**Zeitschrift:** Schweizer Münzblätter = Gazette numismatique suisse = Gazzetta numismatica svizzera

**Herausgeber:** Schweizerische Numismatische Gesellschaft

**Band:** 64 (2014)

**Heft:** 255

**Artikel:** Metal analysis of local imitations of early Roman imperial asses found in the Gallo-Roman sanctuary on the Martberg in the Mosel valley

**Autor:** Nüsse, Michael

**DOI:** https://doi.org/10.5169/seals-685834

# Metal analysis of local imitations of early Roman imperial *asses* found in the Gallo-Roman sanctuary on the Martberg in the Mosel valley

Michael Nüsse

## Imitations of early Imperial *asses*[1]

In many archaeological sites in Spain, Gaul and the Northwestern provinces of the Roman Empire, large numbers of early imperial copper coins are found that differ in fabric, weight and style from regular coinage[2]. Most of these coins imitate *asses* of the emperor Claudius, but imitations of *asses* of Augustus – especially of the Lyons altar series I and II –, of Tiberius (PROVIDENTIA *asses*), Caligula and Nero were also found. In the middle of the 1st century AD there was obviously a great need for small change caused by the increasing monetization of these provinces and, particularly, due to the cessation of minting official *aes* coinage in Rome between about 42 and 62 AD. Also the local *aes* coinage in Gaul and the Iberian peninsula was abandoned. This lack of small change probably led to a massive local minting of mainly copper *(as)* coinage[3]. These copies are usually characterized by their poorer design of image and letters compared with their official prototypes. They were minted on flans cast using various copper alloys and had a weight which was usually lower than that of official coins. Among these imitations the nearly full-weight coins made in comparably good style are assumed by several authors to have been struck in mints operated by the military or were produced in the civilian sector. However, there is no evidence for any of these assumptions. The poorer imitations with lower weight seem to have been produced in the local area. For example, local imitations such as those found in the Rhine/Mosel area could have been made with a weight equal to about one-half *as*. One might conclude that at the local level, a need for smaller nominals existed, a phenomenon that can be traced over time, and is in the tradition of the halved *asses* often found in Augustan and Tiberian times.

The mass production of imitations in the 1st century AD seems to have ended during the reign of Nero, because the minting of *aes* coins was resumed in 62/63 AD. Claudian imitations might still have been produced under the reign of Nero because Neronic models were initially not available as a template for the production of imitations. In addition, the few imitations with Neronian coin types were usually of better quality, and no hybrids or die links between Neronian and Claudian coin types were found so far.

Based on die links and hybrids, Giard already has pointed out that many copies of Augustan and Tiberian models must have been produced in the Claudian period. However, it was not always possible to determine whether individual copies of this group all belong to the Claudian period, or were minted at or around the same time as their models. Similar results were later published by other authors based on die links and hybrids among the coin finds from the Martberg and other find spots nearby. One must ask, therefore, whether those

1 The results of metal-analytical studies on imitations of early imperial asses and their interpretation presented here are part of a recent dissertation of the author: M. Nüsse, Archäologische, numismatische und archäometrische Untersuchungen zu den Fundmünzen vom Martberg bei Pommern im Moseltal (Lkr. Cochem-Zell), Dissertation Goethe Universität (Frankfurt 2012). It is published as http://publikationen.ub.uni-frankfurt.de/frontdoor/index/index/docId/30129. Cf. also: C. Nickel, Martberg: Heiligtum und Oppidum der Treverer III Die Siedlung. Funde und Befunde sowie naturwissenschaftliche Ergebnisse der Grabungen 1986/87 und 1994–2010. Mit Beiträgen von C. Bendall, M. Helfert, H. Kroll, M. Nüsse, S. Scholz, D. Wigg-Wolf und C. Wustrow, Ber. Arch. Mittelrhein u. Mosel 19 (Koblenz 2013).

2 The many references concerning imitations are presented in the dissertation of the author. Most of these references are omitted here for clarity and shortness of the text.

