REVUE BELGE
DE
NUMISMATIQUE
ET DE SIGILLOGRAPHIE

PUBLIÉE
SOUS LE HAUT PATRONAGE
DE S. M. LE ROI
PAR LA
SOCIÉTÉ ROYALE
DE NUMISMATIQUE DE BELGIQUE
AVEC L'AIDE FINANCIÈRE DU
Ministère de l'Éducation nationale
ET DE LA CULTURE FRANÇAISE
ET DU
Ministère van Nationale Opvoeding
EN NEDERLANDSE CULTUUR

UITGEGEVEN
ONDER DE HOGE BESCHERMING
VAN Z. M. DE KONING
DOOR HET
KONINKLIJK BELGISCH
GENOOTSCHAP VOOR NUMISMATIEK
MET DE FINANCIËLE HULP VAN HET
Ministerie van Nationale Opvoeding
EN NEDERLANDSE CULTUUR
EN HET
Ministère de l'Éducation nationale
ET DE LA CULTURE FRANÇAISE

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CXXIII - 1977

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SILVER AND TIN
IN THE BYZANTINE TRACHY COINAGES,
cia. 1160-1261

(Plates V-VII)

Two scenarios have been sketched for the Byzantine monetary decline and fiscal crisis in the years preceding the Fourth Crusade of 1204—a decline that was mirrored in the billon or copper trachy, which were struck in vast quantities and which, with the growing scarcity of gold, made up an increasingly large proportion of the currency. Both scenarios refer to the step-by-step debasement of the billon trachy, and are in fairly close agreement about the date of each downward step. But the two diverge sharply in their interpretations of the pre-1204 copper trachy, and of the «neatly-clipped» trachy.

According to the first version, the trachy, which in the mid-twelfth century was a coin with 6.0-7.0% silver in its composition, was reduced at the beginning of Manuel's third issue (ca. 1160?) to 4.5-6.0%. Under Isaac II (1185-95) the silver contents dropped sharply to ca. 2.5-3.0%, and possibly a little further in the reign of Alexius III (1195-1203) to 2.0-3.0% (1). Stylistically debased copies of the trachy of Manuel, Isaac, and Alexius contain roughly 0.5, 0.5, and <0.2% silver respectively, amounts which may be merely adventitious in what are essentially copper coins, struck after ca. 1195 by the Asenid tsars of Bulgaria (2). The final stage

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1) This briefly summarizes M. F. HENDY and J. A. CHARLES, *The production techniques, silver content and circulation history of the twelfth-century Byzantine trachy*, in *Archaeometry*, XII, 1970, 13-21, an excellent pioneering study on which all subsequent work has been based.

2) Results are presented and discussed in an Appendix to HENDY and CHARLES, *op. cit.*
of the Byzantine collapse was marked by the withdrawal, clipping, and re-issue of some of the circulating medium, at a date in the reign of Alexius III: these are the « neatly-clipped » trachea (3). After the Fourth Crusade, the Latin rulers of Constantinople and Thessalonica continued to mint trachea in the Byzantine tradition, but more in the style of the Bulgarian coins, and, like them, containing 0.5% silver or less (4).

According to the second version, the so-called « Bulgarian imitative » trachea are regular Byzantine issues struck under the emperors whose types they bear. They are reduced-value coins issued from ca. 1170-75 (Manuel's fourth type) onwards as an austerity coinage. Those of Isaac are relatively abundant in the war-zone of the Bulgarian frontier, which suggests that they may have been used by the Byzantine forces to pay for military provisions during the independence struggle of the Second Bulgarian Empire (5). The neatly-clipped trachea began even earlier, in the 1160's or at the latest by 1171, and they were likewise an expediency coinage of lower value, occasionally used by the government for making half-and-half payments (half in good coin) to creditors who were, presumably, in no position to argue (6). The origins of both types of debased trachea are thus interpreted as lying much closer to the events of 1171, when, after several years of worsening relations between Byzantium and Venice, Manuel carried out a coup on 12 March, arresting on one day all the Venetians who were present in his territories, and confiscating their goods. In view of the dependence of the Byzantine economy on the Italian mercantile cities, Manuel's attempt to reverse Alexius I's policy of 1082 was rash, and had later to be undone by Andronicus I (1183-5) and Isaac, by the payment of reparations (7).


(4) Hendy and Charles, op. cit., Appendix.


The neatly-clipped trachea of Alexius III are a numismatic crux. It has been argued on purely numismatic grounds that they are not ordinary coins which have been clipped down, but rather that many if not all of them were specially made by the mint in that curious fabric (8). Analyses of 6 coins, undertaken by Professor Gordus using neutron activation analysis (NAA), have been published, showing that their silver contents are markedly different from those of the normal, unclipped coins (9), and this is, of course, a weighty argument which says again that they were specially made. Professor Grierson has disputed the facts of the case, on the basis of analyses of three more specimens done for him by Dr. J. A. Charles using atomic absorption spectroscopy, which indicate that the neatly-clipped coins of Alexius are no different in alloy from unclipped coins (10). On the strength of having challenged the argument from the alloy, he dismisses also the numismatic arguments about the date of the coins, and, by implication, much or all of the second scenario sketched above. Unfortunately for his case, the original analyses made by Gordus have been checked, and have been found to be perfectly reliable.

The purpose of this article is to undertake a wider survey of the metal contents of various trachy coinages. Newly-developed equipment for X-ray fluorescence spectrometry (XRF) has permitted the non-destructive analysis of some 300 specimens (11). The results confirm and add to those obtained by destructive analysis and XRF by Hendy and Charles, and modify their conclusions in a few respects. Thus, for example, the alloy of the normal trachea of Manuel’s fourth coinage, which they quoted as

XII secolo, in Rivista storica italiana, LXXVI, 1964, p. 982-1011; Id., Studi sulle colonie veneziane in Romania nel XIII secolo, Naples, 1966. The total value of the goods sequestrated has been estimated at 400,000 hyperpyra.


(9) A. A. Gordus and D. M. Metcalfe, Neutron activation analyses of Byzantine neatly-clipped trachea of the late twelfth century, ibid., LXXXII, 1974, p. 55-56.

(10) P. Grierson, The date and fineness of Byzantine neatly-clipped trachea, ibid., LXXXIII, 1975, p. 58.

