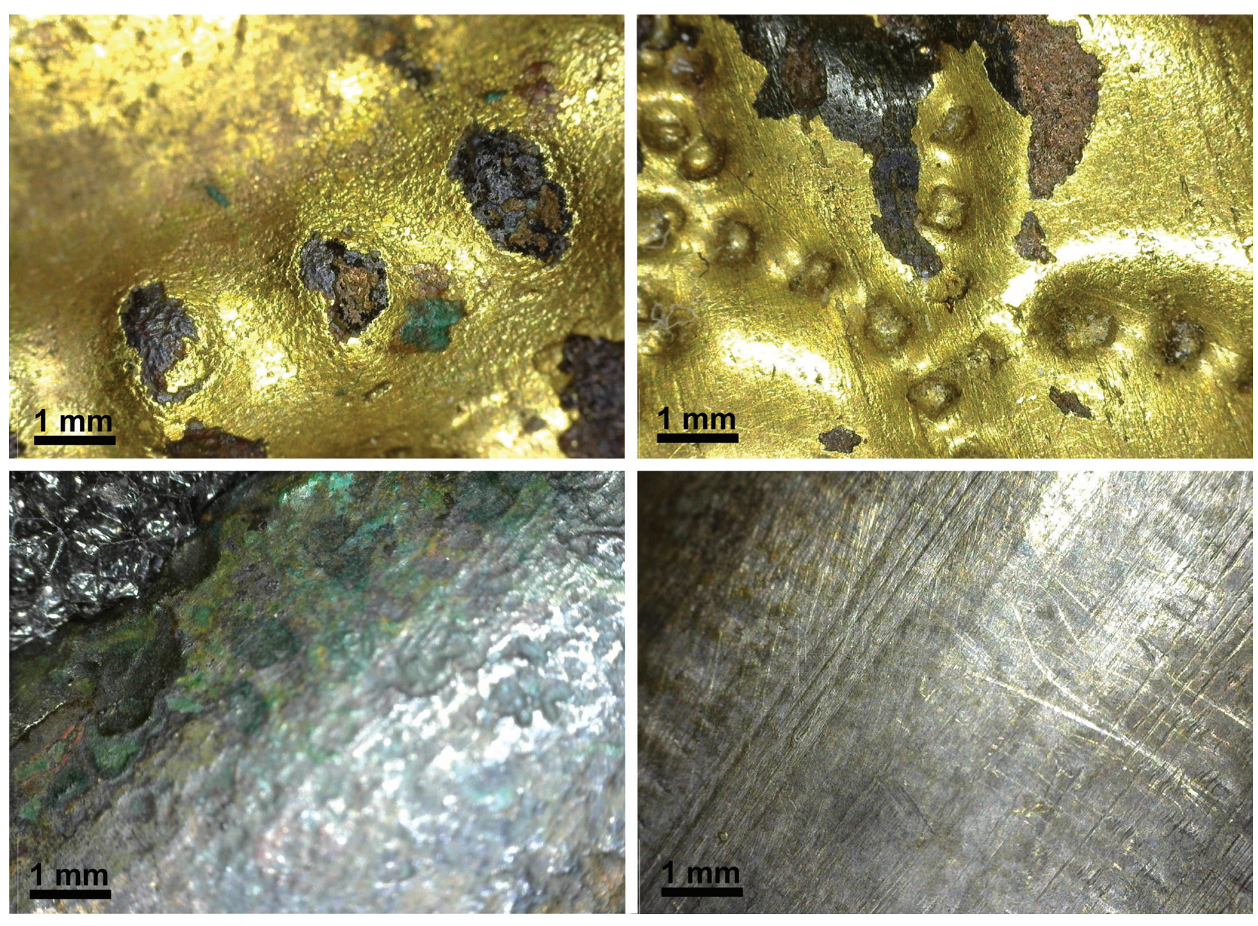

Figure 14. Digital microscopic images showing a phalera (upper left), the decoration of the saddle plate (upper right), and the two covers of the *nagaika* (lower) from Léva.

