Silver Coins from Ancient Cities of Aegean Thrace through XRF Analysis

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Abstract: *The ancient cities of Aegean Thrace—region between Nestos and Hebros Rivers—began issuing silver coins of various denominations almost immediately after their founding. This not only affirmed their status as city-states but also demonstrated their direct access to Thrace's abundant and renowned precious metal reserves, deposits that according to archaeological evidence were likely being exploited as early as the late 6th century BC. This study provides insights into the region's historical metallurgy and economy and aims to evaluate the quality of the silver used in these coins by analysing their chemical composition and comparing different chronological phases.*

Key words: ancient numismatic, Greek coins, Greek colonies, ancient mines, silver alloy.

Ключови думи: антична нумизматика, гръцки монети, гръцки колонии, антични мини, сребърна сплав.

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Several factors such as including the integration of the region into robust trade networks that facilitated increased economic interactions, as well as access to rich resources such as fertile agricultural land, timber, and metals, contributed to the early adoption of coinage. Especially for Aegean Thrace, connections with Ionian cities and the Persian Empire, as early as the 7th century BC through pottery imports, played a pivotal role in the initial expansion of monetization in the northern Aegean. As the home to numerous colonial settlements of Ionian cities that eventually evolved into autonomous city-states, the inception of minting promptly following their establishment in the late 6th century BC testifies to this status[1]. Moreover, it demonstrates their direct access to Thrace's abundant and renowned precious metal reserves[2]. Abdera, Dikaia and Maroneia struck silver coins systematically till the end of the 4th century BC and with interruptions due

[1] *Isaac* 1986: 73-158; *Tiverios* 2008: 91-118; *Triantafyllos* 2009.
[2] *Stos-Gale* 2023.

Figure 1. Map of Aegean Thrace showing major Greek colonies.

to difficult historical events till the first half of the 1st century BC (**Fig. 1**). Thus, by analysing the chemical composition of silver issues using a portable HHXRF[3] and comparing them as per chronological phase, our aim is to evaluate the purity of silver acquired in each case and how this might have changed over time, particularly during periods marked by historical crises. It is worth noting, that the majority of the examined coins emanate from –namely circulate in– two important archaeological sites of the region, Molyvoti and Zone that provided us with 2.500 and 7.000 coins respectively[4]. A total of 96 silver coins have been analysed. Upon verification, the statistics in the tables have been updated, as we have retained only those coins for which we are confident in the accuracy of their quantitative data, i.e. 44 silver coins.

A total of 14 silver coins of various dates and denominations originating from the mint of Abdera were subjected to examination, though eight gave precise and accurate quantitative data (**Tab. 1**). As a colony founded by Clazomenians in the 7th century BC, Abdera did not initially issue its own coins until new settlers from Teos arrived. May in 1965 places the beginning of its issues around 540 BC but this date was subsequently revised by Chryssanthaki two decades later[5]. The city continued to mint silver coins uninterrupted until the mid-3rd century BC, paid for several years tribute to the Delian/Athenian League, while in 424 BC along with Dikaia had to pay the enormous sum of 75 talents. The substantial number of dies (over 300) confirms an extensive and long-lasting production, supporting the inference that Abderitans had access to precious metals. Notably, while examples for period four are missing, period six is fully represented with a silver tetradrachm, the largest denomination of the period, a half stater, a drachm, and finally, a hemidrachm analyzed. We would also point out that during this period the invasion of the Triballoi with the participation of the Maronitans resulted in the destruction of the city in 375 BC[6]. Subsequently, the following

Table 1. Results from coin analysis of Abdera.

A/A	Coin No.	Denomination/period/ date (BC)	Weight/g.	Reference	Ag %	Cu %	Pb %	Au %	Pt %	Ti %	Fe %
1	11463	Obol, I, 520-500	0.60	CN 51525	97.83	1.34	0.38	0.40	0.01	n.d.	n.d.
2	1448	Drachm, III, 475-450	3.04	CN 48219	97.86	n.d.	2.12	n.d.	0.01	n.d.	n.d.
3	C494	Diobol, V, 415-395	0.76	CN 28419	96.17	3.09	0.32	0.25	0.11	n.d.	n.d.
4	973	Half Stater, VI, 395-360	5.13	CN 47916	96.77	2.39	0.72	n.d.	0.07	n.d.	n.d.
5	C430	Stater, VI, 395-360	10.31	CN 29199	94.35	3.00	2.35	0.26	0.01	n.d.	n.d.
6	C254	Drachm, VII, 360-350	1.50	CN 6505	95.82	2.86	0.96	0.32	0.02	n.d.	n.d.
7	1755	Drachm, VIII, 346-336	2.57	CN 51683	95.80	2.84	0.71	0.64	n.d.	n.d.	n.d.
8	846	Drachm, IX, 336-311	1.73	CN 48186	96.52	n.d.	1.65	1.49	n.d.	n.d.	n.d.