(11) The analyses were carried out by the writer at the Research Laboratory for Archaeology, Oxford, by kind permission of the Director, Professor E. T. Hall.
5-6%, has turned out to be a more complex topic, as has Isaac’s coinage, for which they gave a figure of 2.5-3.0%. For both issues, it now seems that different varieties may have differed in fineness. The neatly-clipped trachea of Isaac are also, as Gordus found, on a higher alloy-standard than 2.5-3.0%. The small amounts of silver in the reduced-value issues of Manuel and Isaac are not adventitious, as the more exact (and statistically more broadly based) XRF measurements demonstrate. The major technical advance which the new analytical equipment has made possible is the measurement of small amounts of tin. Tin was deliberately added to the alloy of the debased trachea from the 1170’s onwards. It may have been used to improve the workability of the alloy rather than as a «silver substitute». Certainly it was absent from the regular trachea up to 1204, and from the neatly-clipped trachea. But it was used after the Latin Conquest, particularly in the Nicaean Empire, but also at Constantinople. The post-1204 coinages also contained small but apparently deliberate additions of silver.

Tin is not the easiest of elements to measure in non-destructive analysis. If it occurs in combination with silver, the silver «peak» in the spectrum, at ca. 3.0 keV, overwhelms or at least merges with the tin peak at ca. 3.6 keV, making separate measurements impossible. But with the «Isoprobe», developed by Professor Hall and in use at the Research Laboratory for Archaeology in Oxford University (12), a radioactive isotope source of excitation (241 Americium), as an alternative to the traditional X-ray source, permits the measurement of spectral peaks for silver and tin at ca. 22 keV and ca. 28.2 keV. These higher energy frequencies bite more deeply into the coin’s surface, and surface enrichment is therefore somewhat less of a practical problem. Standards of known com-

(12) E. T. HALL, F. SCHWEIZER, and P. A. TOLLER, X-ray fluorescence analysis of museum objects: a new instrument, in Archaeometry XV, 1973, p. 53-78. The isoprobe is a non-dispersive instrument using a lithium-drifted silicon detector, a miniature X-ray tube, and a computer programmed as a multi-channel analyser. For information on the limits of detection, see F. SCHWEIZER, X-ray fluorescence analysis of museum objects: a new instrument and its application to the analysis of early Chinese white porcelain, in Applicazione dei metodi nucleari nel campo delle opere d’arte (Atti dei convegni Linee, XI), Rome, 1976, p. 227-245. The figure for Sn Kα, using the 241 Am source, is 0.1%, and for Ag Kα, 0.03% — although the present writer found some difficulty in distinguishing such low silver counts from background.
position, against which to calibrate the results, are not hard to find: the pennies of Queen Victoria, for example, contained 4% tin, and modern pennies contain 0.5% tin. The Royal Mint even publishes the results of quality-control assays! (13)

Even supposing the alloy standard of an issue of trachea was precisely ordered, individual coins will show a certain variation either because of imperfect mixing, or because a prolonged melt led to excessive oxidation (14), or because of a different history since loss. It is advisable, therefore, to analyse at least half-a-dozen coins of an issue, and preferably many more than that, in order to judge whether the dispersion of values approximates to a normal type of distribution. (Even where the average value was the same, the dispersions could themselves constitute evidence of differences in mint practice.) The most effective argument is one which begins by comparing two dispersions (for two different issues of coinage) and establishing that there is a statistically significant contrast between them, — as illustrated, for example, in Fig. 1.

Fig. 1. — Normal trachea of Alexius III (o) and Theodore I (x).

(14) Hendy and Charles, op. cit., p. 18.
It then remains to discuss what the numismatic significance of such a contrast might be; and even when the facts are clear, the interpretation may of course be debatable. Groups of coins from before and after 1204 will be discussed in turn below, relying upon this comparative method.

A problem which can only be partly overcome is that of surface enrichment. Important experiments by Hendy and Charles have shown that surface analysis by XRF on well-cleaned coins can still give results that are anything from 46% to 88% too high, in comparison with wet chemical analyses which are fully reliable and which have been quoted above. Experiments were made in the course of the present project, by thoroughly filing the surface layers of selected coins, from a part of the wide obverse margins which are a feature of the trachea, in order to compare the silver and tin contents of the surface and the interior (15). It was found at an early stage that thickly-patinated coins generally showed a considerable discrepancy (e.g. 40% or more), and such coins were thereafter excluded from the programme wherever possible. It should be mentioned that cleaning of thickly patinated coins sometimes raised the silver measurement. Tin readings were relatively little altered by cleaning, but were usually subject to wider margins of sampling error. Most of the specimens analysed were selected from five hoards, and had a thin, hard patina, or had been thoroughly cleaned. The hoards were:

1. The South Serbia hoard. This was the most weathered, and a higher proportion of the specimens were therefore analysed on abraded patches (16).

(15) It should be emphasized that this was a very different affair from the gentle and cautious cleaning with fine emery paper which one practises on the edge of silver coins for XRF. A coarse-cut 20 cm file was used briskly to remove 100-300μ, and the resulting surface, at the margin of the flan, was then abraded with emery paper. The coins were positioned for analysis so that they could be gradually raised, until the cleaned area at the edge of the flan just intersected the beam of radiation, as indicated by the count rate/second. Measurements were made at about two-thirds the full count rate, on an area roughly 6 mm × 4 mm.

(16) D. M. Metcalf, Classification of Byzantine Stamena in the light of a hoard found in southern Serbia (= Situla, vol. IX), Ljubljana, 1967. I have preferred to use the detailed classifications of varieties of the trachea of Manuel, Isaac, and Alexius set out there, for reasons explained in a review of Hendy’s
2. The Istanbul hoard of 1946 (17).

3. A hoard, acquired by the Ashmolean Museum in 1967 on the London market, and said to be of Turkish provenance. These coins all have a hard, thin, dark green patina (18).

4. The « Peter and Paul » hoard. The coins appear to have been stripped, possibly with sulphuric acid, but they retain a smooth, thin, brown patina (19).

5. A parcel of coins of Theodore I, probably uncleaned, as some were still dirty. Otherwise with a hard, olive-green patina (20).

Other hoards, from which smaller numbers of coins were analysed, included the « Thessaly » hoard of 1957 (21), a « Macedonian » hoard of 1959 (22), a Greek hoard of 1963 (23), and the Yenimahalle hoard (24).

