Koray Konuk, « The Electrum Coinage of Samos in the Light of a Recent Hoard », in : E. Schwertheim & E. Winter (ed.), *Neue Forschungen zu Ionien*, Asia Minor Studien (Bonn, forthcoming).

The Electrum Coinage of Samos in the Light of a Recent Hoard [1]

The origins of struck money (coinage) and, in particular, the reasons which led to its creation are still much debated.[2] Its primary function remains equally hypothetical. What we may take for granted is that this invention took place in western Asia Minor, in the area controlled by the Lydians, and that it happened, with less certainty, in c. 600 BC. For about half a century an alloy mainly made of gold and silver called electrum, which occurs naturally in Lydia, was the only metal used for these first coins. Identifying minting authorities, i.e. states and perhaps private individuals, is a difficult task owing to the paucity of inscriptions on coins and provenances. The study of hoards and the analysis of the metal of these coins may provide some answers. Among the first civic mints identified with certainty are Sardis, Kyzikos, Phokaia, Ephesos, Miletos and Samos.

Like its powerful Ionian neighbours, Samos struck its first coinage c. 600 BC in electrum.[3] The attribution of these coin types to the mint of Samos is mainly based on finds made on the island, of which the most important was a hoard found in 1894. Ernest Babelon published 34 coins from the hoard of which 18 were acquired by the Cabinet des Médailles in Paris.[4] A further group of 25 coins passed to the British Museum through Lawson of Smyrna.[5] Some pieces went astray and altogether the hoard comprised more than 60 coins in 7 denominations: 3 staters (units), 4 hemistaters (1/2), 24 hektai (1/6), 15 hemihekta (1/12), 12 quarter hektai (1/24), 1 forty-eighth and 1 sixty-fourth.[6]

What distinguishes the Samian electrum coinage is the use of the Euboic-Samian standard, whereas the Milesian standard prevailed in Lydia and Ionia, with the exception of northern Ionia where the Phokaic standard was used. Another feature is the shape and position of the punches on the reverse of its coins: two rectangular punches on its staters, one rectangle and one square (occasionally triangular) on half staters; an incuse square on the smaller denominations.

A number of previously unrecorded electrum coins of Samos began to surface on the European market in 1998. Rumours of a hoard followed but there was little hard evidence about the circumstances of its discovery. Some sources indicated that metal detectorists chanced upon the hoard somewhere along the Turkish coastline opposite Samos, probably on

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Nicolet-Pierre, Samos	H. Nicolet-Pierre-J. – N. Barrandon, Monnaies d'*électrum* archaïques, le trésor de Samos de 1894 (*IGCH* 1158) conservé à Paris, RN 152 (1997) 121-135.
Keyser, Electrum	P. T. Keyser – D. D. Clark, Analysing and Interpreting the Metallurgy of Early Electrum Coins in: M. S. Balmuth (ed.), Hacksilber to Coinage, New Insights into the Monetary History of the Near East and Greece (2001) 105-126.
Ramage, Croesus' Gold	A. Ramage – P. Craddock, King Croesus' Gold. Excavations at Sardis and the History of Gold Refining (2000).

[1] I would like to thank Dr Jean-Noël Barrandon of the Centre Ernest Babelon (CNRS) in Orléans for carrying out the proton activation (PAA) analysis of 12 coins from the hoard. My thanks also go to Richard Ashton for greatly improving the text.

[2] See most recently, L. Kurke, Coins, Bodies, Games and Gold (1999). G. Le Rider, La naissance de la monnaie (2001). D. Schaps, The Invention of Coinage and the Monetization of Ancient Greece (2003). R. Seaford, Money and the Early Greek Mind (2004).

[3] There is little evidence for the date of the Samian electrum; the dates proposed are those given to early electrum coinage in general.

[4] E. Babelon, RN 1894, 149-163. Inventory of Greek Coin Hoards (IGCH), 1158. Nicolet-Pierre, Samos.

[5] J. P. Barron, The Silver Coins of Samos (1966) 6.

[6] Barron, 15, cites "more than 40 pieces"; IGCH, 1158 cites 60+. I follow the latters's list.

the northern slope of the Mykale mountain range. Coin Hoards IX, 341 lists it with the heading "Unknown findspot, 1998" and states that it included 18 electrum coins, all Samian except 4 electrum fractions labelled "Milesian/Lydian". Certainty is impossible, but, since my informants described only Samian coins, and since hoards of electrum with coins of different weight standards are exceptional, I would be inclined to view these "Milesian/Lydian" coins as intrusions occurring after the discovery of the hoard, something which happens very often with detectorists finds. The electrum coins of Samos are very rare and their appearance in numbers from 1998 strongly suggests a common origin.[7] Moreover, coins which I have been able to examine myself and those which have been illustrated in colour in catalogues all show a distinctive copper-brown earth incrustation, usually quite visible on the reverse. At least 5 different types and 5 denominations are represented in the hoard. The following catalogue contains 44 specimens from the hoard which I could trace in auction catalogues and fixed priced lists available to me, but does not purport to be complete. No doubt others have escaped my notice, many were probably sold without appearing in commercial catalogues, as was the case with 12 discussed below.