[3] The instrument used is a portable hand-held X-ray Fluorescence (HH-XRF) device (Bruker Tracer 5g). Calibration was achieved using the deconvolution curve for precious metals stored in the system. Each spectrum was checked for an accurate determination of the major and secondary peaks for each of the detected elements. Two measurements were taken, one on each side of every coin and the average was calculated.

[4] *Psoma, Karadima, Terzopoulou* 2008; *Arrington et al.* 2016; *Tasaklaki* forthcoming b; *Galani-Krikou, Tasaklaki, Tselekas* 2015; *Tsatsopoulou et al.* 2015. In light of this, we extend our gratitude to the Ephorates of Antiquity of Rhodope and Evros for granting us the necessary permissions for this research endeavor.

[5] For the coinage of Abdera, see *May* 1965; *Chryssanthaki-Nagle* 2007. For a brief history of the city, see IThrAeg 159-182.

[6] IThrAeg 162; *Chryssanthaki-Nagle* 2007: 124-125; *Psoma, Karadima, Terzopoulou* 2008: 175.

eighth period was relatively brief, as Philip II's arrival in the region soon after led to significant geopolitical changes. During this period, Abdera minted gold coins, although none is present in the Museum's collection. However, one drachm was analyzed. The data from Abdera clearly show debasement over time. The silver contents decrease from the earlier examples toward the later ones, while lead and copper levels increase.

Dikaia, presumed to be a Samian and/or Milisian colony, as iconographic types of the first period certainly point to, on the other band of Vistonis Lake, starts issuing silver and electrum coins – for the moment no excavated electrum examples from the site are known[7]. The payment of increased tribute to the Delian League from 454 BC onwards, the number of dies – 8 in 1975 – and the large denominations – double staters – also suggest the city's access to a mining zone. Its history is intimately intertwined with neighboring Abdera, which is evident in the fact that for some years they paid their tribute to the Athenian League together. Two silver coins are attributed to the first period according to May and Schönert-Geiss. The subsequent period, characterized by a larger volume of examples, likely corresponds with the organization of the Delian/Athenian League (**Tab. 2**). Overall, there are fluctuations in silver contents during the two main periods of the Dikaia issues. The trend line shows a very subtle decease over time. Yet four of the second period coins contain above 97 % silver suggesting that the city had a reliable access to a source of silver for the time represented by these coins.

Maroneia, akin to Dikaia in striking electrum coins and following Abdera in producing gold coins, did not issue large denominations such as the eight-drachm observed in Abdera or the double stater in Dikaia until the late 5th century BC[8]. However, its silver coinage persisted uninterrupted until the end of the 4th century BC, with a last final issue dated to the period of the Mithridatic wars. As for the five coins belonging to the early series of 520-430 BC, the results have shown that these are made of purer silver with no added copper (**Tab. 3**). It seems that copper becomes a more consistent alloying addition from the 450s onwards – period V –, when the production of the coins is more systematic – with 44 obverse dies for double staters.

In the first century together with Thasos they issue silver tetradrachms bearing Dionysos head on the obverse and Dionysos and

Table 2. Results from coin analysis of Dikaia.