A proportion of the coins were cleaned by severe filing in the way described, specimens being selected either because their surface silver contents were exceptionally high for the variety to which they belonged, or because they were obviously weathered, or because their appearance was silvery, suggesting that they might have been blanched at the mint, or cleaned in some way that would affect the surface composition. The discrepancies varied, but were mostly less than those found by Hendy and Charles, possibly because more of their coins were more weathered. The « cleaned »

work in Hamburger Beiträge zur Numismatik (forthcoming). His broader conclusions are, however, fully acceptable, and mark a great advance in our understanding of the trachy coinages of the twelfth and thirteenth centuries.


(18) To be published.


(20) I am indebted to Mr. Simon Bendall, of A. H. Baldwin and Sons, Ltd., for the loan of the hoard.


(23) Unpublished.

(24) HENDY, op. cit., p. 401. Coins from the hoard were marketed by Baldwins in 1969.
results are shown throughout the text following the surface figure for the same coin, thus: 6.0 (→ 5.0). The reader will easily form an impression of the degree of surface enrichment involved, which is generally 10-25% over the "cleaned" figure, and, hopefully, less rather than more in the case of the coins that were not cleaned. One should remember, of course, that the discrepancy may vary erratically from coin to coin. The specimens are numbered in sequence throughout the text, and the same numbering is used in the notes on provenance and in the plates. In selecting coins for illustration, an attempt has been made to include those where the style may possibly be relevant to future analytical studies.

1. **Surface silvering of Manuel's first coinage (1143 - ca. 1150)**

Roman coins of the third and fourth centuries were often silvered at the mint, most probably (as Cope has shown) by dipping them in molten silver chloride (25), to give a surface layer of fairly pure silver, a few microns in thickness. Cope noted that the same technique might have been used to "wash" Byzantine trachea with silver, but he stressed the need for metallurgical study, if false conclusions were to be avoided.

When such a layer of silvering visibly survives on trachea — and that is, not often — one can measure it non-destructively by comparative methods. First, one can focus the X-ray tube on silvery and un-silvery areas (the measured area is not much more than 1 mm$^2$) to compare the results. Secondly, one can compare X-ray tube measurements of silver, using the L line at ca. 3 keV, with isotope measurements, using the K line at 22 keV. The former derives half the fluorescent radiation from the first 5 microns or so of the coin's surface, whereas the latter bites deeper — half the radiation comes from the first 35 to 40 microns thickness (26), and the effective penetration extends to 60 μ (27). The difference between the two will reflect both surface enrichment, i.e. weathering,

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(26) J. Condamin and M. Picon, *Changes suffered by coins in the course of time and the influence of these on the results of different methods of analysis*, *ibid.*, p. 49-66, at p. 56.

and also any official silvering, whereas the spot checks with the X-ray tube will to some extent discount weathering.

Two coins of Manuel's first coinage from a Macedonian hoard, with rich, bright silvering in the recessed parts of the design were analysed at half-a-dozen different places on obverse and reverse. Silvery patches gave readings consistently over 15%, and up to 24%, while the hard olive-green patina of the unsilvered surface gave 9-10% (28). Isotope measurements on unsilvered areas gave 7.5-9.5%. The discrepancy is not dramatic, but it probably results from a very thin silver chloride « wash ». A third coin, not from the hoard, gave similar results. A series of readings through the silvery surface of the emperor's face and chest, at intervals of ca 1 mm, revealed much local variation: 18%, 13.5%, 14.5%, 20%, 10%, in that order. The 3.0 keV results, on unsilvered and silvered areas, are shown below in brackets. The degree of surface enrichment may be judged by a comparison with the chemical analyses of Hendy and Charles, who found 6-7% silver. This result was repeated on a cleaned patch on the third coin, where 6.5% silver was measured.

Variety A: 7.4 (9.5/18.5), 8.5 (10 → 6.5/20) [1-2]
Variety B: 9.2 (8/24) [3]
1, 3, Macedonian hoard. 1-3, Collection of DMM.

Coins of John II may be seen with visible silvering. Whether the practice was continued in Manuel's second coinage remains to be determined.

2. Manuel's third coinage (ca. 1160-70): normal and neatly-clipped trachea

The four chemical analyses published by Hendy and Charles showed silver contents for this type of 5.5, 4.9, 4.6, and 4.5%. They suggested a range of 4.5-6%, which is repeated by the analyses (cleaned values).

The neatly-clipped coins give marginally higher values — 5.5-6.5%. A much larger number of specimens would be needed to confirm the contrast, which, although surprising, certainly recurs in later types.

(28) The figure of 24%, for example, will be an average deriving from a thin layer of good silver, and an underlying layer of baser metal.
Tin was present in the surface layers of no. 9 (ca. 0.5%) and perhaps also in no. 8 (0.2%) but absent or virtually absent in the remaining coins.

Single cross: 6.8 (→ 5.4)

Patriarchal cross: 7.9 (→ 5.4), 7.2 (→ 6.3), 7.1 (→ 5.8)

Neatly-clipped: single cross: 6.5

—: patriarchal cross. 7.5 (→ 5.7), 7.2 (→ 6.5), 7.2 (→ 6.1), 6.7 (→ 6.2)


3. Manuel's fourth coinage (ca. 1170-80): normal and neatly-clipped trachea

The classification of varieties within the fourth coinage is determined by the number of dots on the emperor's loros, and the version of it that has been used is summarized for convenience in Fig. 2.

<table>
<thead>
<tr>
<th>Variety</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Single cross</td>
</tr>
<tr>
<td>B</td>
<td>Single cross with three dots</td>
</tr>
<tr>
<td>ii ii</td>
<td>Single cross with two dots</td>
</tr>
<tr>
<td>iii</td>
<td>Single cross with one dot</td>
</tr>
<tr>
<td>iv</td>
<td>Single cross with one dot and a small cross</td>
</tr>
<tr>
<td>C i</td>
<td>Patriarchal cross</td>
</tr>
<tr>
<td>C ii</td>
<td>Three dots at shoulders</td>
</tr>
<tr>
<td>C iii</td>
<td>Three dots at shoulders</td>
</tr>
</tbody>
</table>

Fig. 2. — Classification of Manuel's fourth coinage (Situra, vol. IX)

From the rather limited number of normal trachea available for analysis, it nevertheless seems clear that the issue was not on a uniform alloy-standard. Variety B, as was pointed out in the study of a South Serbian hoard (29), was often heavily worn, and many specimens (unlike the other varieties) showed traces of silvering. Measurements with the X-ray tube at 3 keV on a coin of characteristic colour (no. 17) were ambiguous: the figures at intervals of ca. 1 mm across the reverse design were 14, 17.5, 13, and 12.5% silver. On another coin (no. 15), two readings of 13% were obtained. No clear evidence was forthcoming, therefore, of deliberate silvering such as appears to have been practised during the first issue, although the coins of variety B may have been heavily silvered.

