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THE METALWORKING INDUSTRY IN IRAN IN THE EARLY ISLAMIC PERIOD

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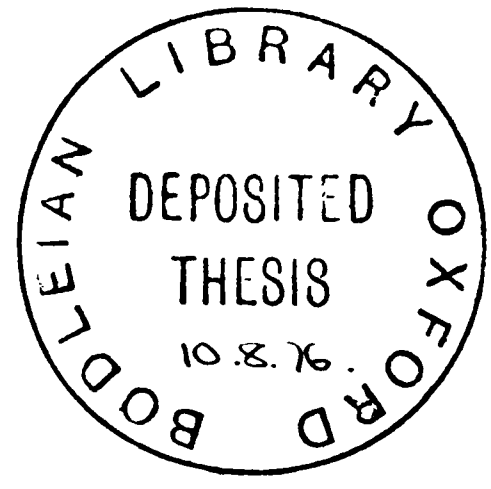
VOLUME I



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ABSTRACT

Although there are a few general surveys of early Islamic metalwork, and numerous detailed studies of particular objects or object groups, no comprehensive study of the metalworking industry in Iran in early Islamic times has yet been written. This thesis aims to provide that study first by assembling as much as possible of the basic information on metalworking in Iran from the Islamic conquests to the mid 13th century and then by using it to draw some general conclusions about the range and history of Iran's metalworking industries at this time.

The primary sources used are the references to metals and metalworking in early Islamic literature and the surviving objects. For technical information and for select vocabularies of the relevant Arabic and Persian terminologies the technical treatises of al-Hamdānī, al-Birūnī, Naṣīr al-Dīn Ṭūsī, and Abū'l-Qāsim al-Kāshānī have been particularly exploited. For the names and functions of particular objects or object groups a range of Arabic non-technical works has been searched. For the gazetteers and general discussions of metal sources Arabic and Persian geographical works have been utilised.

The objects catalogued and discussed here include all the published pieces known to the author, together with unpublished objects in the British Museum, the Victoria and Albert Museum, the Ashmolean Museum (including Sīrāf excavation material), the Musée du Louvre in Paris (including Susa excavation material), the Museum für Islamische Kunst Berlin-Dahlem, the Staatliche Museum in East Berlin, the Museum für Kunst und Gewerbe in Hamburg, the Philadelphia University Museum (including the Rayy excavation material), the Walters Art Gallery, the Freer Gallery of Art, the Metropolitan Museum of Art (including the

Nīshāpūr excavation material), and the Boston Museum of Fine Arts. All objects have been arranged in groups on the basis of metal, function, and form, and catalogued accordingly, and an overall dating and provenancing for each group has been established through reference to their decoration, including inscriptions where relevant, and archaeological data. Additional use has been made of analyses undertaken by the Metropolitan Museum of Art, the British Museum, the Musée du Louvre, and the Ashmolean Museum, plus a limited number of other published analyses: all these are included in a single Table.

The thesis is divided into three sections. In Section 1 mercury, gold and silver are each treated separately. Particular emphasis is given to the sources of the metals, the methods used for their production, and to their movement as items of trade within Iran and between Iran and other lands. In the second chapter of this section the objects are discussed under four main headings: Household Equipment; Personal and Cosmetic Articles; Weapon Fittings; Unidentified Objects. In conclusion it is suggested that technologically there were no important developments in the exploitation of precious metals in early Islamic times, though the early Islamic texts are important as the first surviving detailed descriptions of many of the techniques used. The repertory of shapes is similar to that used in Iran in pre-Islamic times, but certain forms were much more widely produced than before. The period is notable for the emphasis on colour in the decoration of silver objects.

In Section 2 the non-ferrous base metals are discussed. The source of tin is shown to have been almost exclusively south-east Asia, and care is taken to distinguish the terminology used for tin and lead in the various sources cited. The various possible meanings of the word <u>sufr</u> in the texts are also established. The extensive sources of lead in Iran are emphasised, as too the local nature of medieval lead production,

and a similar situation is shown to have existed with regard to copper. The textual references to the production of zinc oxide and the various possible meanings of tūtīyā are surveyed. Analyses are then used to identify various copper alloys mentioned in the texts. Thus safīdruy is high tin bronze, khār ṣīnī probably refers to the high tin bronze with a small lead content used by Chinese metalworkers, and it is suggested that ḥadīd ṣīnī and ṭālīqūn are synonyms for the latter. The further identification of batruy as lead bronze and of shabah mufragh as a quaternary alloy of copper, lead, zinc and tin suggest that no distinction was made in medieval Islamic terminology between copper and low tin bronze. It is suggested that this may have some bearing on the use of the word ṣufr in many of the sources. In the final part of the chapter discussion of kuḥl, ithmid and surma shows that these substances, far from being antimony, are in fact lead minerals. Brief comments on arsenic, nickel, cobalt and chrome show that these metals were not isolated by early Islamic craftsmen nor deliberately added to other alloys.