3 M. Peter, Imitation und Fälschung in römischer Zeit, in: A.-F. Auberson – H. R. Derschka – S. Frey-Kupper (eds), Fälschungen – Beischläge – Imitationen (Lausanne 2004), pp. 19–29.

imitations, which show coin types of Augustus, Tiberius or Caligula alone, were also struck in the Claudian period. Other questions refer to the source of the copper used for minting the imitations and the organizations or persons/workshops responsible for minting.

Metal-analytical data of imitations including chemical characterization and lead isotope ratios in comparison to similar data measured in official *asses* might contribute to discuss and to render more precisely the source of the copper used for minting these imitations. Chemical characterization provides important information about the material from which the coins were produced. The results from lead isotope analysis might be used to trace potential ore sources and their geological background and can, therefore, reveal the locations where the copper was mined. Hitherto published data showed – amongst others – enhanced tin, antimony, lead and zinc contents in imitations compared to official *asses*. Provenance studies of their copper using lead isotope ratios have so far only been performed for official *asses* minted in Rome or Lyon and a few imitations.

The coin finds in the Gallo-Roman temple district on the Martberg in the Mosel valley stand out by their large number of more than 10 000 coins found during the excavations in the sanctuary and the nearby settlement[4]. The majority of over 7000 coins came from the sanctuary and its immediate surroundings, and must, therefore, have played an important role in the ritual acts performed in the temple district. The earliest Celtic coins date from the late 2nd and 1st century BC. Roman coins date from the Republic and the Augustan period up to the end of the 4th century AD. Among these Roman coins were many imitations from the first half of the 1st century AD.

The aim of this study is to present new data on the chemical composition and possible provenance of the copper in more than 100 imitated *asses* of the Julio-Claudian period found during the excavations on the Martberg. These data are discussed taking into account data of official coins minted in Rome and Lyon published earlier. The results presented here obviously apply to the imitations having circulated in the Rhine-Mosel area. However, they might – within certain limits – also be representative of imitations found outside of this region.

## Analytical methods

Samples were taken from the coins by drilling or cutting bits of 0,5 to 1,0 mm in diameter. Electron microprobe analysis was carried out with a Jeol Superprobe JXA-8900 with a wavelength-dispersive spectrometer system. Isotopic measurements were performed with an MC-ICP-MS (NeptuneTM, Finnigan MAT).

## Analyzed Coins

### *Imitations*

114 imitated *asses* were selected from 259 Julio-Claudian imitations found on the Martberg[5]: 38 imitations of Augustan types (37 RIC I² 230 ff, one RIC I² 373 ff), nine imitations of Tiberius types (RIC I² 80/81: PROVIDENTIA-type), four

4 C. Nickel – M. Thoma – D. Wigg-Wolf, Martberg: Heiligtum und Oppidum der Treverer, Ber. Arch. Mittelrhein u. Mosel 14 (Koblenz 2008).

5 See FMRD IV Band 4/1. Koblenz: Der Martberg bei Pommern (ehem. Kreis Cochem) 1 (Mainz 2005). Band 4/2 in Vorbereitung.

from Caligula (RIC I² 58: AGRIPPA-*asses*) and 63 from Claudius (one RIC I² 95/111: CONSTANTIA-type, seven RIC I² 97/113: LIBERTAS-type and 55 RIC I² 100/116: MINERVA-type). In addition, the data from six imitations (Augustus RIC I² 230/233) found in Mainz[6], and from 10 imitations published earlier without lead isotope data were included.

Therefore, data about the chemical distribution obtained from a total of 130 imitations were used for the analysis; lead isotope data were, however, only available for 116 imitations.

Photos of a selection of 18 analyzed imitations from the Martberg are shown in plate 1.


