The first comprehensive metallurgical study of Roman military diplomas

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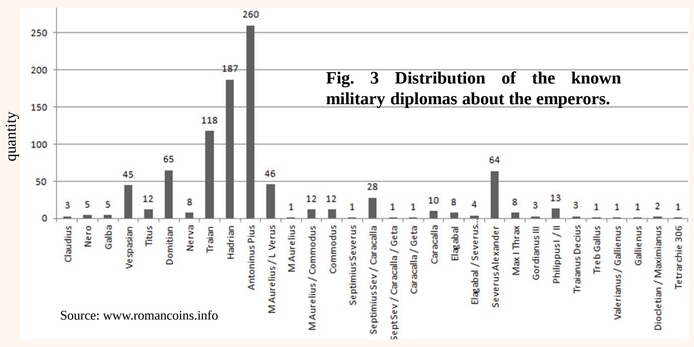
Introduction and scientific question

The aim of this study was the question if metal analyses of 500 dated Roman military diplomas could establish a chronology of Roman AE alloys over 200 years, from ca 60-260AD? Roman military diplomas are notarized bronze copies of citizenship decrees, issued by the emperor in Rome for long serving veterans of the Roman army and their families. They were dated to the day, and are known to us from ca. 50-305 AD. The initial hypothesis of this investigation using X-ray-fluorescence analysis (pXRF) was that expected changes in the metal alloy composition of bronze Roman military diplomas over time might serve as chronologic reference for other Roman archaeological objects made of bronze such as coins, tabulas, military objects, statues etc. The analysis of the Military diplomas showed however that no major changes in alloy composition over the 200 years investigated, from ca 60-260 AD.

1. Military diplomas

All diplomas were mass produced in Rome and notarized right there by 7 witnesses. Over 1300 diplomas (many only as fragments) are known to date. They are a key epigraphic source for our knowledge of consuls, governors, commanders, soldiers and the movement of troops in periods of peace, war and crisis. The production process was: Unit sends list of veterans ready to receive citizenship to the province governor, a list of such veterans of the province sent to Rome, Imperial administration in Rome prepares the constitution in which the emperor grants them citizenship. A constitution bronze plate was publically hung in Rome, copies (diplomas) were mass produced: Ink prewritten text was engraved into bronze on both sides, wired and sealed (= notarized). Sent to the province for distribution to the troops and veterans (Fig. 2).

Fig. 1 Example of an auxiliary diploma. Issued by Vespasian on 7. February 78 AD for the troops of Moesia.



Source: www.romancoins.info

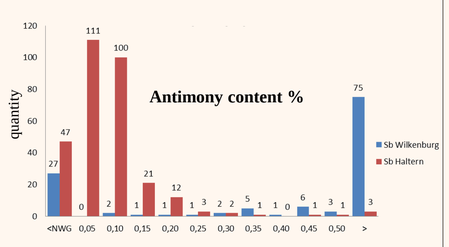
Fig. 3 Distribution of the known military diplomas about the emperors.

Fig. 2 Example of an complete diploma. The plates were bound together with wire and sealed in wax with 7 seals, the wax seals being protected in a metal cover.

2. Comparison with other roman alloys

Besides Roman military diplomas the following archaeological object classes were analyzed for comparison:

- Metal alloys from Military camps, e.g. Wilkenburg, Haltern and Kalkriese (North Germany), Carlisle (GB)
- Diplomas made in the 3rd century of 1) a reused imperial constitution tabula (CIL XVI 153) and 2) a reused tabula of unknown origin (PA 498)
- Roman AE coins from the time of Augustus to Gallienus. (Coins of the Staatliche Münzsammlung Munich, Museum Carnuntinum Bad Deutsch-Altenburg, Austria, and various private collections; of Orichalcum (Dupondii and Sestertii), and copper (Asses).
- Medals and contorniates (struck and cast)
- Tabulas thicker than ca 1 cm, with text on only one side
- Tabulas / Objects of mm thickness with text; not military diplomas (varying)
- Military objects like helmets, armour, etc. (forged)
- Statuettes and Statues (cast)
- Seal covers with portraits of Julio-Claudian to Flavian times (pressed)



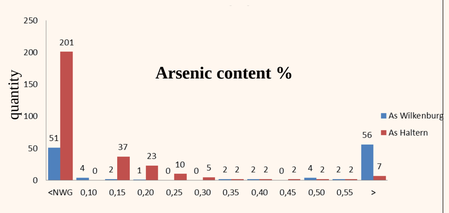


Fig. 4 Distribution ot the frequency of finds from the Roman Imperial period as a function of the arsenic and antimony content of the Roman camps Wilkenburg (blue) and Haltern (red). Source: FAN1

