

Métallurgie susienne I: De la fondation de Suse au XVIII^e siècle avant J.-C. (1) et (2). By FRANÇOISE TALLON. Musée du Louvre, Département des Antiquités Orientales, Notes et Documents des Musées de France 15. Paris: Ministère de la Culture et de la Communication, Editions de la Réunion des Musées Nationaux, 1987. Pt. 1, pp. 416 + figs.; pt. 2, figs. + pls. 500 francs (both pts.).

This monograph, based on a doctoral dissertation, will certainly be most welcome to students of early material culture in Mesopotamia and of early metallurgy in particular. It has

long been felt that the body of evidence from Mesopotamia is inadequate to assess the extent of the early metal industry in this region. It has even been suggested that metal played virtually no role in the social and economic development in Mesopotamia prior to the third millennium B.C. Indeed, in southern Mesopotamia there are no metal finds known from the Ubaid period but only baked clay forms, which may or may not imitate metal tools. Metal objects from the Proto-literate period are rare and generally small.

It is against this background that the inventory of metal finds from Susa stand out as exceptional. They have long been known and mentioned but Tallon's book is the first complete description and study of the Louvre collection from Susa comprising 1,337 metal objects. The work consists of two volumes, one containing a catalogue and illustrations of the objects (most of them detailed drawings) and one containing the text and a contribution by J.-M. Malfoy and M. Menu of the Louvre research laboratories on the chemical analyses, which were performed on about a third of the objects.

The text can be roughly divided into three parts: first, an introduction with an account of the chronology and the archaeological context of Susa is given. Here Tallon describes and justifies her division of the stratigraphic record into five main periods starting with Susa I, somewhere around 4000 B.C., and ending with Susa V, contemporary with the Third Dynasty of Ur. This chronological framework, which is based on the deep soundings "Acropole I" by A. Le Brun and "Ville Royale I" by E. Carter, appears convincing and is obviously intended to replace earlier periodizations such as "Susa A to D" by L. Le Breton (in *Iraq* 19 [1957]:79-124) and the rather rough dates given by R. de Mecquenem in his excavation reports (also in *MDP* 25 [1934]: 99-132).

Surprisingly, in the second part of the text this new chronology is never used. This part essentially consists of a typological study where Tallon largely follows Deshayes (*Les Outils de bronze de l'Indus au Danube, IV^e au II^e millénaire* [Paris, 1960]) with several amplifications and regroupings. An admirable wealth

of typological parallels from the literature is given for each type of artifact. In most cases, however, the non-specialist will be missing a summarizing statement referring to the date of an object in terms of the chronological system introduced at the beginning. Even turning to the catalogue in the second volume does not help because there only the stratigraphic dating (in quotes) by the excavator (in most cases Mecquenem), and a reference to the excavation notebooks is cited. This is all the more surprising since in the introduction Tallon mentions that these notes are sometimes inconsistent. Since the excavations began at the end of last century when excavation techniques were not comparable to modern standards, the stratigraphic state of many objects cannot be reconstructed in great detail. In such a situation, one would expect the incomplete record to be supplemented through the typological study as far as possible. Instead, Tallon supplies only typological parallels and leaves the final judgment entirely to the reader. This is not to say that she does not make up her mind herself. In the third and best part of the book she summarizes the evidence for the evolution of metallurgical techniques at Susa in the fourth and third millennia B.C. Here she takes up her chronological system and mentions catalogue numbers of objects belonging to a certain period. But this is done in a somewhat casual way, and it is not always clear if the numbers given are exhaustive for each period or if they designate merely objects typical for a certain period. Thus it is not easy to sum up the number of objects designated to each period. In the appendix a number of analyses is given for each period. For instance, from Susa IV, 184 objects have been analyzed (Table G), but only 111 of those are assigned to one of three subperiods in the same table. Are the remaining ones only generally dated to Susa IV? This may be so, but it is impossible to find this out from the text. The impression prevails that the sections of the book stand isolated and are hardly intertwined, which makes it rather hard to work with.

The summary makes clear how impressive the inventory of metal objects from Susa is compared with southern Mesopotamia. There

are 70 pieces from Susa I (Terminal Ubaid, around 4000 B.C.) and about 110 from Susa II and III (Uruk and Jamdat Nasr periods in Mesopotamian terms). Tallon also correctly points out that not only the number but also the size of these objects from the fourth millennium B.C. is exceptional. While contemporary sites mainly yielded small pins and chisels, the finds from Susa I are largely flat axes and mirrors, the largest of which possibly approach one kilogram in weight. Incidentally, weights are rarely given in typological studies except for precious metals. However, in discussing metallurgical techniques and the relative importance of various sites for early metallurgy, this is certainly an informative parameter, which can be very easily obtained. Tallon argues that a quantitative assessment of the total amount of metal at Susa cannot be made because the Louvre collection contains only part of the finds. According to Mecquenem, some 300 kg of metal were found belonging to the periods up to Ur III. Nevertheless, even what is left from the fourth millennium B.C. probably far exceeds the adjacent regions in quantity.

Regarding metallurgical techniques, the copper tools of Susa I most likely have been cast in open moulds, and Tallon argues that they have actually been used and do not represent any form of ingots. She also notes that the latest objects of this period from the transitional phase to Uruk show a clear improvement in the production technique in that they are furnished with shaftholes. There also appears to be a change in metal composition from relatively pure copper to copper containing up to 4.2 percent lead.