**Pl. 1: Selection of imitations from the Martberg**

6 S. Klein – H.-M. von Kaenel – Y. Lahaye – G.P. Brey, The Early Roman Imperial AES Coinage III: Chemical and Isotopic Characterisation of Augustan Copper Coins from the Mint of Lyons/Lugdunum, SNR 91, 2012, pp. 63–110.

***Pure copper (trace elements < 0,04 wt%).***

*a: Im1-29 392-Claud: Claudius, As, gall, AD 41? – 50, RIC² 100; 7,69 g; Ø 2,62 cm – 2,70 cm; 12h.*

*b: Im1-26 660-Claud: Claudius, As, gall, AD 41? – 54, RIC² 100/116; 6,39 g; Ø 2,38 cm – 2,45 cm; 2h.*

*c: Im1-31 647-Claud: Claudius, As, gall, AD 41? – 54, RIC² 100/116; 6,95 g; Ø 2,62 cm; 3h.*

*d: Im1-35 708-Claud: Claudius, As, gall, AD 41? – 54, RIC² 100/116; 4,75 g; Ø 2,50 cm; 7h.*

*e: Im2-32 738-Aug: Augustus, As, gall., BC 7 – AD 14, RIC² 230ff; 2,37 g; Ø 2,00 cm – 2,20 cm; 11h.*

*f: Im2-37 721-Claud: Claudius, As, gall, AD 41 – 54, RIC² 97/113; 2,04 g; Ø 2,10 cm; 6h.*

***Copper with Sb (0,15 wt%), As (0,24 wt%), Ag (0,05 wt%), Pb (0,05 wt%).***

*g: Im1-29 302-Claud: Claudius, As, gall, AD 41? – 50, RIC² 100; 6,2 g; Ø 2,50 cm; 6h.*

*h: Im1-21 966-Claud: Claudius, As, gall, AD 41? – 54, RIC² 100/116; 3,44 g; Ø 2,10 cm; 5h.*

*i: Im2-19 921-Aug: Augustus, As, gall., BC 7 – AD 14, RIC² 230ff; 2,7 g; Ø 2,00 cm; 10h*

***Copper with Sb (0,1–0,2 wt%), Pb (0,3 wt%).***

*j: Im2-31 180-Tib: Tiberius, As, gall., AD 22? – 30, RIC² 81; 8,87 g; Ø 2,54 cm; 5h.*

*k: Im1-29 334-Claud: Claudius, As, gall, AD 41? – 54, RIC² 100/116; 3,96 g; Ø 2,20 cm; 11h.*

***Copper with zinc (0,5 wt%) and lead (> 1 wt%).***

*l: Im2-35 699-Tib: Tiberius, As, gall., AD 22? – 30, RIC² 81; 11,77 g; Ø 2,65 cm; 8h.*

***Copper with zinc (0,2–0,4 wt%).***

*m: Im1-26 763-Claud: Claudius, As, gall, AD 41? – 54, RIC² 95/111; 7,97 g; Ø 2,26 cm; 4h.*

*n: Im1-31 917-Claud: Claudius, As, gall, AD 41? – 54, RIC² 100/116; 3,85 g; Ø 2,28 cm; 4h.*

*o: Im1-29 741-Claud: Claudius, As, gall, AD 41 – 54, RIC² 97/113; 7,15 g; Ø 2,34 cm; 6h.*

*p: Im1-31 646-Claud: Claudius, As, gall, AD 41? – 54, RIC² 100/116; 4,34 g; Ø 2,21 cm; 6h.*

***Copper with zinc (0,4 wt%) and iron (0,4 wt%).***

*q: Im1-19 757-Claud: Claudius, As, gall, AD 41? – 50, RIC² 100; 4,30 g; Ø 2,36 cm; 7h.*

***Copper with Sb (0,1 wt%), As (0,1 wt%), Ag (0,06 wt%).***

*r: Im1-32 736-Claud: Claudius, As, gall, AD 41? – 54, RIC² 100/116; 2,51 g; Ø 1,90 cm; 7h.*

### *Official asses*

Answers to the above questions are only possible if similar results on the chemical composition and lead isotope ratios of official copper coins of the Julio-Claudian emperors are available for comparison. Therefore, metal-analytical data of more than 200 official Julio-Claudian coins from the Tiber finds and from Lyon[7] were used here for a closer understanding of the metal composition and possible origin of the copper used in the minting of Claudian imitations.

