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Comment on *Mints not Mines: a macroscale investigation of Roman silver coinage*
by J.R. Wood, M. Ponting, and K. Butcher

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Wood et al. (2023), hereinafter WPB, unveils a number of historical issues relevant to Roman economy and metallurgy based on trace element and Pb isotope abundance data on a large set of important coins minted during the Roman Empire (Ponting and Butcher, 2015). Here, we discuss several points which, in our view, misrepresent the work of other groups, ours included, and bias the overall interpretation of the WPB data set.

1. Silver isotopes were never meant to be used for provenance (Fujii and Albarede, 2018, Milot et al., 2021, Vaxevanopoulos et al., 2022). They can only be used to exclude some potential provenances hinted at by Pb isotopes. The narrow range of silver isotopes in silver coins is not due to mixing. Perreault (2020) is clear on this point: the caption of his Figure 3.12 reads ‘*Mixing increases variance in archaeological assemblages*’. WPB’s Figures 1a and 1b compare the standard deviation of each sample with the standard deviation of the sample means. If the number of samples, means, and variances are unknown and a priori different, a general conclusion cannot be drawn. The point is *not* to explain the variations of Ag isotope abundances but rather to explain the remarkable isotopic homogeneity of all silver sources used for coinage ($\epsilon^{109}\text{Ag} \sim -1$ to $+1$ parts in 10,000) over a time span of 2500 years on several continents. Mixing does not explain why $\epsilon^{109}\text{Ag}$ is similar in Greek and Roman bullion, medieval European coinage, the 8-reales silver coins of the 17th-18th C. from Spanish Americas, and Tudor coinage (Desaulty and Albarede, 2013, Desaulty et al., 2011).
2. WPB assess that debasement of the bullion used to mint coinage from the Roman Empire by Cu addition affects the Pb isotope compositions of silver with respect to the original Pb left by cupellation. This point was also made by Eshel et al. (2021) on the Levant hoards of Hacksilber. An important question therefore is whether this concern is of broader relevance to the heavily debased coinage of the Roman Empire. Chakrabarti (1984) and Teppo et al. (1991) showed that the upper limit of Pb solubility in metallic Cu is very low with a strict upper limit of 4 atoms of Pb per 1000 atoms of Cu, but more likely < 1 atom of Pb per 1000 atoms of Cu (approximately $63.5/207 \times 0.001 = 0.03$ wt.% Pb in solid Cu). Hence, addition of 30 wt.% Cu to molten Ag by increasing the temperature above the solidus will increase the Pb concentration in Roman coins by approximately 0.01%. In order to evaluate how much Pb is left in the metal after cupellation, we referred to the data set of Davis et al. (2020) of 788 Archaic Athenian silver coins. These authors observed that 95% of coins made from bullion obtained by cupellation contain at least 0.03 wt.% Pb, which indicates that Athenian silver was *oversaturated* in Pb with respect to pure Cu. Lead present in Athenian silver coins therefore is inherited from cupellation.
3. At the upper end of the temperature range used to cupellate silver-bearing ore, bismuth is quite volatile (l’Héritier et al., 2015). Its concentration in any given artifact therefore reflects the metallurgical process, making it an unreliable tracer of provenance. On the data set quoted above, Davis et al. (2020) found that the correlation coefficients between Bi on the one hand and Pb and Au on the other hand do not support a common behavior of these elements at a confidence level $>99.9\%$. This is also apparent from the work of Olivier et al. (2017) which found that Bi in silver coinage of Alexander the Great and the Diadochi varies

by several orders of magnitude and that Bi variations are independent of Au content, a finding also confirmed by WPB's own work (see their Figure 11 and Figure 1 in this Comment). The strong negative correlation between the abscissa x and the ordinate y is an artifact due to the simple relationship $x+y = \log(\text{Cu}/\text{Bi}) + \log(\text{Au}/\text{Cu}) = \log(\text{Au}/\text{Bi})$. Lines of constant Au/Bi can be drawn on WPB's Figure 11, confirming that the Au/Bi ratio varies by ~ 8 orders of magnitude. WPB's Figures 11 and 12 assign Cu a purely ancillary role by simply spreading the x and y coordinates. The low values of the correlation coefficients between Bi and Au (-0.20), Pb (-0.1), and Pb isotopic ratios (-0.15 to +0.23) are straightforward, robust evidence that Bi is an unreliable provenance tracer. The wide range of the Au/Bi ratio is not due to variation of Au in the ore but rather reflects variable evaporation of Bi during metallurgy. Such plots misleadingly mingle two unrelated observations: the acceptance of highly debased coinage in the East (Alexandria, Caesarea, Ephesus) as opposed to the West (Lyon, Iberia) and the effect of the metallurgical process.