Type 1

Obv. Rough surface with irregular markings.
Rev. 1. Two parallel oblong incuses with irregular markings (stater).
2. Square incuse set next to oblong incuse, both with irregular markings (hemistater).
3. Square incuse with irregular markings (hektai, hemihekta and quarter hektai).

Stater

O1	R1	a.	17.22	Triton 6 (Jan. 2003), 391; Leu 77 (May 2000), 310. Pl. 2, A.

Hemistater

O2	R2	a.	8.64	SNG Kayhan, 628; Leu 77 (May 2000), 311. Pl. 2, B.

Hekte

O3	R3	a.	2.87	Leu 77 (May 2000), 312. Pl. 2, C.
O4	R4	a.	2.84	Triton 6 (Jan 2003), 392.
		b.	2.91	Kayhan collection, 1. Pl. 1. Same dies as 1894 Samos Hoard L3982.
O5	R5	a.	2.90	Kayhan collection, 2. Pl. 1.
		b.	2.86	Kayhan collection, 3. Pl. 1.
O6	R6	a.	2.89	Kayhan collection, 4. Pl. 1. Same O6 as 1894 Samos Hoard L3979.
O6	R7	a.	2.87	Kayhan collection, 5. Pl. 1. Same dies as 1894 Samos Hoard L3979.
O7	R8	a.	2.88	Kayhan collection, 6. Pl. 1.
O8	R9	a.	2.85	Kayhan collection, 7. Pl. 1.
O9	R10	a.	2.77	Kayhan collection, 8. Pl. 1.

Hemihekton

O10	R11	a.	1.43	Kayhan collection, 9. Pl. 1.
O11	R12	a.	1.42	Kayhan collection, 10. Pl. 1. Same O11 as 1894 Samos Hoard L3981.
O12	R13	a.	1.39	Kayhan collection, 11. Pl. 1.
O13	R14	a.	1.41	Leu 77 (May 2000), 313. Pl. 2, D
O14	R15	a.	1.41	SNG Kayhan, 629; CNG 51 (Sept. 1999), 437 (lot with multiple coins).
O15	R16	a.	1.40	SNG Kayhan, 630; CNG 51 (Sept. 1999), 437 (lot with multiple coins).

[7] The earliest appearances in catalogues are September, October, November and December 1998 (see list of coins).

O16	R17	a.	1.39	SNG Kayhan, 631; CNG 51 (Sept. 1999), 437 (lot with multiple coins).
O17	R18	a.	1.46	SNG Kayhan, 632; CNG 51 (Sept. 1999), 437 (lot with multiple coins).
O18	R19	a.	1.39	SNG Kayhan, 725; CNG 50 (June 1999), 829.

Quarter hekte

O19	R20	a.	0.69	Kayhan collection, 12. Pl. 1.
O20	R21	a.	0.73	SNG Kayhan, 633; CNG 51 (Sept. 1999), 437 (lot with multiple coins). Pl. 2, E.
O21	R22	a.	0.71	SNG Kayhan, 634; CNG 51 (Sept. 1999), 437 (lot with multiple coins).
O22	R23	a.	0.73	Giessener & Mosch 92 (Nov. 1998), 189.

Type 2

Obv. Uncertain type, perhaps an eagle standing right devouring a hare
Rev. Square incuse with irregular markings.

Hekte

O1	R1	a.	2.87	SNG Kayhan, 636; CNG 50 (June 1999), 835. Pl. 2, F
		b.	2.85	Triton 3 (Dec. 1999), 533.
O1	R2	a.	2.88	SNG Kayhan, 635; Triton 2 (Dec. 1998), 425.

Type 3

Obv. Facing head of lioness or panther; background with rough markings.
Rev. Square incuse with irregular markings.

Hekte

O1	R1	a.	2.84	Triton 6 (Jan. 2003), 394.
		b.	2.87	Vinchon (Oct. 2000), 203.
O2	R2	a.	2.86	SNG Kayhan, 638; Triton 3 (Dec. 1999), 532; Peus 357 (Oct. 1998), 303.
		b.	2.88	SNG Kayhan, 639; Triton 2 (Dec. 1998), 427. Pl. 2, G.
		c.	2.87	Giessener & Mosch 95 (March 1999), 289.
		d.	2.93	Giessener & Mosch 121 (March 2003), 173.
		e.	2.86	Giessener & Mosch 125 (Oct. 2003), 195.
		f.	2.82	Numismatic Circular 107/10 (Dec. 1999), 4941.
		g.	2.87	Antiqua, FPL n.d., 41.
		h.	2.85	Vinchon (Oct. 2003), 49.
		i.	2.88	Tkalec (Feb. 2000), 120.

