

Studia Iranica

Tome 29 - 2000

PUBLIÉ PAR L'ASSOCIATION POUR L'AVANCEMENT
DES ÉTUDES IRANIENNES

AVEC LE CONCOURS
DU CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE

ISSN 0221-5004

*La revue STUDIA IRANICA est publiée, en deux fascicules annuels, par
l'ASSOCIATION POUR L'AVANCEMENT DES ÉTUDES IRANIENNES,
c/o Institut d'Études iraniennes, 13 rue de Santeuil, F-75005 Paris.
Télécopie (33 1) 45 87 41 70.*

Direction de la revue

MM. M. BAZIN et R. BOUCHARLAT

Comité Scientifique International

MM. C.-H. de FOUCHÉCOUR, B.G. FRAGNER, Gh. GNOLI,
J. KELLENS, G. LAZARD, N. SIMS-WILLIAMS, M. TARDIEU

Comité de rédaction

M. Ch. ADLE, M^{me} D. AIGLE, MM. M.A. AMIR-MOEZZI,
P. BERNARD, J. CALMARD, Ph. GIGNOUX, Fr. GRENET, P. LECOQ,
A.S. MELIKIAN-CHIRVANI, F. RICHARD, Y. RICHARD

Rédaction

M^{me} M. SZUPPE
studia@ivry.cnrs.fr

Toute correspondance avec la rédaction doit être adressée à :
M. Marcel BAZIN, C.N.R.S., 27 rue Paul Bert, F-94204 Ivry s/Seine,
Télécopie (33 1) 45 21 94 19

ou

M. Rémy BOUCHARLAT, Maison de l'Orient, 7 rue Raulin, F-69007 Lyon
Télécopie (33 4) 78 58 01 48
<Remy.Boucharlat@mom.fr>

THE PROCESSING OF GOLD AND SILVER TAX IN THE ACHAEMENID EMPIRE: HERODOTUS 3.96.2 AND THE ARCHAEOLOGICAL REALITIES*

RÉSUMÉ

Le passage d'Hérodote 3.96.2 se réfère à une pratique Achéménide de conversion de tribut en métaux précieux en lingots suivant une habitude supposée traditionnelle de l'Orient. Cette étude signale l'absence de témoignages solides sur cette coutume traditionnelle supposée, et offre une lecture du texte par rapport au besoin officiel des autorités achéménides de contrôler la teneur variable des métaux précieux en circulation. Ce besoin, que certains commentateurs du texte avaient déjà reconnu, s'accorde avec les spécifications rigoureuses concernant la qualité de l'or et avec la composition chimique constante de l'argent analysé achéménide.

Mots-clés : Hérodote ; empire achéménide ; tribut ; métaux précieux ; monnaie ; "Hacksilber".

SUMMARY

Herodotus 3.96.2 is commonly held to imply that Achaemenid monarchs routinely hoarded their gold and silver revenues in the form of ingots or 'bullion,' presumably in accordance with traditional eastern practice. This study notes the absence of sound evidence for the common presumption that Persian, and generally eastern, authorities hoarded surplus gold and silver in solid form. It proposes that Herodotus' passage ought to be interpreted instead primarily as a reference to a systematic quality control exercised by the Achaemenids over the consistency of gold and silver. The need for such oversight, acknowledged in a number of earlier studies, is here argued to be substantiated not least by the strict requirements of purity of Persian gold and parallel evidence for the existence of a distinct Achaemenid standard of silver composition.

Keywords : Herodotus; Achaemenid empire; tribute/tax; precious metals; money; "Hacksilber".

HERODOTUS 3.96.2 AND EARLIER INTERPRETATIONS

In Book 3 (96.2), following the detailed presentation of the amounts of annual tax reportedly first imposed upon Persia's subjects by Darius I (522-486 B.C.) and largely expressed in talents of gold and silver, Herodotus describes how the Persian king hoarded the incoming precious metal in terms which refer to a metallurgical process:

τοῦτον τὸν φόρον θησαυρίζει βασιλεὺς τρόπῳ τοιῶδε· ἐς πίθους κεραμίνους τήξας καταχέει, πλήσας δὲ τὸ ἄγγος περιαιρέει τὸν κέραμον. ἐπεὰν δὲ δεηθῆι χρημάτων, κατακόπτει τοσοῦτον ὅσου ἂν ἐκάστοτε δέηται.

Herodotus' description of the Persian method of processing tax is vague. The historian does not elaborate on the significance of the Persian king's metallurgical activities nor does he name their end product(s). Taken at face value, his text would suggest that the metal was melted down and, while in a liquid state, run into earthen vessels, which were afterwards removed, leaving the metal in a solid mass.¹ Accordingly, Hero-

* The present issues forth from research undertaken by the author at the Research Centre for Greek and Roman Antiquity (KERA/NHRF, Athens) and, as a Research Associate, in the Department of Near Eastern Studies, UC Berkeley (January and December 1998), partly in collaboration with David Stronach. Preliminary presentations of some of the ideas presented here were made in the 1998-99 Lecture Series of the American School of Classical Studies in Athens (November 1998), the Graduate History Seminar of the University of Crete (Rethymno, June 1999) and the Sixth Congress of Chemistry of Greece and Cyprus (Rhodes, September 1999, see Zournatzi, 1999). Thanks for useful bibliographical references, discussions and suggestions are due to Kathleen McCaffrey, Mark Levi, George Papasavvas and Themistokles Papalas; Crawford H. Greenewalt, Anne Kilmer and David Stronach (UC Berkeley); Angeliki Petropoulou, Katerini Liampi and Anna Michaelidou (KERA/NHRF); James D. Muhly (ASCSA); Yiannis Touratsoglou (Numismatic Museum, Athens); Matthew Stolper (Oriental Institute, University of Chicago); Georghios Varoufakis (ELOT, Athens); Yiannis Maniatis and Themistokles Paradellis (NCSR, "Demokritos", Athens); Dimitrios Kyrtatas and Anna Missiou (University of Crete, Rethymno); Richard P. Woodard (University of Florida). Last, but not least, the final presentation of the thesis has benefited from the review of Paul Bernard (ÉPHÉ, Paris). Responsibility for the interpretations offered is naturally mine as is responsibility for any errors. Unless otherwise indicated in the bibliography, citations to classical authors can be conveniently consulted in the Loeb editions.

¹ This interpretation, offered by Rawlinson, 1942 (1875), p. 260 ("The great king stores away the tribute which he receives after this fashion — he melts it down, and, while it is in a liquid state, runs it into earthen vessels, which are afterwards removed, leaving the metal in a solid mass. When money is wanted, he coins as much of this bullion as the occasion requires"), is also to be found with minor

dotus has been held to testify that Darius (and Achaemenid monarchs in general) cast gold and silver revenues into ingots or bullion destined for the royal treasuries to be used as money when need arose.

While the basic sense of the passage would seem settled, awareness has not been lacking that this “melting-and-casting” operation could allude to a more complex set of metallurgical activities. In the 1930’s and 1940’s, Ch. Torrey,² Otto Eissfeldt³ and Leo Oppenheim⁴ cited complementary Biblical and Mesopotamian textual evidence in order to show that the conversion of gold and silver revenues in solid form, which Herodotus presumably records, was, in effect, an echo of more or less standard Near Eastern palace and temple practice. At the same time, however, references from the Mesopotamian domain in particular, including Achaemenid period documents from Babylonia,⁵ showed unambiguously that a primary aim of that common eastern practice was the assaying and refining of the metals.⁶

Some forty years later, the suggestion, explicitly articulated at least in the writings of Oppenheim and Torrey, namely, that assaying and refining were also inherent in the metallurgical activities referred to in Herodotus, was again proposed (seemingly independently) by Paul Bernard. In his

variations in the other standard translations of Herodotus. See, e.g., A. de Sélincourt’s translation (1996 [1954], p. 193): “The method adopted by the Persian kings of storing their treasure is to melt the metal and pour it into earthenware jars; the jar is then chipped off, leaving the solid metal. When the money is wanted, the necessary amount is coined for the occasion”; Godley, 1971, vol. 2, p. 125: “The tribute is stored by the king in this fashion: he melts it down and pours it into earthen vessels; when the vessel is full he breaks the earthenware away, and when he needs money coins as much as will serve his purpose”; Legrand, 1967, p. 143: “L’or et l’argent du tribut sont conservés par le roi dans ses trésors de la façon que voici: il les fait fondre et verser dans des jarres de terre cuite; lorsque le vase est plein, on enlève l’enveloppe de terre; et, quand le roi a besoin de numéraire, il fait frapper autant de métal qu’il lui en faut chaque fois.” Powell, 1949, vol. I, p. 245, refers the process specifically to gold. See also below, n. 24, for a different approach to the significance of the last sentence of the passage. Subject to the arguments presented in the following pages, an alternative interpretation of Hdt. 3.96.2 is proposed below p. 255.

² Torrey, 1936, pp. 247-60; *idem.* 1943, pp. 295-301.

³ Eissfeldt, 1937, p. 164.

⁴ Oppenheim, 1947, pp. 116-120.

⁵ Strassmaier, 1890, *Camb*, 59:1-5 and 232:1-4 (*apud* Oppenheim, 1947, p. 117).

⁶ As summarized by Oppenheim, 1947, p. 116, the evidence indicates that: “incoming payments, consisting of silver” and, according to references from Mesopotamia cited by Oppenheim, gold “were dropped into a box, the content of which was smelted in the official foundry. When refined, the metal would be cast into ingots and deposited in the treasury.” On the extant written testimony on the refining of precious metals in Mesopotamia, which can be traced in the case of silver to as far back as the mid third millennium B.C., see in general Joannès, 1994, pp. 138-9, and Moorey, 1994, pp. 237-8.

view, the melting of the metal would appear to be dictated “moins par la commodité du stockage, qui n’exigeait pas que l’on donnât aux lingots la forme de vases, que par la nécessité d’homogénéiser par une opération de coupellation la teneur des métaux précieux de provenances diverses et dont le titre pouvait varier à l’intérieur d’une même province.”⁷ This need, he suggested, would have applied in particular in the case of the 360 talents of gold, which the Indians were assessed to pay annually as tax according to Herodotus,⁸ and which arrived in the form of gold-dust (i.e., as raw metal) without prior refining.⁹ He further pointed out that, since the containers used in ancient cementation processes regularly carried the names of pottery vessels, the ceramic containers within which the tax is said to have been melted in Herodotus’ text could well be perceived as analogous to the hermetically sealed, ceramic cementation vessels within which gold, mixed with various reagents, was refined in the descriptions of Diodorus¹⁰ and Pliny.¹¹ Thus, for Bernard, “the ingots ‘in the form of vases’ mentioned by Herodotus could represent the results of a cupellation of the gold and silver before storage in the treasuries of the Great King.”¹²

Viewed in this light, Herodotus’ text would also deserve an important place in discussions of Achaemenid monetary standards.¹³ As it is, however, the relevance of Herodotus in the latter domain would seem difficult to uphold,¹⁴ partly because of the ambiguity of his language and, not least, because explicit evidence on the degree and method(s) of oversight exerted by Achaemenid authorities over gold and silver in general circulation has not been possible to procure from other written sources. More importantly, a systematic need for refining precious metal received by the Achaemenids as tax would seem to be belied by the uniform purity of Achaemenid period silver, as measured by chemical analyses.¹⁵

Yet the textual and material record arguably allows us to venture beyond speculation into two areas that have a bearing upon the issue. First, to my knowledge, nowhere explicitly acknowledged so far is the fact that the

⁷ Bernard, 1987, p. 180.

⁸ Hdt. 3.94.

⁹ A similar view is expressed (independently of Bernard’s suggestions) in Zournatzi, 1999, p. 531.