A/A	Coin No.	Denomination/period/ date (BC)	Weight/g.	Type/Reference	Ag %	Cu %	Pb %	Au %	Pt %	Ti %	Fe %
1	9033	Hemiobol, I, 510-480	0.24	Agora A55, 10.05.2016, 29	98.06	0.88	n.d.	n.d.	n.d.	0.08	n.d.
2	4909	Hemiobol, II, 480-450	0.42	CNG eA406, 27.09.2017, 119	98.04	0.64	1.30	n.d.	n.d.	n.d.	n.d.
3	5885	Trehemiobol, II, 480-450	0.43	CN 50591	96.65	2.75	n.d.	0.56	0.02	n.d.	n.d.
4	8432	Hemiobol, II, 480-450	0.11	Agora eA56, 31.05.2016, 17	99.50	n.d.	n.d.	0.41	0.01	0.05	n.d.
5	11461	Triobol, II, 480-450	1.80	Nomos, A30, 06.11.2023, 1268	98.97	n.d.	0.27	0.75	n.d.	n.d.	n.d.
6	910	Obol, II, 480-450	0.46	CN 50583, CN 8211	94.21	2.48	1.71	n.d.	n.d.	n.d.	1.02
7	11503	Obol, II, 480-450	0.50	CN 50583, CN 8211	95.40	2.28	1.99	0.28	0.02	n.d.	n.d.
8	11484	Hemiobol, II, 480-450	0.29	CNG eA406, 27.09.2017, 119	98.85	0.82	n.d.	0.32	n.d.	n.d.	n.d.
9	11505	Hemiobol, II, 480-450	0.28	CNG eA406, 27.09.2017, 119	97.54	1.96	n.d.	0.48	n.d.	n.d.	n.d.
10	11523	Hemiobol, II, 480-450	0.16	Agora eA56, 31.05.2016, 17	97.48	1.76	0.39	0.34	n.d.	n.d.	n.d.
11	11474	Hemiobol, II, 480-450	0.14	Agora eA56, 31.05.2016, 17	97.95	1.25	0.21	0.52	n.d.	0.05	n.d.
12	11499	Hemiobol, II, 480-450	0.13	Agora eA56, 31.05.2016, 17	98.08	1.14	0.47	0.29	n.d.	n.d.	n.d.
13	11507	Hemiobol, II, 480-450	0.53	Agora eA56, 31.05.2016, 17	97.28	2.29	n.d.	0.41	n.d.	n.d.	n.d.

[7] CN 8156 and CN 8158. For the numismatic corpus of Dikaia see, *May* 1965; *Schönert-Geiss* 1975; *Tasaklaki* forthcoming a. For the archaeological evidence and the city's history, see *Triantaphyllos, Tasaklaki* 2012.

[8] For the coinage of Maroneia, see *Schönert-Geiss* 1987; *Psoma , Karadima, Terzopoulou* 2008; *Tasaklaki* 2024.

Table 3. Results from coin analysis of Maroneia.