In the second chapter, the surviving bronze objects are discussed under the headings Household and Business Equipment (Items connected with Food and Drink, Ablutions Equipment, Lighting Equipment, Measuring Equipment, Writing Equipment, Furniture, Ornamental); Personal and Cosmetic Articles; Scientific Instruments; Tools, Weapons and Musical Instruments; Horse-harness; Architectural, Furniture and Object Fittings; Unidentified Objects. A short section on Lead Objects is appended. Included in these discussions are comments on the hot forging and casting of high tin bronze, the dependency of early high tin bronze objects upon Soghdian silversmithing traditions, and the construction of complex sheet metal objects. In a separate section on techniques the methods used for the casting of other copper alloys and for inlay work are

examined. It is suggested that green sand moulding was introduced to Iran from China c. 1100 A.D. and that the arrival of that technique was one of the reasons for the rapid spread of relief cast bronze mirrors in the 12th century.

The conclusion to Section 2 highlights the origins of the forms used by bronze metalworkers, thereby stressing the Graeco-Roman legacy to be found in Islamic Iran. The limited interplay between crafts is also noted. It is then shown how the survey of objects brings to light the relationships between different alloys within the bronze industry, and the relationships between different metalworking areas within Iran. These latter include 10th-11th century Sīstān, 10th-11th century Khurāsān, 12th-13th century Sīstān, 12th-13th century Khurāsān, and 13th century north-western Iran. The roles of early ʿAbbāsid Mesopotamia and of Transoxania throughout the period are also considered, and the lack of information about the metalworking industry of Jibāl is noted. The sheet bronze industry is then examined and it is concluded that its rise c. 1100 A.D. was not directly due to the ascendancy of the merchant class but rather to a shortage of silver in eastern Islam beginning in about 1075 A.D. This forced silversmiths to move over to bronze and brass, where they reproduced their traditional sheet metal shapes and reutilised their traditional decorative techniques. In the process they not only raised the sheet bronze industry of Iran from obscurity to eminence but also greatly influenced the style of decoration used for cast bronze objects, and the decoration of 12th-13th century bronzes in general, which is strikingly different from the styles which went before, may now be seen as various amalgamations of the designs used on the earlier silver products of western and north-eastern Iran.

In the first chapter of Section 3 the sources of iron in early Islamic Iran are considered, and the various types of iron and steel mentioned in the relevant texts including shāburqān, narm-āhan, and fūlādh are then discussed at length. The second chapter is divided into four parts. The first includes a thorough survey of what is known of early Islamic damascening and brings to light certain details previously unnoticed. The second part deals with the history of sword manufacture and design, making particular use of al-Kindī's letter on the subject. The most important conclusions of this study are that the late Sasanian twin-mount style became the dominant suspension system for swords of the Islamic period, that the Soghdian suspension system and scabbard style also influenced the north-east of Iran for at least two centuries after the Arab conquest of Soghdia, and that the curved sword, known as the qalāchūrī, was probably first used in Iran by the Ghaznavids in the late 10th century having reached their domains via the Qarakhānids from Central Asia. The forms and history of other arms and armour are next discussed, and the fourth and final part of the chapter deals with other objects known either from archaeological excavation or from mention in the literature. In conclusion it is shown that apart from the possible use of cast iron in the making of steel no new techniques are to be attributed to the smiths of early Islamic Iran. Their main claim to fame lies rather in the quantity and quality of their products. The one is visible in the enormous numbers of swords, arms and armour produced in Transoxania and Ghūr prior to the Mongol invasions, the other in their skilled manufacture of the most demanding of all medieval steel objects - damascened swords. The survey finally makes clear that there was virtually no interplay between the iron and steel industry and the craftsmen working in non-ferrous metals.

ERRATA.

'IN THE CATALOGUE IN VOL II ALL
1/2 NUMBERS REFER TO ISTAKHR
NOT RAYY'

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PART 3 - IRON AND STEEL

Preface

The survey which follows utilises two prime sources. The first source is the books available in Oxford in the extremely rich collections of the Bodleian Library, the Ashmolean Library, and the libraries of the Oriental Institute and the Department of Eastern Art in the Ashmolean Museum. Such are their combined holdings that it has only been for the rarest publications that visits to London libraries have been needed, and it is a deep pleasure to record my gratitude for living and working in a city with such facilities. The second source is the material contained in the Museums I have been able to visit. Here I would like to express my thanks to the following curators for allowing me to study their museum collections and for all the assistance and kindness I have been shown: Mr. Pinder-Wilson (British Museum), Mr. Blair and Mr. North (Victoria and Albert Museum), Mme. Bernus-Taylor (Musée du Louvre), Professor Brisch and Dr. Zick-Nissen (Museum für Islamische Kunst, Berlin Dahlem), Dr. Hickmann (Staatliche Museum, East Berlin), Dr. Hempel (Museu für Kunst und Gewerbe, Hamburg), Dr. Fontein (Museum of Fine Arts, Boston Mass.), Professor Ettinghausen and Miss Jenkins (Metropolitan Museum of Art, New York), Dr. Holod (University Museum, Philadelphia), Dr. Atil (Freer Gallery of Art, Washington D.C.) and Mr. Wilkinson (Brooklyn Museum). I am particularly indebted to Dr. Ettinghausen and Dr. Holod for allowing me to use the Nīshāpūr and Rayy excavation material in this thesis, as also to Dr. Whitehouse for placing the metal objects from the Sīrāf excavations at my disposal and permitting me to have a number of them analysed. For the analyses I have especially to thank Dr. Kaczmarczyk for the work he did in Oxford on my behalf; my thanks also to Mme. Bernus-Taylor and Dr. Hughes for allowing me to use the results of their research. For the drawings I am deeply indebted to Mrs. Pat Clark.