¹⁰ Diod. 3.14.

¹¹ Pliny, *Natural History* 33.25.1 and 69.

¹² Cf. Bernard, 1987, p. 181.

¹³ See also Tuplin, 1989, p. 75; Descat, 1995, p. 13: “L’or darique a une valeur fixée par rapport à l’argent officiel, ce qui n’est possible qu’après une opération de fonte, évoquée par Hérodote (III, 96).”

¹⁴ See, e.g., Tuplin, 1987, p. 138, where Tuplin refers to “the metal being presumably supplied in bullion form and certainly stored thus, perhaps after further refinement, to be coined as and when required” (emphasis mine).

¹⁵ See, especially Reade, 1986, pp. 85-6; Hughes, 1986, pp. 87-8; Cowell, 1986, p. 89.

ingots or amorphous bullion we have commonly visualised from Herodotus' text never register among the contents of Achaemenid treasuries, which are quite extensively documented by literary and archaeological testimony. Indeed, the presumption of regular ingot production, which is here argued to be unsubstantiated, may have inhibited a more confident interpretation of Herodotus' passage as a 'refining' text.

Secondly, despite the apparently uniform quality of silver in circulation during the Achaemenid period, the chemical profile of a distinct Achaemenid silver standard can be detected in silver objects of Achaemenid manufacture. That standard, which could only be achieved by technical means, indicates that it would have been in character for the Achaemenid authorities to have systematically exercised control over the consistency of the gold and silver that came into their possession.

THE SHAPE OF ACHAEMENID BULLION

One can reasonably assume that precious metal coming into Achaemenid treasuries arrived in a variety of shapes and forms. From Herodotus we learn that the 360 talents of gold for which the Indians were annually assessed were payable in the form of gold-dust.¹⁶ Our sources do not specify the medium of the remaining tax payments in precious metal.¹⁷ As far as one can tell, however, regal Achaemenid coinage, minted from the late sixth or early fifth century B.C. onwards,¹⁸ was never imposed as the official medium of exchange in the empire. The peoples of each province appear to have been allowed to trade (and pay taxes) according to their traditional devices.

In the west, where civic coinages had become a customary medium of exchange by the late sixth century, tax payments could be conveniently made in units of precious metal that represented the range of denominations and weight standards of local (and Achaemenid) coinages.¹⁹ In the

¹⁶ Hdt. 3.94. Cf. Hdt. 3.97, the two *choinikes* ἀπύρου χρυσίου (in the form of nuggets[?], as in Diod. 2.50.1) due every two years as 'gift' from the Ethiopians.

¹⁷ Even though in those other instances dues expressed in talents of precious metal (Hdt. 3.89-95, identifying the metal as silver) may well have been replaced in some cases by contributions in kind or services (see, e.g., Strabo 15.3.21), there is still little room for doubting that a good portion of the imperial revenues were in silver. For the relevant evidence, see esp. Tuplin, 1987, pp. 137-57.

¹⁸ For a comprehensive treatment of the literary and hoard evidence, see Carradice, 1987, pp. 73-93. On the beginnings of Achaemenid coinage, see also, more recently, Alam, 1993, and Le Rider, 1998.

¹⁹ Cf. Martin, 1985, pp. 119-22. Other forms of payment cannot, of course, be excluded. See, e.g., Hdt. 7.119, where the contributions in precious metal of the inhabitants of the coastal cities of Thrace to Xerxes in 480 B.C. are said to have been in the form "gold and silver craters, cups, and all else that was required for the table (of the King)."

eastern provinces, where precious metal (predominantly silver) by weight served as currency down to the Hellenistic period,²⁰ payments received by Persia's tax collectors theoretically could assume any form. The annual collection of tribute thus probably presented a picture analogous to that of contemporary hoards; in other words, a medley of whole objects (such as vessels, jewelry, coins, bars etc.) as well as various fragments thereof, scrap metal and wire.²¹

Judging by the heterogeneous numismatic practices in effect in the empire, the Persians would obviously have had good reason for converting incoming gold and silver into some standard form, not least for ease of handling and uniformity of accounting. In this regard, the reality of the 'ingots' which has been reconstructed from Herodotus' text would seem to be corroborated, and even further explained and justified, by the archaeological record.

Silver, formed into different regular shapes (such as bars, coils) or simply cooled into lumps is known from a number of first-millennium eastern hoards.²² While such forms of silver could conceivably serve as illustrations of the usual way(s) of storing large quantities of precious metal, as inferred from Herodotus and the eastern texts, in recent decades there is an increasing awareness that these unshaped or cast pieces could just as readily fulfill monetary functions; i.e., that they could be made to weights related to current weight standards and serve as a kind of larger capital from which portions (possibly "quantified in terms of an estab-

²⁰ See, among others, the comments of Schlumberger, 1953, esp. p. 17; Kraay, 1964, p. 91; Powell, 1978, p. 217 and n. 11, with references to Seleucid staters passing by weight in Babylonia in *CAD* s.v. *istatirru*; Joannès, 1994, pp. 142-3.

²¹ A good example of this range of silver is found in the Achaemenid period hoard from Babylon, Robinson, 1950, p. 51 and Reade, 1986, p. 83ff. The function of eastern hoards (consisting mainly of miscellaneous pieces of silver) as currency has been explored by Balmuth in a series of articles (e.g., Balmuth, 1967, pp. 25-32, esp. 28ff.). Overviews of the relevant evidence in Curtis, 1984, pp. 16-9; Moorey, 1994, p. 237; Kroll, 1998, esp. pp. 229-30 and n. 23. See also the abstracts of the papers presented in the colloquium "New insights into the transition from *Hacksilber* to coinage," 1998, pp. 402-3, and Golani and Sass, 1998, pp. 57-81, esp. 58-62.

²² The conversion of precious metal into ingots in the Near East is attested at least as early as the fourth millennium B.C. by the electrum ring-ingots from Palestine: Gopher, Tsuk, Shalev and Gophna, 1990, pp. 436-43, 437 fig. 1. For first millennium examples, see, e.g.: (the Levant) Balmuth, 1967, pp. 25-32; (Iran and Afghanistan) Bivar, 1971, and *idem*, 1982 (bars and references to the circulation of ingots in the Persian empire), and Curtis, 1984, pp. 8-20 (bars and spiral rings from the Nushi Jan hoard); (Mesopotamia) *ibid.*, p. 16ff., and Reade, 1986, p. 83 no. 44 (a silver lump from the Babylon hoard); (Egypt) Price and Waggoner, 1975, pp. 115-6, 126 and 139 n. 233 ("cake" ingots and fragments).

lished system of weights”) could be broken off to pass as smaller currency.²³

By the same token, the conversion of Achaemenid gold and silver into ingots would have also carried the additional advantage of supplying a form of metal ready for numismatic use in eastern contexts, and a direct reference to just such a practice has even been thought to be reflected in Herodotus' additional remark on the Persian king's numismatic practices in the closing sentence of the 3.96.2 passage. In Herodotus' statement, “ἔπειαν δὲ δεηθῆ χρημάτων, κατακόπτει τοσοῦτον ὅσου ἂν ἐκάστοτε δέηται,” the basic sense of the main verb κατακόπτει is “to cut up” or “to cut into pieces.” Thus, taken literally, the statement would mean “when (the king) needs money he cuts/breaks off as much as he needs for the occasion.”²⁴

While seemingly supported simultaneously by Herodotus' language and Near Eastern evidence and practice, the connected suggestions that the Achaemenids would have regularly kept their gold and silver in ingot form, used as an ‘ingot-currency,’ arguably rest on thin ground.

²³ See, in the first place, Bivar, 1971. Cf. *idem*, 1982, and Curtis, 1984, p. 20: “A glance at the weight of the ingots does indeed show some striking correlations, clearly suggesting that they were made or cut to certain standards. Thus two of the complete pieces weigh 100.7g and 100.33g respectively, while two of the fragments are 24.0g and 23.5g respectively. These results seem to indicate that complete pieces intended to be distributed or circulated as currency were made approximately to a recognized weight standard, but that the fragments of ingots and pieces of scrap silver represent nothing more than hastily cut or torn-off pieces of metal to be put on the scales to make up a required weight.” According to Stronach, 1968, p. 182 fig.10, a vertical marking on one of the long faces of one of the bars was possibly intended for future division. According to Thompson, 1999, pp. 49-50, recent calculations of the weights of “the so-called ‘cast’ ingots of Barrekub and the smaller ‘cast’ ingots from the North Palace at Zinjirli...revealed that the aggregate weight of the pieces used to make each ingot matched increments of one or two ‘international’ standards used by Mesopotamians, Philistines, Egyptians and other people along the eastern coast of the Mediterranean.” For the find, see Andrae, 1943, pp. 119-21.

²⁴ Among earlier interpretations of the phrase in this sense, see Littlebury, 1824, p. 192 (“...and when occasion requires, so much is cut off as seems necessary”); Macaulay, 1890, vol. I, p. 258 (“...and when he needs money he cuts off so much as he needs on each occasion,” also followed by Curtis, 1984, p. 20); Cary, 1908, p. 212 (“...and when he wants money he cuts off so much as he has occasion for from time to time”); Schlumberger, 1953, p. 14 (“...le verbe κατακόπτειν signifie seulement que le Roi fait réduire en morceaux la quantité du métal qu’il lui faut,” based on Regling, 1926, p. 233); Greene, 1987, p. 254 (“...when he needs money, he cuts off from the ingot as much as he wants for the coinage,” presumably also followed by Thompson, 1999, p. 50 [“...when he needs money, he cuts off from the ingot as much as he wants...”], in all respects but for his contention that the ingots(!) would necessarily be converted into coinage); Briant, 1996, p. 420 (“...et quand le roi a besoin d’argent, il fait réduire en morceaux la quantité de métal dont il a besoin”); Waterfield, 1998, p. 210 (“Whenever he wants money he slices off as much as he needs at the time”).

To begin with Herodotus' reference to Darius' numismatic practices, it obviously needs to be emphasized that the use of terms whose significance lies in the general realm of "cutting" is not exclusively appropriate to eastern numismatic contexts. In the Greek language, the notion of "cutting" regularly designates the act of minting coins (Gk. κόπτω)²⁵, and one can cite at least one instance in which κατακόπτω is the only verb used to designate a process from which coinage (νόμισμα) issues forth.²⁶ Since Achaemenid rulers are known to have issued coins on the western model from at least the reign of Darius I onward, a use of κατακόπτει in the sense "to mint coins" with reference to Darius' numismatic practices would not be inapposite.²⁷ In that case, Herodotus' statement would serve to point out a characteristic Achaemenid attitude towards coin production well attested by both literary and hoard evidence: namely, that the Achaemenids did not routinely convert their revenues into coinage.²⁸

²⁵ The use of the term for the minting of coinage is securely established by both literary texts and epigraphic documents. See, e.g., Aristophanes, *Frogs* 720 and 726, with the *scholia* on 720 and 725 and the comments of Ferguson, 1932, pp. 86-8; Hdt. 1.94.1 (minting of coinage in Lydia), 3.56.2 (minting of Polykrates' gilt lead coinage), 4.166.2 (minting of Darius' 'pure' gold coinage); Pleket, 1964, no. 3 (composite text of the fifth-century Athenian decree[s] concerning money, weights and measures); *ibid.* no. 11, ll. 6-7 (measures against the counterfeiting of money, third-second century B.C., from Dyme); *IG II²* 1408, l. 12, and 1409, l. 5 (inscriptions related to the treasurers of Athena; cf. Ferguson, 1932, pp. 86-7). See also the use of κοπή for the minting of coinage in Durrbach, 1929, 461 Aa, l. 76 (second century, from Delos).