Hemihekton

O2	R3	a.	1.43	Numismatica Ars Classica N (June 2003), 1324. (same dies as those used for the previous hektai). Pl. 2, H.

Type 4

Obv. Eagle flying right; background with linear markings.
Rev. Square incuse with irregular and roughly linear markings.

Hekte

O1	R1	a.	2.88	SNG Kayhan, 637; Triton 3 (Dec. 1999), 531. Pl. 2, I.
		b.	2.87	Triton 6 (Jan. 2003), 393; Triton 2 (Dec. 1998), 426.
O1	R2	a.	2.85	Tkalec (Feb. 2000), 119.

Type 5

Obv. Duck advancing or swimming to left.
Rev. Square incuse with irregular markings.

Quarter hekte

O1	R1	a.	0.73	SNG Kayhan, 722; Triton 3 (Dec. 1999), 722. Pl. 2, J.

Type 6
It is uncertain whether the following two coins of Type 6 were part of the 1998 hoard because a second hemihekton from the same dies (O1 R1) was auctioned by Giessener in 1995.

Obv. Three sided square with central projection surrounded by radiate lines.
Rev. Square incuse with irregular markings.

Hemihekton

O1	R1	a.	1.47	Triton 8 (Jan. 2005), 454. Pl. 2, K.

Quarter hekte

O1	R2	a.	0.68	Triton 8 (Jan. 2005), 455. Pl. 2, L. From the same obverse die as the hemihekton.

Now part of the Muharrem Kayhan collection, 12 coins (illustrated on plate 1) from the hoard had been in the possession of a European private collector who allowed me to study them and subject them to proton activation (PAA) analysis which was conducted in Orléans by Jean-Noël Barrandon of the Centre Ernest Babelon (CNRS) using the variable energy cyclotron of the CERI (CNRS Orléans). This non-destructive method allows an accurate characterisation of the metal composition of each coin, both for major (measured in percentage) and trace elements (measured in ppm[8]). Barrandon had previously analysed the 18 specimens in Paris from the 1894 hoard by the same method.[9] The 12 coins from the 1998 hoard are hereafter designated with the prefix 1998H and the 18 coins from the 1894 hoard with the prefix 1894H.

[8] Parts per million ; one ppm is equal to 0.0001 %.
[9] Nicolet-Pierre, Samos, 130-134. A few words of caution should be made about a number of methods that have been used to analyse electrum coins. Methods like XRF only analyse the surface of the coin which gives unreliable data for the overall composition of the coin because of the phenomenon known as surface enrichment. The surface of coins which have remained buried for long periods of time tend to lose elements which are prone to oxidation such as copper, tin, lead, iron and to a certain extend silver. Gold is not affected, so that coins tend to have a higher percentage of gold on the surface than their interior.

Table 1 : Weights

		Theoretical Weight	1998 Hoard	1894 Samos Hoard
Stater	1	17.40		17.31
Hemistater	1/2	8.70		8.76: 8.66; 8.60; 7.90
Hekte	1/6	2.90	2.91; 2.90; 2.89; 2.87; 2.88; 2.86; 2.85; 2.77	2.87 (3); 2.86 (2); 2.85 (3)
Hemihekton	1/12	1.45	1.43; 1.42; 1.39	1.43; 1.42
Quarter Hekte	1/24	0.73	0.69	0.69; 0.68

The 12 coins that could be studied here are all of the same type, having an obverse with irregular markings and a reverse with a square punch mark. Three denominations are represented: 8 hektai (1/6th staters); 3 hemihekta (1/12th) and 1 quarter hekte (1/24th). See Table 1 for the weights of the 30 coins concerned and the theoretical weights for each denomination. It is clear that the weights were adjusted with great accuracy.

Table 2 : 1998 Hoard (12 coins)

N°	**Au** %	**Ag** %	**Cu** %	**Sn** ppm	**Pb** ppm	**Weight**
7	83.9	14.7	1.18	640	450	2.85
9	65.3	32.6	2	220	1250	1.43
8	61.6	36.7	1.31	190	2740	2.77
11	60.8	37	2	1280	910	1.39
12	59.9	36.8	2.38	2200	6580	0.69
3	54.1	43.4	1.97	1000	3140	2.86
10	53.1	43.9	2.36	910	4420	1.42
4	51.4	46.1	2.19	1200	1520	2.89
5	50.8	46.7	1.98	860	3360	2.87
2	48.9	47.6	2.7	930	4450	2.90
6	48.5	48.9	2.17	510	2340	2.86
1	48	48.6	2.35	690	9400	2.91

