The origin of the Trojan silver: Lead isotope constraints

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Zusammenfassung:
Zu den Schatzfunden der Berliner Trojanischen Sammlung Heinrich Schliemanns gehören auch elf Silbergefäße und sechs zungenförmige Silberbarren aus der 2. Hälfte des 3. Jts. v. Chr. Erstmals werden die Bleiisotopendaten von acht Silbergefäßen und den sechs Silberbarren zur Ermittlung der möglichen Lagerstättenregion(en) des Silbererzes vorgelegt. Die Daten zeigen, dass die untersuchten Silberobjekte offensichtlich aus derselben Lagerstätte stammen. Laurion, der größte antike Silberlieferant der Region, kommt für die Herkunft des trojanischen Silbers nicht in Betracht. Die Lieferung des Silbers aus kleineren Erzvorkommen auf der griechischen Insel Thasos in der nordöstlichen Ägäis sowie auf dem nordwestanatolischen Festland in der Nähe von Troja ist wahrscheinlicher.

Abstract:
The treasures of Troy in the Berlin Heinrich Schliemann collection contain apart from the renowned gold artefacts of the so called „Priam's Treasure" also eleven silver vessels and six silver ingots from the 2nd half of the 3rd millennium BC. The authors present the first Pb isotope data for eight of these silver vessels and all silver ingots. These data show that the silver of all investigated artefacts form the Late Period of the Early Bronze Age is likely to come from the same deposit and that this deposit is not Laurion, the large ancient silver producer in the Aegean region, but possibly the Greek island of Thasos in the northeastern Aegean Sea, or a smaller ore producer in northwest Anatolia closer to Troy.

The well-known archaeological precious metal finds of Troy, discovered by Heinrich Schliemann between 1871 and 1879, have not been accessible for modern and interdisciplinary scientific investigations after 1945 when they were taken as „war booty" from Berlin to Moscow and St. Petersburg. Eight out of the eleven silver vessels (from the Treasure A found in 1873) were returned to the former GDR in the late 1970s and – after the reunification of the two German states – were brought back to the Museum für Vor- und Frühgeschichte in Berlin to which the treasures had been given testamentary by Schliemann in 1881 (Fig. 1). Authenticity of the vessels has been assessed by comparison with historical photographs, chemcial analyses, and ancient manufacturing research[1]. Pre-war chemical analyses of some silver vessels and one ingot and recent chemical analyses[2] of the silver vessels showed high contents of copper (2–3 wt%) and lead (up to 0.1 wt%), which suggest that the silver of all artefacts has been produced by cupellation of silver-rich copper-bearing lead ore from the same kind of deposit.

The isotopic composition of lead (Pb) shows regional variations in dependence of the geologic history of the rocks and their precursors. Thus, ore deposits show regional variations in Pb isotopic compositions, which allow using the Pb isotopic composition of metal artefacts as a fingerprint for their provenance. There are a few points to be born in mind: (I) direct comparison between the Pb isotopic composition of silver artefacts and ores implicitly assumes that the silver was dominantly acquired from one deposit or ore province and that its Pb isotopic composition was not significantly changed during cupellation. (II) Identical Pb isotopic compositions for artefact and ore suggest that the ore is a *possible* source, whereas (III) contrasting Pb isotopic compositions either exclude the ore as a silver source or imply that the silver represents a mixture from several different sources.

The Pb isotopic compositions of the eight silver vessels at the Museum für Vor- und Frühgeschichte in Berlin are within analytical uncertainties identical (Fig. 2; 3). It coincides with the Pb isotopic composition of the six silver ingots hosted at The State Hermitage Museum in St. Petersburg (Fig. 4). This implies: (I) it is likely that the silver vessels are produced from silver from the same group of deposits.

[1] Born 1997; Koch/Born 2001.

[2] Schmidt 1902; Riederer 2002.

Fig. 1: Top: Section of the original illustration showing the „Schatz des Priamos" (Schliemann 1874, Pl. 204). The six tong shaped silver ingots from Treasure A are shown in the upper left of the photo; the gold and silver vessels from the Treasures A and B are to the right and below the ingots. Bottom: New scientific drawings of the eight silver vessels in the custody of the Museum für Vor- und Frühgeschichte Berlin. Illustration: D. Greinert.