²⁶ Diod. 16.56.6: τὰς γὰρ ἀνατεθείσας ὑπὸ Κροίσου τοῦ Λυδῶν βασιλέως χρυσᾶς πλίνθους, οὔσας ἑκατὸν καὶ εἴκοσι διταλάντους, κατέκοψεν εἰς νόμισμα (cf. 16.56.5: οὐκ ὀλίγα τῶν ἀναθημάτων κατέκοψεν εἰς τὰς τῶν ξένων μισθοφοράς). The term is also probably to be taken in the sense "to mint coinage" (see also *LSJ* and *TGL*) in, e.g., Xenophon, *Hellenica* 1.5.3, relating Cyrus the Younger's willingness to "cut up" (κατακόψειν) even the throne of gold and silver whereon he sat in order to provide for the wages (ultimately set to four obols per day, thus, presumably in coined money) of his Greek sailors, should all other resources at his disposal prove insufficient; and in Demetrius, *Elocutiones* 281: κατακόψωμεν τὰς Νίκας (τὰς χρυσᾶς) εἰς τὸν πόλεμον. The latter instances, however, are admittedly not explicit. Κατακόπτω is also perceived as a regular term for the coining of money by Kurke, 1999, pp. 93-4 n. 62, who does not cite, however, specific examples. An interpretation of κατακόπτει as "mint coinage" would at least accord, furthermore, with Herodotus' use of the term χρημάτων in the same passage, although the latter term (meaning "necessities" and, by extension, "resources," "wealth," "money") does not constitute a secure reference to "coined money" when the context is not explicit in this regard.

²⁷ Also taken in this sense in the translations of Hdt. 3.96.2 cited in n. 1.

²⁸ Explicitly stated in Strabo 15.3.21 (*FGrHist* 128 [Polykleitos von Larissa] F 3): τὸν δὲ πλεῖστον χρυσὸν καὶ ἄργυρον ἐν κατασκευαῖς εἶναι, νομίματι δ' οὐ πολλῶ· πρὸς τε τὰς δωρεὰς ἐκεῖνα κεχαρισμένα νομίζειν μᾶλλον καὶ πρὸς κειμηλίων ἀπόθεσιν· τὸ δὲ νόμισμα τὸ πρὸς τὰς χρείας ἄρκοῦν ἱκανὸν εἶναι, κόπτειν δὲ πάλιν τὸ τοῖς ἀναλώμασι σύμμετρον ("..and that

The presumption that the Achaemenids stored their gold and silver in solid form also needs to be approached with caution. Although ingots clearly occur in Persian period hoards, (so far at least) there is no evidence that any of the surviving ingots (or lumps) were produced by Achaemenid authorities, and the existence of ingots in Persian treasuries remains impossible to confirm.

An extensive array of surviving Achaemenid records of transactions in precious metal refer to gold and silver by weight, occasionally supplying references to its quality, but do not specify its form(s).²⁹ References to ingots are equally absent in classical descriptions of the contents of Persian treasuries, including eye-witness reports of Achaemenid treasures from the time of Alexander's expedition.³⁰ The latter sources, on the contrary, repeatedly stress the Achaemenids' preference for gold and silver in the form of finished items.

Writing some five centuries after Herodotus, but drawing upon the report of Polyclitus of Larissa, a historian of Alexander, Strabo states that, in the main, the rich stores of gold and silver which had accumulated from the revenues in the treasuries of Darius I and his successors (at Susa) were

most of the gold and silver is used in articles of equipment, but not much in money; and that they [i.e., the Persians] consider those metals as better adapted for presents and for depositing in storehouses; and that so much coined money as suffices their needs is enough; and that they coin only what money is commensurate with their expenditures," L.H. Jones, transl., Loeb). Cf. Diod. 17.66.1-3. As pointed out by Bosworth, 1980, vol. 1, pp. 316-7 (commentary on Arrian, *Anabasis* III.16.7), there is little to recommend the accuracy of Plutarch's statement (*Alexander* 36.1) that the 40,000 talents seized by Alexander at Susa were *all* in the form of coin. Unwarranted is also the rendering of ἀργυρίου τάλαντα in Diod. 17.64.3 and Arrian, *Anabasis* 3.16.7 as "talents d'argent monnayé" in de Callataÿ, 1989, p. 260. For Howgego, 1990, p. 2, the insistence of classical authors upon the fact that the Achaemenids did not routinely convert gold and silver into coin would be meant to bring out a contrast with Greek state practice. The limited circulation of Achaemenid coinage in the empire, initially observed on the evidence of hoards known up to 1953 by Schlumberger, 1953, pp. 3-62, stands confirmed by the more recent finds discussed in Carradice, 1987, esp. 89-90.

²⁹ This is consistently the case in the numerous official transactions in silver recorded in the Persepolis Treasury Elamite tablets, Cameron, 1948, *passim*, and in references to gold and silver in the Aramaic documents from Elephantine, e.g., Kraeling, 1953, AP 2, 15. For earlier, highly tentative instances of the 'recognition' of ingots in Late Period documents from Egypt, see Tuplin, 1989, p. 62 (e).

³⁰ The relevant classical references are listed in a number of earlier works, e.g., Cameron, 1948, pp. 10-11; Schmidt, 1953, pp. 156-7; Nylander, 1968, p. 124ff.; de Callataÿ, 1989, pp. 260-1. "Rough ingots" 'materialize' in the Loeb translation of Quintus Curtius 5.2.11, "Ut vero urbem intravit, incredibilem ex thesauris summam pecuniae egessit, L milia talentum argenti, non signati forma, sed rudi pondere" ("Moreover, when he entered the city, he amassed from its treasures an incredible sum of money, 50,000 talents of silver, not stamped into coins, but rough ingots"), strictly in keeping with the translator's fancy.

in the form of κατασκευαῖς (“wrought items”).³¹ While the term *kataskueuais* used by Strabo (or his source) could designate items of any shape, thus, conceivably, even ingots, in this particular context, the stated destination of the gold and silver so described as δωρεαῖς (“gifts”) must necessarily imply finished objects. In Persian, and more general Near Eastern practice, gold and silver offered as gifts were by definition in the form of articles.³²

The impression that Achaemenid gold and silver was largely hoarded in the form of finished objects is reinforced by surviving descriptions of Persian treasures, in which total figures of value (expressed in talents and minas of precious metal) are directly equated to luxurious articles.³³ The relevant testimony multiplies if one counts the isolated references to articles of silver and gold which emerged regularly from Persian treasuries as prestigious gifts, rewards to collaborators, or incentives to foreigners in a position to promote the Persian cause.³⁴

As already recognized by a number of scholars, such articles were not merely appreciated for their aesthetic and prestige value, but could function simultaneously as ‘bullion’ and as monetary instruments.³⁵ This conclusion, largely thought to be supported so far by indications that Achaemenid objects, and in particular vessels, of silver³⁶ and gold³⁷ were

³¹ Strabo 15.3.21, above (n. 28).

³² See, e.g., Zaccagnini, 1989, pp. 195-8.

³³ E.g., Athenaeus, *Deipnosophists* 11.782a, where the booty taken from the Persians by Alexander and his soldiers is stated to have been recorded in Parmenion’s “Letters to Alexander” as “gold drinking-cups, weighing 73 Babylonian talents, 52 minas (over 4 tons), drinking-cups inlaid with precious stones, weighing 56 Babylonian talents, 34 minas,” and Diod. 19.48.7-8, describing the contents of the treasure seized by Antigonos at Susa as a golden climbing vine and a multitude of *kataskueasmata* amounting to 15,000 talents, and, in addition, crowns and other gifts and spoils, amounting to another 5,000 talents. See also Schmidt, 1953, pp. 156-7, Nylander, 1968, p. 124 ff., and Briant, 1996, p. 408, with further examples.

³⁴ See conveniently Nylander, 1968, p. 125 n. 26; Sancisi-Weerdenburg, 1989, pp. 129-46; Dandamaev and Lukonin, 1989, p. 181.

³⁵ See esp. Nylander, 1968, p. 125f. n. 27.

³⁶ Numerous references to silver articles of the Achaemenid period manufactured to standard (often Achaemenid) weights in Vickers, 1990, p. 615ff. Cf. Curtis, Cowell and Walker, 1995, p. 151.

³⁷ E.g., the gold cup of Darius in the Metropolitan whose weight, 1,100g, as Moorey (1988, p. 87, no. 108a) initially pointed out, corresponds exactly “to 130 darics at 8,46g (i.e. freshly minted coin)” (from Curtis *et al.*, 1995, p. 151 n. 32). Among other examples of Persian articles of gold manufactured to prescribed weights, see the gold cup given by the Great King to Demos, son of Ppyrilampes, in Lysias 19.25, which, in the estimate of M. Vickers, 1984[1990], pp. 48-53, must have weighed 100 darics. *Idem*, 1990, p. 622 n. 107, also draws attention to the gold “akinakes” of Mardonios, which weighed, according to Demosthenes 24.129, a round sum of 300 darics.

made (whether individually or as sets) to Achaemenid weights, can now be seen to be further corroborated by evidence that the alloys of Achaemenid silver objects also complied to Achaemenid monetary quality standards. The latter is the case with three inscribed bowls of Artaxerxes I (465-425 B.C.),³⁸ which as indicated by the standard formula “made in the (royal) house” inscribed on the inner rim of each vase were made by the royal treasury,³⁹ and whose analyses reveal a metallic composition directly comparable to that of analysed specimens of Achaemenid sigloi (Table I).⁴⁰

Furthermore, the use of such items as currency in financial exchanges, strongly implied by textual references,⁴¹ is also suggested by the fact that the larger values, which those objects represented when intact, could be subdivided by cutting off pieces appropriate for smaller transactions. This seems to have been the case, for instance, with the miscellaneous silver jewelry and vessel fragments found, together with complete and fragmentary coins, in the Babylon hoard, the whole presumably serving monetary functions.⁴²

Thus, while references to ingots are not to be found in connection with Persian treasures, the luxurious articles of gold and silver attested instead could fulfill a full range of practical and monetary functions. Finally, in the case of bowls, in particular, which could be stacked one on top of (or within) another, one should note the significant practical advantages the shapes of such vessels could offer for storage.

In short, the impression we form from our sources is that Achaemenid notions of a convenient form of gold and silver bullion did not necessarily

³⁸ The initial publication of the bowls is Herzfeld, 1935, pp. 1-8; cf. *idem*, 1937, pp. 5-17. They are now conserved, one each, in the Metropolitan Museum of Art (MMA 47.100.84: Muscarella, 1980, pp. 32-3, pl. XII fig. 10), the Freer Gallery of Art (Freer 74.30: Gunter and Jett, 1992, pp. 69-73, and Gunter and Root, 1998), the British Museum (BM 1994-1-27: Curtis *et al.*, 1995, formerly in the Adams Collection, Moorey, 1974, p. 182 no. 181), and the Reza Abbasi Collection in Teheran (Curtis, 1997, p. 16 n. 2). For the history of the vessels and arguments in support of their authenticity, see now extensively Gunter and Root, 1998, pp. 3-16.

³⁹ For the inscription, see Kent, 1953, A¹I. Cf. *idem*, XH for the formula “made in the (royal) house” on a fragment of a silver pitcher of Xerxes. References to the “house of the king” as a treasury in Tuplin, 1984, p. 128 and n. 75. The formula “made in the (royal) house” on the vessels of Xerxes and Artaxerxes I is interpreted as a treasury mark of guarantee of the official quality of the vessels’ silver in Zournatzi, (forthcoming).

⁴⁰ See more extensively pp. 260-5 below.

⁴¹ Examples cited in Vickers, 1990, pp. 615 ff.