Table 3 : 1894 Samos Hoard (18 coins)

N°	**Au** %	**Ag** %	**Cu** %	**Sn** ppm	**Pb** ppm	**Weight**
L3982	80.6	18.5	0.87	240	350	2.87
L3989	73.8	25.2	0.97	300	200	0.69
L3984	65.5	33.5	0.98	370	340	0.68
L3983	62.6	35.2	2.16	910	1940	1.39
L3990	61.6	36.2	2.23	1200	6500	2.85
L3988	61.5	37.3	1.23	300	1200	2.85
L3987	60.3	38	1.7	1200	1300	1.42
L3992	57.8	39.8	2.36	1100	5200	8.66
L3980	57.65	40.2	2.15	730	1300	2.87
L3991	57.6	40	2.4	1200	2700	1.43
L3986	57.5	39.4	3.08	2000	7600	2.86
L3979	57.4	40.1	2.46	400	1200	2.87
L3981	56.55	40.8	2.65	920	3900	2.86
L3985	55.9	41.2	2.88	1100	5200	2.85
L3976	53.05	44.4	2.55	390	5900	8.60
L3977	52.6	43.8	3.6	1000	6900	8.76
L3978	50.9	45.9	3.22	770	5600	7.90
L3975	46.4	50.3	3.3	1200	8500	17.31

Table 2 and 3, dealing respectively with the 12 coins from 1998H and 18 from 1894H, give the percentage results obtained by proton activation analysis for 5 elements: gold (Au), silver (Ag) and copper (Cu), and ppm readings for tin (Sn) and lead (Pb); table 1 shows the results for 1998H (12 coins) and table 2 those for 1884H (18 coins). The coins are listed in descending order of gold content, the highest level being over 80 % and the lowest just under 50 %. The results for both hoards are remarkably consistent. Although the weight of the coins are carefully regulated, their fineness varies considerably. For instance, the weights of coins 7 and 1 are very close (2.85g and 2.91g, respectively), but their gold contents (which determine their intrinsic value) are very different (84 and 48 %, respectively). In fact, coin 7 is almost 80 % more valuable than coin 1, even though they both represent the same denomination.

Coins 1998H, 1 and 1894H, L3982 were struck from the same obverse and reverse dies, suggesting strongly that they were issued roughly at the same time). We would thus expect them to have similar metal contents. They are, however, completely different. 1998H, 1 has the lowest level gold content among the 12 coins from its hoard, whereas 1894H, L3982 has the highest level of gold among the 18 coins from its hoard. A completely different electrum alloy was used for striking these two coins. Even if we were to assume that these two coins were not part of the same batch, they cannot be chronologically far apart given that the dies show similar wear on both coins. This confirms the assumption that coins with high levels of gold (generally regarded as natural electrum – see below) were probably struck and circulated at the same time as coins with lower gold levels (i.e. with artificial electrum).[10] 1998H, 4 and 5 share the same obverse die and 1998H, 4 shares the obverse and reverse dies of 1894H, L3979; this time the three coins show quite similar metal profiles. 1998H, 10 and

[10] Nicolet-Pierre, Samos, 133. The authors were tempted to suggest that there might have been a chronological gap between gold-rich electrum coins and those which are silver-rich. Coin L3982 prevented them from drawing that conclusion "Cependant l'hecté no. 8 [L3982] empêche de conclure de cette façon relativement simple. Cette dernière monnaie est même la plus riche en or, et elle (et elle seule) entre exactement dans la fourche observée une fois pour de l'or du Pactole. Les autres hectés si semblables mais qui sont d'argent allié ne peuvent guère en être éloignées dans le temps. L'usage d'un *electrum* artificiel semblerait bien alors remonter plus haut, vers la création même de l'objet monétaire".

1894H, L3981 share an obverse die, although they are different denominations (hemihekton and hekte), and again are metallurgically very close.