### Provenance of the copper based on lead isotope signatures – Comparison of regular *asses* and imitations

Published lead isotope ratios ($^{207}Pb/^{206}Pb$ and $^{208}Pb/^{206}Pb$) of official *asses* and *quadrantes* minted in Rome during the first half of the 1st Century AD have shown that their copper was mined mainly in two regions of Spain, the Iberian Pyrite Belt (IPB) and the Central Iberian Zone (CIZ, Sierra Morena region). Apparently, the mint in Rome used copper from the CIZ and later copper from the IPB areas. *Asses* produced with copper from the IPB did not appear until Tiberius' reign in AD 15/16. *Asses* of the Lyon altar series I (LAS I) and II (LAS II) minted at Lugdunum, however, differed in their lead isotope ratios. The copper used for most of the LAS I seems to have been mined in a local source in France (Massif Central, MC)[8], copper for LAS II also came from Southern Spain (IPB). Therefore, with the production of LAS II *asses* in AD 8(?)/9–10 and 13 (?) the mint in Lugdunum changed its metal supply to copper coming from the IPB in Spain. The *asses* from Rome have widely scattered $^{207}Pb/^{206}Pb$ ratios, the *asses* from Lyon, however, show distinct clusters in their $^{207}Pb/^{206}Pb$ ratios. Most of the officially minted Tiberian and Claudian *asses* were also produced using copper from the IPB area. Only during the reign of Caligula copper from the CIZ was used in *asses* exclusively.

Remarkably 99 of the 116 imitations (85%) have been minted with copper from the IPB (see Table 1 and Fig. 1). The data in Table 1 suggest that the copper used for the imitations with Claudian coin types was mined in different deposits in Spain: 12 imitations (19%) in the CIZ area, 51 imitations (81%) in the IPB area. Similarly, 38 imitations (90%) with Augustan coin type (LAS I or LAS II) were made with copper from the IPB area. Only four of these imitations (10%) were minted using copper from the CIZ. Although few imitations with

| | $^{207}Pb/^{206}Pb < 0{,}855$: CIZ | $^{207}Pb/^{206}Pb > 0{,}855$: IPB | Sum |
|---|---|---|---|
| Augustus | 4 (10%) | 38 (90%) | 42 |
| Tiberius | 1 (12%) | 7 (88%) | 8 |
| Caligula | 0 | 3 (100%) | 3 |
| Claudius | 12 (19%) | 51 (81%) | 63 |
| Sum | 17 (15%) | 99 (85%) | 116 |

**Table 1: Number and percentage of imitations minted with copper from the CIZ ($^{207}Pb/^{206}Pb < 0{,}855$) and the IPB ($^{207}Pb/^{206}Pb > 0{,}855$).**

7 The data were obtained from: S. Klein – H.-M. V. Kaenel, Metal analysis and numismatic studies of early Roman imperial bronze coinage. Part 1: Chemical characterisation of copper coins from Augustus to Claudius, SNR 79, 2000, pp. 53–106; S. Klein – Y. Lahaye – G.P. Brey – H.-M. von Kaenel, The early Roman Imperial aes coinage II: Tracing the copper sources by lead- and copper-isotope analysis – copper coins of Augustus and Tiberius, Archaeometry 46, 2004, pp. 469–480.

