Ika Prpa-Stojanac

Čišćenje i analiza rimskoga provincijalnog novca iz Salone

Cleaning and analysis of Roman provincial coins from Salona

Ika Prpa-Stojanac
HR, 21000 Split
Arheološki muzej u Splitu
Zrinsko-Frankopanska 25
ika.prpa-stojanac@armus.hr

UDK: 902.2(497.583Solin)
621.7.022:671.411/.418]:069(497.583Split)
Stručni članak
Primljeno: 10. 11. 2020.
Prihvaćeno: 18. 1. 2021.

Ika Prpa-Stojanac
Croatia, 21000 Split
Archaeological Museum in Split
Zrinsko-Frankopanska 25
ika.prpa-stojanac@armus.hr

UDC: 902.2(497.583Solin)
621.7.022:671.411/.418]:069(497.583Split)
Professional paper
Received: 10 November 2020
Accepted: 18 January 2021

U zaštitnim arheološkim istraživanjima u Solinu 1986. – 1987. godine na trasi proširenja ceste Trogir-Split (tzv. solinska obilaznica) između ostalih nalaza pronađen je i istražen 561 grob. U ovom radu opisujemo način čišćenja novca iz groba 207, skeletni grob bez arhitekture u sektoru III (Hortus). U grobu je pronađena keramička lucerna (pečat VIBIANI), oko 30 komada loše očuvanih željeznih čavlića i 20 komada rimskoga provincijalnog novca. Novac je očišćen te je pomoću XRF uređaja obavljena analiza metala, čiji se rezultati također donose.

Ključne riječi: *rimski provincijalni novac, čišćenje novca, analiza metala, XRF uređaj, srebro, bilon, Salona*

During rescue archaeological excavations conducted in Solin in 1986-1987 on the expansion of a section on the Trogir-Split road (the so-called Solin bypass), among the finds 561 graves were discovered and examined. In this paper, I shall describe the method employed to clean the coins from grave 207, a skeletal burial without architecture in sector III (Hortus). The grave contained a ceramic oil lamp (its stamp reading VIBIANI), approximately 30 poorly preserved iron nails and 20 Roman provincial coins. The coins were cleaned and, with the help of an XRF device, a metal analysis was conducted and the results thereof are also presented.

Key words: *Roman provincial coins, cleaning of coins, metals analysis, XRF device, silver, billon, Salona*

Zatečeno stanje

Prije početka restauratorsko-konzervatorskih radova novac je fotografiran u zatečenom stanju (sl. 1a i 1b). Preliminarni pregled obavljen je pod binokularnim mikroskopom s povećanjem od dva do četiri puta. Utvrđeno je stanje sačuvanosti novca i definiran način daljnje obrade. Površina novca bila je prekrivena naslagama stvrdnute zemlje i pijeska te debelim i tvrdim slojem korozijskih produkata. Naslage su nastale slojevito i imale su čvršću strukturu od same površine, što je čest slučaj na novcu. Djelovanjem korozijskih produkata novac je bio „zalijepljen" u skupine od dva do četiri komada.

Mehaničko čišćenje

Mehaničkim čišćenjem lakše se može kontrolirati proces čišćenja novca, mogu se izbjeći oštećenja njegove površine te se može sačuvati plemenitu patinu. Takav način je dugotrajan, ali bolji i sigurniji od kemijskog čišćenja. U ovom slučaju mehaničko čišćenje novca provodilo se uz odgovarajuću opremu i vrlo pažljivo. Korišten je sljedeći pribor: skalpeli različitih oblika, ultrazvučne igle, zubarski mikromotor s gibljivom osovinom i rotirajućim četkama različite tvrdoće, odnosno materijala. Danas se ta metoda više koristi zbog moderne opreme koja nam je dostupna. Tretiranje metalnog arheološkog materijala kemijskim putem (kiselinama ili lužinama) uzrokuje trajno i nepopravljivo oštećenje površine, što onemogućuje dobru interpretaciju materijala.[1]