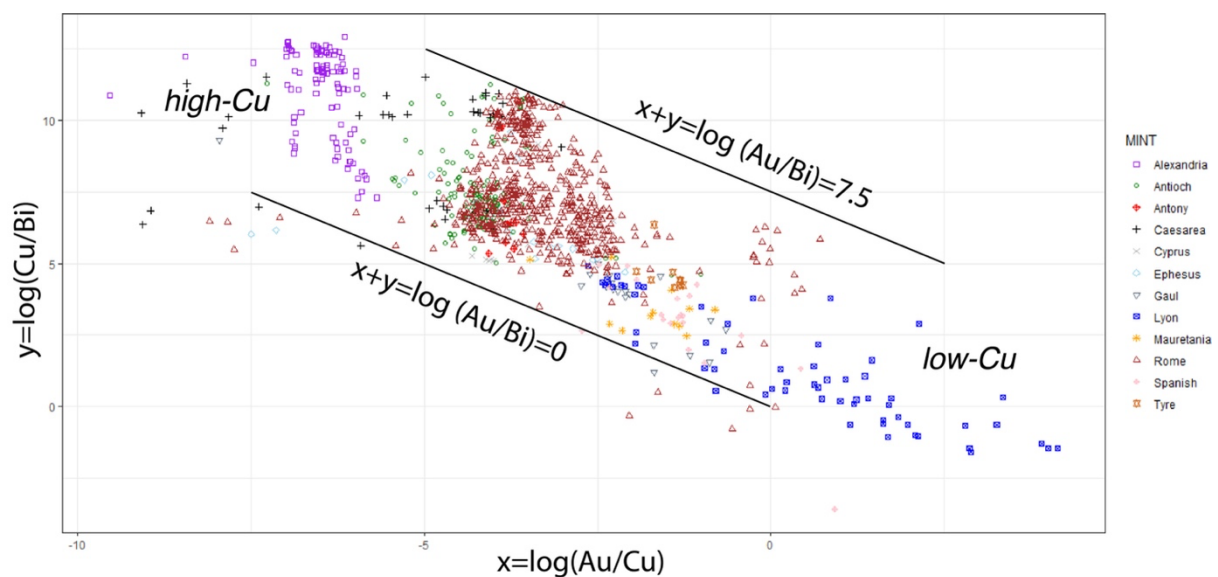


Figure 1. This plot, redrawn from Wood et al.'s (2023) Figure 11, is germane to a simple $\log(\text{Au}/\text{Bi})$ histogram. The role of Cu is simply to artificially extend the range of variation. The Au/Bi ratios in Roman coins vary by 8 orders of magnitude as a result of metallurgical conditions. Severely debased coinage is the hallmark of the Eastern Empire, whereas the highest fineness is found in the West.

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CHAKRABARTI, D. & LAUGHLIN, D. 1984. The Cu–Pb (Copper-Lead) system. *Bulletin of Alloy Phase Diagrams*, 5, 503-510, <https://doi.org/10.1007/BF02872905>.

DAVIS, G., GORE, D. B., SHEEDY, K. A. & ALBAREDE, F. 2020. Separating silver sources of Archaic Athenian coinage by comprehensive compositional analyses. *Journal of Archaeological Science*, 114, 105068, <https://doi.org/10.1016/j.jas.2019.105068>.

DESAULTY, A. M. & ALBAREDE, F. 2013. Copper, lead, and silver isotopes solve a major economic conundrum of Tudor and early Stuart Europe. *Geology*, 41, 135-138, <https://doi.org/10.1130/G33555.1>.

DESAULTY, A. M., TELOUK, P., ALBALAT, E. & ALBAREDE, F. 2011. Isotopic Ag-Cu-Pb record of silver circulation through 16th-18th century Spain. *Proceedings of the National*

- Academy of Sciences of the United States of America*, 108, 9002-9007, <https://doi.org/10.1073/pnas.10182101>.
- ESHEL, T., GILBOA, A., YAHALOM-MACK, N., TIROSH, O. & EREL, Y. 2021. Debasement of silver throughout the Late Bronze–Iron Age transition in the Southern Levant: Analytical and cultural implications. *Journal of Archaeological Science*, 125, 105268, <https://doi.org/10.1016/j.jas.2020.105268>.
- FUJII, T. & ALBAREDE, F. 2018. ^{109}Ag – ^{107}Ag fractionation in fluids with applications to ore deposits, archeometry, and cosmochemistry. *Geochimica et Cosmochimica Acta*, 234, 37-49, <https://doi.org/10.1016/j.gca.2018.05.013>.
- L'HÉRITIER, M., BARON, S., CASSAYRE, L. & TÉREYGEOL, F. 2015. Bismuth behaviour during ancient processes of silver–lead production. *Journal of Archaeological Science*, 57, 56-68, <https://doi.org/10.1016/j.jas.2015.02.002>.
- MILOT, J., BLICHERT-TOFT, J., SANZ, M. A. & MALOD-DOGNIN, C. 2021. Silver isotope and volatile trace element systematics in galena samples from the Iberian Peninsula and the quest for silver sources of Roman coinage. *Geology*, <https://doi.org/10.1130/G49690.1>, <https://doi.org/10.1130/G49690.1>.
- OLIVIER, J., DUYPAT, F., CARRIER, C. & BLET-LEMARQUAND, M. Minted Silver in the Empire of Alexander. Alexander the Great, a Linked Open World, 2017. Ausonius Éditions, 127–146.
- PERREAULT, C. 2020. *The quality of the archaeological record*, Chicago, University of Chicago Press <https://doi.org/10.7208/9780226631011>.
- PONTING, M. & BUTCHER, K. 2015. Analysis of Roman Silver Coins, Augustus to the Reform of Trajan (27 BC-AD 100) [data-set], York, Archaeology Data Service [distributor] <https://doi.org/10.5284/1035238>.
- TEPPO, O., NIEMELÄ, J. & TASKINEN, P. 1991. The copper-lead phase diagram. *Thermochimica acta*, 185, 155-169, [https://doi.org/10.1016/0040-6031\(91\)80126-4](https://doi.org/10.1016/0040-6031(91)80126-4).
- VAXEVANOPOULOS, M., DAVIS, G., MILOT, J., BLICHERT-TOFT, J., MALOD-DOGNIN, C. & ALBARÈDE, F. 2022. Narrowing provenance for ancient Greek silver coins using Ag isotopes and Sb contents of potential ores. *Journal of Archaeological Science*, 145, 105645, <https://doi.org/10.1016/j.jas.2022.105645>.
- WOOD, J. R., PONTING, M. & BUTCHER, K. 2023. Mints not Mines: a macroscale investigation of Roman silver coinage. *Internet Archaeology* 61, <https://doi.org/10.11141/ia.61.10>.