A/A	Coin No.	Denomination/period/ date (BC)	Weight/g.	Type/Reference	Ag %	Cu %	Pb %	Au %	Pt %	Ti %	Fe %
1	80	Stater, I, 520-500	8.92	CN 1310	97.77	0.30	0.20	1.71	n.d.	n.d.	n.d.
2	C297	Drachm, II, 500-480	3.48	CN 1830	98.49	n.d.	1.50	n.d.	n.d.	n.d.	n.d.
3	11460	Hemidrachm, III, 480-450	1.49	CN 3437	95.36	0.38	4.23	n.d.	0.01	n.d.	n.d.
4	8063	Hemiobol, IV, 450-430	0.24	Nomos, A16, 11.11.2020, 48	99.72	n.d.	n.d.	0.27	n.d.	n.d.	n.d.
5	11493	3/4 obols, IV, 450-430	0.24	CNG eA484, 27.01.2021, 92	96.28	1.98	1.37	n.d.	n.d.	0.07	n.d.
6	11470	Hemiobol,IV, 450-430	0.93	CNG eA484, 27.01.2021,92	99.94	n.d.	n.d.	n.d.	0.05	n.d.	n.d.
7	11514	Hemiobol,IV, 450-430	0.36	Nomos,A23, 12.06.2021, 236	95.50	2.12	n.d.	2.36	n.d.	n.d.	n.d.
8	8434	Hemiobol, IV, 450-430	0.14	Nomos,A23, 12.06.2021, 236	97.61	1.72	0.41	0.25	n.d.	n.d.	n.d.
9	8435	3/4 obols, IV, 450-430	0.43	CNG eA484, 27.01.2021, 92	99.28	n.d.	n.d.	0.71	n.d.	n.d.	n.d.
10	8422	Tertartemoria, V, 430-400	0.09	Nomos,A23, 12.06.2021, 50	97.61	1.67	0.38	0.32	n.d.	n.d.	n.d.
11	1059	Drachm, VI, 400-377	3.18	CN 53058	99.98	n.d.	n.d.	n.d.	0.01	n.d.	n.d.
12	2106	Tetradrachm, VI, 400-377	13.93	CN 51673	98.14	1.21	0.21	n.d.	0.04	n.d.	0.35
13	11485	Hemidrachm, VI, 400-377	1.18	CN 47972	95.43	3.64	0.66	0.26	n.d.	n.d.	n.d.
14	11519	Hemidrachm, VI, 400-377	1.05	CN 47972	96.094	2.81	0.81	0.26	n.d.	n.d.	n.d.
15	5361	Drachm, VI, 400-377	1.23	CN 53058	95.60	2.62	1.41	0.32	0.01	n.d.	n.d.
16	C137	Drachm, VII, 377-365	1.01	CN 2689	95.89	2.63	1.01	0.42	n.d.	n.d.	n.d.
17	9184	Drachm, VII, 377-365	2.43	CN 5592	95.82	2.74	0.90	0.50	0.01	n.d.	n.d.
18	11456	Drachm, VII, 377-365	2.16	CN 48557	95.64	3.45	0.61	0.26	0.02	n.d.	n.d.
19	11483	Drachm, VII, 377-365	2.11	CN 48375	93.69	4.71	1.28	0.30	n.d.	n.d.	n.d.
20	11479	Drachm, VII, 377-365	0.87	CN 5424	96.64	2.25	0.66	0.34	0.05	n.d.	n.d.
21	C272	Drachm, VIII, 365-330	2.07	CN 5401	94.97	3.37	0.56	1.06	0.01	n.d.	n.d.
22	8387	Drachm, VIII, 365-330	2.30	CN 12474	98.21	0.59	0.36	0.83	n.d.	n.d.	n.d.
23	C722	Drachm, VIII, 365-330	2.25	CN 5401	95.84	2.78	0.60	0.75	n.d.	n.d.	n.d.

Hercules as saviours on the reverse (**Fig. 2**)[9]. Those have been found in large quantities in the Thracian hinterland and have been imitated both by Thracian tribes and Celts[10]. This group of coins in particular is certain to owe its issue to the Mithridatic wars and the payment of soldiers. The analysis has shown that coin No. 70 from Maroneia is debased, containing 6.9 wt% copper as is coin No. 956 from Thasos with 2.6 wt% copper. On the contrary, the oth-

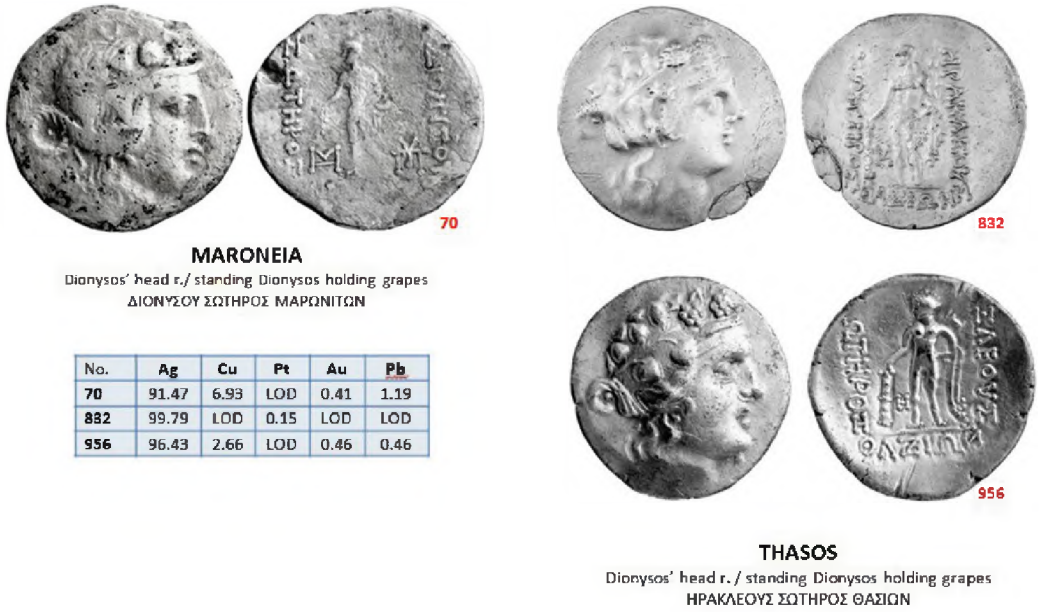

Figure 2. Tetradrachms of Maroneia and Thasos, 1st c. BC. Inset table shows their composition.