My thanks too to three private collectors: Mr. de Unger, Dr. Widmaier and Dr. Schultz-Frentzel, for allowing me to study their collections, to the University of Oxford for making money available to finance my visit to the U.S.A. in 1974, and to the Visitors of the Ashmolean Museum for their generous grants to enable me to visit Iran in 1970 and Germany in 1973. In addition I would like to thank Professor C.S. Smith of M.I.T. for illuminating certain aspects of medieval technology for me during my brief stay in Harvard, Dr. Marlik and Mr. Budgen for help over some of the Russian articles, my Supervisor, Mr. Pinder-Wilson, for the hours he has devoted to my problems and for the many constructive discussions we have had together over a kabāb, and Dr. Roger Moorey, colleague and friend, who has acted as on-the-spot adviser, consultant, and refuge. The emergence of these two volumes from bundles of badly typed and extensively over-scribbled drafts is a lasting tribute to Jennifer's capacity for work and her devotion as well as to her deciphering skills.

Foot-notes are only employed in this thesis in exceptional circumstances. References are usually placed in brackets in the text, and consist of the name of the author or authors followed by the year of publication, with volume, page, plate and figure numbers following as needed; the bibliography in Volume II is arranged to fit this system. The use of Roman numerals has been restricted to volume numbers unless a particular book employs both Roman and Arabic numerals for plate or page numbering, as, for example, does Sourdel-Thomine and Spuler 1974. The transliterations follow the Royal Asiatic Society system with certain exceptions: Iran, Iraq, Tehrān and Herāt. Moreover, in view of their increasingly common usage in English the words kufic and naskhi, to mean a geometric and a cursive form of script respectively, have been given English spellings and are not underlined. The same is true of dirham when used to

mean a coin or money unit; when it has been used as a measure of weight however, it has been treated as an Arabic word. The nouns Iran and Persia, and the adjectives derived from them, are treated as synonyms, and relate to the geographical area today called Iran. Russian transliterations follow the Taylorian system.

Abbreviations

All the abbreviations used for primary sources in the thesis refer to texts, never to translations, unless otherwise stated. For details of the texts and translations concerned see the Bibliography.

ADu	Abū Dulaf
Bir	al-Birūnī
Dim	al-Dimashqī
EI_1	Encyclopaedia of Islam 1st edition (see Houtsma 1913 in Bibliography)
EI_2	Encyclopaedia of Islam 2nd edition (see Kramers et al. 1954 in Bibliography)
FM	Fakhr-i Mudabbir
FN	Ibn al-Balkhī
ḤA	Ḥudūd al-ʿālam in Minorsky's translation
Ham	al-Hamdānī's Kitāb al-jawharatain
Ham Ṣifa	al-Hamdānī's Ṣifa jazīrat al-ʿarab
Hamadh	al-Hamadhāni
Ḥar	al-Ḥarīrī
Idr	al-Idrīsī
IF	Ibn al-Faqīh
IḤ	Ibn Ḥawqal
IK	Ibn Khurdādhba
IR	Ibn Rusta
Isf	Ibn Isfandiyār
Iṣṭ	al-Iṣṭakhrī
Jāḥ	al-Jāḥiẓ's Kitāb al-tabaṣṣar bi'l-tijāra
Jāḥ Bayān	al-Jāḥiẓ's al-Bayān wa'l-tabyīn
Jūz	al-Jūzjānī
K. & D.	Kalīla wa Dimna

Māf	al-Māfarrūkhī
Mas	al-Masʿūdī's Kitāb murūj al-dhahab in the 1962-71 translation
Muq	al-Muqaddasī
Nar	al-Narshakhī
NK	Nāṣir-i Khusraw
NṬ	Naṣīr al-dīn Ṭūsī
Qud	Qudāma
ShN	Shāh-nāma
Tan	al-Tanūkhī's Jāmiʿ al-tawārīkh
Tan Faraj	al-Tanūkhī's Kitāb al-faraj baʿd al-shidda
Ṭar	al-Ṭarsūsī (see Cahen 1947)
Tha	al-Thaʿālibī
Yaq	Yaʿqūbī
Yqt	Yāqūt's Muʿjam al-buldān
Yqt Mushtarik	Yāqūt's al-Mushtarik
Zuh	al-Zuhrī

The following standard abbreviations are also used:-

C. centigrade; c. circa; ch. chapter; cm. centimetre; e.g. for example; et al. et alia (used where there are more than two authors' names in a reference); ff. following; fig. figure; fol. folio; ft. foot; in. inch; kg. kilogram; km. kilometre; lb. pound; lit. literally; m. metre; n. note; p. page; pp. pages; pl. plate.