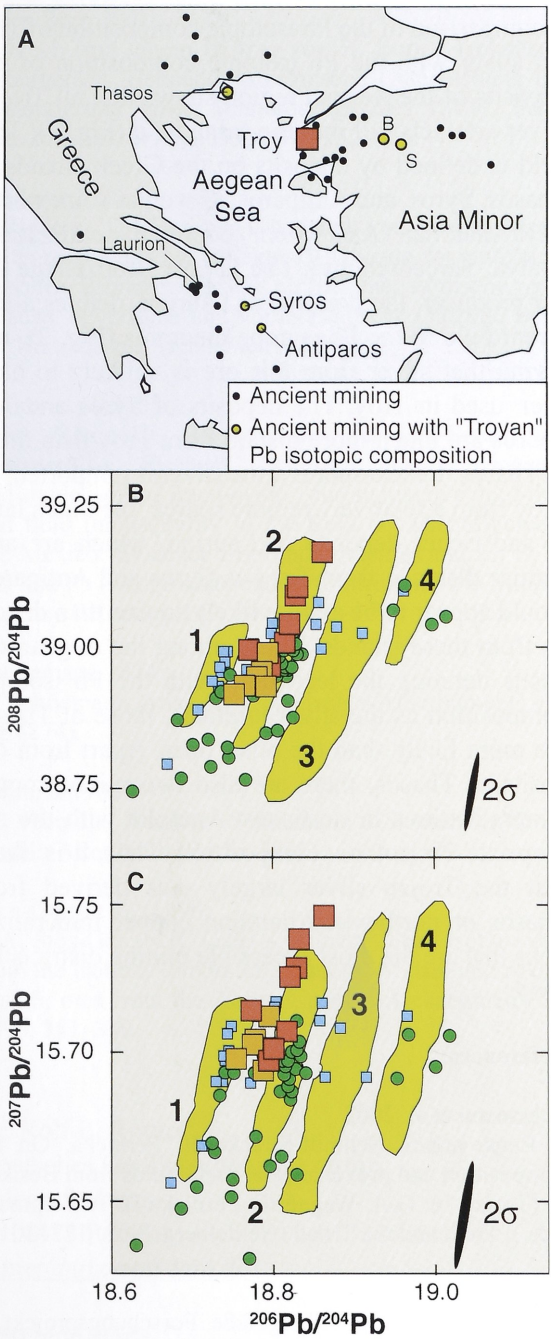

Fig. 2: A: Location of Troy and Bronze Age mining activity. Cu ores on Asia Minor: B = Balya, S = Serçeörenköy. – B and C: Pb isotopic composition of Cu and Pb ores of the Aegean that have been worked during the Bronze Age. Red squares = silver vessels; orange squares = silver ingots; small blue squares = copper and bronze artefacts from Troy I level; green circles = Cu and Pb ores in Asia Minor. Pb fields defined by: 1 = Siphnos; 2 = Antiparos, Syros, Thasos; 3 = Laurion, Kamarea, Plaka Kea, Seriphos; 4 = Thera, Kythnos, Poliegos. Data of Trojan silver are taken from Fig. 3. The Pb fields for Aegean mineral deposits are based on data from Gale/Stos-Gale 1981 and Stos-Gale et al. 1997. Data for copper and bronze artefacts and Pb and Cu ores of Asia Minor are from Begemann et al. 2002. Illustration: R. L. Romer.