In 1894H, the coins with the lowest content of gold are the larger denominations (the unit called the stater has the least gold, followed by three hemistaters). One would have expected the opposite since smaller denominations are pro rata more costly to produce. Nicolet-Pierre and Barrandon observed that in the case of the 1894H coins, the amount of copper increased in parallel with the increase in silver content: the higher the percentage of silver, the higher the copper percentage (see fig. 1). In both hoards, the coins with the lowest content of copper are also those with the highest percentage of gold (coins 7 and L3982). Nicolet-Pierre and Barrandon suggested that 1894H, L3982, L3989 and L3984, which are rich in gold and low in copper (respectively, 80.63 %, 73.83 % and 65.52 % gold, and 0.87 %, 0.97 % and 0.98 % copper) were produced with natural electrum.[11] There has been some debate as to the amount of copper that natural electrum contains. According to Ramage and Craddock, copper is rarely found in quantities greater than 1 % or 2 %.[12] Keyser and Clark believe that copper is found in native electrum only in very small amounts, rarely as high as 0.3 %; they argue that the presence of even 1 % copper in an electrum object would be evidence of its deliberate addition.[13] The matter can only be resolved by the analysis, using a reliable method, of several samples of natural electrum from the Tmolos watersheds, the Pactolos and the Hermos analysed with a reliable method. Until recently we had to rely on a single neutron activation analysis of a sample.[14] Now we have a further analysis of "a natural granule of alluvial gold",[15] an elongated piece weighing 2.00g found during the excavations of the gold refinery at Sardis. According to Ramage, "Area analysis of the cross-section of the large piece shows it to contain Au 69.6 %, Ag 29.8 %, Cu 0.6 %, a typical composition for unrefined native gold. A small lump on the side of the large piece has a different composition, but still well within the range of natural gold: 83.3 %, Ag 16.2 %, Cu 0.5 %. Probably these are two grains of alluvial gold stuck together over time". This is evidence to the natural variability of alluvial electrum, although the copper amount is consistent at around half a percent.

Examination of the 1998H coins and their metallurgical analysis allows further conclusion to be drawn. Hitherto, I had been under the impression that observable differences in the colour of electrum coins would be a function of their gold-silver ratio.[16] The more gold, the deeper yellow the tone of the coin would be; the less gold (i.e. the more silver), the paler the coin would be.[17] However, when I examined the 12 coins using natural light (with and without direct sunlight), I was unable to differentiate them by deepness of colour, for all showed a very even, constant medium yellow. I could not even tell apart the two specimens with the highest and the lowest gold percentages (no. 7 and 1). The explanation may be the levels of copper. As I have noted above, the level of copper increases proportionally with the rising level of silver, and decreases as the level of gold drops. This is not a natural phenomenon as it is with lead, whose level increases with that of silver (lead is a native component of silver ore), see fig. 2. The reason for adding copper cannot have been a need to

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[11] Nicolet-Pierre, Samos, 132.
[12] Ramage, Croesus' Gold, 11.
[13] Keyser, Electrum, 106.
[14] S. M. Goldstein, Bulletin of the American Schools of Oriental Research 199, 1970, 26-28. J. C. Waldbaum, Metalwork from Sardis, the Finds through 1974 (1983) 186. Keyser, Electrum, 107.
[15] Ramage, Croesus' Gold, 148, sample 30A.
[16] See, G. Le Rider, La naissance de la monnaie (2001) 87, n. 1, commenting on the variations of the gold-silver ratio in electrum coins notes that 'Ces variations, dont la réalité n'échappe pas à l'œil (certaines pièces sont nettement plus pâles que d'autres)…'.
[17] Modern jewellers detect a green colour when gold alloys contain high levels of silver.

harden the electrum alloy, for if the metal in any coins required hardening, it would have been that with the highest levels of gold, not that with high levels of silver which is harder than gold.[18] A more plausible explanation is that the addition of copper served to standardise the appearance of Samian electrum coins. It was added when an alloy had a low gold content, and gave the coins struck from it the same deeper colour as coins made from an alloy with higher gold content. From pale yellow, copper would turn the colour into a more gold-rich tone, and the silver-rich alloy would look as if it had more gold than its actual ratio. This simple ploy would have been sufficient to deceive the naked eye. Further testing would have been necessary, such as the use of the touchstone aptly called in antiquity 'Lydian stone', to determine the actual gold content of an electrum coin.

Although the mint of Samos, like other issuing authorities, took great care over the weights of its coins, this was not the case with the alloy used to strike them.[19] Even coins struck from the same dies could vary greatly in intrinsic value. But the consistency of their weights implies that they were intended to have a set value (i.e. a facial value), even if their value as bullion varied greatly. The addition of copper to ensure that even coins with low gold content looked the same as those with high will have been part of this process, and would have helped to prevent users from creaming off coins with the highest levels of gold.

We have seen that natural electrum varies greatly in composition, and it is at first glance strange such a metal should have been used to strike the first coins when more reliable metals such as pure silver or pure gold were not difficult to obtain; there is ample evidence that uncoined gold and especially silver, which could be exchanged by weight, were used as means of exchange in the ancient world before and after the advent of coinage.[20] Electrum was available locally, but that is hardly a sufficient explanation. A more satisfactory explanation is that advanced by Robert Wallace, namely that coinage was invented precisely because of the varying intrinsic value of electrum, which could not circulate without a guarantee. Coinage was meant to solve a local difficulty in Lydia and its subject territories: that of using electrum as bullion in transactions. By putting devices on carefully weighed lumps of electrum, the issuing authority would fix the face value of electrum.[21] The addition of copper to create a uniform colour would have been a further device to sustain the face value of the first electrum coins (and maintain the confidence of their users), and consequently prevent the coins with the highest gold content from being melted down or selected for hoarding under the operation of Gresham's Law.