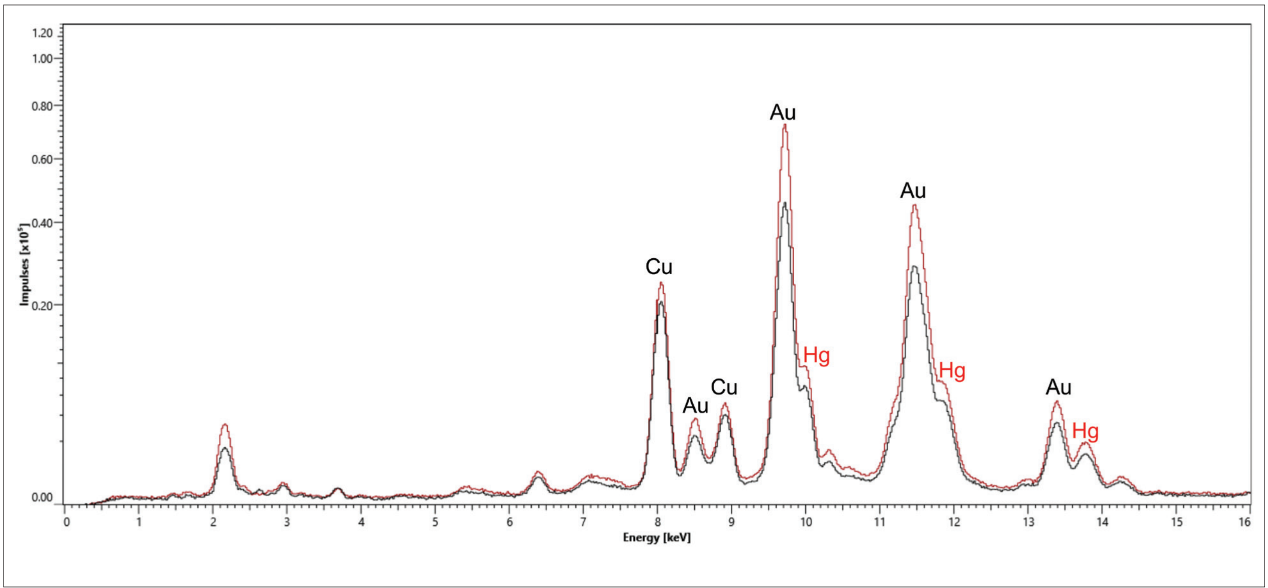

Figure 15. XRF spectra of the gilding of the objects from Léva, showing the emission lines of the characteristic elements (black, bridle mount; red, saddle plate).

Hopefully, the groups and subgroups identified by our investigations will help to describe and classify objects of the 'pressed gold plate horizon' that are found in the future.

Acknowledgements

We are grateful to the staff of the museums who made the research possible: Gergely Kovaliczky from the Janus Pannonius Museum (Pécs), Zsuzsanna Hajnal from the Hungarian National Museum (Budapest), and Eszter Istvánovits from the Jósa András Museum (Nyíregyháza).

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NAUJI KARPATŲ REGIONO HUNIŠKOJO LAIKOTARPIO ŽIRGO APRANGOS TYRIMŲ REZULTATAI, REMIANTIS NEDESTRUKCINIU ARCHEOMETRINIU TYRIMO METODU

RÉKA ÁGNES PIROS, VIKTÓRIA MOZGAI, BERNADETT BAJNÓCZI

Santrauka

Žirgų apranga regione žinoma iš vėlyvosios antikos ir ankstyvojo tautų kraustymosi laikotarpio (1–10, 13, 14 pav.). Ko gero, visame žirgo aprangos kontekste „presuotos aukso plokštelės“, kaip savotiškas laikotarpį atspindintis stilistinis reiškinys ar „dirbinių horizontas“, yra išsamiausiai tyrinėtas. Tačiau niekada nebuvo atlikti straipsnyje aptariamų auksinių plokštelių archeometriniai tyrimai. Šiame straipsnyje aptariami trys Karpatų regiono žirgo aprangos rinkiniai, tai Pécsüszög ir Nyíregyháza-Oros „ritualiniai depozitai“ (aukos), Lévos kapo radiniai. Šio straipsnio tikslas – nustatyti tiriamų dirbinių cheminę sudėtį, auksavimo technologiją ir dekoravimo būdą. Išanalizavus *Untersiebenbrunn* stiliaus žirgų aprangos detales, iškilo kitas klausimas, ar galima šio stiliaus ir kitur rastą vizualiai panašią medžiagą susieti tarpusavyje, įvertinus atliktus elementinės sudėties ir auksavimo tyrimus. Tiksliau, ar galima, naudojant dirbinio elementinės sudėties duomenis, pagrįsti, jog skirtingose vietose rasti dirbiniai pagaminti tose pačiose dirbtuvėse, ar priešingai, tirti dirbiniai gaminti skirtingose dirbtuvėse vieno ar kelių juvelyrų. Atskiros žirgo aprangos detalės buvo pakeistos kitomis joms tiesiog sulūžus. Pasikeitimus neabejotinai turėtų atspindėti skirtinga cheminė dirbinių sudėtis.

Išnagrinėjus minėtų trijų žirgo aprangos komplektų liekanas, pagal skirtingos spalvos ar stilistikos elementus, suirimo lygį, išskirtos vienalaikės detalės (kamanų ir balnų apkalai, žąslų dalys), galimai gamintos tose pačiose dirbtuvėse, taip pat pastebėti vėlesni pakeitimai, atsiradę kaip taisymų rezultatas. Rentgeno spindulių spektrometrija (XRF) nustatyta elementinė radinių sudėtis ir skirtingi auksavimo būdai: karštas dirbinio paviršiaus auksavimas (amalgama) (Léva), dirbinio dengimas plonais aukso lapeliais (Nyíregyháza-Oros, Bátaszék, Pécsüszög, Nagy-széksós), auksuotomis sidabro plokštelėmis (Göd-Bócsaújtelep, Nyíregyháza-Oros, Telki) ir auksuotomis vario lydinio plokštelėmis (Leva).