Prije mehaničkog čišćenja novac je namakan pa ispiran u običnoj vodi, čime je skinut površinski sloj zemlje. Nakon toga tretiran je u blagoj otopini 1% natrijeva hidrogenkarbonata ($NaHCO_3$)[2] u demineraliziranoj vodi, kako bi se površinski omekšale tvrde naslage. Namakanjem predmeta od bronce i njegovih slitina pospješuje se omekšavanje naslaga. Otopina može biti hladna ili zagrijana do vrenja. U ovom slučaju ona je bila sobne temperature jer blaga otopina neće promijeniti boju patine. Otopina se mijenjala svaki dan, uz provjeravanje tvrdoća naslaga te ih se postupno odstranjivalo. Takvo intenzivno ispiranje bilo je potrebno jer se njime iz predmeta odstranjuju kloridi.[3] Postupak skidanja prvog sloja na novcu, koji je uvijek i najtvrđi, proveden je pod binokularnim mikroskopom pomoću ultrazvučne igle i demineralizirane vode. Na taj se način naslage lakše skidaju i odmah ispiru.

Odvajanje „zalijepljenog" novca koji je bio prekriven tvrdim slojem bio je najzahtjevniji (sl. 2a i 2b). Naslage je trebalo omekšavati i skidati sloj po sloj, a da se pritom ne ošteti površina novca. Postupak namakanja ponavljan je u otopini 1%

1 Vidi pregledno Budija 2001; Budija 2002.
2 Plenderleith 1979, str. 54.
3 Donelli 1999, str. 464.

Initial condition

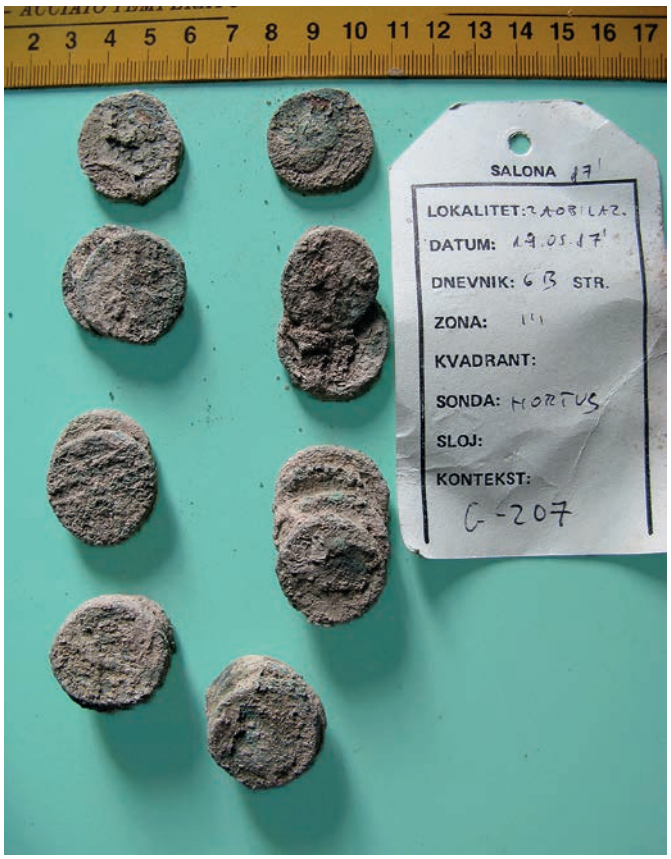
Prior to the commencement of restoration/conservation works, the coins were photographed in their condition as found (fig. 1a and 1b). A preliminary examination was conducted under a stereoscopic microscope with magnification set at a factor of two to four. The condition of the coins was ascertained and methods for further processing were defined. The surface of the coins was covered with sediments of hardened soil and sand and a thick and firm layer of corrosion by-products. The sediments accrued in layers and had a firmer structure than the surface itself, which is often the case on coins. The coins were "affixed" into groups of two to four due to the effect of the corrosion by-products.