(29) Metcalf, op. cit., note 16.
blanched. On cleaned surfaces the silver contents fall to 7-9%.
Even so, one may conclude that the intended silver contents of
variety B were higher than any of the other varieties. B is on a
different (and lower) weight standard — but still amounting to a
higher intrinsic value — and it apparently marks an attempt to
return to the alloy-standard of Manuel's second coinage, an at­
ttempt that was in due course abandoned. Hendy's classification
conflates varieties A and B (his Ac and Aa plus b).

B : (ii) 11.5 (→ 9.0), 11.2 (→ 9.1). (ii-iii) 9.9 (→ 8.5),
10.2 (→ 6.9).
Ci : 6.8 (→ 5.4), 5.5, 5.1. Neatly-clipped : 9.75 (→ 6.6), 5.65
Ci : 6.3, 5.1 (→ 4.9). Neatly-clipped : 7.6 (→ 5.9), 7.0
(→ 5.7).
Civ : 8.2 (→ 7.1), 7.2, 4.9

We should briefly examine, if only to reject, the idea that the
sequence of the third and fourth coinages might be reversed, —
which would make B a direct continuation of the alloy-standard
of the second coinage, and would account for Hendy and Charles's
observation that the silver contents of the fourth coinage are higher
than those of the third. The Bulgarian hoards seem not to offer
any useful evidence for the correct sequence, and indeed Hendy
quite properly made it clear that his choice of an order was based
mainly on the relative abundance of the fourth type. The one
broad argument upon which a case may rest is that the design of
the third issue was not repeated in an expediency coinage.

The date of the attempted reform associated with variety B is
uncertain. There are attractions to seeing it as an outcome of
the events of 1171.

Bi, with a star-pattern on the loros, may turn out on the evidence
of a larger number of analyses to be of slightly better silver than
Bii-iii. The same may be true of the proposed sequences A-Cii
and Civ-Cii (proposed for the South Serbia hoard), as the figures
now published seem to imply. But one will wish to suspend judg­
ment on a question which involves both the detailed numismatic
arrangement of the coins, and also relatively small differences in
their alloy. The problem is a delicate one, but it is perhaps worth
drawing attention to it, since the numismatic consequences would be very interesting if the hypothesis could be sustained.

The neatly-clipped coins fall within the same percentage limits as the normal coins, and it would seem, therefore, that for both denominations, leaving variety B on one side, the alloy ranged from 8% down to 5% (→ ca. 6.5% down to ca. 5%). The range of «cleaned» values corresponds closely with the chemical analyses published by Hendy and Charles, namely 6.2-5.1%.

Tin occurs in roughly half the coins in amounts up to ca. 0.1%, but was below the level of detectability in the rest.

4. Manuel’s fourth coinage: reduced-value trachae

The silver contents of the expediency coinage were reduced from 6.5-5% down to ca. 1.6%, and tin was deliberately added to the alloy, in amounts of around 0.8-1.0%.

There is a good deal of variation in the weight, and even more obviously the size, of the coins. The specimens analysed include several of the smaller module from Greek hoards, and others of the larger size from the Turkish hoard. The latter contain, on average, slightly more silver, but there is nothing which at present would amount to evidence for two different alloy standards. (Hendy and Charles published readings of 4.00% Ag (from a heavily corroded coin) and 1.68%, and postulated from them an original alloy of ca. 0.5%, but this figure is decidedly too low. The weight of each coin is given first, followed by its silver/tin contents.

3.67 g, 1.9/1.0 ; 3.60 g, 1.5/0 ; 3.32 g, 1.7/0.6 ; 3.18 g, 1.9/1.3 ; 3.02 g, 2.05/1.4 (→ 1.55/0.3) ; 2.91 g, 1.8/0.7 ; 2.86 g, 3.6/1.4 (→ 3.6/2.1).

3.98 g, 1.75/0.9 ; 2.59 g, 1.75/0.75, with a trace of zinc ; 2.5 g, 1.3/0.4 (→ 1.2/0.3) ; 2.49 g, 0.9/0.3 ; 2.47 g, 1.5/0.45 ; 2.18 g, 1.4/1.5, trace of lead ; 2.14 g, 1.4/1.2 [41-47]
43, 45. From a Macedonian hoard.

5. Andronicus I (1183-85)

The XRF analyses are comparable with the published chemical analyses of 5.4 and 4.6 (30). As the reign was short, and was marked by an attempt to renew the trachy coinage and rid it of abuses,
one would guess that there was a single alloy-standard, of around 4.5 to 6.0 %, perhaps the same as that which had been used for Manuel's third and fourth coinages. The 1.5 % range found among Andronicus's coins offers a common-sense warning against too readily detecting significant variation in other issues.

7.2 (→ 6.2), 5.8, 4.9, 4.9.

48. S. Serbian hoard. 49. DMM. 50. Goodacre.

6. Isaac II (1185-95): normal and neatly-clipped trachea

Isaac reduced the alloy standard, although not as sharply as has been supposed. His trachea of varieties A-E (see Fig. 3) are on a weight-standard of ca. 3.6-3.7 g, while F and the reduced-value coins weigh ca. 2.9 g. Variety G, which averages 3.4 g, is problematic, and shows signs of including the same two weight-standards.