⁴² Above (n. 21). Fragments of Achaemenid royally inscribed silver also occur among the contents of hoards. For one such fragment from the Black Sea hoard, see Hulin, 1972, pp. 121-4, pl. I, and Kraay and Moorey, 1981, p. 16 no. 137, pl. 8. A second example comes from the Cabul hoard, Curiel and Schlumberger, 1953, p. 41, 45, pl. V, iii.12, and Henning, 1956, pp. 327-8.

coincide with those of, say, modern banks whose reserves demonstrably take the form of bars.⁴³ It may further be significant that difficulties in substantiating the presumed important role of ingots as a standard means of hoarding wealth are not confined exclusively to Achaemenid contexts.

Table I: Official Achaemenid silver (i.e. sigloi and vessels with a stamp of Achaemenid provenance).

No.	Object	Method of analysis	% Silver	% Copper	% Lead	% Gold
1	Siglos	NAA/AA*	97.2	1.85	0.63	0.17
2	Siglos	NAA/AA*	96.8	2.30	0.44	0.35
3	Siglos	NAA/AA*	96.1	2.63	0.92	0.16
4	Bowl	XRF	97.2	2.2	0.4	0.3
		NAA	96.2	—	—	0.36
5	Bowl	XRF	96.5	2.5	0.9	0.5
		NAA	97.3	2.41	—	0.34
6	Bowl	XRF	—	—	—	—
		NAA	97.1	2.55	—	0.32
7	Siglos	XRF	97.1	2.3	0.2	0.4
8	Siglos	XRF	97.4	1.8	0.3	0.5
9	Siglos	XRF	98.1	1.5	0.3	0.15
10	Siglos	XRF	96.6	2.5	0.8	0.15
11	Siglos	XRF	96.8	2.3	0.5	0.45
12	Siglos	XRF	96.4	2.3	1.2	0.15
13	Siglos	XRF	96.9	2.8	0.2	0.15
14	Siglos	—	96.35	2.67	0.82	0.10

Nos. 1-3: Asyut hoard, nos. 716, 722, 715, respectively (after Gale *et al.*, 1980, pp. 16-7, Table 3).

Nos. 4-6: BM 1994-1-27, Freer 74.30 and MMA 47.100.84, respectively (after Gunter and Jett, 1992, pp. 72-3, and Curtis *et al.*, 1995, p. 150).

Nos. 7-13: Babylon hoard, nos. CM 1948/12/2/11,7,8,9,10,12,19, respectively (after Cowell, 1986, p. 89).

No. 14: Uncertain provenance (after Caley, 1951).

* Silver, copper and gold contents determined by NAA. AA used for lead and a cross-check on copper.

⁴³ Persian authorities might still have produced bars/ingots as a kind of currency to be circulated in the east, as suggested by Bivar, 1982.

HERODOTUS 3.96.2 AS A 'REFINING' TEXT

Any final assessment of the textual evidence concerning the form in which gold and silver were 'traditionally' stored in Near Eastern palaces and temples must rest, of course, with specialists dealing with Near Eastern texts. So far, however, references to gold and silver ingots also remain elusive in those texts,⁴⁴ and even the general belief that the processing of gold and silver revenues ultimately aimed at producing ingots for storage can be put to question. The three examples cited by Oppenheim in this regard illustrate the uncertainty.

In the first case, a text dated to the reign of the last Babylonian monarch Nabonidus, states that "9 $\frac{3}{4}$ shekel of gold, being the revenue of the month Aiaru (*ir-bi šá arah*A.) were given to E. and (his) goldsmiths for smelting (*a-na pí-ta*)." ⁴⁵ A second document, from the reign of the Persian monarch Cambyses, records "1 mina 7 shekel of silver, the revenue of the current month [*ir-bu šá arhi*], given to the goldsmith Z for smelting (*a-na pi-te-qu*)." ⁴⁶ The third example, also from the reign of Cambyses, records that "[...] mina of silver from the revenues (collected) at the gate of the storehouse [*ul-tu ir-bi šá bâbi šá é.gur7 meš*] have been smelted," specifying that "1 mina 39 $\frac{1}{2}$ shekel of silver were lost in the refining [*ina pi-te-qu*]." ⁴⁷

From the last example, which states the loss of a part of the silver's initial weight equivalent to 1 mina and 39 $\frac{1}{2}$ shekels in the process, it is clear that the processing of revenues aimed at assaying and, if necessary, refining the precious metal.⁴⁸ *Pataqu*, the verb by which the nature of the process is designated in all three examples, normally means "to cast", or "to form."⁴⁹ Hence, primarily, the impression that the processing of gold and silver revenues resulted in the production of ingots for storage. However, as in Herodotus, the products of the activity of the Babylonian goldsmiths are not named, and evidently this happens as a rule in instances where the term *pataqu* refers to the processing of revenues.⁵⁰

⁴⁴ Note, e.g., the divergent interpretations of *šibirtu* silver as a "block or lump" of silver by Landsberger, 1930, p. 285 (cf. CAD and Joannès, 1994, pp. 142-3) and as "scrap silver or fragments" by Powell, 1978, pp. 222-3.

⁴⁵ Strassmaier, 1889, *Nbn*, 758: 1-5 (*apud* Oppenheim, 1947, p. 117).

⁴⁶ Strassmaier, 1890, *Camb*, 59: 1-5 (*apud* Oppenheim, 1947, p. 117).

⁴⁷ Strassmaier, 1890, *Camb*, 232: 1-4 (*apud* Oppenheim, 1947, p. 117).

⁴⁸ Cf. Dougherty, 1923, vol. I, pp. 359:1ff. and 404:1-2, where the silver coming from revenues is described as *la pi-it-qu*, "unsmelted" (*apud* Oppenheim, 1947, p. 117).

⁴⁹ Information kindly provided by Anne D. Kilmer and Matthew W. Stolper.

⁵⁰ As Matthew Stolper informs me (personal communication 23/6/1999), "uses of *pataqu* that name the thing cast all deal with items of jewelry or cast sculpture or decoration, not bars or ingots."

Given the consistently aorist use of *pataqu* in the latter cases, it would not seem unreasonable to propose that the use of the term in those particular contexts does not necessarily imply the ultimate production of some specific, customary form of gold and silver meant for long-term storage but was perhaps merely due to the fact that “‘something’ is ‘cast’ in the assaying process.”⁵¹ Or, one could even suggest that *pataqu* had a variable meaning that allowed it to be employed for both “forming”/“casting” and “refining”/“smelting” operations.

If this line of reasoning is correct, one would be all the more justified in arguing for an analogous significance in the case of Herodotus’ text as well. The conventional interpretation of the passage as a description of a process of casting derives, seemingly logically, from the “melting” of the precious metal, the use of the verb *καταχέει* and the references to the “filling of the vessel” and the subsequent removal of the *κέραμος*. However, references to the melting of metals are not justified solely in connection with casting.⁵² In Hesiod, *Theogony* 862-4, “καὶ ἐτήκετο κασσίτερος ὦς/ τέχνη ὑπ’ αἰζηῶν ἐν εὐτρήτοις χοάνοισι/ θαλφθείς,” for instance, the verb *τήκω* clearly applies to the smelting of tin.⁵³ The same term is used later in Manetho for the refining of gold and silver or, perhaps, exclusively for the cementation of gold.⁵⁴ An analogous significance might apply to Herodotus’ term *καταχέει*, which also occurs elsewhere in his narrative in a context that strongly implies the ability of Lydian metallurgists to produce ‘pure’ gold out of the electrum of the Pactolus.⁵⁵

In the lack of any clarification as to their function, the ceramic containers (*πίθοι*, *ἄγγος*, *κέραμος*) mentioned in the passage could also be associated with a range of metallurgical activities. In this case, they could be perceived as either molds for casting or as cupellation or cementation vessels, as Bernard proposed.⁵⁶

Finally, in broad terms at least, the sum of Herodotus’ references would seem to allow a comparison with the method employed by the

⁵¹ Wording Matthew Stolper (23/6/1999).

⁵² See also Bernard, 1987, p. 181.

⁵³ Cf. the German term “schmelzen” which applies equally to “melting” and “smelting.”

⁵⁴ Manetho 6.387-8: “ἐν χοάνοις χρυσὸν τε καὶ ἄργυρον αἰγλήεντα/ τήκοντας ῥέζει,” with the comments of West, 1966, pp. 394-5.

⁵⁵ Hdt. 1.50: (Κροῖσος) καταχεάμενος χρυσὸν ἄπλετον ἡμιπλίνθια ἐξ αὐτοῦ ἐξήλαυνε.

⁵⁶ Bernard, 1987, p. 181, refers to *catinus* used in the refining of gold in Pliny, *Natural History* 33.69, *κάλαθος* for iron in Hesychius s.v., and *ἄγγειον* in Theophrastus (Pollux, *Onomasticon* 7.99 and 10.149, cited earlier by Halleux, 1974, p. 197). For the ceramic vessels employed in the processing of electrum in the gold-refining installations at Sardis (Pactolus North), see Ramage and Goldstein, 1983.

“ancient kings of Egypt” for the refining of gold, as recorded by Agatharchides (2nd c. B.C.):

τὸ δὲ τελευταῖον ἄλλοι τεχνῖται παραλαμβάνοντες μέτρῳ καὶ σταθμῶ τὸ συνηγμένον εἰς κεραμεοῦς χύτρους ἐμβάλλουσι· μίξαντες δὲ κατὰ τὸ πλῆθος ἀνάλογον μολίβδου βῶλον καὶ χόνδρους ἁλῶν, ἔτι δὲ βραχὺ καττιτέρου, καὶ κρίθινον πίτυρον προσεμβάλλουσι· ἄρμοστον δ' ἐπίθημα ποιήσῃντες καὶ πηλῶ φιλοπόνως περιχρίσαντες ὀπτῶσιν ἐν καμίνῳ πέντε ἡμέρας καὶ νύκτας ἴσας ἀδιαλείπτως· ἔπειτα ἐάσαντες ψυχθῆναι τῶν μὲν ἄλλων οὐδὲν εὐρίσκουσιν ἐν τοῖς ἀγγείοις, τὸν δὲ χρυσὸν καθαρὸν λαμβάνουσι ὀλίγης ἀπουσίας γεγεννημένης.⁵⁷

While the κεράμινοι πίθοι of the Persians' smiths in Herodotus do not sound very different from the Egyptians' κεραμεοῦς χύτρους, Herodotus' reference to the filling of the ἄγγος could allude to the addition of reagents (such as lead, tin, salts and barley husks or others) into the vessels containing the metal to be refined (or even possibly to the impregnation of the ceramic container with the substances separated from the metal under refinement in the course of cementation or cupellation?). Furthermore, while possibly just indicating the removal of the metal from the cupellation (or cementation) vessels, as Bernard suggested, the expression περιαιρέει τὸν κέραμον might refer alternatively to the removal of the ἄρμοστον ἐπίθημα of the vessels at the end of the process. This last detail, which is stressed by Agatharchides, apparently had a particular technical significance: The tight-fitting lid would have been meant to prevent the loss of silver and salts by evaporation as silver chloride.⁵⁸

One could, therefore, propose the following as a viable alternative to the customary translation of Herodotus 3.96.2:

“The king hoards this tax in the following manner: having melted (or ‘smelted’) it in earthen vessels he refines it; having filled (or impregnated?) the vessel, he afterwards removes the crucible (or perhaps specifically the tight-fitting clay lid of the cementation vessel?); and, when he needs money, he mints as much as is required on each occasion.”

⁵⁷ Diod. 3.14.3-4: “Finally, other technicians gather up the gold that has been collected, and pack it according to a fixed measure and weight into pottery vessels. They mix in a lump of lead of a size proportionate to the amount of gold and pieces of salt and, in addition, they add a little tin and barley bran. Having covered it with a close fitting lid and thoroughly sealed it with clay, they bake it in a kiln for five days and an equal number of nights continuously. Then, after allowing it to cool, they find in the jars none of the other substances, but they obtain pure gold with only a small amount having been lost” (transl. Burstein, 1989, 65-6 [5.28b]).