Mechanical cleaning

With mechanical cleaning, it is easier to control the coin cleaning process, damaging their surface may be avoided and the noble patina can be preserved. This method is time-consuming, but better and safer than chemical cleaning. In this case, mechanical cleaning of the coins was done with the proper equipment and very cautiously. The following accessories were used: scalpels of various profiles, ultrasonic needles, a dental micrometre with a flexible shaft and rotating brushes of varying coarseness and made of different materials. Today this method is employed more because of the cutting edge equipment available to us. Chemical treatment of metallic archaeological materials (using either acids or bases) causes permanent and irreparable damage to surfaces, which hinders their proper interpretation.[1]

Prior to mechanical cleaning, the coins were soaked and then rinsed in ordinary water, thereby removing the surface layer of dirt. After this they were treated in a mild (1%) sodium hydrogen carbonate ($NaHCO_3$)[2] solution in demineralized water to soften the hard surface sediments. Soaking items made of bronze and its alloys facilitates the softening of sediments. The solution may be cold or heated to boiling. In this case it was left at room temperature because a mild solution will not alter the patina's colour. The solution was replaced every day, with verification of the hardness of the sediments; they were gradually removed. Such intensive rinsing was necessary because it removed the chlorides from the coins.[3] The procedure for removing the first layer on the coins, which is always the hardest, was done under a stereoscopic microscope with the help of an ultrasonic needle and demineralized water. In this manner, the sediments are more easily removed and immediately rinsed off.

1 See the overview in Budija 2001; Budija 2002.
2 Plenderleith 1979, p. 54.
3 Donelli 1999, p. 464.



Slika 1a. i 1b.
Novac prije mehaničke obrade
(foto: I. Prpa-Stojanac)

Figure 1a. and 1b.
Coins prior to mechanical cleaning
(photo: I. Prpa-Stojanac)

Slika 2a.
Novac nakon odvajanja/avers
(foto: I. Prpa-Stojanac)

Figure 2a.
Coins after separation/ obverse
(photo: I. Prpa-Stojanac)

Slika 2b.
Novac nakon odvajanja/revers
(foto: I. Prpa-Stojanac)

Figure 2b.
Coins after separation /reverse
(photo: I. Prpa-Stojanac)

natrijeva hidrogenkarbonata ($NaHCO_3$) u demineraliziranoj vodi, a mehanička obrada nastavljena je pomoću skalpela ili ultrazvučne igle. Tek nakon odvajanja novca moglo se započeti s čišćenjem njegove površinu od naslaga. Njihovim pomnim skidanjem počeo se naslućivati prikaz na novcu. Na površini je prevladavao tanak sloj željeznog oksida i patine koja je dala naslutiti da se radi o brončanom novcu (sl. 3a i 3b). Debeli sloj zelenog oksida nije upućivao na prisutnost srebra, nego na broncu. Međutim, na nekim primjercima, gdje nije bila prisutna ta vrsta patine i gdje su naslage bile tanje, mjestimično se počelo pojavljivati srebro. To svjedoči o količini bronce pomiješane sa srebrom ili o prisutnosti bronce i njezinih produkata u zemlji.

Predmeti od bronce/bakra ili srebra najčešće se čiste mehanički na suho, ali je u ovoj prigodi čišćenje nastavljeno uz pomoć demineralizirane vode. Dugogodišnje iskustvo rada na čišćenju predmeta od bronce na suho potaklo je na traženje drugog načina da se odstrane odstranjivanja naslaga s površine predmeta. Primjena čišćenja novca u demineraliziranoj vodi pokazala se uspješnom jer ne dovodi do "utrljavanja" naslaga na površinu metala i ne ostavlja tragove, osobito kod srebra, koje je mekše od bronce.[4]