[9] *Psoma, Karadima, Terzopoulou* 2008: 179-182.
[10] *Prokopov* 2006.

Table 4. Results from coin analysis of Neapolis.

A/A	Coin No.	Denomination/period/ date (BC)	Weight/gr	Type/Reference	Ti	Fe	Cu	Ag	Pt	Au	Hg	Pb
1	5666	Diobol,500-480	1.49	SNG ANS 423	n.d.	n.d.	1.26	98.24	0.02	0.29	n.d.	0.34
2	11470	Diobol,500-480	0.93	SNG ANS 423	n.d.	n.d.	n.d.	99.93	0.06	n.d.	n.d.	n.d.
3	5665	Obol, 450-430	0.41	CNG, eA 274, 22.02.2012, 62	n.d.	n.d.	2.10	96.97	0.01	n.d.	n.d.	0.92
4	11455	Obol, 450-430	0.56	CNG, eA 274, 22.02.2012, 62	n.d.	n.d.	3.01	96.13	n.d.	n.d.	n.d.	0.86
5	11478	Obol, 450-430	0.44	CNG, eA 274, 22.02.2012, 62	n.d.	n.d.	3.60	95.59	n.d.	0.30	n.d.	0.51
6	11494	Obol, 450-430	0.49	CNG, eA 274, 22.02.2012, 62	0.07	n.d.	2.24	96.04	n.d.	n.d.	n.d.	1.54
7	11515	Obol, 450-430	0.51	CNG, eA 274, 22.02.2012, 62	n.d.	n.d.	2.33	97.18	n.d.	n.d.	n.d.	0.49
8	6062	Obol, 450-430	0,45	CNG, eA 274, 22.02.2012, 62	n.d.	n.d.	1.49	96.79	0.01	n.d.	0.64	1.39
9	8516	Hemiobol, 450-430	0.23	CNG, eA 286, 05.09.2012, 39	n.d.	n.d.	0.458	99.236	n.d.	0.306	n.d.	n.d.
10	9045	Hemiobol, 450-430	0.21	CNG, eA 286, 05.09.2012, 39	n.d.	n.d.	3.32	95.90	n.d.	0.51	n.d.	0.26
11	C589	Hemiobol, 450-430	0,31	CNG, eA 286, 05.09.2012, 39	n.d.	n.d.	1.85	94.62	n.d.	1.67	1.38	1.16
12	11504	Hemiobol, 450-430	0.18	CNG, eA 286, 05.09.2012, 39	n.d.	n.d.	3.19	96.04	0.02	0.30	n.d.	0.44

er coin from Thasos, namely No. 832 is exceptionally pure in silver.

Neapolis' coins[11], especially those of the second half of the 5th century BC, are numerous at the sites of Molyvoti and Zone and are found together with Dikaia's and Maroneia's low denominations. All the 12 Neapolis' coins (**Tab. 4**) we analyzed seem to follow a similar compositional pattern with those from Dikaia and Maroneia with two examples made of purer silver and the rest containing low copper contents of 2 % in average. The alloy synthesis and the fact that all those have been found in Stryme or Zone and not in Abdera can support a hypothesis that is a denomination of Maroneia mint.

Finally, examples from Ainos, Apollonia Pontica and Thracian Chersonnese are isolated for now and can only provide limited data for comparative use available to other scholars (**Tab. 5**).

Providing a general overview of the results of the chemical composition analysis it appears that, in addition to silver, most of the coins contain varying amounts of copper, lead, and gold, with lower contents of platinum being present in only a few cases. Impurities such as iron and titanium are rare and have been detected in a limited number of coins. The mean value of silver is 97.01 % with a range of 93.69 to 99.98 %. It is obvious that higher concentrations of copper and lead are present in the coins with the lowest silver content.