⁵⁸ Craddock *et al.*, 1998, p. 116 (reference owed to Crawford H. Greenewalt).

The general character of Herodotus' description admittedly leaves in doubt the proposed interpretation of his passage. However, lack of specific technical detail does seem to be the rule in ancient descriptions of metallurgical processes⁵⁹ and, in any case, Herodotus need not have been any more knowledgeable about the technical details and vocabulary of metallurgy than the average modern historian. If his observations in this instance are not based on autopsy (as seems highly likely in view of the general character of his report),⁶⁰ one should allow, moreover, even for the possibility of misunderstanding of the details (and perhaps even the significance?) of the process by Herodotus or his source.

The point is, however, that regardless of what one may think of the proposed interpretation of Herodotus' passage, the need for a systematic metallurgical control of the quality of payments in gold and silver received by the Achaemenids can also be seen to emerge from more explicit testimony.

THE TESTIMONY OF ACHAEMENID GOLD AND SILVER

Herodotus reports that Darius I, wishing to leave an everlasting monument of his rule with something that none of his predecessors had accomplished, “χρυσίον καθαρώτατον ἀπεψήσας ἐς τὸ δυνατώτατον νόμισμα ἐκόψατο,” that is to say, “he issued coinage from gold which he refined to the greatest possible degree of purity.”⁶¹ Darius' claim is apparently born out by the quality of the *daric*,⁶² the standard Achaemenid gold coin, which is held to have been introduced in the course of his reign, and which in at least empirical estimates is nearly 100% fine.⁶³ Since pure gold

⁵⁹ Diod. 3.14.3 and Pliny, *Natural History* 34.106 are exceptional. Cf. Craddock *et al.*, 1998, p. 116f.

⁶⁰ Given Herodotus' diligence in naming, describing and even interpreting the nature of the objects he mentions throughout his work, it would be out of character for him not to mention more specific information about the processing of Achaemenid taxes if he had any or not to inquire about its significance and details if he personally observed it. See, e.g., his detailed description of the gifts sent by Croesus to Delphi in 1.49f., in which, among others, ingots of gold and silver are named (ἡμιπλίνθια) and their dimensions are given; cf. Diod. 16.56.6, where the ingots are called πλίνθοι.

⁶¹ Hdt. 4.166, with the comment of Tuplin, 1989, p. 63.

⁶² On the initial significance of the term as a particular (royal) unit of weight and not a coin, see Descat, 1995, pp. 12-3.

⁶³ Olmstead, 1948, p. 188: “The *daric* of 129 grains was 23 1/2 carats fine, 98 per cent pure gold,” without citing the source (or method) of the estimate. Analyses of Achaemenid gold appear to be extremely rare. Two British Museum darics, dated to the middle to late fourth century B.C., contained, respectively, 99.3% and 98.9% gold and 0.6% and 1.00% silver (analyses by M.R. Cowell, cited by Tuplin, 1989, p. 72).

is extremely rare in nature and the quality of the natural gold alloys vary significantly,⁶⁴ the numismatic use of gold would presuppose the ability of the issuing authority to guarantee systematically the fixed quality of the metal. The introduction of a gold coin of high title (and fixed value) by the Persians must be connected, therefore, in any case with their ability to refine the natural metal on the basis of predetermined and elevated standards of purity.

Given the high standards of purity of Persian gold, and not least the metal's fixed value with respect to silver,⁶⁵ it seems highly unlikely, as Bernard and others sensed,⁶⁶ that Persian authorities would have taken for granted the quality of, say, the 360 talents of gold in natural state, and thus unrefined, which came in as tax from India.⁶⁷ In that case, furthermore, since dust appears to have been the regular form in which (natural) gold was refined,⁶⁸ it might further be suggested that the express provision for gold in the form of "dust" (as opposed to, say, finished items), as Herodotus specifies, was dictated by the immediate destination of the metal for the cementation vessel.

Telling indications of a parallel Achaemenid concern over the quality of silver (again implied *a priori* by the fixed ratio of the values of gold and silver) are also present in the textual record. The inscription on a tablet found in the Persepolis Treasury records in Babylonian the metallurgical processing of different amounts of silver paid as tax by at least four individuals in the "nineteenth and twentieth years of 'Darius the King' (doubtless Darius the Great)," simultaneously specifying their devaluation in minas and shekels after refining.⁶⁹

In Babylonia, Achaemenid period texts attest to the scrutiny of even small quantities of silver on the basis of a predetermined standard, which is designated by the term *ginnu*.⁷⁰ In the texts, *ginnu* silver is sometimes

⁶⁴ See, e.g., the extant analyses of natural gold from Sardis which show a purity range between 65% and 85%, Craddock *et al.*, 1998, p. 115.

⁶⁵ Hdt. 3.95.

⁶⁶ Bernard, 1987, p. 180ff.; cf. Descat, 1995.

⁶⁷ Hdt. 3.94.

⁶⁸ See Craddock *et al.*, 1998, pp. 115, 117.

⁶⁹ Cameron, 1948, PT 85, pp. 4 and 200-3. Cf. Olmstead, 1948, pp. 189-90. The Persepolitan origin of the tablet, initially doubted by Cameron on account of its being written in Babylonian, as opposed to Elamite in which the rest of the tablets recovered from the Treasury are written, was subsequently defended by Stolper, 1984, p. 304.

⁷⁰ That the term *ginnu*, attested in cuneiform texts from the reign of Cyrus I through the end of the Achaemenid period, probably implied a "normal, standard alloy" seems to be accepted by most authorities: see, e.g., CAD (following Landsberger, 1930); Powell, 1978, p. 224; Moorey, 1994, p. 238; Joannès, 1994, pp. 139-40 and esp. 142: "on peut donc considérer...que l'argent 'poinçonné' [*ša ginnu*] était affecté

characterized as appropriate for commercial transactions (*ša nadānu [u] mahāri*, “for use in buying and selling”),⁷¹ and as shown on two occasions, was protected by royal law,⁷² something more or less expected if *ginnu* silver had the status of official currency.⁷³ One of the latter references specifically warns, moreover, that the “forming” or “casting” (the verb employed is, again, *pataqu*) of *ginnu* silver constituted “a serious crime against the king,”⁷⁴ presumably as opposed to the legality (or necessity?) of “forming” or “casting” other (unofficial?) silver.

d'une pureté connue car quantifiée.”). The scepticism of Reade, 1986, p. 85, as to whether *ginnu*, and indeed any of the qualifiers used of silver in cuneiform texts, actually denoted the quality of the metal, as opposed to its shape or appearance, seems to derive mainly from the apparent absence of indications for significantly contrasting grades of silver in the results of modern analyses of silver objects found in Mesopotamia. See, however, below pp. 260-5. It is by no means clear from the contexts in which the term *ginnu* is attested that it referred “to a mark actually stamped on the metal” or that the silver so designated would have been “of inferior quality, and only to be used as currency, not for the making of ingots (sic!) or silver objects” (e.g., Landsberger, 1930, p. 284; CAD, Joannès, 1994, p. 140). For Powell, 1978, p. 224, who also accepts the probability that *ginnu* denoted a mark, the term could refer to “silver which bears the stamp of the king,” thus “some type of coinage.” The etymology of *ginnu* remains difficult to establish (cf. Reade, 1986, p. 85). The CAD’s interpretation of *ginnu* silver as a “normal, standard” alloy implies an association with the Middle-Babylonian, Neo-Assyrian and Neo-Babylonian *ginû*, whose primary significance is “customary, normal, ordinary,” and whose uses encompass a semantic range analogous to that of Greek νομιζόμενα (i.e., “something sanctioned by custom or currency”). If actually derived from *ginû*, *ginnu* could be perceived as analogous to Greek νόμισμα. On the connotation of *nomisma* as “lawful,” “customary,” see Laroche, 1949, p. 232, and the recent commentary of Kurke, 1999, pp. 13-4 and n. 34.

⁷¹ CAD *ginnu* (b).

⁷² CAD *ginnu* (e). Cf. Powell, 1978, p. 224, Reade, 1986, p. 85, and, more recently, Joannès, 1994, pp. 139-40.

⁷³ A similar state concern over the quality of silver coinage in the Athenian sphere is documented by the inscription of a law of 375/4 B.C. from the Agora published by Stroud, 1974, pp. 157-199 (cf. Buttrey, 1979, pp. 33-45, and Figueira, 1998, pp. 537-47). The text mentions, among others, officials, who bore the title of *dokimastes* (a “tester” or “assayer”), and who were responsible for testing silver coins in the commercial quarters of the city and the Piraeus on a daily basis, and at the Bouleuterion on days when payments were due to the state. It further specifies the procedure to be followed for coins diagnosed as fake (three such categories are mentioned on ll. 10-1: “ὑπ[ό]χρακον] ἢ ὑπομόλυβδον ἢ κίβδηλον”) and punishments for those who might not comply with the decisions of the *dokimastai* as well as for the *dokimastai* themselves in the event of negligence of their duty. According to Stroud (1974, pp. 176-7), the office can be traced to at least as early as 398/7 B.C. However, the institution of state measures for the oversight of the quality of monetary silver from still earlier times is at least implied by written evidence on late-sixth- and fifth-century Athenian monetary practice and legislation: e.g., Aristotle, *Oeconomica* 1347a, and Pleket, 1964, no. 3 (Athenian decree[s] concerning money, weights and measures).

⁷⁴ CAD *ginnu* (e).

Darius' feud with Aryandes might supply another important instance from Egypt. In sequel to Darius' accomplishments in the domain of gold refining, Herodotus⁷⁵ reports that Aryandes, the Persian governor of Egypt, wishing to equal his monarch, did the same with silver, and that Aryandic silver (ἀργύριον...τὸ Ἀρυανδικόν) was renowned for its purity to Herodotus' time. Upon hearing of the undertaking, Darius, we are told, put Aryandes to death, "ostensibly for being a rebel." Whatever the 'true' causes of Aryandes' punishment or the political moral of the story,⁷⁶ Darius' swift reaction to a challenge against the quality of his silver in Egypt could still be said to imply the existence of a strict, empire-wide Achaemenid monetary policy.

Despite this latter observation, Achaemenid 'inclinations' in the context of silver refining are difficult to pin down. Suggestive though it may be of an Achaemenid unwillingness to compromise Achaemenid standards of silver quality,⁷⁷ the Persepolis Treasury tablet, if actually referring to activities taking place in Persepolis itself, would be our only explicit document on Achaemenid silver refining. It thus falls short of establishing the universality of the practice.⁷⁸ Furthermore, while our texts can be said

⁷⁵ Hdt. 4.166.

⁷⁶ For the different interpretations of the significance of the story offered so far, see Tuplin, 1989, pp. 61-82 (with a systematic presentation of earlier views); Howgego, 1995, pp. 46-7; Briant, 1996, p. 960; Kurke, 1999, pp. 68-80. The legitimacy of using Herodotus' testimony in this instance as evidence for Achaemenid practice would seem to be undermined by doubts cast upon the truth of the story on the grounds that the silver coinage — which in the usual interpretation of *argyron...Aryandikon* — was produced by Aryandes is not attested among numismatic finds and, at the same time, there is no evidence for the minting of coinage in Egypt prior to the fourth century B.C. (cf. Kurke, 1999, p. 69; earlier views along the same lines are summarized by Tuplin, 1989, pp. 62-3, [b] and [c], who, in contrast, defends the reality of Aryandic coinage). The point is, however, that Herodotus does not speak of Aryandes' coinage but of Aryandes' *argyron*, a term which does on occasion refer to coinage but which can equally mean just "silver," as is clearly indicated, among others, by the use of the analogous term *chryson* earlier in the same passage to designate the gold metal refined by Darius. So the passage need not imply that Aryandes actually minted coinage (cf. Martin Price's comment to Tuplin's paper in the Bordeaux discussion). However, even if he did (and, admittedly, the viability of this alternative would much depend upon whether or not Achaemenid silver coinage was minted in Egypt) one should not too readily assume that Aryandic coinage would be easily identifiable. The thought that Aryandes' *argyron* could refer to *sigloi* was initially expressed by Head, 1911, p. 845, and indeed, 'Aryandic' coinage need not have differed from standard Achaemenid silver issues in any other respect but its superior intrinsic value.