8 See note 6.

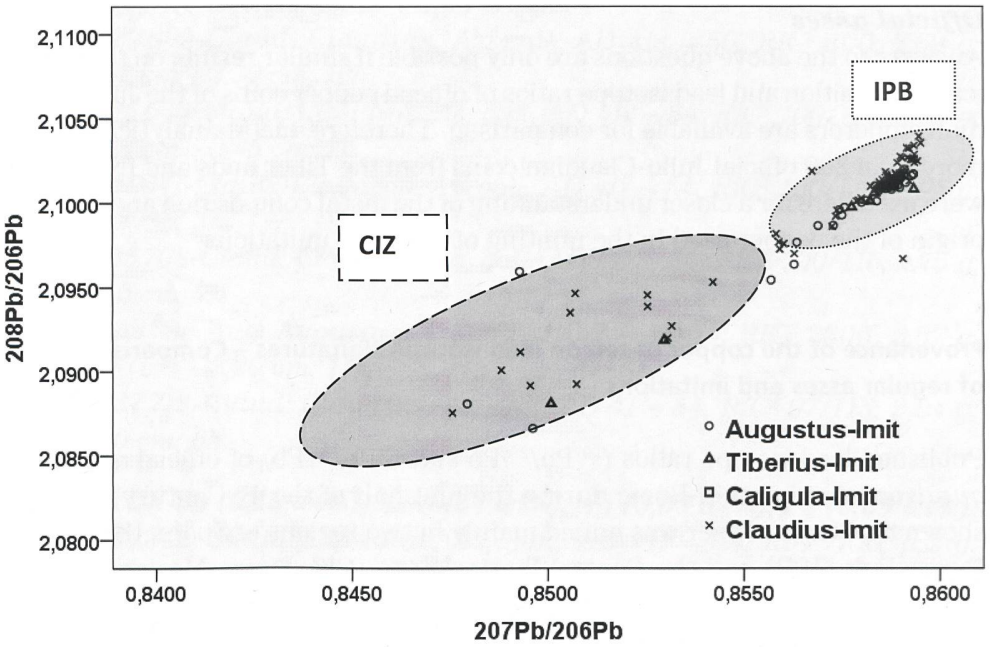


**Fig. 1: Lead isotope ratios ($^{207}Pb/^{206}Pb$ versus $^{208}Pb/^{206}Pb$) in imitations of coin types of Augustus, Tiberius, Caligula and Claudius. (CIZ: Central Iberian Zone $^{207}Pb/^{206}Pb < 0,855$; IPB: Iberian Pyrite Belt $^{207}Pb/^{206}Pb > 0,855$).**

coin types from Tiberius (eight coins) and Caligula (three coins) were analyzed, the results show again that the majority of these coins (nine of the 11 imitations, 82%) were also made with copper from the IPB.

Therefore, the vast majority of the imitations analyzed so far (around 85%) were minted using copper from the IPB (Table 1). Only 15% of the imitations were produced with copper mined in the CIZ. It is obvious that the copper used for the imitations came from the same mining areas in Spain as for the official coins of this period (first half of the 1st century AD).

It is, however, not yet clear, whether copper from these mining areas was used directly for the production of imitations (eg. via copper ingots) or, alternatively, by melting copper originally used for other purposes (coins, copper residues). By an additional analysis of the chemical composition of imitations in comparison to similar measurements in official coins it might be possible to get a closer insight into the mechanisms of the production of imitations. The results of this approach will be summarized in the following section.

### Element pattern – Comparison of regular *asses* and imitations

The chemical composition of the imitations studied in my dissertation show that they can have very different element patterns, but also that a large number of imitations hardly differ in their pattern because of the purity of their copper. In addition, the data demonstrate that many imitations of coin types of Augustus, Tiberius, Caligula and Claudius have very similar element pattern and lead isotope ratios.