Technical Glossary

Chasing - variously used in books on metalwork to mean any work done on sheet metal from the front, decorative incising of a metal surface, or surface modelling. Avoided here because of its ambiguity. (See *incising* and *relief decoration*)

Engraving - linear decoration of a metal surface by the removal of a sliver of metal using a very sharp pointed tool or *graver*

Filigree - decoration of a metal surface by soldering down fine wires

Granulation - decoration of a metal surface with tiny spheres of gold

Incising - used here to cover both *engraving* and *tracing* where objects have not been studied in sufficient detail for the technique to have been recognised with certainty

Openwork - construction of a metal surface by soldering together smaller pieces of metal, leaving gaps in appropriate places between them

Piercing - cutting of holes through metal

Punching - the production of a repetitive design on a metal surface by hammering with a patterned tool

Relief decoration - decoration which stands out from the surface of a cast or sheet metal object. In the latter case it may have been worked from the back (*repoussé*) and finished off from the front, or worked wholly from the front.

Repoussé - relief decoration worked in sheet metal from behind, usually finished off from the front

Tracing - linear decoration of a metal surface by displacement, using a *tracer* and hammer

INTRODUCTION

Aims and limitations

Treatment of metals and metal objects associated with early Islamic Iran by scholars up to the present time has been decidedly fragmentary. Both Schwarz in 1896 and Le Strange in 1905 assembled the main references to mining sites and production centres in Iran, but only as part of encyclopaedic surveys of Iran in general, and Lombard (1974), who was extremely thorough in his use of sources, saw metals in terms of their effect on the economies of Europe and the Middle East rather than for their own sakes. Other works on metals have come from numismatists, but these again see metals as part of financial systems: such, for example, seems to have been the motive behind Toll's edition and translation of al-Hamdānī Kitāb al-jawharatain (1968). The objects have been dealt with by a larger number of different authorities, most of whom have been united in an art historical approach which sought to place the objects in some sort of cultural or historical context by reference to their decoration. Some writers have been more successful in this venture than others. The largest general survey, and the least informative, is that of Harari in the Survey of Persian Art (Pope 1938). Extremely concise, and far more useful, is the short survey by Barrett (1949). Mayer's book on metalworkers (1959) not only contains an extremely valuable list of all the signed pieces of Islamic metalwork known to him, but also has an eight page introduction which will remain for many years to come the authoritative statement on the role of the metalworkers themselves and on manufacturing terminology. More detailed studies of particular objects or object groups have come from the hand of D.S. Rice (1952-1961), whose monographs will never be surpassed for

their thoroughness and superb drawings. There is little doubt that had he lived and pursued this means of study Rice would have been in a unique position to write a wide-ranging survey of Islamic bronze objects in general. Since his death most of the articles published on metalwork have come from the pen of A.S. Melikian-Chirvani, whose exhibition catalogue (1973) and entries in the catalogue of the Orangerie exhibition (Paris Orangerie 1972) have set a new standard for cataloguers of the future by the inclusion of all inscriptions rigorously transcribed and translated.

This combination of inadequate or very short general surveys and numerous articles on particular objects or object groups has many major weaknesses. Thus, metals are rarely treated together: yet a study of bronze is incomplete if it is not related to gold, silver and iron. Objects are rarely related to their parent metals: yet they are dependent upon the material of which they are made for their essential characteristics. Objects are rarely compared with the relevant references in the contemporary literature, and object groups are rarely compared with object groups: yet it is only through such comparisons that the relationship of objects with their society may be understood. To remedy such deficiencies it is necessary to begin at the very root of the problem, with the facts. In other words, before the relationships of metals to metals, objects to objects, objects to the literature, object groups to society etc. can be discussed at all, every piece of relevant information on all these aspects has to be gathered together. Then, and only then, when the facts can be seen and the relevant merit and importance of those facts assessed, can the information be meaningfully utilised. The compilation is often tedious; for example, as will be seen, 103 different ewers are catalogued, and all of them require a suitable comment giving their probable date and provenance and the reasons for that choice. Inevitably, the finished product is neither light nor

easy reading. But without such a compilation both scholars and students will be like travellers trying to decide on a route through a territory without a map. The time has come for a map of the land of the early Islamic metalworking industry of Iran to be drawn, a map, albeit incomplete, on which future accurately-pointed investigations may be confidently based. The aim of this thesis is to provide that map, and thereby to encourage the study of Persian Islamic metalwork to develop more fruitfully.

Grabar (1957 p.257) writes that "the main problem of all these groups in metal is to find the means by which to organise them into meaningful groups". The means seems to me less of a problem than having the energy to carry the work through to the bitter end. In this thesis the system chosen for the grouping of the objects is the standard one employed in all such surveys, whether the objects are part of a collection or part of the finds from an archaeological excavation. Objects are classified according to their metal, shape and purpose. Thus a bronze object of pear-shaped form designed for pouring water in a private house is catalogued first under "Bronze", then under a general heading "Household and business equipment", and then under an object-type heading "Ewers". It is finally placed in a category of ewers appropriate to its shape. The exact workings of this system may be seen in the contents of the Catalogue in Volume II. Such a system is simple. It allows information to be classified and retrieved without difficulty, it treats objects according to their three prime features - material, use and shape, and places decoration where it rightfully belongs in a secondary role. It throws objects into relief in relation to one another and societal traditions, and patterns may be easily recognised as they begin to emerge from the accumulating facts. Where the survey goes beyond what many other surveys attempt is in placing

at the beginning of each of the three main sections of the thesis a comprehensive account of the relevant metals and metal technologies as they relate to early Islamic Iran. In this way the metals are seen not only as an integral part but as the very basis of the study of metal objects.