⁷⁷ Cf. Cameron's suggestion, 1948, p. 4, that "even this early (in his reign), Darius was unwilling to accept coinage(!) that was not full weight or was impure, and...he was endeavoring to call it in and replace it by the official standard of the realm."

⁷⁸ The numerous Babylonian references to refining (see, e.g., the recent review by Joannès, 1994, pp. 137-42) do little to remedy the lack of evidence since they do not

to imply a contrast between official (*ginnu*) and other kinds of silver in circulation, contrasting silver qualities have not been detected so far through the medium of modern chemical analysis.

In technical analyses of 14 silver articles of certain Achaemenid manufacture (i.e., of 11 Persian sigloi⁷⁹ and three of the inscribed phialai of Artaxerxes I bearing the formula “made in the [royal] house”⁸⁰), the degrees of purity of those objects ranges between 96.1% and 98.1% (Table I). Judging by those results, Persian silver would not appear to deviate significantly from that of other coins and objects that circulated in the Persian period.

The silver percentages of 14 analysed items from the Babylon hoard range between 95.3% and 98.9% (Table II, nos. 1-14).⁸¹ The same basic range is evident in the cases of another 24 objects of uncertain provenance from the territory of the empire cited by M.J. Hughes (Table II: nos. 15-24),⁸² of which, as Julian Reade points out, “only two ... had a silver content below 94.5 per cent, while the remainder averaged well over 96 per cent.”⁸³ Silver percentages between 95% and 99% are also common in analysed (non-Achaemenid) coinages of the archaic and classical periods.⁸⁴

A silver range of about 96% to 98% for Achaemenid silver objects, which were produced as a rule from recycled metal, might be thought of as a probable outcome of a ‘casual melting’ of the different silver alloys in circulation at the time, for which analyses indicate identical, or closely similar, degrees of purity.⁸⁵ On this evidence alone, the regular need for

relate explicitly to official Achaemenid practice (Matthew Stolper, personal communication, 23/6/1999).

⁷⁹ Gale *et al.*, 1980, pp. 16-7, Table 3 (Asyut hoard); Cowell, 1986, p. 89 (Babylon hoard); Caley, 1951 (Asia Minor?). Further analyses of Persian sigloi, said to have been “planned” and intended to be published by Carradice and Cowell (Cowell, 1986, p. 89), do not appear to have been published. Not included here are four nineteenth-century (and perhaps not as reliable) analyses of sigloi with 94%, 93%, 90.10% and 88.40% silver, cited by Caley, 1951 (reference from Reade, 1986, p. 86).

⁸⁰ Gunter and Jett, 1992, pp. 72-73; Curtis *et al.*, 1995, p. 150.

⁸¹ Hughes, 1986, p. 88.

⁸² Hughes, 1997, p. 59 and n. 1.

⁸³ Reade, 1986, p. 85f. The two exceptions are said to have been “a bowl, BM 117839, with 92.8 per cent, and the silver part of the ‘rhyton,’ BM 116411, with 81.75 per cent.”

⁸⁴ See esp. Gale *et al.*, 1980, pp. 14-21, Tables 3 and 4.

⁸⁵ Hughes, 1986, p. 88: “If the textual references to silver of different kinds at use in this period are to silver of different fineness, then the absence of clearly defined fineness ‘bands’ within the present (admittedly small) selection of material does not provide any link with the texts”; cf. Reade, 1986, p. 86: “Our Babylon *sigloi*...turn out to have a range of fineness between 98.1 per cent and 96.4 per cent silver, and

any large-scale refining of the Achaemenid revenues in the form of silver, to which Herodotus 3.96.2 appears to allude, can only be described as unproven. In the event, the Achaemenids may have been simply content to assay silver empirically as was presumably done in Athens.⁸⁶

On the other hand, the high silver percentages found in the above-mentioned objects may not constitute an accurate reflection of the range of silver qualities in circulation throughout the Achaemenid period. It is worth noting, for instance, the generally lower and more varied degrees of silver (89.4%-97.9%) in analysed objects from the Nush-i Jan hoard (Table III).⁸⁷ Although the burial date of the hoard is set between 650 and 575 B.C., and thus predates the Achaemenid period, the contents of the hoard might still evidence qualities of silver currency circulating in Iran (and possibly elsewhere) in the early years of the empire if not still later.⁸⁸

At the same time, assaying and refining were possibly not the only reasons that might have driven the Persians to submit incoming silver payments to metallurgical processing. Indeed, while closely comparable with regard to their silver content with other coins and vessels of the same period, the objects of Achaemenid provenance on Table I exhibit a characteristic peculiarity with regard to their copper contents: they all contain basically stable amounts of copper ranging between about 1.5% and 2.5%. Copper percentages in analysed contemporary 'eastern' objects from Babylon and elsewhere range from below 1% to above 5% (Table II).⁸⁹ In the case of Greek silver coinage, analyses indicate an even wider copper range, and even variable copper percentages for coins coming from the same mint.⁹⁰ Considerable variation is observed in the cases of the silver objects from the Nush-i Jan hoard as well.⁹¹ In Table III copper values are in the majority above 3% and reaching up to 9.5%.

their quality was therefore directly comparable with that of the scrap objects. Here again, then, there is no evidence for more than one standard."

⁸⁶ Above (n. 73). For possible "non-destructive" methods available to Athenian *dokimastai* for testing the quality of silver coinage, see Varoufakis, 1996, and *idem*, 1997.

⁸⁷ Hughes, 1986, p. 58, Table 1.

⁸⁸ For the date of the hoard, see Stronach and Roaf, 1978, pp. 10-1. Cf. the composition of fifth-fourth century silver from Egypt with only 82.1% silver (17.9% gold) in Lucas, 1989, pp. 491 (table) and 492 no. 17.

⁸⁹ Copper values between 0.10% and 1.00% are reported for the five analysed silver earrings from the Jordan hoard, now in the Ashmolean Museum, in Kraay and Moorey, 1968, p. 229.

⁹⁰ See, e.g., Kraay and Eumeleus, 1962, pp. 13-32; Gale *et al.*, 1980, pp. 14-21, Tables 3-4.

⁹¹ Hughes, 1986, p. 58 Table 1.

Table II: Achaemenid period silver of uncertain provenance.

No.	BM no.	Object	Method of analysis	% Silver	% Copper	% Lead	% Gold
1a	82-12-20, 24	Handle, winged bull	AA	98.3	1.10	0.49	n.a.
1b	82-12-20, 24	Handle, winged bull	XRF	98.1	1.10	0.60	0.30
2	82-12-20, 25	Earring	XRF	98.9	0.14	0.01	0.30
3	82-12-20, 27	Sheet	XRF	98.9	0.84	0.06	0.30
4	82-12-20, 28	Folded sheet	XRF	95.9	3.40	0.05	0.40
5	82-12-20, 29	Folded sheet	XRF	98.1	1.10	0.11	0.45
6	82-12-20, 30	Sheet	XRF	96.3	3.00	0.22	0.27
7	82-12-20, 32	Sheet	XRF	98.7	0.74	0.06	0.35
8	82-12-20, 33	Sheet fragment	XRF	97.7	1.31	0.48	0.38
9	82-12-20, 33	Bead (stuck to sheet)	XRF	95.6	2.40	1.20	0.46
10a	82-12-20, 34	Sheet (outer)	XRF	98.7	0.60	0.30	0.32
10b	82-12-20, 34	Sheet (inner)	XRF	95.8	2.70	0.85	0.57
11	82-12-20, 35	Sheet	XRF	95.3	3.61	0.46	0.55
12	82-12-20, 36	Sheet	XRF	98.1	1.11	0.06	0.60
13	82-12-20, 37	Sheet	XRF	95.6	3.47	0.35	0.44
14	83-1-18, 902	Ingot	XRF	98.9	0.26	0.13	0.49
15	123915	Animal's head terminal	AA	94.7	4.6	0.46	n.a.
16	123256	Bowl	XRF	97.5	1.8	0.2	0.6
17	123259	Bowl	XRF	98.2	1.2	0.2	0.4
18	124082	Bowl	AA	94.5	4.7	0.64	n.a.
19	123263	Scoop	AA	96.6	3.0	0.14	n.a.
20	123264	Scoop	XRF	97.4	2.2	0.04	0.5
21	123265	Cylindrical box	XRF	98.7	1.0	0.1	0.2
22	123265	Lid of above	XRF	96.5	3.0	0.1	0.4
23a	120450	Vase handle	AA	98.3	1.1	0.49	n.a.
23b	120450	Vase handle	XRF	98.1	1.1	0.6	0.3
24	117839	Bowl	AA	92.8	6.3	0.53	n.a.

Nos. 1-14: Babylon hoard (after Hughes, 1986, p. 88).

Nos. 15-24: Various provenances (after Hughes, 1984, p. 59 Table 2).

Table III : Silver from the Nush-i Jan (Iran) hoard buried *ca.* 650-575 B.C.

No.	BM no.	Object	Method of analysis	% Silver	% Copper	% Lead	% Gold
1	135077	Double spiral pendant no.3	XRF	96.2	3.2	0.11	0.29
2	135072	Quadruple spiral bead no. 8	XRF	97.4	2.1	0.06	0.20
3	135079	Quadruple spiral bead no. 20	XRF	97.3	2.2	0.08	0.29
4	135078	Quadruple spiral bead no. 33	XRF	89.4	9.2	0.22	0.68
5	135085	Finger-ring no. 38	XRF	91.3	7.7	0.51	0.16
6	135073	Spiral ring no. 54	XRF	95.0	4.4	0.13	0.25
7	135084	Spiral ring no. 63	XRF	97.9	1.6	0.10	0.28
8	135083	Ingot no. 92	AA	90.1	9.5	0.3	n.a.
9	135082	Ingot no. 93	AA	92.3	5.3	1.91	n.a.
10	135074	Lump no. 131	AA	93.7	4.6	1.05	n.a.
11	135075	Lump no. 132	AA	97.3	1.2	0.88	n.a.
12	135076	Sheet fragment no. 193	XRF	95.7	3.8	0.21	0.20

(After Hughes, 1984, p. 58, Table 1.)

A possibility that the degree of purity of the Achaemenid sigloi and vessels in Table I was the outcome of 'random'/'casual' mixing of the different silver alloys coming in as tax (presumably once that silver had passed at least some empirical control of quality by the official *dokimastai*) has already been alluded to. The probability that such a 'random' blending of various alloys in circulation could have also resulted simultaneously in the basically stable copper values of the Achaemenid silver coins and vessels in Table I would nevertheless seem to me to be remote.

The number of Achaemenid samples discussed here is admittedly very limited. From a statistical point of view, however, their testimony cannot be considered insignificant. Even if all Achaemenid sigloi were produced in western Asia Minor (Sardis), as is usually surmised,⁹² a provenance from the same 'mint' cannot easily be postulated for the three Artaxerxes

⁹² Yet "that certain later groups were produced in eastern Asia Minor, or indeed further East" is a viable possibility according to Carradice, 1987, p. 90.

phialai. Those three vessels, said to have been recovered at Ecbatana,⁹³ are of shapes widely produced throughout the empire and could have been made (and inscribed) at any Achaemenid capital or provincial center.