Looking at the silver contents across the whole assemblage, it has been noted that 90.9 % contain up to 95 % silver. About 29.5 % of the coins contain up to 98 % silver showing that higher purity coins are not the majority. Copper is present in contents between 0.3 and 4.7 wt% with the majority in the 1 to 3 wt%

Table 5. Results from coin analysis of various issuing authorities at the Archaeological Museum of Komotini.

City	Coin No.	Ti	Fe	Cu	Ag	Pt	Au	Hg	Pb
Thasos	956	n.d.	n.d.	2.66	96.43	n.d.	0.46	n.d.	0.46
Thasos	832	n.d.	n.d.	n.d.	99.79	n.d.	0.15	n.d.	n.d.
Thasos	139	n.d.	n.d.	2.93	96.12	n.d.	0.28	n.d.	0.67
Ainos	1353	n.d.	n.d.	1.53	96.64	n.d.	n.d.	n.d.	1.83
Ainos	248	n.d.	0.72	0.97	95.70	n.d.	1.58	n.d.	1.04
Apollonia	204	n.d.	n.d.	5.30	93.39	n.d.	0.28	n.d.	1.15
Chersonnesos	C378	n.d.	n.d.	11.99	87.52	n.d.	0.29	n.d.	0.40
Athens	5667	n.d.	n.d.	n.d.	98.54	0.01	n.d.	n.d.	1.45
Athens	8749	n.d.	n.d.	0.22	98.02	n.d.	n.d.	n.d.	1.76

[11] *Papaevangelou-Genakos* 2000.

range, and a smaller group of coins with contents below 1%. According to previous studies the presence of copper in excess of 0.5 % represents a deliberate addition, most probably to increase the hardness of the alloy which otherwise would have been too soft to be worked[12]. It is therefore reasonable to speculate that in our case too copper was added deliberately. The silver/copper correlation diagram displays a rather populated group in the range of 1-3.5 % copper with only 1 coin with copper contents above 4 %. Lead contents range between 0.2 and 4.2 % displaying two rather loose groupings as shown in the silver/lead correlation diagram. Such concentrations might be the result of the cupellation process applied for the separation of silver most probably deriving from argentiferous lead ores. Alternatively, it could derive from deliberate addition particularly when it is detected above 1 %. In the assemblage under study, 21 coins contain lead in concentrations of 0.3 to 1 % and these might be suggestive of its origin from cupelled ores. For 11 coins, lead concentrations are between 1 and 3 % suggesting a probably intentional addition while in one case, the amount of 16.8 % of lead indicates deliberate debasement. The silver/gold correlation shows that the majority of coins contain gold in concentrations below 1 % in both low and higher purity coins. Four coins contain gold in contents between 1 and 1.7 % and a fourth one 2.3 %. Since lead contents are either absent of very low in these four coins this might be suggestive of a long cupellation process during which an increase in silver and gold could occur with a simultaneous decrease in lead values. The frequency of gold in the assemblage shows the majority falling within the compositional range of 0.15 to 0.62 % (24 coins), followed by a smaller number of six coins in the range of 0.62-1.09 %. This consistent pattern of low values seems to corroborate the hypothesis that gold was present in the argentiferous ores such as chlorargyte or acanthite used for the extraction of silver.

For the time being and based on a small volume of coins we can proceed with the analysis of silver coins from the three major cities of Aegean Thrace, i.e. Maroneia, Dikaia, and Abdera and to draw some preliminary conclusions. This has shown how the supply of silver had been more or less constant from the late sixth to the second century BC although some small devaluation is apparent in the long term. This devaluation through time has been more pronounced for the case of Abdera and might be related to the political and military history of the city as the invasion of the Tribalioi in particular coincides with the 6th series of coinage after which devaluation becomes more prominent. The coins of Maroneia show some fluctuations through time with higher and lower silver contents coexisting, as is the case with the coinage from Dikaia. The results testify that the deposits of Thrace were under exploitation from at least the late 6th century BC when the earliest coins in the region were struck. The main alloying agent was copper that was added in most cases between 1 and 3 %. And finally, lead could be considered as an alloying addition for at least 11 coins where its concentration is between 1 and 4.2 % and for the rest reflects a reminiscent from the cupellation process. Our results are in accordance with the geological/geochemical studies, confirming that most of the silver-bearing deposits of Thrace contain low gold contents. Three main types of mineralisation present in northeastern Greece should be considered in this context (**Fig. 3-4**). Galena is one of the main minerals exploited for its rich silver contents and secondary jarosite and anglesite are present in these mineralisations. The most important carbonate replacement bodies are located in NE Chalcidice, Thasos and Palaia Kavala[13] with increased silver and gold contents and ample archaeological evidence for ancient mining. The carbonate replacement system in Thermes, north of Xanthi is characterized by low silver