Given enough energy such a survey, although vast, sounds fairly straightforward. As always, however, there are problems which arise as the survey proceeds which often severely limit its results. A number of such limitations must now be mentioned. The most far-reaching ones are the lack of excavated material, and the lack of scientific methods in most of the excavation work actually done.

Within the boundaries of modern Iran four important Islamic sites have been examined by archaeological teams: Susa, Rayy, Nīshāpūr and Sīrāf. Susa was first excavated by Loftus in 1851-2, and was then taken over by French archaeologists - Dieulafoy (1884-6), de Morgan (1897-1910), de Mecquenem (1908-14, 1920-33) and finally Ghirshman, who has been leading the French Archaeological Mission's excavations at the site since 1964. Rayy was excavated by Schmidt on behalf of the University Museum Philadelphia and the Boston Museum of Fine Art in 1934, Nīshāpūr by Hauser, Upton and Wilkinson for the Metropolitan Museum of Art in 1935-40 and 1947, and Sīrāf by Whitehouse for the British Institute of Persian Studies between 1966 and 1973. The sites are well spread out but there inevitably remain enormous areas of the country about which nothing is known. Particularly lacking is excavated material from western or north-western Iran. Furthermore, only one of the sites excavated was investigated methodically and scientifically, Sīrāf. Some of the main periods do seem to have been separated out at Susa, at least under Ghirshman, but no stratigraphy whatsoever is recorded for Rayy or Nīshāpūr, which is particularly tragic in the latter instance since Nīshāpūr yielded such rich bronze finds. More tragic still almost none

of the metal finds from these latter three sites have ever been published by the excavators.

A third serious limitation on the study of metalwork in early Islamic Iran is the lack of reliable information on the development of palaeographic styles. True, there are a few publications: Moritz's illustrations of handwriting of different periods in different areas, Flury's studies of writing styles from Ghazna, Nā'īn and Diyarbekir, Grohmann's two volume survey of Arabische Paläographie. None of these however, are definitive, and they are all of surprisingly little value when one is attempting to date many of the inscriptions on metal objects. Particular problems which recur are the relationship of Persian palaeography to that of Egypt, and the relationship of architectural scripts to those found on objets d'art in Iran itself.

A fourth serious limitation is the lack of scientific examination of any of the objects. Virtually no analyses have ever been published, and the confusion in the general text books on Islamic art between brass and bronze is second only to the confusion between tracing and engraving. This confusion is hardly to be laid at the doors of the writers concerned; the fact is that there has never been any work done to define the metal alloys used and the methods of decorating the finished objects. The only scholar to have attempted to get to grips with the technical problems is Rice who, for example, gives a drawing in one of his articles to show the different methods of inlaying gold and silver in the Mamlūk period (Rice 1953a p.299 fig.9). Such technical points require extremely careful study of the objects. Eye-sight is usually not enough, nor even a good magnifying glass. The ideal piece of equipment is a microscope with photographic attachment so that the different techniques can be studied at first hand and recorded for comparison later. Without such equipment, and trying to study objects in ill-lit museum storages, or

behind glass, most of the technical problems remain. I am particularly fortunate in having access to a report prepared by Dr. Michael Hughes of the British Museum Research Laboratory for the Department of Oriental Antiquities which gives details of the techniques used on four Persian objects (see p.385) as also analyses of the metals, but work of this detail has not been possible for me myself, except in connection with the Ashmolean Museum objects, and any fuller technical study of early Islamic Persian metal objects has therefore been out of the question.

Finally I have imposed certain deliberate limits on the study. First is a historical one. In the title of this thesis "early Islamic" refers to the period from the Arab conquests to about 1250 A.D. This date range is designed to exclude object types developed after the Mongol conquests, but two Il-Khānid period texts have been utilised, those of Ṭūsī and Abū'l-Qāsim. Secondly, in geographical terms early Islamic Iran is envisaged as the provinces between Jibāl in the west and Sīstān in the east. This includes modern Afghanistān but in theory at least excludes the land occupied by modern Iraq and the lands beyond the Oxus. Because Khurāsān and Transoxania for much of the early Islamic period were united politically and culturally, evidence derived from Transoxanian metals and metal objects has been included where that information has direct relevance to Khurāsān or other areas on the near side of the Oxus. Where, however, a type of object existed in Transoxania but was evidently unknown further to the south or west those objects have only been referred to in passing, not catalogued or studied in depth. In the west the problem does not arise quite so acutely since the lands to the west of Khuzistān and Jibāl had no metal resources of their own. On the other hand a ewer inscribed with the information that it was made in Baṣra shows that a metalworking industry existed, and here again such

objects have been included in the thesis where they can be seen as an integral part of an otherwise Persian tradition. The third limitation deliberately imposed on this study is the exclusion of coins and coin evidence in any but the most general terms. I am not a numismatist, and this is a specialised study upon which I am not qualified to embark.

The literary sources

A large amount of the information on the mine-sites and the methods used for the extraction and purification of metals comes from writers of the early Islamic period. Before using such information it is necessary briefly to survey what is known of the writers and works concerned so as to assess their reliability.