While the analysed objects could well represent at least two different (and geographically remote) 'mints', they equally span in all probability different regnal periods. The silver phialai of Artaxerxes I were almost certainly produced in the course of the reign of that monarch, thus between 465 and 425 B.C. Judging by current datings of the Asyut hoard as about 475 B.C. or "a few years later,"⁹⁴ the three analysed sigloi from that hoard would appear to have been minted either in Darius I's or Xerxes' reign. The type IIIb sigloi from the Babylon hoard could have been minted at any time between the 480's, when the type appears to have been introduced,⁹⁵ and the middle of the first quarter of the 4th century (reign of Artaxerxes II), when the hoard is estimated to have been buried.⁹⁶

The technical means by which the metallurgists of the Persians would have been able to regulate the copper percentages of Achaemenid silver, as well as the possible motives for a specific Persian preference for a silver alloy with *c.* 1.5% - *c.* 2.5% copper, remain open questions.⁹⁷ What does remain arresting, however, is the probability — at least on present, still limited evidence — that the silver which the Achaemenid authorities collected as tax must have been systematically submitted to a metallurgical process which aimed (however approximately) to meet specific Persian standards of composition for this precious metal.

⁹³ Herzfeld, 1935.

⁹⁴ Carradice, 1987, pp. 82-3.

⁹⁵ Carradice, 1987, p. 79.

⁹⁶ Robinson, 1950, p. 49.

⁹⁷ Simply put, we are not quite certain whether the metallurgists of the period would have been able to remove, first, all copper from the silver alloys and, then, add as much copper as was required to reach (approximately) the attested percentages; or if they would be merely able to remove copper down to a certain percentage, in this case to roughly 1.5% to 2.5% (James Muhly, personal communication). According to Robert Maddin (7/6/99, information kindly obtained and forwarded by James Muhly), "it would be exceedingly difficult to remove small amounts (on the order of one %) of Cu from Ag." According to Hughes' discussion of the results of analyses of samples from the Babylon hoard (1986, p. 88): "The items with copper over 2 per cent most probably represent a deliberate slight debasement of the silver with a small addition of copper...(items) containing over 1 per cent copper...might represent slightly less successful versions of 'pure' silver arising from variations in the refining process, or alternatively remelting and mixing of scrap silver of different qualities." The latter supposition, however, would still not account adequately for the overall consistent copper range of Achaemenid objects. For a later (Roman period) instance of adherence to a prescribed, standard silver/copper alloy in silver coinage regardless of mint, see Butcher and Ponting, 1995.

CLOSING REMARKS

This probe into the implications of the testimony of Herodotus 3.96.2 and related evidence on the handling of precious metals by Achaemenid authorities cannot claim, of course, to offer a definitive view on Achaemenid approaches to gold and silver quality standards. The foregoing observations would at least suggest, however, the need for continued attention to a subject which has the potential to contribute to our understanding of ancient monetary standards and practice in general, especially at a time when extensive analyses of ancient silver and gold are under way or planned for the near future.

Antigoni ZOURNATZI,
Research Centre for Greek and Roman Antiquity,
The National Hellenic Research Foundation,
48, Vassileos Constantinou Avenue,
11635 Athens. Greece.

BIBLIOGRAPHY

Abbreviations :

- BM : British Museum
Freer : Freer Gallery of Art
MMA : Metropolitan Museum of Art

- Alram, M., 1993, "Dareikos und Siglos. Ein neuer Schatzfund achaimenidischer Sigloi aus Kleinasien," in *Circulation des monnaies des marchandises et des biens*, R. Gysselen (ed.), Res Orientales V, Bures-sur-Yvette, pp. 23-53.
- Andrae, W., 1943, *Die Kleinfunde von Sendschirli*, Ausgrabungen in Sendschirli 5, Berlin.
- Balmuth, M., 1967, "The monetary forerunners of coinage in Phoenicia and Palestine," in *The Patterns of Monetary Development in Phoenicia and Palestine in Antiquity. Proceedings of the International Numismatic Convention, Jerusalem 1963*, A. Kindler (ed.), Tel Aviv, pp. 25-32.
- Bernard, P., 1987, "Les Indiens de la liste des tributs d'Hérodote," *Studia Iranica* 16, pp. 177-91.

- Bivar, A.D.H., 1971, "A hoard of ingot-currency of the Median period from Nûsh-i Jân, near Malayir," *Iran* 9, pp. 97-111.
- , 1982, "Bent bars and straight bars: an appendix to the Mir Zakah hoard," *Studia Iranica* 11, pp. 49-60.
- Bosworth, A.B., 1980, *A Historical Commentary on Arrian's History of Alexander*, Oxford.
- Briant, P., 1996, *Histoire de l'Empire perse. De Cyrus à Alexandre*, Paris.
- Burstein, S.M., (transl. and ed.), 1989, *Agatharchides of Cnidus. On the Erythraean Sea*, London.
- Butcher, K., and M. Ponting, 1995, "Rome and the East. Production of Roman Provincial Silver Coinage for Caesarea in Cappadocia under Vespasian, AD 69-79," *Oxford Journal of Archaeology* 14, pp. 63-74.
- Buttrey, T.V., 1979, "The Athenian Currency Law of 375/4 B.C.," in *Greek Numismatics and Archaeology: Essays in Honor of Margaret Thompson*, O. Mørkholm and N.M. Waggoner (eds.), Wetteren, pp. 33-45.
- CAD = *The Assyrian Dictionary of the Oriental Institute of the University of Chicago*, A.L. Oppenheim et al. (eds.), Chicago and Glückstadt, 1956 - .
- Caley, E.R., 1951, *Letter* (dated 16 July 1951), quoted by Noe, 1956, 21-2.
- Callataÿ, F. de, 1989, "Les trésors achéménides et les monnayages d'Alexandre: espèces immobilisées et espèces circulantes," in *L'Or perse et l'histoire grecque. Table ronde, CNRS, Bordeaux, 20-22 Mars 1989*, R. Descat (ed.), *Revue des études anciennes* 91:1-2, pp. 259-73.
- Cameron, G.G., 1948, *Persepolis Treasury Tablets*, Oriental Institute Publications LXV, Chicago.
- Carradice, I., 1987, "The 'Regal' Coinage of the Persian Empire," in *Coinage and Administration in the Athenian and Persian Empires. The Ninth Oxford Symposium on Coinage and Monetary History*, I. Carradice (ed.), BAR International Series 343, Oxford, pp. 73-107.
- Cary, H. (Rev.) (transl.), 1908, *Herodotus*, London.
- Cowell, M.R., 1986, "Preliminary note on analysis of *sigloi* in a hoard found at Babylon," *Iran* 24, p. 89.
- Craddock, P., N. Meeks, M. Cowell, A. Middleton, H. Duncan, A. Ramage and E. Geçkinli, 1998, "The refining of gold in the Classical World," in *The Art of the Greek Goldsmith*, D. Williams (ed.), London, pp. 111-21.
- Curiel, R., and D. Schlumberger, 1953, *Trésors monétaires d'Afghanistan*, Mémoires de la Délégation Archéologique Française en Afghanistan XIV, Paris.
- Curtis, J., 1984, *Nush-i Jan III. The Small Finds*, London.
- , 1997, "Introduction," in *Mesopotamia and Iran in the Persian Period: Conquest and Imperialism 539-331 B.C. Proceedings of a Seminar in memory of Vladimir G. Lukonin*, J. Curtis (ed.), London.
- Curtis, J.E., M.R. Cowell and C.B.F. Walker, 1995, "A silver bowl of Artaxerxes I," *Iran* 33, pp. 149-53.
- Dandamaev, M.A., and V.G. Lukonin, 1989, *The Culture and Social Institutions of Ancient Iran*, Ph.L. Kohl (ed.), Cambridge.

- Demetrius, *Elocutiones* = W. Rhys Roberts, ed., 1969, *Demetrius on Style*, Hildesheim (Cambridge, 1902).
- Descat, R., 1995, "Darius I^{er} et la monnaie," *Annali dell'Istituto Italiano di Numismatica* 42, pp. 9-20.
- Diod. = Vogel, F. (ed.), 1867-1906, *Diodori Bibliotheca Historica*, Leipzig.
- Dougherty, R.P., 1923, *The Goucher College Cuneiform Inscriptions*, vol. I, New Haven, Co., and London.
- Durrbach, F., 1929, *Inscriptions de Délos: Comptes des hiéropes (nos. 372-498); lois ou règlements, contrats d'entreprises et devis (nos. 499-509)*, Paris.
- Eissfeldt, O., 1937, "Eine Einschmelzstelle am Tempel zu Jerusalem," *Forschungen und Fortschritte* 13, May, pp. 163-4.
- Ferguson, W.S., 1932, *The Treasurers of Athena*, Cambridge, Mass.
- FGrHist* = Jacoby, F., 1923-58, *Die Fragmente der griechischen Historiker*, v.p.
- Figueira, T., 1998, *The Power of Money. Coinage and Politics in the Athenian Empire*, Philadelphia.
- Gale, N.H., W. Gentner and G.A. Wagner, 1980, "Mineralogical and Geographical Silver Sources of Archaic Greek Coinage," *Metallurgy in Numismatics I*, D.M. Metcalf and W.A. Oddy (eds.), London, pp. 3-49.
- Godley, A.D. (transl.), 1971, *Herodotus*, The Loeb Classical Library, London and Cambridge, Mass.
- Golani, A. and B. Sass, 1998, "Three Seventh-Century B.C.E. Hoards of Silver Jewelry from Tel Miqne-Ekron," *Bulletin of the American Schools of Oriental Research* 311, pp. 57-81.
- Gopher, A., T. Tsuk, S. Shalev and R. Gophna, 1990, "Earliest Gold Artifacts in the Levant," *Current Anthropology* 31, pp. 436-443.
- Greene, D. (transl.), 1987, *The History of Herodotus*, Chicago and London.
- Gunter, A.C., and P. Jett, 1992, *Ancient Iranian Metalwork in the Arthur M. Sackler Gallery and the Freer Gallery of Art*, Washington D.C.
- Gunter, A.C., and M.C. Root, 1998, "Replicating, Inscribing, Giving: Ernst Herzfeld and Artaxerxes' Silver *Phiale* in the Freer Gallery of Art," *Ars Orientalis* 28, pp. 3-38.
- Halleux, R., 1974, *Le problème des métaux dans la science antique*, Paris.
- Hdt. = Hude, C. (ed.), 1927, *Herodoti Historiae*, 3rd edn., Oxford.
- Head, B.V., 1911, *Historia Numorum*, 2nd enlarged edn., Oxford.
- Henning, W.B., 1956, "The 'coin' with cuneiform inscription," *Numismatic Chronicle* 6th series, 16, pp. 327-8.
- Herzfeld, E., 1935, "Eine Silberschüssel Artaxerxes' I," *Archäologische Mitteilungen aus Iran* 7, pp. 1-8.
- , 1937, "Die Silberschüsseln Artaxerxes' des I, und die goldene Fundamenturkunde der Ariaramnes," *Archäologische Mitteilungen aus Iran* 8, pp. 5-17.
- Hesychius = Schmidt, M. (ed.), 1965, *Hesychii Alexandrini lexicon*, vol. 2, Amsterdam (Jena 1860).
- Howgego, C.J., 1990, "Why did the ancient states strike coins?," *Numismatic Chronicle* 150, pp. 2-25.
- , 1995, *Ancient History from Coins*, London.