U plitku staklenu posudu s demineraliziranom vodom novac je uronjen tako da bude u neposrednoj blizini rotirajuće četke, koja nanosi vodu na novac. Time je izbjegnuto zagrijavanje metala, četka ne ostavlja tragove na površini novca, a oksid se bolje i lakše odstranjuje. Takav je postupak primjereniji jer je srebro kao materijal osjetljivije na mehanička oštećenja. Demineraliziranu vodu potrebno je često mijenjati jer je i čistoća vode pokazatelj jesu li naslage još prisutne na površini. Na taj način očišćen je velik dio površine. Ostale su mjestimične naslage, koje su bile tvrđe ili nakupljene u udubinama prikaza na novcu; i one su čišćene na isti način, tj. pomoću skalpela i pod mikroskopom.

Ponovljeno je tretiranje novca u dosta blagoj otopini od 0,5% natrijeva hidrogenkarbonata ($NaHCO_3$) u demineraliziranoj vodi. Nakon mehaničke obrade ponovljen je postupak ispiranja novca u demineraliziranoj vodi te je novac stavljen u sterilizator.

U procesu sušenja novca na njegovoj površini se stvorio novi tanki film zaostalih produkata korozije metala. Bio je vidljiv pod mikroskopom te je odstranjen mekim četkama od prirodnih vlakana. Radi preciznije identifikacije novca bilo je potrebno čišćenjem doći što bliže njegovu izvornom obliku, što je postignuto zahvaljujući navedenom postupku. Detalji na aversu i reversu postali su vidljivi i nedvojbeno se utvrdilo da se radi o srebrnom novcu, točnije o novcu od bilona[5] (sl. 4a i 4b).

The separation of the "attached" coins that were covered in a hard layer was the most demanding task (fig. 2a and 2b). The sediments had to be softened and removed layer by layer, without damaging the surface of the coins in the process. Soaking in a 1% sodium hydrogen carbonate ($NaHCO_3$) solution in demineralised water was repeated, and then mechanical procedures continued with the help of a scalpel or ultrasonic needle. Only after the coins were separated could the cleaning of sediments from their surfaces begin. As they were carefully removed, the images on the coins could begin to be discerned. A thin layer of iron oxide and patina predominated on the surfaces, which pointed to the conclusion that they were bronze coins (fig. 3a and 3b). The thick layer of iron oxide did not point to the presence of silver, but rather bronze. However, on some examples on which this type of patina was not present and the sediments were thinner, silver began to appear at places. This testifies to a quantity of bronze mixed with silver or the presence of bronze and its by-products in the soil.

Items made of bronze/copper or silver are most often mechanically cleaned in a dry process, but in this instance cleaning continued with the help of demineralized water. Long-term experience in work on the cleaning of items made of bronze in a dry process prompted a search for another way of removing sediments from their surfaces. The cleaning of coins in demineralized water has proven successful, because it does not lead to the "rubbing" of sediments into the metal's surface and does not leave marks, particularly on silver, which is softer than bronze.[4]

The coins were submerged in demineralized water in a shallow glass dish in order to be near a rotating brush that applies water to them. This avoided heating the metal; the brush does not leave traces on the surface of the coins, while the oxide is better and more easily removed. Such a procedure is more appropriate because silver as a material is more sensitive to mechanical damage. The demineralized water must be changed frequently, because the purity of the water is also an indicator of whether sediments are still present on the surface. A considerable portion of the surfaces was cleaned in this manner. Sediments only remained at places, where they were harder or packed into depressions in the images on the coins; they were also cleaned in the same way, i.e., with the help of a scalpel under a microscope.

Treatment of the coins in a considerably mild 0.5% sodium hydrogen carbonate ($NaHCO_3$) solution in demineralized water was repeated. After mechanical processing, the coins were again rinsed in demineralized water and then placed in a sterilizer.

In the process of drying the coins, a new thin film of lingering metal corrosion by-products formed on their surfaces.