There can be no doubt that more than one alloy-standard was in use. Varieties A-E contain 4-5% silver, F contains 2.5-3.5%,

\[
\begin{array}{c}
\text{A-E} \\
\text{F} \\
\text{G (over 3 g)} \\
\text{G (under 3 g)} \\
\text{Neatly-clipped, F} \\
\text{—, G.} \\
\end{array}
\]

\[
\begin{array}{c}
5.9 \ (\rightarrow 5.1), \ 5.3 \ (\rightarrow 5.2), \ 5.9 \ (\rightarrow 4.8), \ 4.8, \ 4.7, \ 4.0 \ (\rightarrow 3.95), \ 3.5. \\
4.4 \ (\rightarrow 3.5), \ 3.3, \ 2.8, \ 2.7 \\
4.6 \ (\rightarrow 4.2), \ 3.7 \ (\rightarrow 3.4), \ 3.4 \\
3.7 \ (\rightarrow 2.9), \ 3.6 \ (\rightarrow 3.2), \ 3.2 \ (\rightarrow 3.1), \ 2.7 \ (\rightarrow 3.0), \ 2.7 \ (\rightarrow 2.9) \\
5.6 \ (\rightarrow 4.7), \ 4.7 \ (\rightarrow 4.1), \ 4.7 \ (\rightarrow 3.7), \ 4.3 \ (\rightarrow 2.8), \ 3.6 \\
3.3 \\
\end{array}
\]

52, 55, 58, 66. DMM. 53-55, 59, 64. S. Serbia hoard. 58. This low value is from a coin of low weight, P. 16 (2.7g), which is however a die-duplicate of a coin weighing 4.1g. 63. S. Serbia hoard, on a large flan, 4.20g. 64. Star-pattern on loros. 65, 69-70. Thessaly hoard, 1957.
and the lighter coins of G contain ca. 3%, while the heavier specimens of the same variety seem to be slightly better (3-4%).

These results are obviously difficult to interpret with any confidence: more analyses will be required in order to confirm or modify the pattern and to give precision to the figures for the ranges of silver contents. The numerous published hoards (31) give no encouragement to suppose that varieties A-E (= Hendy var. A) are early; there are on the other hand two or three hoards which suggest that F might be late (32). So it seems that two alloy-standards may have been in use concurrently, quite apart from the lower standard of the reduced-value trachea (see below).

The neatly-clipped coins of variety F from the Istanbul hoard were re-analysed after thorough abrasion, after it had been noticed that they were so different in their silver contents from the normal coins of the same variety. Removal of the surface layers failed to reduce them to the 2.5-3.5% standard, and the facts thus strongly suggest that some neatly-clipped coins (like those of Alexius III) were specially minted, on a higher alloy-standard.

Isaac's coins contain even less tin than Manuel's fourth issue — less than 0.1%. Such traces are probably adventitious.

7. Isaac II: reduced-value trachea

2.6/0.6 (→ 2.2/0.65), 2.0/0.9, 1.8/1.0, 1.8/0.95, 1.7/1.5, 1.6/0.7, 1.5/1.0, 1.5/0.9, 1.1/0.4, 1.0/0.3, 0.95/0.4 [77-87]

77-8, 81. DMM. 79-80, 83-6. Turkish hoard. 81. Thessaly hoard.

The silver and tin contents of the reduced-value trachea match those of Manuel well, and one may postulate a similar standard of ca. 1.6% silver and 0.8-1.0% tin.

8. Alexius III (1193-1203): the normal trachea

The detailed stylistic classification of Alexius's trachea is exceptionally difficult, and no finality is claimed for the preferred scheme, which is summarized in Fig. 4. Varieties A and B are heavier than C-F, but their alloy-standard is not obviously any better. The great majority of the specimens analysed, of whatever

(32) E.g. the Kaloyannovets hoard, and one published by M. D. O'Hara in Coin Hoards II/326.
variety, show silver contents distributed quite closely around a modal value of ca. 2.2%. One may guess at a «cleaned» value close to 2%. The few exceptions include two particularly heavy, deeply scyphate specimens of variety A, with «cleaned» silver contents of over 3%, and also examples of varieties B, D, and F, with 2.5-3.0% silver.

Fig. 4. — Classification of the Trachy of Alexius III (Silula, vol. IX).

The 2% standard is clearly lower than any standard found under Isaac. This indicates a deliberate reduction by Alexius; and it also seems to preclude the possibility of attributing any coins of Isaac to his second reign (August 1203 - January 1204).

A 3.9 (→ 3.2), 3.6 (→ 3.3), 2.2, 1.9 (→ 2.4) [88-91]
B 3.1 (→ 2.8), 2.3 (→ 2.2), 2.1, 2.1, 1.9, 1.8 [92-97]
C 2.5 (→ 2.1), 2.5, 2.4, 2.1, 2.1, 1.6 [98-103]
D 2.6 (→ 2.5), 2.2, 1.7 [104-106]
E 2.4 (→ 1.8), 2.3, 2.0, 1.9, 1.9 [107-111]
F 2.8 (→ 2.6), 2.8, 2.3, 2.2, 2.1, 2.1 [112-117]
Irregular. 1.9 [118]

88. 4.30g. 89. 4.19g. Goodacre. 92,95. S. Serbia hoard. 98. Thessaly hoard, 1957. 105, 111. Turkish hoard.

9. Alexius III: the neatly-clipped trachea

The neatly-clipped coins from the Istanbul hoard form a group with quite different silver contents from the normal coins, as may be judged from Fig. 5. It is unfortunate that the facts should have been mistakenly disputed. The neatly-clipped coins that Charles analysed by atomic absorption spectroscopy matched the normal coins more closely (33). There was at least one coin in the

(33) They were not, however, from the Istanbul hoard. Professor Grierson has been good enough to look again at the remaining portions of the three coins of Alexius III analysed by Dr. Charles, and he writes, in a letter of 1 January 1977, «I checked before leaving Washington, and find that they were all ex Bertelè. They were also, to judge by the very different colours of their surfaces, from three separate finds. »
Istanbul hoard of which the same was true, and two other coins in the Ashmolean Museum were similar — possibly because they were in fact normal coins that had subsequently been clipped.

Fig. 5. — Silver contents of the normal (o) and neatly-clipped (x) trachea of Alexius III.

The six coins that were illustrated in 1974, from among those analysed by Gordus and the writer using NAA, have each been carefully re-analysed by XRF in at least six different places on the flan, three on the reverse and three on the obverse. The results suggest that Gordus's results, in spite of his disclaimer, were essentially correct and reliable (34). Certainly, any inaccuracies which the figures may embody did not and do not affect the statistical contrast between the Istanbul coins and the normal trachea of Alexius. Nor is there any reason to think that the deceptive effects of surface enrichment or of deliberate surface silvering could alter this judgement.