- Hughes, M.J., 1984, "Analyses of silver objects in the British Museum," in Curtis, 1984, pp. 58-60.
- , 1986, "Analysis of silver and gold items in a hoard found at Babylon," *Iran* 24, pp. 87-8.
- Hulin, P., 1972, "An inscribed piece of Darius," *Orientalia Lovaniensia Periodica* 3, pp. 121-4.
- IG II²* = Kirchner, J. (ed.), 1927, *Inscriptiones Graecae*, Vols. II-III, Editio Minor, Pars II, Fasc. I, Berlin.
- Joannès, F., 1994, "Métaux précieux et moyens de paiement en Babylonie achéménide et hellénistique," *Transeuphratène* 8, pp. 137-44.
- Kent, R.G., 1953, *Old Persian: Grammar, Texts, Lexicon*, 2nd edn., American Oriental Series 33, New Haven, Co.
- Kraay, C.M., 1964, "Hoards, small change and the origin of coinage," *Journal of Hellenic Studies* 84, pp. 76-91.
- Kraay, C.M., and V.M. Eumeleus, 1962, *The composition of Greek silver coins*, Oxford.
- Kraay, C.M., and P.R.S. Moorey, 1968, "Two Fifth Century Hoards from the Near East," *Revue Numismatique*, VI^e Sér., X, pp. 181-235.
- , "A Black Sea Hoard of the late fifth century," *Numismatic Chronicle* 141, pp. 1-19.
- Kraeling, E.G., 1953, *The Brooklyn Museum Aramaic Papyri. New Documents of the Fifth Century B.C. from the Jewish Colony at Elephantine*, New Haven, Co.
- Kroll, J.H., 1998, "Silver in Solon's Laws," in *Studies in Greek Numismatics in Memory of Martin Jessop Price*, R. Ashton and S. Hurter (eds.), in association with G. Le Rider and R. Bland, London, pp. 225-32.
- Kurke, L., 1999, *Coins, Bodies, Metals, and Gold. The Politics of Meaning in Archaic Greece*, Princeton.
- Landsberger, B., 1930, "Bemerkungen zu San Nicolò und Ungrad, Neubabylonische Realitäts- und Verwaltungsurkunden, Bd. I I.2," *Zeitschrift für Assyriologie und Vorderasiatische Archäologie* 39, pp. 277-94.
- Laroche, E., 1949, *Histoire de la racine nem- en grec ancien*, Paris.
- Legrand, Ph.-E. (transl.), 1967, *Hérodote, Histoires Livre III*, 4th edn., Association Guillaume Budé, Paris.
- Le Rider, G., 1998, "Le début du monnayage achéménide: continuation ou innovation?" in *Light on Top of the Black Hill. Studies presented to Halet Çambel*, G. Arsebük, M.J. Mellink and W. Shirmer (eds.), Istanbul, pp. 663-73.
- Littlebury, I. (transl.), 1824, *The History of Herodotus*, Oxford.
- LSJ* = Liddell, H.G., and R. Scott, 1978(1940), *A Greek-English Lexicon*, 9th edn., revised by H. Stuart Jones (1925-40), Oxford.
- Lucas, A., 1989, *Ancient Egyptian Materials and Industries*, 4th edn., rev. by J.R. Harris, London.
- Macauley, G.C. (transl.), 1890, *The History of Herodotus*, vols. I-II, London and New York.
- Manetho = Koechly, A. (ed.), 1858, *Manethonis Apotelesmaticorum*, Leipzig.
- Martin, T.R., 1985, *Sovereignty and Coinage in Classical Greece*, Princeton, New Jersey.
- Moorey, P.R.S., 1974, *Ancient Persian bronzes in the Adam Collection*, London.

- , 1988, "Aspects of life and crafts," *The Cambridge Ancient History: Plates to Volume IV*, Cambridge.
- , 1994, *Mesopotamian Materials and Industries. The Archaeological Evidence*, Oxford.
- Muscarella, O.W., 1980, "Excavated and Unexcavated Achaemenid Art," in *Ancient Persia: The Art of an Empire*, D. Schmandt-Besserat (ed.), Malibu, Ca., pp. 23-42.
- "New insights into the transition from *Hacksilber* to coinage," 1998, abstracts of the papers presented in the colloquium, *American Journal of Archaeology* 102, pp. 402-403.
- Noe, S.P., 1956, *Two Hoards of Persian Sigloi*, American Numismatic Society. Numismatic Notes and Monographs 136, New York.
- Nylander, C., 1968, "Assyria grammata: remarks on the 21st letter of Themistokles," *Opuscula Atheniensia* 8, pp. 119-36.
- Olmstead, A.T., 1948, *History of the Persian Empire*, Chicago.
- Oppenheim, A.L., 1947, "A Fiscal Practice of the Ancient Near East," *Journal of Near Eastern Studies* 6, pp. 116-120.
- Pleket, H.W., 1964, *Epigraphica*. Vol. I, *Texts on the Economic History of the Greek World*, Leiden.
- Pollux, *Onomasticon* = Bethe, E. (ed.), 1967, *Pollucis Onomasticon*, vols. 1-3, *Lexicographi Graeci* 9, Stuttgart.
- Powell, J.E. (transl.), 1949, *Herodotus*, vols. I-II, Oxford.
- Powell, M.A., 1978, "A Contribution to the History of Money in Meopotamia prior to the Invention of Coinage," *Festschrift Lubor Matuš II*, B. Hruška and G. Komoróczy, (eds.), Budapest, pp. 211-43.
- Price, M., 1989, "Intervention," to Tuplin 1989, in *L'Or Perse et l'Histoire Grecque*, R. Descat (ed.), *Revue des études anciennes* 91: 1-2, pp. 166-7.
- Price, M., and N. Waggoner, 1975, *Archaic Greek Coinage: The Asyut Hoard*, London.
- Ramage, A., and S.M. Goldstein, 1983, "Goldworking installations and techniques: Lydian gold industry at Sardis," in *Sardis from Prehistoric to Roman Times. Results of the Archaeological Exploration of Sardis 1958-1975*, G.M.A. Hanfmann and W.E. Mierse (eds.), Cambridge, Mass., pp. 26-52.
- Rawlinson, G., (transl.), 1942 (1875), *Herodotus. The Persian Wars*, with an introduction by R.B. Godolphin (1942), New York.
- Reade, J., 1986, "A hoard of silver currency from Achaemenid Babylon," *Iran* 24, pp. 79-87.
- Regling, K., 1926, "Geld," in *Reallexikon der Vorgeschichte*, vol. IV, M. Ebert (ed.), Berlin, pp. 204-38.
- Robinson, E.S.G., 1950, "A 'silversmith's hoard' from Mesopotamia," *Iraq* XII, pp. 44-51.
- Sancisi-Weerdenburg, H., 1989, "Gifts in the Persian Empire," in *Le Tribut dans l'Empire Perse. Actes de la Table ronde de Paris, 12-13 Décembre 1986*, P. Briant and C. Herrenschild (eds.), *Travaux de l'Institut d'Études Iraniennes de l'Université de la Sorbonne Nouvelle* 13, Paris, pp. 129-46.
- Schlumberger, D., 1953, "L'argent grec dans l'empire achéménide," in Curiel and Schlumberger, 1953.

- Schmidt, E.F., 1953, *Persepolis I. Structures, Reliefs, Inscriptions*, Oriental Institute Publications LXVIII, Chicago.
- Sélincourt, A. de, (transl.), 1996(1954), *Herodotus. The Histories*, revised with introductory matter and notes by J. Marincola (1996), Benguin Books.
- Stolper, M.W., 1984, "The Neo-Babylonian text from the Persepolis Fortification," *Journal of Near Eastern Studies*, 43, pp. 299-310.
- Strassmaier, J.N., 1889, *Inschriften von Nabonidus, König von Babylon (555-538 v. Chr.) von den Thontafeln des Britischen Museums, copirt und autographirt von J.N. Strassmaier*, Babylonische Texte 1-4, Leipzig. (not seen)
- , 1890, *Inschriften von Cambyses, König von Babylon (529-521 v. Chr.) von den Thontafeln des Britischen Museums, copirt und autographirt von J.N. Strassmaier*, Babylonische Texte 8-9, Leipzig. (not seen)
- Stronach, D., 1968, "Tepe Nush-i Jan: a mound in Media," *The Metropolitan Museum of Art Bulletin* XXVII (33 Nov. 1968), pp. 177-86.
- Stronach, D., and M. Roaf, 1978, "Tepe Nush-i Jan, 1970: second interim report," *Iran* 11, pp. 129-40.
- Stroud, R.S., 1974, "An Athenian Law on Silver Coinage," *Hesperia* 43, pp. 157-199.
- Thompson, Ch.M., 1999, "A new look at Barrekub's treasure: Silver from Zinjirli," *Minerva* 10:2, pp. 48-50.
- TGL = Estienne, H., 1954, *Thesaurus Graecae Linguae*, Graz.
- Torrey, Ch., 1936, "The Foundry of the Second Temple at Jerusalem," *Journal of Biblical Languages and Literature* LV, pp. 247-60.
- , 1943, "The evolution of a Financier in the Ancient Near East," *Journal of Near Eastern Studies* 2, pp. 295-301.
- Tuplin, Ch., 1987, "The Administration of the Achaemenid Empire," in *Coinage and Administration in the Athenian and Persian Empires. The Ninth Oxford Symposium on Coinage and Monetary History*, I. Carradice (ed.), BAR International Series 343, Oxford, pp. 109-66.
- , 1989, "The coinage of Aryandes," in *L'Or Perse et l'Histoire Grecque*, R. Descat (éd.), *Revue des études anciennes* 91: 1-2, pp. 61-82.
- Varoufakis, 1996, "Non-destructive tests of attic silver coins in antiquity," *Proceedings of the first joint Belgian-Hellenic Conference on Non Destructive Testing, Patras, Greece, 22-23 May 1995*, D. van Hemelrijck and A. Anastassopoulos (eds.), Rotterdam, pp. 3-10.
- , 1997, "Ο έλεγχος ποιότητας και η προστασία του καταναλωτή στην αρχαιότητα," *Ancient Greek Technology. Proceedings of the First International Conference, Thessaloniki 4-7 September 1997*, Thessaloniki, pp. 141-6.
- Vickers, M., 1984 [1990], "Demus' Gold *Phiale* (Lysias 19.25)," *American Journal of Ancient History* 9, pp. 48-53.
- , 1990, "Golden Greece: Relative Values, Minae, and Temple Inventories," *American Journal of Archaeology* 94, pp. 613-25.
- Waterfield, R. (transl.), 1998, *Herodotus "The Histories"*, with an introduction and notes by C. Dewald, Oxford-New York.
- West, M.L., (ed.), 1966, *Hesiod, "Theogony"*, Oxford.

- Zaccagnini, C., 1989, "Prehistory of the Achaemenid tributary system," in *Le Tribut dans l'Empire Perse. Actes de la Table ronde de Paris, 12-12 Décembre 1986*, P. Briant and C. Herrenschildt (eds.), Travaux de l'Institut d'Études Iraniennes de l'Université de la Sorbonne Nouvelle 13, Paris, pp. 193-215.
- Zournatzi, A., 1999, "Ηρόδοτος 3.96.2 και ο έλεγχος της ποιότητας του χρυσού και του αργύρου στην αυτοκρατορία των Αχαιμενιδών Περσών," in *Chemistry and Systems of Quality in Production and Control. Proceedings of the 6th Congress of Chemistry of Greece and Cyprus, Rhodes 2-5 September 1999*, Athens, pp. 530-4.
- , "Inscribed Silver Vessels of the Odrysian Kings: Gifts, Tribute and the Diffusion of the Forms of 'Achaemenid' Metalware in Thrace," *American Journal of Archaeology* (forthcoming).