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[18] *Pace* Keyser, Electrum, 116.
[19] In contrast with the mint of Sardis which appears to have produced an electrum coinage with a regular gold-silver ratio, analysed coins averaging 54 % of gold. See, Ramage, Croesus' Gold, 169-174.
[20] See e.g. G. Le Rider, La naissance de la monnaie (2001), chapter 1.
[21] R. W. Wallace, AJA 91, 1987, 385-397; idem in: M. S. Balmuth (ed.), Hacksilber to Coinage, New Insights into the Monetary History of the Near East and Greece (2001) 127-134. I have little doubt that, ever since its inception, coinage was also meant to bring some profit to the issuing authority. In its early stage, electrum coinage developed and was confined to mints which were either subjected to the Lydian state or had close relationship with it. Electrum coins did not circulate beyond this realm. In M. J. Price in: C. N. L. Brooke et al. (ed.), Studies in Numismatic Method Presented to Philip Grierson (1983) 4, Price states that the face value of electrum coins must have been fixed at the highest point of the range of their intrinsic values.

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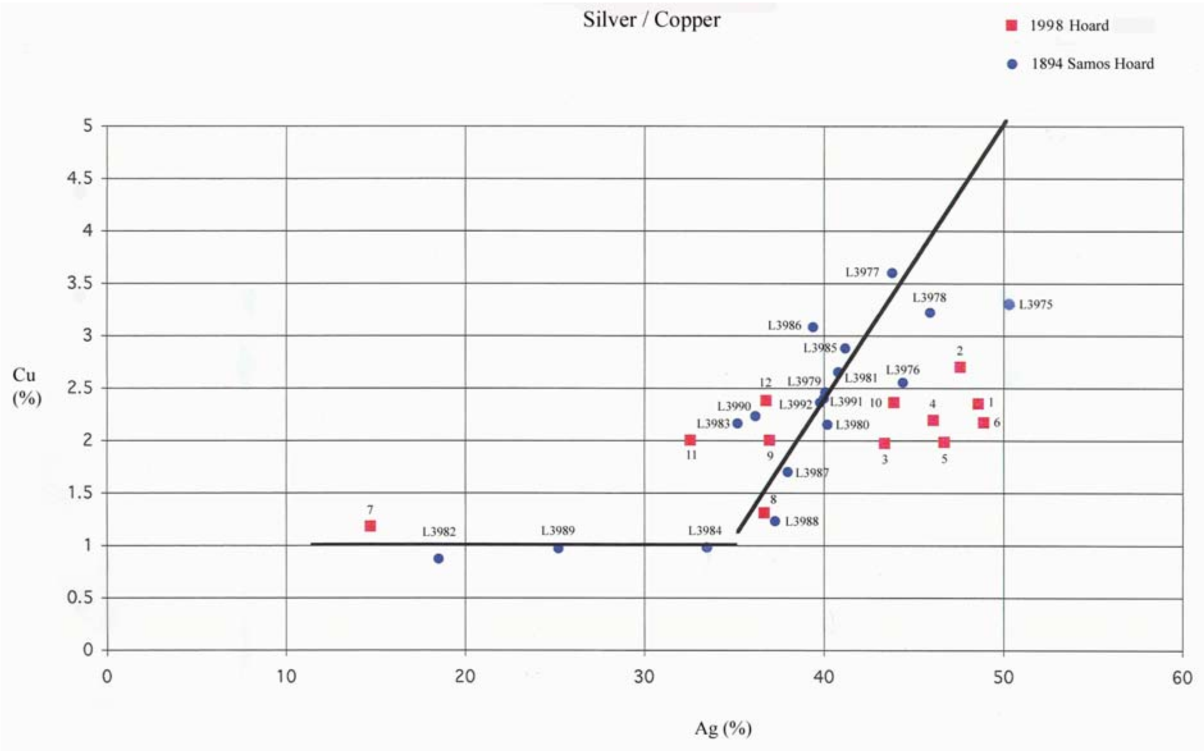

Fig. 1 : Silver and copper

Koray Konuk, « The Electrum Coinage of Samos in the Light of a Recent Hoard », in : E. Schwertheim & E. Winter (ed.), *Neue Forschungen zu Ionien*, Asia Minor Studien (Bonn, forthcoming).