(34) Grierson was badly advised by Gordus, in a letter of 21 September 1974, of which Professor Grierson was good enough to provide me with an extract. Gordus pointed out that the results on the neatly-clipped coins were obtained in early days of the development of the NAA technique, that the curved fabric made accurate measurement difficult, and that « a re-evaluation of the various data for the 15 coins will probably result in the data for the later coins being decreased, bringing them more into line with the chemical analysis data. »
The two sets of results for the six coins are as follows:

<table>
<thead>
<tr>
<th>Manuel</th>
<th>NAA</th>
<th>XRF</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>5.3</td>
<td>6.0</td>
<td>+0.7</td>
</tr>
<tr>
<td>5</td>
<td>5.4</td>
<td>5.7</td>
<td>+0.3</td>
</tr>
<tr>
<td>6</td>
<td>5.8</td>
<td>7.0 (→ 5.7)</td>
<td>-0.1</td>
</tr>
<tr>
<td>Alexius</td>
<td>10</td>
<td>3.5</td>
<td>+0.4</td>
</tr>
<tr>
<td>13</td>
<td>5.6</td>
<td>5.3 (→ 5.4)</td>
<td>-0.3</td>
</tr>
<tr>
<td>14</td>
<td>4.6</td>
<td>5.0</td>
<td>-0.1</td>
</tr>
</tbody>
</table>

The silvery appearance of some of the coins has been commented upon in discussions of the hoard. No. 128, which was unusually silvery in appearance, was analysed for surface silvering, with the X-ray tube, a series of measurements being made at intervals of ca 1 mm across the face. The results were unexpected: the tin peak, at ca. 3.6 keV, was higher than that for silver, and silver readings of up to ca. 20% were obtained. Another slightly silvery coin, no. 129, showed at most 7.5% silver.

The other specimens analysed by Gordus were not easily available for re-analysis; but a better statistical basis for the comparison of Alexius's coins is provided by 7 further coins from the Istanbul hoard, and two others also in the Ashmolean Museum. The illustrations show coins with no obverse legend, and also coins with irregular arrangements of dots on the emperor's loros — one coin with only three dots at the shoulders, another with as many as six dots on the chest, and others with unusual cross- or star patterns on the stomach.

With obv. legend. 5.8 (→ 5.7), 5.0, 3.3, 2.9, 2.7, 2.4 [119-124]
Without obv. legend. 6.0, 5.3 (→ 5.4), 4.7, 6.4 (→ 4.6), 4.5, 4.5 [125-130]

119-121, 123, 125-30. Istanbul hoard. 120. Gordus: 4.6% 121. Gordus: 3.5% 122. Evans bequest. 123. From its appearance, this coin could have been clipped after issue. 124. Turkish hoard, possibly clipped after issue. 126. Gordus: 5.6% 128. This coin has a distinct silvery appearance, caused, it would seem, by a silver/tin wash. 129-30. DMM.

10. Alexius III: reduced-value trachea

The silver contents fall sharply to 0.2% in Alexius's reduced value trachea, although generous amounts of tin are still added to the alloy. Some of the specimens of Greek or Balkan provenance might be imitations minted after 1204, but it need not be doubted that those from the Turkish hoard are really coins of Alexius.
Turkish hoard: 0.27/0, 0.23/0.8, 0.19/0.6, 0.17/1.0, 0.11/0.3, 0.10/1.6 [131-136]
Greek provenance: 0.13/1.1, 0.13/0.2, 0.12/1.6 [137-139]
Peter and Paul hoard: 0.2/1.0, 0.17/2.5, 0.1/0.8, 0/0.2 [140-143]

140. Loros type D, 2.1g. 141. NC 1973 pl. 8, 9. 142. Distinctive style, pl. 8, 11. 143. Similar to 142, but not from the Peter and Paul hoard.

11. Isaac, Usurper in Cyprus, 1184-91

Two specimens of Type A (Hendy, pl. 19, 6-7) were found to contain a similar amount of silver to the coins of Alexius III, and no tin.

Type A: 2.2/0, 2.2/0 [144-145]

12. Theodore Mangaphas, Usurper in Philadelphia, 1189-90

A coin that is probably attributable to Theodore was found to contain negligible amounts of silver and tin. Iordanov has published hoard-evidence which proves that the issue dates from before 1195. 

0<0.1 [146]


Fifteen large-module coins from a single hoard were analysed: they are of the type showing Theodore with St. Theodore. The average weight was close to 4 g for both the main varieties, namely with \( \checkmark \) or with \( \checkmark \) on the emperor's chest. In addition, a specimen of the second coinage, visibly restruck on a first-coinage flan, was analysed. Two coins, which may possibly be early, contain over 1% silver. The remainder fall in the range 0.1-0.4%. The coins marked \( \checkmark \) are apparently rather better than those with \( \checkmark \); but there is no correlation between silver contents and weight. Variable amounts of tin occur in the alloy — from 0 to over 2%, with an average of 1.1%. Until 1204, tin had not been used in the "normal" trachea.

\( \checkmark \) on chest 1.6/0.4, 1.2/0.8, 0.38/1.4, 0.35/1.1, 0.3/2.1, 0.24/1.4, 0.15/1.4, 0.14/1.0, 0.13/1.0 [147-155]

\( \checkmark \) on chest 0.3/0.4, 0.25/2.5, 0.25/0, 0.2/1.0, 0.15/1.5, 0.15/1.0 ; 0.15/1.1. [156-162]

162. Restrike.
14. Theodore I: first coinage of the Nicaea mint: reduced-value trachea in the Turkish hoard

The group of coins of this type from the Turkish hoard weigh much less — 2 to 3 g instead of 4 g — and are, with one or two exceptions, obviously inferior in style. They seem to be analogous to the reduced-value trachea from before 1204. The numismatic analysis of the results is problematic, but it is suggested that one should distinguish a group of presentable coins, with silver contents of 0.1 to 0.2% and low tin contents, from other specimens of inferior style and very variable alloy, sometimes with high tin contents, which may well not be official Nicaean coins. This interpretation is to some extent confirmed by the analyses of small-module coins ostensibly of Theodore from Greek hoards (section 15).