[12] *Karydas, Anglos, Harith* 2008; *Kladouri, Skaltsa, Gerodimos, Pezouvani, Karydas* 2023.

[13] For Chalcidice, see *Wagner, Pernicka, Vavelidis, Baranyi, Bassiakos* 1986; For Thasos, see *Wagner, Weisgerber* 1988; For Kavala, see *Photos, Koukouli-Chryssanthaki, Tylecote, Gialoglou* 1989; *Vavelidis, Gialoglou* 1997; *Fornadel, Spry, Melfos, Vavelidis, Voudouris* 2011. *Vavelidis, Christofidis, Melfos* 1997.

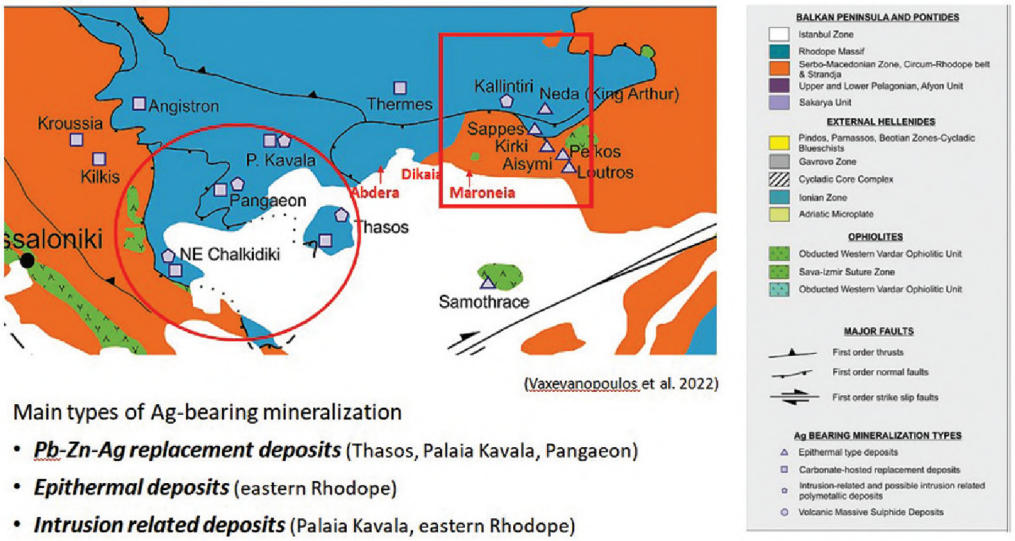

Figure 3. Map of Easter Macedonia and Thrace with main types of Ag-bearing mineralization.