4 Prpa-Stojanac 2009.

5 Bilon je legura od plemenitog metala, najčešće srebra, ali i zlata, i većeg dijela osnovnih metala, poput bakra. Koristi se uglavnom za

4 Prpa-Stojanac 2009.

Slika 3a.
Čišćenje novca/avers
(foto: T. Seser)

Figure 3a.
Cleaning of coins /obverse
(photo: T. Sesar)

Slika 3b.
Čišćenje novca/revers
(foto: T. Seser)

Figure 3b.
Cleaning of coins /reverse
(photo: T. Sesar)

Slika 4a.
Novac nakon mehaničke obrade/avers
(foto: T. Seser)

Figure 4a.
Coins after mechanical cleaning /obverse
(photo: T. Sesar)

Slika 4b.
Novac nakon mehaničke obrade/revers
(foto: T. Seser)

Figure 4b.
Coins after mechanical cleaning /reverse
(photo: T. Sesar)

Analiza novca pomoću XRF uređaja

Metoda analize rendgenskom fluorescencijom[6] (XRF) dokazala se kao jedna od najpogodnijih nedestruktivnih tehnika za elementarnu analizu materijala. To je brza, univerzalna i

It was visible under a microscope, and was removed by soft brushes made of natural fibres. In order to more precisely identify the coins, it was necessary to arrive at their original form by cleaning, which was achieved by the aforementioned procedure. The details on the obverse and reverse became visible and it was ascertained without doubt that they are silver coins, more accurately coins made of billon[5] (fig. 4a and 4b).

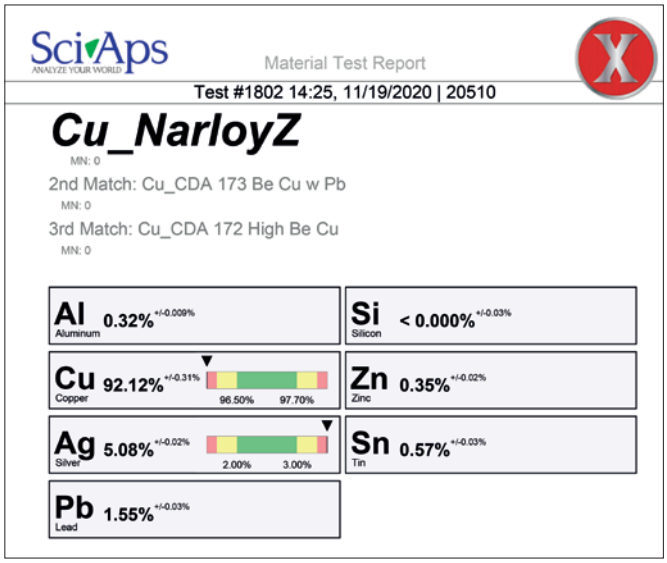
izradu kovanica, medalja i žetona.

6 Prednost, dobrobit, korist, ali i poneki nedostatak ove metode demonstrirani su na nekoliko primjera iz prakse: terensko istraživanje pigmenata drvene polikromije u crkvi sv. Marije Jeruzalemske u Trškom Vrhu i određivanje sastava legure skulpture Hrvatskog Apoksiomena. Vidi Desnica 2012.

5 Billon is an alloy of a precious metal, most often silver, but also gold, and a larger portion of a base metal, such as copper. It was generally used to make coins, medals and tokens.