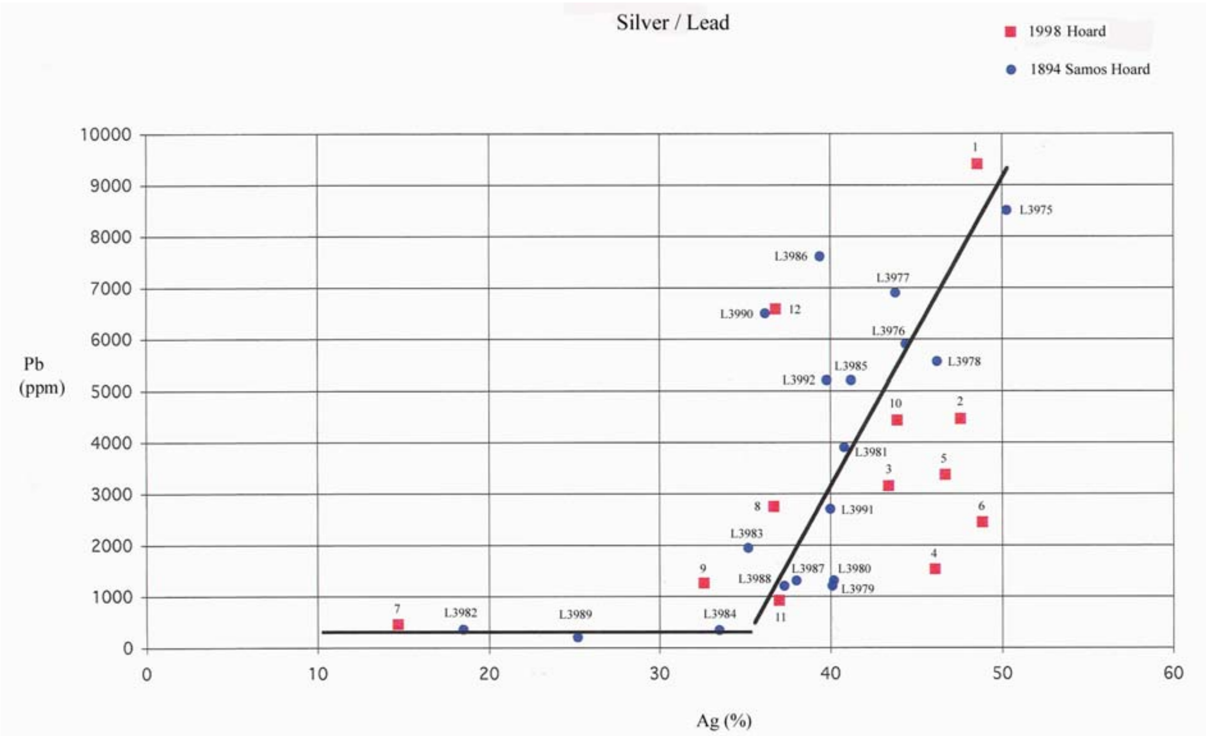

Fig. 2 : Silver and lead

Koray Konuk, « The Electrum Coinage of Samos in the Light of a Recent Hoard », in : E. Schwertheim & E. Winter (ed.), *Neue Forschungen zu Ionien*, Asia Minor Studien (Bonn, forthcoming).