Better style. 0.16/1.4
Inferior style, generally over 2 g. 0.2/0.18, 0.2/0.4, 0.15/<0.1, 0.12/0.17, 0.14/<0.1, 0.10/<0.1, 0.1/0.15
Poor style, variable size, but generally small and light. 0.25/1.7, 0.15/1.3, 0.14/0.8, 1.1/0.3, <0.1/<0.1, <0.1/<0.1, 0.12/0

163. This coin weighing 3.38 g, it is suggested, is a « normal » trachy belonging with those in section 13.

164. ... on chest. One would have said « normal » style; but the weight is only 1.98 g. 165. 3.05 g. Details indistinct.

Irregular flans and low weights are characteristic of coins from Greek hoards, and it is difficult to suppose that their metal contents are compatible with their having been struck in the same mint as Theodore’s official coinage.

Thessaly hoard, 1957 0.08/0.3, 0/0
Greek hoard, 1963 0.4/0.6, 0.08/<0.1, 0/<0.1, 0.3/0
Other sources 0.25/2.5, 0.25/0.6

178. 2.08 g. 179. 0.6 g. 180. 2.83 g. 181. 2.71 g. 182. 2.50 g. 183. 2.21 g. 184. 2.62 g. 185. 3.31 g. 178-185. DMM.

Arrangements of dots on the emperor’s loros are sometimes unusual and at least two specimens show Theodore with a round instead of a forked beard.
16. Theodore I: second coinage of the Nicaea mint

This type is rarely found in Balkan hoards, nor does it occur in a small module. It therefore offers a useful control on the numismatic interpretation of the first coinage (paragraphs 13-15). All the specimens analysed are from the Turkish hoard. The silver contents lie in the range 0.2 to 0.4%, as compared with 0.1 to 0.4% for the first coinage. There is no significant contrast in the tin contents, except that the distribution of values in the second coinage is more compact — 0.5 to 1.5%. There is no obvious sign of any correlation between alloy and weight or details of the design.

0.42/1.2, 0.36/0.6, 0.33/0.55, 0.27/1.0, 0.26/0.53, 0.25/1.0, 0.23/1.5, 0.22/1.3, 0.21/1.2, 0.21/0.9, 0.20/0.45, 0.17/0.6 [186-197]

17. The Nicaean Coinage at Magnesia

Six small coins from the « Peter and Paul » hoard, of Theodore I and John III, contain 0.1-0.2% silver, with very variable amounts of tin. A large-module coin attributed to Theodore II is on a much superior standard, with ca. 2.5% silver. The analysis of more large-module coins is a desideratum.

<0.1/0.1, 0.12/0, 0.2/1.8, <0.1/0.2, 0.18/<0.1, 0.18/1.1 [198-203] 2.7/0.3 [204]


18. Latin Emperors of Constantinople: Types A-C

The three early types A, B, and C each occur in large and small modules. Not enough specimens of B and C were available for a proper study, which remains to be undertaken.

Type A was the last substantive issue of trachea to contain worthwhile amounts of silver, and this may help to explain the vogue it enjoyed. There were two different alloy-standards, one for the large module, and the other for the small coins, which were presumably analogous to the pre-1204 reduced-value trachea, although it may be merely that the small-module coins available for analysis were almost all a few years later in date.

Large module: 1.3/0.9, 1.3/0.8, 1.3/0.6, 1.3/0.4, 1.2/0.6, 1.1/0.5 [205-210]
Small module: 1.1/0.3, 0.8/0.6, 0.8/1.0, 0.7/0.5, 0.7/0.5; 0.7/0.3, 0.6/0.5, 0.4/0.3, 0.3/1.2


The tin contents of the larger coins are in the range 0.5-1.0%, while those of the smaller coins are marginally lower.

Type B contains very much less silver, and there seems to be no significant difference between the two modules.

Large module: 0.17 (→ 0.18)/0.3, 0.15/<0.1, 0.1/1.2
Small module: 0.17/0.2, 0.17/<0.1, 0.12/0

Very small module: 0.28 (→ 0.27)/0.5

Hendy and Charles found <0.20, 0.22, and 0.24% silver in three large-module coins of this type from the Yenimahalle hoard. The tin contents are in general much reduced, compared with type A.

Type C perhaps matches B.

Small module: 0.1/0
227. Peter and Paul hoard. NC, plate, 10,68.

19. Latin imitative coins attributed to Thessalonica

Types A and B, and their small-module equivalents D and E, belong closely together, and begin to appear in Balkan hoards quite early in the thirteenth century. Types C and small-module F, the Hagioconstantinata, are less common in hoards and possibly rather later in date. The alloy is somewhat variable, but averages about 0.25% silver, and a similar proportion of tin. Hendy and Charles analysed six specimens of Type A from the Yenimahalle hoard, and found 0.30, 0.31, and 0.20% silver on heavily corroded coins, and 0.23, <0.20, and <0.20% on cleaner coins. Compare, however, no. 228, where filing increased rather than lowered the silver reading.

A. 0.32 (→ 0.41)/0.2, 0.15/0
Small-module D. 0.25/0.4, 0.25/0, 0.15/0.1, 0.1/<0.1, <0.1/0.2
B and 0.5/0.2, 0.3/0.2, 0.3/<0.1, 0.23/0.35
Small-module E 0.17/0.7
C 0.1(<0.1)/<0.1
Small-module F 0.45/0.3, 0.3/0.6
240. DMM. 241-2. Peter and Paul hoard, pl. 10, 79 and 78.

20. Types D-U: Constantinople or Bulgaria?

The attribution of this long series of types, in two modules, remains problematic. Types D, O, and P, which the hoards suggest may be early, certainly afford a contrast with all the other types as regards their alloy. They contain 0.25 to 0.5% silver, whereas the remaining types are quite consistently in the range 0.1 to 0.2%. It is reasonably certain that Types T and U are late, and one may therefore conclude that there was no significant decline in the alloy.

The tin contents are variable but generally low — ca. 0.25% or less. If Types E/K and F contain rather more tin, it may be that a reduction in the silver contents at that moment was compensated by an increase in tin contents. But more analyses are needed.

In terms of their alloy, Types D, O, and P do not follow on from Constantinopolitan Types B and C, which contain distinctly less silver. There might, of course, have been a deliberate improvement at the Constantinople mint. It seems preferable to think, however, guided by the hoard-evidence, that D marks the beginning of a separate series.