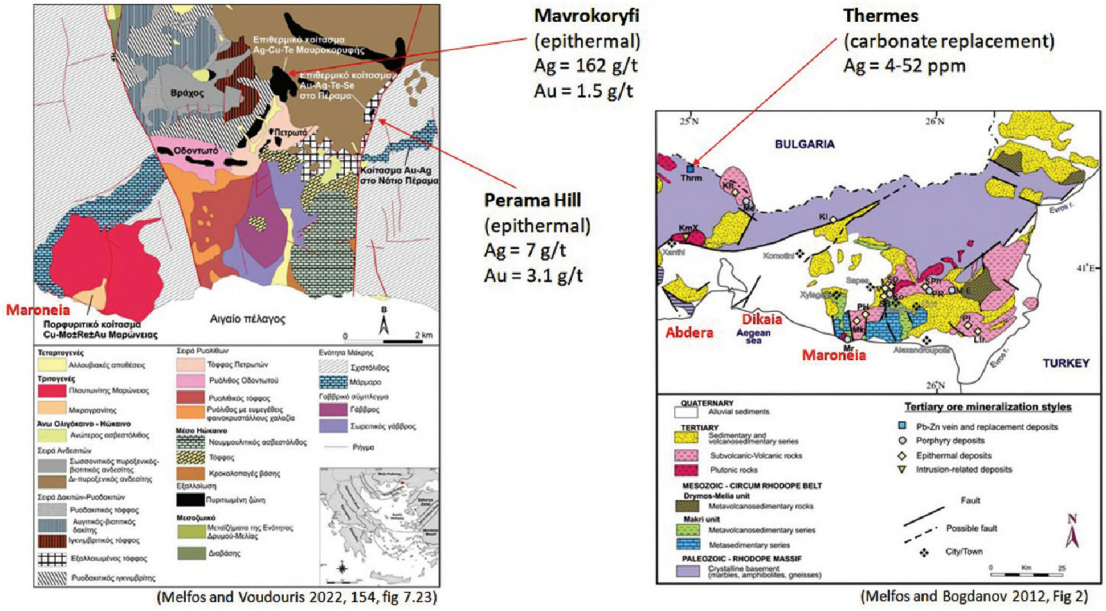

Figure 4. Maps of Aegean Thrace with epithermal mineral deposits.

concentrations[14]. Significant epithermal deposits exist at the eastern Rhodope Mountain range in the regions of Sapes-Kirki, Neda, Pefka but also at Maroneia and Melitaina[15]. The epithermal deposit at Perama Hill in eastern Rhodope/Evros is located at the eastern margin of the tectonic fault of Petrota-Maroneia[16]. Last is the nearby epithermal deposit of Mavrokoryfi[17].

All these deposits are potential sources of silver for the coins under study but before

[14] There is evidence for tentatively mining in the Roman period and associated to a military camp found nearby and to the Mithras relief, see ΟΔΥΣΣΕΥΣ, the official site of Hellenic Ministry of Culture (http://odysseus.culture.gr/h/2/eh251.jsp?obj_id=715:Maria Chrysaphi).

[15] The first contain up to 66 ppm Silver according to a recent study. Although the area of Kirki has Silver-rich mineralisations only a Large-scale modern mining has been detected. Prospection through trenches and adits at Aisymi, Sapes, and Neda might have obliterated ancient phases of mining and extraction of minerals. *Melfos, Vavelidis, Bogdanov* 2003.

[16] For Perama, see *Voudouris, Melfos, Spry, Moritz, Papavassiliou, Falalakis*, 2011; For Maroneia, see *Papastamataki, Orphanos, Demetriou, Triantafyllos, Karadima* 2001.

[17] *Voudouris* 2011.

performing lead isotope analysis and/or trace elements analysis, it is premature to arrive at any conclusions concerning provenance. Additionally, we need to stress that despite the progress in recent years of lead isotope studies, the overlapping isotopic compositions of several deposits across northeastern Greece shows the complexity of assigning coins from this region to specific geological sources. Thus, approaching such issues of procurement of raw materials one needs to take into consideration not only the geological and geochemical information but also the political relations and their fluctuations over time between the different cities affecting their access to such resources.

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CN = Corpus Numorum, https://www.corpus-nummorum.eu/

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Сребърни монети от антични градове в Егейска Тракия представени чрез XRF анализ

Марина Тасаклаки, Неранцис Неранцис

Проучването има за цел да анализира качеството на сребърната сплав, използвана за монетосеченето, чрез неинвазивна оценка на елементния състав на монетите. По време на началния етап бяха изследвани общо 96 сребърни монети с помощта на преносим XRF апарат. Количествени данни бяха получени само за 44 монети и резултатите са представени тук. Особено внимание заслужават предварителните аналитични данни, получени от монети от сребърни сплави, произхождащи от три известни града в Егейска Тракия – Абдера, Дикая и Маронея. Разгледани са и примери от монети, за които се предполага, че са емитирани в Неаполис. Елементният състав разкрива наличието на сребро (Ag), мед (Cu), олово (Pb), злато (Au), както и следи от платина (Pt), желязо (Fe), титан (Ti). Предварителните данни показват постоянна наличност на сребро от края на VI до II в. пр. Хр., с някои данни за дългосрочна девалвация.