The earliest geographical works containing references to metals in Islamic Iran were written in the second half of the 9th century - Ibn Khurdādhba's Kitāb al-masālik wa 'l-mamālik and Yaʿqūbī's Kitāb al-buldān. Ibn Khurdādhba (EI_2 Ibn Khurradādhbih) lived from about 820-911 A.D. and spent much of his life in the service of the government, first as Director of Posts and Intelligence in Jibāl province, and then as Director-General of the same Department in Baghdād. As such he must have been well acquainted with affairs all over the ʿAbbāsid empire, and his information about metals, though slight, is probably accurate. Yaʿqūbī (EI_1 Yaʿḳūbī), though son of a caliph, did not hold an official government position such as Ibn Khurdādhba. He was, however, in the service of the Ṭāhirids in Khurāsān shortly before their downfall, and his two records of metal in Ushrushāna province, and near Bāmiyān (Yaq pp.294,289) are likely to be reliable. Qudāma (EI_1 Ḳudāma), another official of the central ʿAbbāsid administration writing early in the following century, merely confirms the existence of the important silver mine at Shāsh mentioned by Ibn Khurdādhba (Qud pp.207-8; IK p.39).

From the 10th century a larger number of more detailed travel books and geographies have survived - Ibn al-Faqīh's Kitāb al-buldān (902-3 A.D.) al-Iṣṭakhrī's Kitāb masālik al-mamālik (930-1), al-Mas'ūdī's Kitāb murūj al-dhahab (943), Ibn Ḥawqal's Kitāb sūrat al-'arḍ (978), the anonymous Ḥudūd al-'ālam (982-3), and al-Muqaddasī's Aḥsan al-taqāsīm fī ma'rifat al-aqālīm (985). The information they supply, however, has to be evaluated on the basis of the probable contents of two other geographical works, now unfortunately lost: those of al-Balkhī (c.920), which was probably called Sūrat al-aqālīm (EI_2 al-Balkhī), and Jayhānī (early 10th century) (ḤA pp.23-24). al-Balkhī lived from about 850-934 A.D., and spent most of his life in his native province of Khurāsān. He was essentially a scholar, though he also acted as secretary to one of the Sāmānid rulers, and the late 10th century writer al-Muqaddasī says that he was an expert on geographical information, despite his lack of wide travelling. His book appears to have been an original work, whereas that of Jayhānī was an amalgamation of Ibn Khurdādhba's book and oral information acquired by the author himself. Jayhānī was a Sāmānid vizier, and therefore in an excellent position to acquire information about districts or countries which he himself had never visited, and indeed he seems to have made a point of asking foreigners to tell him about their home countries. The works of these two men were probably, therefore, unbiased and reliable descriptions of Persia and its neighbouring lands in the early 10th century.

The earliest extant geography of the 10th century is that of Ibn al-Faqīh (EI_2 Ibn al-Faḳīh), a comprehensive survey of the whole Muslim world which seems to have been largely original. Little is known of the author except that he was a native of Hamadān. The version of his book which has survived is probably a shortened edition of the original. The accuracy of the information included in the book can only be

ascertained on its own merits, and by comparing it with other reliable sources: except in one particular instance (see p.150) there seems to be no reason for doubting Ibn al-Faqīh's word. al-Masʿūdī (EI_1 Masʿūdī) was a great traveller, with a tendency to accept uncritically legends and tales he picked up as he went along. Nevertheless his books contain information of importance on a variety of subjects, and that which he supplies on metals will be treated on its own merits. al-Iṣṭakhrī's work (EI_1 Iṣṭakhrī; ḤA pp.22-3), which is as wide ranging as Ibn al-Faqīh's, is generally considered to be a second and greatly enlarged edition of al-Balkhī's book, the extant text being probably a slightly shortened version of the original. Although almost nothing is known of Iṣṭakhrī's life, the fact that his work is based on that of al-Balkhī suggests that it gives a trustworthy account of Persia in the early 10th century. Ibn Ḥawqal (EI_2 Ibn Ḥawḳal) was acquainted with the work of Jayhānī, and probably set out to revise Iṣṭakhrī's book. However, as a result of his numerous and far-ranging journeys in the Islamic world between 950 and 970 he decided to expand his predecessor's work, and his personal observations and interest in what he saw make the resulting volume a fundamental source of information for Persia and the rest of the Islamic world in the second half of the 10th century. Almost all the relevant information found in Ḥudūd al-ʿālam, on the other hand, is copied straight from Iṣṭakhrī, and the only areas which seem to have been known personally to the anonymous author are Gīlān and Gūzgān (ḤA p.xiv). al-Muqaddasī (ḤA pp.xvi-xix) also used Iṣṭakhrī in his wide-ranging geographical work, as well as Ibn al-Faqīh and Jayhānī. His comments on the metals found at Bādhghīs and Jīruft appear to be based on Iṣṭakhrī, but all the rest of his information relating to metals is independent of any earlier author's statements. Too little is known of his life to assess his reliability for certain, but since modern scholarship appears to rate him highly, his word has been accepted in what follows unless it conflicts with more reliable information.