Differences and similarities among imitations and official *asses* were then quantified by a cluster analysis. According to their element concentrations and lead isotope ratios (without the 14 imitations whose lead isotope data were not available), the coins were grouped in clusters whose coins showed very similar data[9]. From this analysis the number of imitations with coin types of the various Julio-Claudian emperors classified together with official *asses* of these emperors was obtained and, in addition, the number of imitations that had no official counterparts in their clusters.

| Imitations | Together with official coins of: | | | | | |
|---|---|---|---|---|---|---|
| | Aug. (Rom) | Aug. (Lyons) | Tib. | Calig./Claud. | Imitations with zinc | Sum of imitations |
| Imitations Aug. type. | 3 (6%) | 18 (38%) | 3 (6%) | 17 (35%) | 7 (15%) | 48 (100%) |
| Imitations Tib. type | 0 | 4 (44%) | 1 (11%) | 4 (44%) | 0 | 9 (100%) |
| Imitations Calig. type | 0 | 2 (50%) | 0 | 2 (50%) | 0 | 4 (100%) |
| Imitations Claud. type | 5 (7%) | 19 (28%) | 3 (4%) | 24 (33%) | 19 (28%) | 69 (100%) |
| Sum of imitations | 8 (6%) | 43 (33%) | 7 (5%) | 47 (36%) | 26 (20%) | 130 (100%) |

**Table 2: Number and relative fraction (in brackets) of imitations with coin types of Augustus, Tiberius, Caligula and Claudius, that were classified in a cluster together with official coins of Augustus minted in Rome or Lyons, Tiberius, Caligula and Claudius. The official coins of Caligula and Claudius were combined because of the great similarity in the purity of their copper. Imitations containing zinc were recorded separately.**

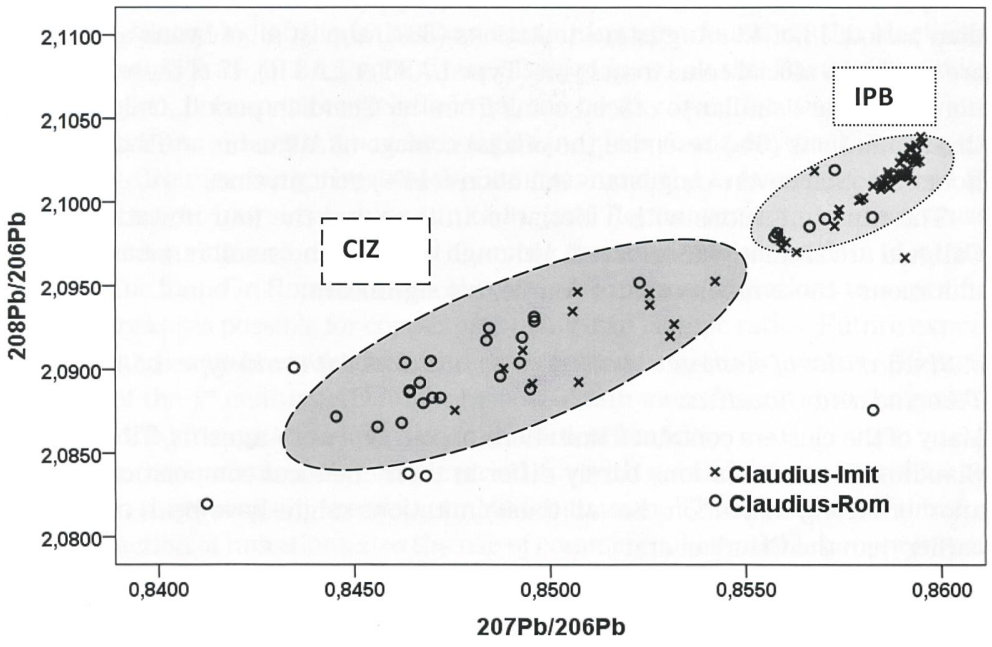


**Fig. 2: Lead isotope ratios ($^{207}Pb/^{206}Pb$ versus $^{208}Pb/^{206}Pb$) of imitations and official asses of Claudian coin type only.**