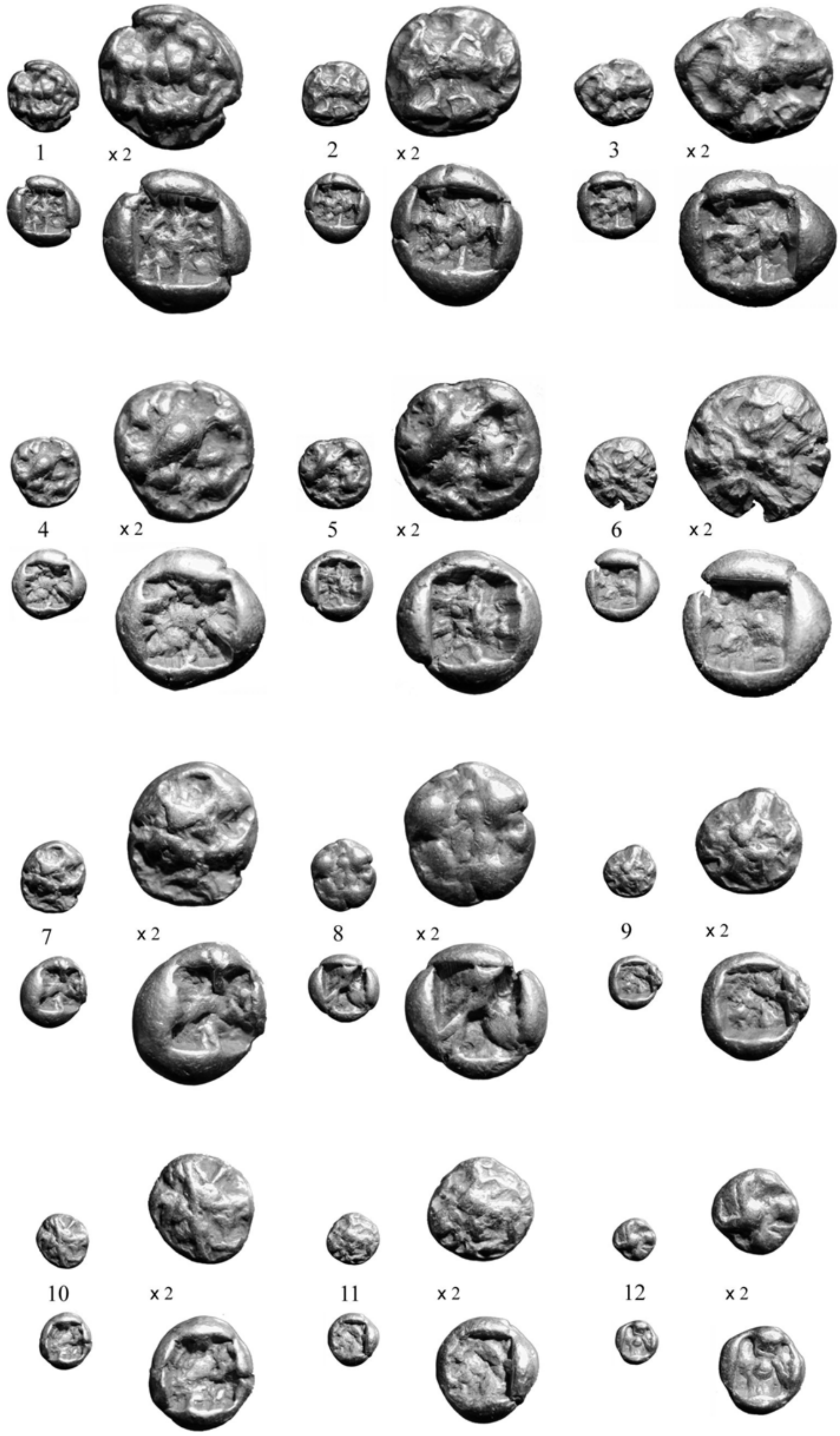

PLATE 1

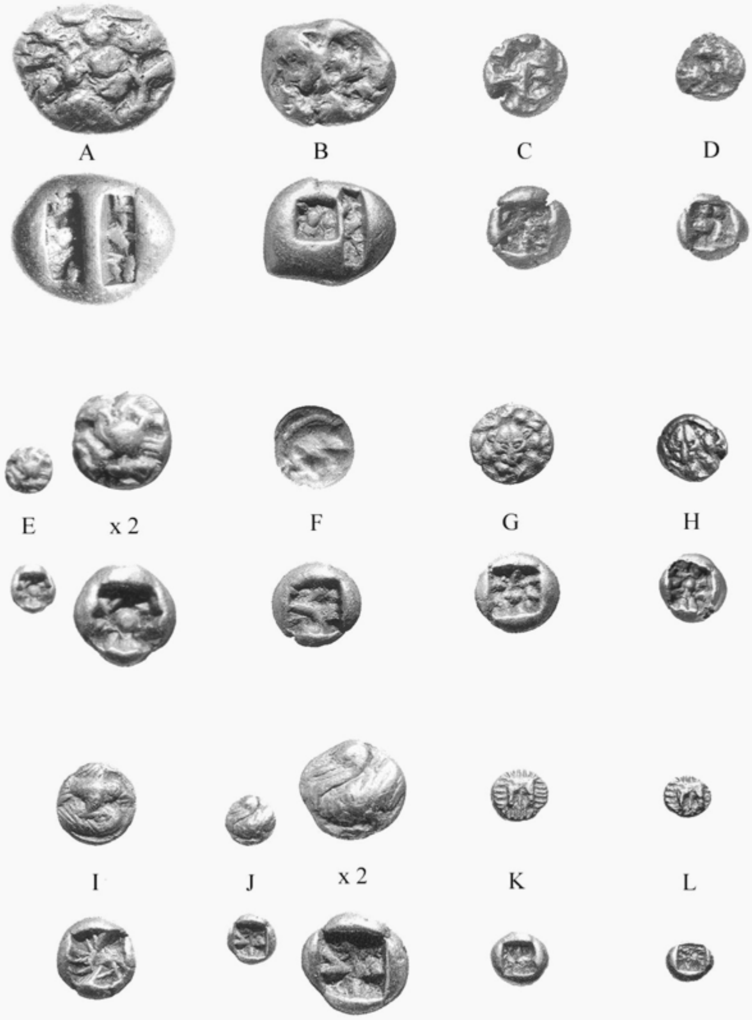

PLATE 2