Tallon suggests that the earlier objects consist of native copper, and she refers to T. Berthoud's thesis ("Etude par l'analyse des traces et la modélisation de la filiation entre minerais de cuivre et objets archéologiques du Moyen-Orient (IV^e et III^e millénaires avant notre ère)") [Paris, 1979], who maintains that this copper came from Anarak in central Iran. This may well be so, but the time has not yet come and indeed may never come at all to make affirmative statements on the provenance of copper based on trace element analysis. It is

even difficult, if not impossible, to distinguish between native copper and copper smelted from pure ores after it has been melted and cast. Nevertheless, it is uncommon for native copper to contain lead in the percent range so that some of the earlier objects from Susa may well be of smelted copper, with lead being an accidental impurity.

A second point has to be mentioned. The strength of physico-chemical analysis is the *exclusion* of certain raw materials and ore deposits. If the composition of an artifact resembles an ore deposit, it does not necessarily mean that it derives from there. Anarak is certainly a likely source for early copper metallurgy in Iran and possibly Mesopotamia, but the metallogenic map of Iran shows numerous ore deposits in the Zagros mountains which could perhaps be equally reasonable sources but have not yet been investigated.

Metallurgically, Susa II/III is also very interesting. Not only is there a greater diversity in shapes, but, in addition, a new metal type is introduced, arsenical copper. Although only one-fourth of the finds from this period have been analyzed, it is clear that on average they show the largest arsenic contents of all periods. This development is in accord with other regions in southwest Asia and probably reflects the need for a harder material than pure copper. Again, surprisingly, high lead concentrations are reported for these objects (more than 5 percent in seven out of 28 analyzed objects). Most likely this is still an accidental admixture from the ore and may point to the possibility that copper was associated with lead ores. Such mixed deposits are the most frequent type of ore deposits in the Zagros mountains, with lead mostly being economically predominant today. For ancient economic standards, however, copper may be present in sufficient amounts to support a regional metal production. Accordingly, such mixed deposits must be included in the discussion on possible ore sources for southwest Iran and Mesopotamia. So far, only a few copper deposits have been investigated in this respect in Iran.

Besides copper, other metals begin to appear at Susa in the late Uruk period (late Susa II): a vase and four bowls made of lead,

a few small pendants with silver and a small dog-shaped gold pendant weighing 2.3 grams. These are very fine and delicate works, which demonstrate the mastering of a variety of metallurgical techniques, possibly the earliest evidence so far, including soldering of gold. As with copper, for these metals Tallon favors a provenance from Iran.

The following Jamdat Nasr and Early Dynastic I and II periods (Susa IIIB and IIIC) are not well represented. Metal finds are rare and only two were analyzed. Tin bronze appears only at the end of Susa IVA (contemporary with Early Dynastic IIIB) but does not prevail. Even during Susa V (Ur III and later) only about half of the metal objects contain more than 1 percent tin. Arsenical copper and a ternary alloy of copper, arsenic, and lead is still in use. In this respect, there is much similarity to southern Mesopotamia, in accord with the stylistic parallels during this period.

Apart from the introduction of tin bronze, the major change in Susa IV according to Tallon is the importation of copper from Oman instead of Iran. Once more she cites Berthoud as a source but again this conclusion appears premature at best. Archaeologically this change appears entirely reasonable, but I would hesitate to regard the case as scientifically proven. It has not yet been convincingly demonstrated that one can distinguish by chemical analysis the cupriferous regions of Oman, Cyprus, and Ergani Maden, all of which are found in similar geological environments.

The contribution by J.-M. Malfoy and M. Menu in the appendix does not add much information beyond an earlier article (T. Berthoud, S. Cleuziou, L. P. Hurtel, M. Menu, and C. Volkofsky, *Paléorient* 8/2 [1982]:39-54) but, in fact, mainly creates confusion. There is almost no information on the methods used to obtain the compositional data. It seems that several different instruments for optical emission spectrometry have been used, but one would like to know how they compare in precision and accuracy and how they compare with Berthoud's data, which have been accomplished by spark source mass spectrometry. This is important for the discussion of alloys because the latter method can hardly distin-

guish between, for example, 2 and 4 percent arsenic, which may be metallurgically quite significant. A casual comparison with Berthoud's thesis suggests that some of his analyses have been included in the catalogue and from the footnote of Table G one even gets the impression that all analyses are by spark source mass spectrometry. On the other hand, in the table of analyses, copper contents are given up to a ridiculous six digits, although copper has obviously not been measured but added up to 100 percent.

Coming to the number of analyses, Malfoy and Menu use a total of 479 analyzed objects in their tables and discussion. If one takes the trouble to count the number of analyses in their catalogue, one arrives at a total of 487. Some of those are duplicate and multiply analyses of the same object (with the same method?), so that one is left with 440 analyzed objects. In the article in *Paléorient*, 452 analyzed objects from Susa are discussed, of which 131 have not been dated with certainty. It is not possible to identify these samples individually (see above). Already with some despair one turns to the text and finds two scatter plots of the analyses from Susa IV using principal components. No information is given on the data base, the statistical method used, or the treatment of missing values. In fact, the plots are not even discussed, which makes it unnecessary to comment on the use and misuse of multivariate statistical techniques in provenance determination of archaeological objects.

In summary, the principal merit of this book is the comprehensive publication of the important corpus of metal objects from Susa in the Louvre collection with meticulous illustrations and a detailed typological study. It documents a close similarity of the pattern of metallurgical evolution with southern Mesopotamia and the Deh Luran plain. This can be deduced from the typological study and the compositional analyses. It may be possible to extract more information on fabrication techniques and provenance of raw materials from these objects by metallurgical, chemical, and lead isotope studies, especially when more comparative data from other sites can be included in

the discussion. Such technical studies are announced for the future and will certainly be a most valuable supplement to the present volume.

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