A comparison of the metallurgical fingerprint of the bronze objects as above reveals interesting differences. For example, the finds from Haltern as well as military diplomas contain significantly less arsenic and antimony in the bronze than in Wilkenburg (Fig. 4). This is a possible indication of a different chronology and troops of different origins. In general, the bronzes containing arsenic and antimony disappear around the turn of the millennium. Wilkenburg where they are still strongly represented is now dated to 4/5 AD. This is why the finds from Wilkenburg are important, because they lie on the edge of a metallurgical change. In Haltern and Kalkriese the metallurgy is already clearly different and younger. In Carlisle (GB), it is completely different from that in northern Germany and even younger. This can be helpful to discuss a possible dating. The difference in metallurgy between Haltern and Kalkriese is so significant that a time gap of more than 4 years (to 9 AD) could be assumed. Coins, on the other hand, represent a metallurgical field of their own and show no strong overlaps with Roman civilian bronzes.

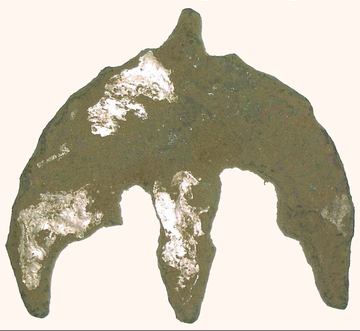


Fig. 5 (Left) Tinned horse harness pendant from the Roman camp Wilkenburg (probably 4/5 AD). The metallurgy is still partly late republican due to high amounts of arsenic and antimony.

Fig. 6 (Right) Helmet type Weisenau, second half first century. There are different Cu-alloys, with different properties. The frontal row bar is made of harder bronze than the corpus and decorative parts.

3. Results pXRF

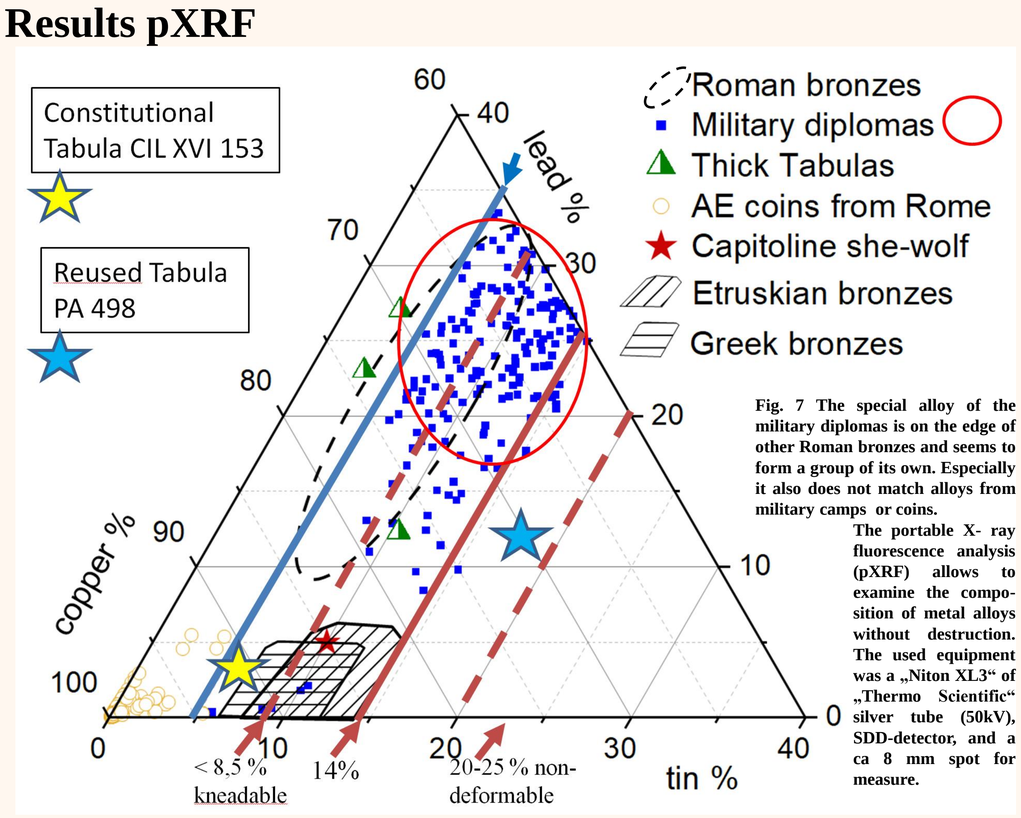


Fig. 7 The special alloy of the military diplomas is on the edge of other Roman bronzes and seems to form a group of its own. Especially it also does not match alloys from military camps or coins.