Sample[a]		$^{206}Pb^{b}/^{204}Pb$	$^{207}Pb^{b}/^{204}Pb$	$^{208}Pb^{b}/^{204}Pb$
Silver vessels				
1	SCH 5861	18.791	15.702	38.939
2	SCH 5867	18.820	15.729	39.064
3	SCH 5868	18.807	15.709	38.978
4	SCH 5869	18.783	15.699	38.954
5	SCH 5870	18.853	15.747	39.150
6	SCH 5871	18.761	15.715	38.961
7	SCH 5872	18.811	15.726	39.014
8	SCH 5873	18.822	15.739	39.082
Silver ingots				
9	SCH 5967	18.776	15.703	38.944
10	SCH 5668	18.776	15.704	38.947
11	SCH 5969	18.752	15.699	38.917
12	SCH 5970	18.791	15.713	38.984
13	SCH 5971	18.782	15.702	38.954
14	SCH 5972	18.782	15.695	38.939

[a] Sample numbers as in Schmidt (1902). The samples are represent metallic silver and alteration crusts (acantite). All samples were dissolved in 7N HNO_3. After drying, the samples were redissolved in 0.8 N HBr, which brought Pb (and most other metals) into solution, but left Ag as insoluble bromide behind. Pb was purified using ion exchange chromatography (Romer et al., 2005).

[b] The Pb isotopic composition was determined using a Finnigan MAT262 mass spectrometer at Deutsches GeoForschungsZentrum using static multi-collection (Romer et al., 2005). The Pb isotopic composition was corrected for mass fractionation by 0.1% per a.m.u. as determined from the repeated measurement of Pb reference material NBS 981. The reported isotope ratios are accurate better than 0.1% at the 2σ level.

Fig. 3: The Pb isotopic compositions of the eight silver vessels at the Museum für Vor- und Frühgeschichte.

(II) The silver ingots and the silver vessels are likely to be derived from the same source. The ingots may represent the intermediate product traded from the mines to the location of silver use. We infer that manufacturing of the vessels (Fig. 1) occurred in the workshops of Trojan silversmiths.

The Pb isotopic composition of ore deposits in the eastern Mediterranean and in particular the Aegean regions that have been or might have been in operation during the Bronze Age have been documented

Fig. 4: The silver ingots were sampled at The State Hermitage Museum in St Petersburg by Hermann Born on June 18, 2007, under the supervision and with the kind permit of Yurij Piotrovsky (Department of Archaeology, The State Hermitage Museum). The picture shows H. Born marking the sampling position on one of the ingots. Photo: M. Bertram.

in systematic surveys[3]. Within the Aegean region, Pb-rich vein deposits fall into four different groups in the $^{206}Pb/^{204}Pb - ^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb - ^{208}Pb/^{204}Pb$ diagrams (Fig. 2). The Pb isotopic composition of each deposit is relatively homogeneous. Data from each deposit fall in only one lead field; there are no deposits that fall into several fields. Each field is defined by Pb isotope data from several, in part regionally separated deposits, which illustrates the fact that Pb isotopic compositions are strong evidence to exclude derivation from a certain deposit, but provide little support for the derivation from a particular deposit. There is no systematic variation of the Pb isotopic composition with geographic position, which suggests that the Pb isotopic composition of each deposit is largely influenced by local geological factors.

A comparison of the Pb isotopic composition of Trojan silver with the Pb isotopic composition of ore deposits of the Aegean region shows that all Trojan silver artefacts fall into the same field (Fig. 2). This field is defined by deposits on the Greek islands of Thasos, Syros, and Antiparos, as well as some northwest Anatolian (Asia Minor) copper mineralizations (Balya, Serçeörenköy). The largest Bronze Age silver producer, the deposits at Laurion, defines a different field in the Pb isotope diagrams (Fig. 2), implying that silver from this ore is unlikely to have been used in Troy. The deposits of Syros and Antiparos are much more distant from Troy than those of Thasos. Furthermore, if the silver is „imported" to Troy from a relatively remote source, the much larger and richer deposits of Laurion, which are at a similar distance from Troy as Syros and Antiparos, would appear to be a more likely source than deposits from these islands. Thus, among the Aegean deposits defining the lead field with the Pb isotopic composition as the silver artefacts, those of Thasos are more likely than the other ones. Apart from deposits of Thasos, there are also two minor copper mineralizations in northwest Anatolia with the appropriate Pb isotopic composition. Thus, it is likely that the Trojan silver largely was derived from Thasos or northwest Anatolian copper mineralizations that are the most accessible mining districts for Troy.

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