9 Cluster analysis is a method used to discover structures in large datasets. Thus found groups of «similar» objects are called clusters. The clusters can also have hierarchic structures describing subgroups in groups. Goal of a cluster analysis is the subdivision of a data set into groups (clusters), so that on the one hand, the differences between the individual clusters are as large as possible and, on the other hand, the differences within the individual clusters are as small as possible.
A «hierarchical» cluster analysis (here, the «Ward» method was used) is the method of choice when one has no idea of the number of clusters. Using this method, first, the mean values for each variable are calculated within each cluster. Subsequently, for each case, the squared Euclidean distance to the cluster mean values is calculated. These distances are summed up for all cases. At each step the two merged clusters are those that result in the smallest increase in the total sum of the squared Euclidean distances within the groups. Here, the Euclidean distance is the square root of the sum of squared differences between the values of the entries. The Ward method leads to a very homogeneous distribution of the clusters.

Table 2 summarizes the results of this cluster analysis. For each group of imitations with coin types of Augustus, Tiberius, Caligula and Claudius, the number of imitations found in a cluster together with official *asses* of Augustus minted in Rome or Lyon, of Tiberius and of Caligula/Claudius was obtained. For seven imitations with Augustan coin types and 19 imitations with Claudian coin types no clusters were found containing official *asses* of similar composition. All these imitations contained zinc, some in relatively high concentrations (up to 0.6 wt%), in some cases of lead and tin in addition.

With Table 2 the following results can be summarized:

*1. Imitations with Claudian coin type (last row in Table 2)*
24 (33%) of the 69 imitations of the Claudian coin types, having been minted during or after the reign of Claudius, show element pattern and lead isotope ratios as official coins of Claudius and three imitations (4%) are similar to official coins of Tiberius. 19 imitations (28%) resemble in their element pattern coins of Augustus from Lyon and five imitations (7%) resemble official coins of Augustus minted in Rome. One can conclude from these results that the imitations with Claudian coin types might have been produced from copper alloys melted down from official coins of these emperors. 19 imitations (28%) contain zinc and can, due to this property only, be distinguished from official coins.

*2. Imitations with coin types of Augustus, Tiberius and Caligula (1.–3. row in Table 2)*
Comparatively similar results are obtained for the 48 imitations of Augustan and the nine imitations of Tiberian coin types. Nearly 80% of all imitations of Augustan or Tiberian coin types resemble in their element pattern and their lead isotope ratios official coins of Augustus (Rome and Lyon) and official coins from the Claudian period. 18 of 48 «Augustan» imitations (38%, almost all of Lyon's altar-type) are similar to official coins from Lyon (Type LAS I or LAS II), 17 of these 48 imitations (35%) are similar to official coins from the Claudian period. Only three of these imitations (6%) resemble the official coinage of Augustus or Tiberius from Rome. Another seven «Augustan» imitations (14%) contain zinc.

The nine imitations with Tiberian coin type and the four imitations from Caligula are similarly distributed, although – due to the small number of these imitations –these results are, of course, not significant.

*3. Similarities of elemental pattern in imitations with coin types of Augustus, Tiberius and Claudius*
Many of the clusters contained imitations of coin types of Augustus, Tiberius and Claudius. These imitations barely differ in their chemical composition. This is another strong indication that all these imitations might have been minted no earlier than the Claudian era.

*4. Imitations containing zinc*
Seven imitations of Augustan coin types and 19 imitations of Claudian coin types contained zinc, some in relatively high concentrations (up to 1,0 wt%), in some

cases of lead and tin in addition. Therefore, 20% of the 130 imitations differed in their element pattern from the more than 200 official coins analyzed[10].

Quite similar results to those presented in Table 2 were obtained including metal-analytical data published earlier by several other authors. This combined analysis of all available data is found elsewhere[11]. With these results it can again be concluded that the vast majority of imitations of Augustan or Tiberian coin types found on the Martberg were produced in the Claudian period and minted from the same copper alloys as the imitations with Claudian coin types: From the coins of the previous emperors and/or the official coins of Claudius, available at that time. These coins might have been melted for the production of imitations. This conjecture was already suggested earlier on the basis of die links of Claudian imitations with imitations of Augustus or Tiberius.