The portable X- ray fluorescence analysis (pXRF) allows to examine the composition of metal alloys without destruction. The used equipment was a „Niton XL3“ of „Thermo Scientific“ silver tube (50kV), SDD-detector, and a ca 8 mm spot for measure.

➢ No chronology is recognizable in the metallurgy of military diplomas, not in main elements (Fig. 7) and not in the main trace elements (Fig. 8-9)! A similar and special alloy has been used throughout the ages: About 5 to 15 % tin, together with more than 15 % lead → optimizing the alloy for forming/hammering. Only the trace elements change over time due to changes in smelting metallurgy and the use of new raw material sources (Fig. 8), but do not allow sufficient chronological differentiation on their own due to increased recycling (Fig. 9).

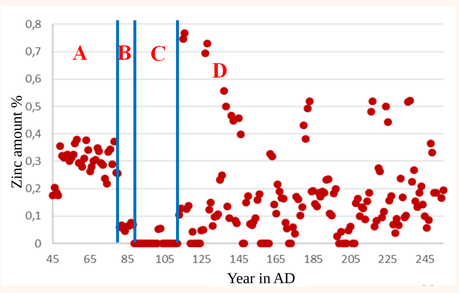


Fig. 8 Origin of Ore: fresh (lead/copper) or recycling. Different amounts of Zinc are hints to distinct ore origin (A, B, C), large scattering indicates increasing recycling and groups of different origin (D).

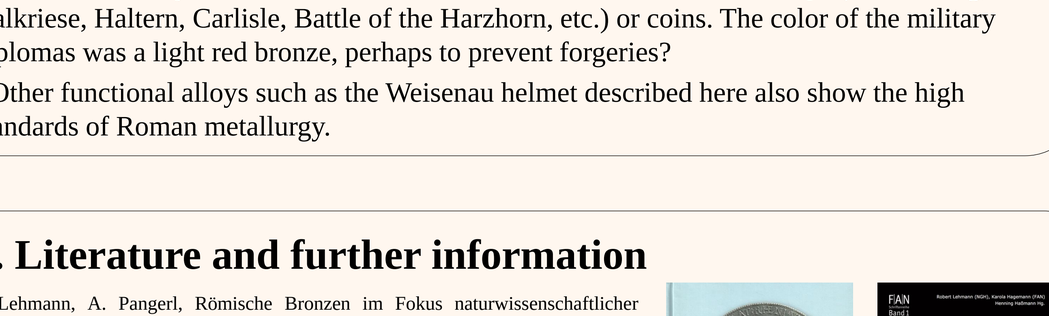


Fig. 9 The dispersion of gold traces increases, silver seems to decrease over the centuries → Indication of changes in origin. The proportion of ore used containing silver decreases and dilute silver. Over time, the traces of gold increase, as gilded bronze is probably increasingly recycled. 30 late 3th century Roman diplomas we measured show a lower proportion of arsenic, also an indication of the recycling of old bronze. Antimony almost constantly low.

4. Conclusion

- The analysis of about 500 Military diplomas showed no major changes in alloy composition over the 200 years investigated, from ca 60-260 AD.
- The manufacturers kept the bronze alloy constantly in a narrow range of 8+ % tin and above 20 % lead. This functional lead bronze alloy must have been chosen to optimize the mass production process for the metal plates, which are usually between 0,5-2 mm thin, and to allow engraving of the diploma text on both sides of the plates.
- This continuity was kept up by the imperial administration regardless of cost throughout multiple crises into the middle of the 3rd century AD.
- The special alloy of military diplomas seems to differ from other Roman alloys. It also does not match the alloys of civilian tabulas and bronze finds from Roman camps (Wilkenburg, Kalkriese, Haltern, Carlisle, Battle of the Harzhorn, etc.) or coins. The color of the military diplomas was a light red bronze, perhaps to prevent forgeries?
- Other functional alloys such as the Weisenau helmet described here also show the high standards of Roman metallurgy.

5. Literature and further information

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CIL Corpus Inscriptionum Latiarum XVI and supplement // RMD I–V Roman Military Diplomas, London