The question again arises whether such small amounts of silver as 0.1–0.2% are not merely adventitious. The contrast between D, O, and P and the remaining types argues against such an interpretation. If it seemed reasonable to the authorities to add ca. 0.3% silver to the coinage metal, one can better understand a subsequent decision to halve that amount, and add only ca. 0.15%. If the silver in Types E/K-U were adventitious, it might be present either because there were traces of silver in the copper ores from which the coins were being made, or because the recovery of silver from the older trachea that were being melted down was incomplete. In the first case, the traces would be more variable, and it would be difficult to explain the contrast between Types D, O, P, and the rest. In the second case, analytical experience with late Roman coins suggests that a better recovery rate would be possible, and that the coins would mostly contain less than 0.1%
silver (35). But the figures are uncomfortably close to the lower limit of detectability for the isoprobe, and further research, using a more suitable analytical technique, would be in order.

\[
\begin{array}{l}
D & 0.31/0.2, 0.29/0.1, 0.26/0.1, 0.26/0.1,\cr & 0.25/0.1, <0.1/0.2 \\
O & 0.42/0.1, 0.32/0.35, 0.31/0.7 \\
P & 0.5/0.1, 0.38/0.27, 0.37/0.1, 0.25/0.2, \\
& 0.23/<0.1, 0.20/<0.1 \\
E/K & 0.16/0.25, 0.13/0.5 \\
F & 0.23/0.25, 0.23/0.25 \\
G & 0.21/<0.1, 0.08/0.2 \\
H & 0.13/0.1, 0.1/0.25 \\
J & 0.14/0.2, 0.11/0.3, <0.1/0.1 \\
Cat. 168-176 & 0.19/0.3, 0.11/0.25 \\
N & 0.17/<0.1, 0.12/0.7 \\
Cat. 193-205 & 0.2/0.5, 0.16/0.25, 0.15/0.35, 0.14/0.38 \\
R & 0.17/0.3 \\
S & 0.12/<0.1 \\
T & 0.18/0.3, 0.15/0.2, 0.13/0.2, 0.13/0.1, 0.11/0.1 \\
U & 0.18/0.25, 0.14/0.2 \\
\end{array}
\]

21. The Byzantine mint of Thessalonica, 1224-61

Byzantine rule was restored in Thessalonica in 1224 by Theodora, who proceeded to strike coins of very careful workmanship and on an improved alloy-standard of ca. 0.5% silver, with ca. 0.5% tin. They afford another argument against interpreting the small amounts of silver in the thirteenth-century trachy coinages as adventitious. Some at least of the coins of Manuel Comnenus-Ducas (1230-37) are on the same alloy-standard of ca. 0.5% silver, but others show a decline to 0.2-0.3%, a trend which continues under John Ducas (1237-44).

When John III took control of Thessalonica in 1246, he struck coins on a similar standard, which are rather better than the small coins he minted at Magnesia.

Theodore, Type A 0.5/0.6, 0.5/0.45, 0.4/0.7  [286-288]
- Type G 0.7/0.4  [289]
Manuel, Type A 0.5/0.1, 0.28/0.5  [290-291]
- cf. Type C 0.22/0.5  [292]
- Type G 0.26/0.2  [293]
John, Type F (small) 0.18/<0.1  [294]
- Type H (small) <0.1/0.25  [295]
John III, Type A 0.3/0.1, 0.25/0.2  [296-297]
- Type B 0.4/0.8  [298]
- Type G 0.3/0.6  [299]


22. Bulgaria under Ivan Asen II and Constantine Asen

The western or Macedonian coinage of Ivan Asen (1218-41) is perhaps on the alloy-standard then in use at the Thessalonica mint. 0.34/0.25  [300]

300. Hendy pl. 46, 10-11.

Constantine Asen (1257-77) apparently revived a similar standard for his «horseman» coinage, but then struck trachea, with his standing figure, which contained little or no silver.

Horseman 0.4/0.6  [301]
Standing figure <0.1/0  [302]


Summing up. The pressure on rulers’ ability to strike good coinage was compounded, as ever, of an underlying economic imbalance, and of unforeseen needs for expenditure, generally for military purposes. The debasement of the trachy was kept within perfectly respectable limits until the death of Andronicus, although expediency is manifested already from ca. 1170 in the use of tin in the alloy of lower-grade silver coins. Isaac’s need for revenue, announced in 1185 by his marriage-tax, led to further debasement, and to the complexities of trachea minted on different alloy-standards. Alexius III succeeded in curbing that abuse as regards the normal trachea, although he retained a separate standard (as Isaac had done) for the neatly-clipped coins.
After 1204 the shortage of silver rapidly became acute. The Constantinople large-module type A, which is the earliest issue, contained ca. 1.2%, as compared with Alexius's 2.2%. Within perhaps five or six years, the small-module equivalent contained only ca. 0.6%, and in at most another decade, coins were minted containing only about a quarter of one per cent silver. Such very small traces have hitherto been regarded as adventitious, but it seems that they were in the alloy intentionally — perhaps as a political gesture of good faith, or perhaps merely because people could not rid their minds of the conservative belief that trachae ought to contain some silver. The clearest evidence of intention is provided by the coinage of Theodore of Thessalonica, who succeeded in restoring a better alloy-standard for his coinage: a good half of one per cent. That he should have set his sights no higher is a measure of the monetary difficulties of the time.

Theodore of Nicaea struck trachae of two categories, in very different styles and with different metal contents, which seem to correspond to the twelfth-century tradition of parallel issues of normal and reduced-value trachae; if this interpretation is correct it is an aspect of the evidence which supports the second scenario of monetary decline mentioned above.

Even the tin content of the coins fell to trifling proportions, a further indication of monetary impoverishment. One might have imagined, incidentally, that analyses of the tetartera of the thirteenth century would solve the argument about adventitious traces of silver, since they might be assumed to be copper coins. But they are not: they are ceremonial tetartera (continuing a tradition from the twelfth century) (36), struck no doubt for purposes of largesse, and those of Theodore for example are of the same alloy as his trachae.

Other attempts were made to strike substantive issues of better trachae, in particular for Types D, O, and P, which stand at the beginning of a series of debateable attribution; and for the western coinage of Ivan Asen II of Bulgaria, and the trachae struck at Tryovo by Constantine Asen. There may also have been some ceremonial issues of trachae with higher silver contents, but they would of course have been minted only on a very small scale.

(36) D. M. Metcalf, The tetartera in the twelfth century, forthcoming.
Byzantine Thryph Coinage
BYZANTINE TRACHY COINAGE
Byzantine Trachy Coinage