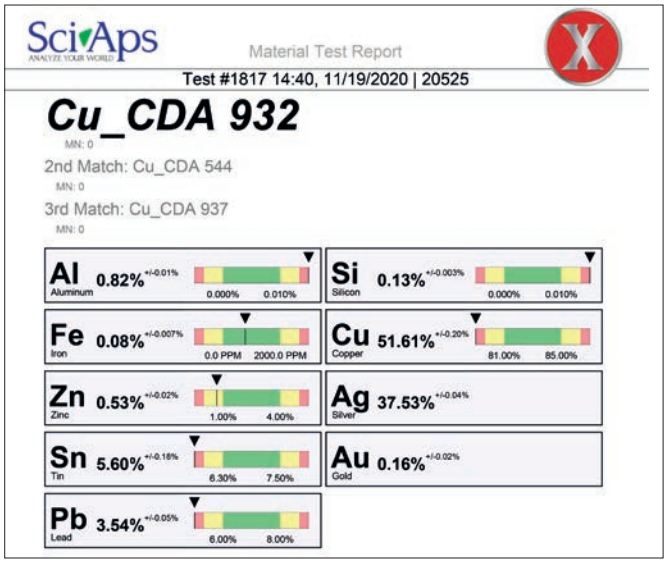
Slika 5.
Analiza novca pomoću uređaja x200 SciAps (foto: T. Seser)

Figure 5.
Analysis of coins using the SciAps x-200 analyser (photo: T. Sesar)



Slika 6.
Rezultati analize novca inv. br. 20510, najmanji postotak srebra

Figure 6.
Results of analysis of coin, inv. no. 20510, lowest share of silver



Slika 7.
Rezultati analize novca inv. br. 20525, najveći postotak srebra

Figure 7.
Results of analysis of coin, inv. no. 20525, highest share of silver

relativno jednostavna analitička metoda za multimedijalnu analizu artefakata i kao takva u svijetu je tretirana kao jedna od najosnovnijih fizikalnih metoda za istraživanje u konzervatorsko-restauratorskom području. U svojoj prijenosnoj inačici metoda je neinvazivna te omogućuje očuvanje kulturne baštine na najvišoj razini. Prijenosni XRF uređaj omogućuje *in situ* analizu objekta bez obzira na njegovu veličinu, oblik ili mjesto na kojem se nalazi ili na kojem je izložen (npr. galerija ili muzej) i može se primjenjivati praktički u svim situacijama.

Analysis of coins with the help of an XRF device

The X-ray fluorescence (XRF) method[6] has proven to be one of the most suitable non-destructive techniques for an elementary analysis of materials. This is a fast, universal and relatively simple analytical method for the multimedia analysis of artefacts and as such it is deemed one of the most basic physical research methods in the conservation/restoration field throughout the world. In its portable variant it is non-invasive and allows for the preservation of the cultural heritage at the highest level. A portable XRF device allows for the *in situ* analysis of objects regardless of their size, shape or the position in which they are found or exhibited (e.g. in a gallery or museum) and it may be applied in practically any situation.

This is why it was decided that after cleaning the analysis of all 20 coins would be done with the help of a XRF device[7]

6 The advantages, benefits and uses but also certain shortcomings in this method were demonstrated by several examples from practice: field research of pigments on multi-coloured wood in the Church of St. Mary of Jerusalem in Trški Vrh and the determination of the alloy composition in the Croatian Apoxyomenos. See Desnica 2012.

7 The SciAps x-200 analyser was used, with maximum power of 50

Zato je odlučeno da se analiza svih 20 komada novca napravi nakon čišćenja pomoću uređaja XRF[7] (sl. 5). Rezultati analize pokazali su da u leguri ima najviše bakra, srebra, olova, i kositra, a manje od 1% nikla, silicija, bizmuta, zlata, aluminija, željeza i cinka. Utvrđeno je da novac inv. br. 20510 ima najmanji udio srebra (Ag) 5,08 $\%^{+/-0.02\%}$, bakra (Cu) 92,12 $\%^{+/-0.31\%}$. Novac koji ima najveći udio srebra je inv. br. 20525 srebra (Ag) 37,53 $\%^{+/-0.04\%}$, bakra (Cu) 51,61 $\%^{+/-0.20\%}$ površina novca je glatka i izrazitijeg sjaja za razliku od ostalog novca koji ima manji udio srebra u leguri.(sl. 6, 7).