All the 10th century sources mentioned above, with the exception of that of Qudāma, fall into the category of general geographies. They were designed to give an overall picture of the Muslim world or a large section of it, and it is therefore likely that the places mentioned by these authors as being the sources of particular metals were indeed the major sources of those metals, and as such played an important role in the economy of Persia at the time. Two other 10th century works, however, give a rather different picture. Ibn Rusta's Kitāb al-aʿlaq al-nafīsa (EI_2 Ibn Rusta) was written between about 903 and 913, and although it is fairly general in its scope, its references to sources of metal are with one exception limited to the Iṣfahān area. The reason for this seems to be that Ibn Rusta was a native of Iṣfahān and therefore knew a great deal more about it than elsewhere. The picture he gives of Persia's metal resources is, as a result, of quite different value to that given in the works so far discussed. Likewise Abū Dulaf, whose al-risālat al-thāniya describes a series of journeys made by the author round about 950 in western and northern Persia. Abū Dulaf's first risāla, included in Yāqūt's Muʿjam al-buldān, has been the subject of much discussion as to its accuracy and reliability. Minorsky's conclusion about the second (ADu pp.1-29) was that it is perfectly reliable, except in two or three particular instances. Abū Dulaf was obviously interested in minerals and metals, and provides a substantial amount of information on those present in the regions through which he passed. Sometimes the text is unclear, sometimes the author's meaning is elusive; in general, however, the risāla is a useful source.

Over the next three centuries there is a similar range of literature, but quality and usefulness lie much more with the local than the general accounts. al-Māfarrūkhī's Kitāb mahāsan Iṣfahān, written sometime between 1072 and 1092, is a book specifically about the Iṣfahān region, and Ibn al-Balkhī was commissioned by the Saljūq Sulṭān Ghīāth al-Dīn Muḥammad

to write a book specifically about Fārs, hence the Fārs-nāma (1107). No general 11th century geographies seem to have survived, as it happens, and such general works as Thaʿālibī's Kitāb laṭāʾif al-maʿārif (c.1000) and Nāṣir-i Khusraw's Safar-nāma (1047) contain all too little useful information as regards metals. What they do contain, however, is probably accurate, and there is certainly no reason to doubt the information contained in the works of al-Māfarrūkhī and Ibn al-Balkhī. In the 12th century there is one important general geography: the Nuzhat al-mushtaqq fī ikhtirāq al-āfāq of al-Idrīsī, written about 1154. Unfortunately, however, Idrīsī's comments on metals point to his having used 10th century works in most cases, and in the absence of a critical edition it is very difficult to establish the value of his book. Finally, in the period before the Mongol invasions, Ibn Isfandīyār's Tārīkh-i Ṭabaristān (1216-17) is, as its name implies, the work of a Ṭabaristānī historian, and therefore purely local in outlook, while Yāqūt's Muʿjam al-buldān is a compilation of earlier sources, and of little value in assessing the situation in Persia at the time of its compilation or at any definite previous date.

The above works provide most of the information about the ore sources of metals in early Islamic Iran. For technical information, both general and detailed, and with it some further information on other matters pertaining to metals, four important texts have survived. These too need some assessment before they can be utilised. They are al-Hamdānī's Kitāb al-jawharatain al-ʿatīqatain, al-Birūnī's Kitāb al-jamāhir fī maʿrifat al-jawāhir, Naṣīr al-Dīn Ṭūsī's Tansūkh-nāma, and Abū'l-Qāsim's ʿArāyis al-jawāhir wa nafāyis al-ʾaṭāyib. The earliest of these, and very comprehensive, is that of al-Hamdānī, written in about 942 A.D. in the Yemen. From the text it is clear that the author had personal experience of a large number of the silver and gold-working processes

he describes, and came from a family well-informed in the business - he quotes his father, for example (fol.25b), and his great uncle (fol.46b), and the latter was controller of assaying in Ṣanʿā'. In addition he sought information from other highly qualified men such as the mint-master of Ṣanʿā' and Ṣaʿda, who came of a family of mint-masters (fol.44a). The information contained in al-Hamdānī's book can therefore be taken as an accurate account of metallurgical techniques in Yemen in the 10th century.

But although al-Hamdānī was a native of Ṣanʿā', probably spent his whole life there, and writes of the techniques he saw around him or of those current in that area, his book is of much wider importance. Yemen was at least from the end of the 6th century until 628 A.D. part of the Persian empire, and al-Hamdānī more than once mentions the presence of Persians in Yemen, noting in particular their part in mining activities. For instance (fol.25a), he talks of Persians who lived and worked at al-Raḍrāḍ, the finest silver mine in the Yemen, who were known locally as furs al-maʿdan. And in Samām, a village with silver and copper mines, there had previously lived and worked a thousand magi (fol.24b; also Ham Ṣifa I p.149). The Persian influence on mining and metalworking is also clear from al-Hamdānī's use of Persian words e.g. anbur for tongs (fol.33b), and zar sīm for electrum (fol.33b). Hence the Kitāb al-jawharatain al-ʿatīqatain can be used with confidence as a basis for compiling information on Persian metallurgical techniques in the 10th century.

al-Birūnī, writing probably in Ghazna in the middle of the following century, does not seem to have had personal experience of all the processes familiar to Hamdānī. On the other hand his wide-ranging scholarship was famous among his contemporaries, and is still held in great respect by orientalists today. He treated metal in a careful and

scholarly manner, gathering information on all aspects of it from people he met, sifting literary sources for references to it, and interesting himself in every aspect of its mining, production, and use. If in the end he gives very little technical information on gold and silver not found in al-Hamdānī, nevertheless, his book is valuable for its wider range and as confirmation of the earlier work. In particular it confirms the validity of using al-Hamdānī in a study of Persian techniques.