## Conclusions

Although only a limited number of coins was analysed (130 imitations and about 200 official coins) the joint cluster analysis of these Julio-Claudian copper coins (almost all of them were *asses*) indicate that the vast majority of so-called Claudian imitations must have been produced in the Claudian period from copper melted down from official coins. Since these Claudian imitations show coin types of the emperors Augustus, Tiberius, Caligula and Claudius it can also be assumed that the circulating official coins have served as templates for the imitations.

A special case are the imitations containing zinc. Around one-third of all analyzed imitations fall into this group. For the production of these imitations, copper alloys contaminated with zinc at concentrations between 0,15 wt% and 1 wt% have been used. The copper melted for these imitations might have been composed by *asses* and a few brass coins *(dupondii* or *sestertii)*. Assuming, however, that some of the imitations containing zinc found on the Martberg (between 0,15 wt% and 0,6 wt%) were also produced on the Martberg or in its wider region, it cannot be excluded that the copper used for these imitations was contaminated with zinc. Although zinc ores found in the Eifel region (Stolberg-Breinigerberg, Gressenich, Bad Ems) and the area east of Aachen in Germany might have been mined in Celtic and Roman times to produce brass by cosmelting zinc ores, copper and charcoal, there are yet too few data to attribute the zinc found in Roman brass coins and also in these imitations to a specific mining area as is possible for copper ores using lead isotope ratios. Future experimental studies on brass artifacts and coins dating from the 1st century BC until the end of the 1st century AD might help to obtain more insight into the provenance of the zinc ores used for the production of brass.

Similar comparisons were also carried out with data of copper ingots found in Roman shipwrecks in the western Mediterranean. The results show that for the production of imitations also the use of commercially available copper ingots might have been possible[12]. A significant proportion of the imitations have element pattern and lead isotope ratios similar to those of some contemporaneous copper ingots. Other ingots, however, are less comparable to the imitations, although they have also been made of relatively pure copper. A large number of

10 With the exeption of some official coins, see Nüsse (note 1).

11 Nüsse (note 1), Vol. 2, pp. 257–279.

12 Nüsse (note 1), Vol. 1, pp. 241–249.

ingots, however, show only a slight resemblance to the analyzed imitations. It can, therefore, not be excluded that copper ingots, used for minting official coins, were also melted down for the production of imitations.

Of course it is not possible to deduce from these studies the ultimate cause of the phenomenon of the imitations produced in large quantities during the Claudian period and the organizations or persons who might have been responsible for their minting. Taking into account the structural characteristics one thinks first of private citizens and or entrepreneurs operating in the money business. Future studies of chemical compositions of Claudian imitations found in other areas of the Northwestern provinces and Spain including analysis of the provenance of their copper have to be performed to find out if the huge masses of imitations found in these provinces are rather multiple local reactions of businessmen to the lack of official coins or a planned reaction of authorities with access to metal sources (coins, copper ingots) as proposed earlier (army, administration etc.).

**Acknowledgements**

I would like to thank Prof. Dr. Hans-Markus von Kaenel for many helpful suggestions. My special thanks go to Dr. Sabine Klein, Dr. Heidi Höfer and Dr. Michael Seitz of the Institute of Geosciences, Goethe University Frankfurt for their help in the preparation of coin samples and their measurements with the EPMA and the MC-ICP-MS mass spectrometer. The measurements on coin samples was financed by the long-term projects of the DFG: «Archaeological, numismatic and scientific research on the Celtic-Roman sanctuary and oppidum on the Martberg near Pommern and Karden at the Lower Moselle.»

Michael Nüsse
Goethe-Universität Frankfurt am Main
Institut für Archäologie, Abteilung II: Archäologie und Geschichte der römischen Provinzen sowie Archäologie von Münze, Geld und von Wirtschaft in der Antike
Grüneburgplatz 1
D-60 629 Frankfurt am Main