S obzirom na zastupljenost srebra, novac se može podijeliti u četiri skupine:

1. četiri primjerka: srebro 5,08 % – 10,34 %, bakar 78,65 % – 92,12 %
2. šest primjeraka: srebro 12,99 % – 15,78 %, bakar 76,54 % – 78,87 %
3. šest primjeraka: srebro 20,62 % – 26,12 %, bakar 67,94 % – 68,24 %
4. četiri primjerka, kod kojih je i najveća zastupljenost srebra: srebro 33,53 % – 37,53 %, bakar 51,61 % – 59,62 %.

Ovi podatci mogu poslužiti za daljnja istraživanja povijesti ovog novca, a konzervatorima mogu poslužiti za praćenje promjena na njegovoj površini. Naime, pod utjecajem mikroklimatskih uvjeta, ovisno o sastavu materijala, na površini novca nastaju promjene u boji.

Zaključak

Restauratorsko-konzervatorski zahvati na arheološkoj građi koju čine predmeti od različitih metala osjetljiv su i odgovoran posao jer se provode na predmetima od kulturno-povijesnog i umjetničkog značenja. Prilikom čišćenja treba obratiti pozornost na to da se agresivnim metodama ne uništi prvotni izgled predmeta, odnosno ono što se od njega sačuvalo, poput izvorne plemenite patine, pozlate, posrebrenja, ukrasa, tragova boje, načina obrade i slično, a bilo je skriveno pod korom korozije i nečistoća. Odgovornost, sposobnost i strpljivost restauratora važni su pri procjeni i donošenju odluke o najprikladnijoj metodi čišćenja za svaki pojedini predmet. Nakon obrade predmeta s njima treba pažljivo rukovati (u pamučnim rukavicama), a za pohranu koristiti bezkiselinski papir ili bezkiselinske kutije. Potrebno je kontinuirano voditi računa o mikroklimatskim uvjetima prostora u kojem se predmeti nalaze, bilo da su izloženi u vitrinama ili pohranjeni u čuvaonicama. Potrebno je izbjegavati veće oscilacije temperature i relativne

(fig. 5). The results of the analysis have shown that the alloy mostly contains copper, silver, lead and tin, and less than 1% nickel, silicon, bismuth, gold, aluminium, iron and zinc. It was ascertained that the coin, inv. no. 20510, has the lowest share of silver (Ag) 5.08 $\%^{+/-0.02\%}$ and copper (Cu) 92.12 $\%^{+/-0.31\%}$. The coin with the largest share of silver is inv. no. 20525 silver (Ag) 37.53 $\%^{+/-0.04\%}$ and copper (Cu) 51.61 $\%^{+/-0.20\%}$; the coin's surface is smooth with notable lustre, as opposed to the remaining coins, which have a lower share of silver in the alloy (fig. 6, 7).

Given the presence of silver, the coins may be divided into four groups:

1. four coins: silver 5.08 % – 10.34 %, copper 78.65 % – 92.12 %
2. six coins: silver 12.99 % – 15.78 %, copper 76.54 % – 78.87 %
3. six coins: silver 20.62 % – 26.12 %, copper 67.94 % – 68.24 %
4. four coins, in which the share of silver is highest: silver 33.53 % – 37.53 %, copper 51.61 % – 59.62 %.

These data may serve for further research into the history of these coins, and serve conservation specialists to monitor the changes on their surfaces. This is because microclimatic conditions lead to changes in colour on the surface of coins depending on their physical composition.

Conclusion

Restoration and conservation works on archaeological materials consisting of various metals are sensitive and demanding, as they are conducted on items with cultural/historical and artistic significance. In the course of cleaning them, care must be taken so that aggressive methods do not destroy the appearance of the objects or whatever aspect of them has been preserved, such as the original noble patina, gilding, silver-plating, decorations, paint traces, etc. which was obscured below a crust of corrosion and impurities. The responsibility, capability and patience of restoration specialists are vital to evaluation and decision-making on the most appropriate cleaning method for each individual item. After the items are processed, they must be carefully handled (using cotton gloves), and stored in acid-free paper or acid-free boxes. The microclimatic conditions of the space in which the items are located, whether exhibited in display cases or stored in depots, must always be taken into account. Significant variations in the air temperature and relative moisture must be avoided. As in other professions, so too must the conservation/restoration field remain apprised and make use of new work methods, keep abreast of new knowledge and exchange experiences

7 Korišten je XRF uređaj oznake *x200 SciAps*, maksimalna snaga ovog uređaja je 50 kV , a anoda je Rh, izvještaj o analizi potpisuje Damir Živkušić iz *Trokuttest grupe* iz Zagreba.
Zahvaljujem kolegici M. Bonačić Mandinić na suradnji tijekom konzervatorske obrade novca, T. Seseru na fotografijama i L. Stojancu za obradu fotgrafija.

kV and Rh anode; the analysis report was signed by Damir Živkušić from Trokut Test Group in Zagreb.
I would like to thank my colleague M. Bonačić Mandinić for her collaboration during the conservation processing of the coins, T. Sesar for the photographs and L. Stojanac for developing the photographs.

vlažnosti zraka. Kao i kod drugih struka, tako je i u konzervatorsko-restauratorskoj potrebno pratiti i koristiti nove metode u radu, usavršavati se i razmjenjivati iskustva s kolegama iz drugih, srodnih ustanova. Jako je važna suradnja konzervatora-restauratora i arheologa koji znaju što se može očekivati na pojedinom predmetu ili kakav oblik treba imati taj predmet.

with colleagues from other, similar institutions. Collaboration between conservation/restoration specialists and archaeologists, who know what to expect for individual items or the proper form of such items, is extremely vital.

Prijevod** / **Translation: Apostrof d. o. o.

Literatura / Bibliography

Budija 2001
G. Budija, *Čišćenje, zaštita i održavanje umjetničkih predmeta i starina od bakra i njegovih slitina*, Vijesti muzealaca i konzervatora 4, Zagreb 2001, 137-150.

Budija 2002
G. Budija, *Čišćenje, zaštita i održavanje umjetničkih predmeta i starina od željeza i njegovih slitina*, Vijesti muzealaca i konzervatora 1, Zagreb 2002, 83-91.

Desnica 2012
V. Desnica, *Prijenosni uređaj za rentgensku fluorescentnu analizu (XRF) kao jedinstveni instrument za in situ elementnu karakterizaciju objekta kulturne baštine*, Godišnjak zaštite spomenika kulture Hrvatske 33-34/2009-2010, Zagreb 2012, 187-196.

Donelli, Mihanović 1999
I. Donelli, F. Mihanović, *Metode snimanja i konzervacija metalnih arheoloških predmeta,* Vjesnik za arheologiju i historiju dalmatinsku 90-91, Split 1999, 460-477.

Doračić 2007
D. Doračić, *Restauratorsko-istraživački postupci na kacigi iz Nove Gradiške*, Vjesnik Arheološkog muzeja u Zagrebu, 3. ser., vol. 40, br. 1, Zagreb 2007, 147-166.

Plenderleith H. J. 1979
H. J. Plenderleith, *The preservation of antiquities*, London 1979.

Prpa-Stojanac 2009
I. Prpa-Stojanac, *Čišćenje srebrenog i brončanog rimskog novca iz Isse*, in: L. Bekić (ed.), *Jurišićev zbornik: zbornik radova u znak sjećanja na Marija Jurišića*, Zagreb 2009, 360-364.

Prpa-Stojanac 2017
I. Prpa-Stojanac, *Metode čišćenja konzervacija novca i kemijska analiza naslaga*, in: E. Marin et alii, *Forum Naronitanum*, Vid 2017, 407-413.

Vješnica 2005
B. Vješnica, *Rekonstrukcija brončane posude s lokaliteta Plećaševe štale/Gornje njive*, Vjesnik za arheologiju i povijest dalmatinsku 98, Split 2005, 289-294.