The third important literary source for our knowledge of Persian techniques was produced some two hundred years later. Naṣīr al-Dīn Ṭūsī (EI_1 al-Ṭūsī) (1201-1274 A.D.) was one of the most powerful men of his day, a trusted adviser of Hūlāgū, in his later years vizier, and at the same time one of the greatest Persian astronomers and scientists. He is particularly remembered as founder of the observatory at Marāgha, which he used to calculate a new set of planetary tables, but he is also noted for a mathematical book on the principle of the transversal as well as his interest in optics. This latter interest, and a general medical background knowledge, are both visible in the Tansūkh-nāma, which is, like al-Birūnī's work, a compendium of information on minerals, precious stones, metals and other materials, both natural and artificial. Much of the information refers either to the theory of the origin of a given substance, or its medical application, but specific technical information about metals is also included.

In a sense, however, the main importance of the Tansūkh-nāma is as the source of a certain part of Abū'l-Qāsim's information some thirty years later. There is no doubt at all that Abū'l-Qāsim, writing in Tabrīz about 1300 A.D., had read Ṭūsī's book, and that he lifted whole paragraphs from it and used those paragraphs as starting points for his own additional pieces of information. But if he used his predecessor

somewhat unscrupulously, Abū'l-Qāsim added so much valuable information himself that his book is the most comprehensive and important metallurgical treatise to have survived from the medieval Islamic world. If one were to single out his special contribution to our knowledge of techniques current in his day it would be his recipes for alloys and other compounds; if one were to single out a particular weakness it would be in the realm of iron and steel working about which he evidently knew little. But in general he provides information not available in any other source, and information which has every appearance of being reliable and was probably based on personal experience.

PART 1 - MERCURY, GOLD AND SILVER

Chapter 1 THE METALS

Mercury

Mercury is known in Arabic as zībaq or zi'baq (Bir pp.229-232; Ham fol.65a-67b), or occasionally as zāūqā (Bir p.229), and in Persian as sīmāb, literally "silver-water" (NṬ pp.207-9; AQ pp.211-212). Mercury generally occurs in nature in the form of cinnabar, mercury sulphide ore, but sometimes also as droplets of native mercury oozing out of cracks in that ore. Both forms occur in the mercury deposits recorded in modern Iran, situated at Zira Shūrān, south-south-east of Tabrīz (Ladame 1945 p.268; Harrison 1958 p.513), and both forms also occurred in Transoxania, the most important mercury producing area for the early Islamic Persian world: for example, Qubā is specified by al-Muqaddasī as having a "spring" of mercury. The richness of the Transoxanian deposits is emphasised by al-Iṣṭakhrī and Ibn Ḥawqal in the 10th century, though both also mention a deposit near Iṣṭakhr in Fārs, and the existence of other small local deposits is suggested by Abū Dulaf who draws attention to the mercury produced at Shīz (Table 1).

The description of the method for extracting mercury from its ore as given by al-Hamdānī seems to have been lifted from the work of Dioscorides (Ham fol. 65a, 65b), and by itself it is therefore unreliable as evidence of early Islamic techniques. Fortunately, however, the process is also mentioned by al-Birūnī (p.231): "(Mercury) is extracted from red stones ... Men refine the stones and distill them in distillation-type vessels, gourds and an alembic, and the mercury is gathered in the receptacle". This passage shows that the traditional form of extraction was in use, based on the low temperature evaporation of mercury (357^{o}C). The cinnabar is roasted in air, the

mercury comes off as vapour, and is collected by condensing it on a cool surface and running it into a suitable container. Special precautions would have been taken to seal the vessels with clay to prevent the mercury vapours escaping, their poisonous effects being well known (Bir p.230). A full description of the virtually identical medieval European process appears in Agricola (Agricola p.426-432).

The primary use of mercury throughout the classical and medieval world was for extracting gold by amalgamation (see p. 30), and the demand for the latter metal was undoubtedly the cause of the high value placed on the former. It had other uses too - in alchemy, in gilding (see p. 36), and in the production of the artificial painting pigment cinnabar (vermilion - zinjfar) (Qaz II p.220), which was also used as an ointment. A comment by al-Muqaddasī (Muq p.128) suggests that Irāq was probably the centre of the latter industry. It was also used for counterfeiting coins - a practice particularly prevalent at pilgrimage time in Mecca according to al-Birūnī (Bir pp.229-230), and recorded elsewhere in Arabia by the author of Ḥudūd al-ʿālam (ḤA para. 37.19). Whether such counterfeiting occurred in Iran is not known, though quite likely; the construction of a tank holding mercury to impress visitors at Madīnat al-Ẓahrā (Zuh para.228) was probably a unique event and only possible because of Spain's substantial mercury deposits.

Whether Spanish mercury ever travelled as far as Iran is in fact an interesting question. Medieval sources constantly testify to the mercury resources of the peninsular, pinpointing such places as Batrūsh (Zuh para.226), Besṭasat, Faḥṣ and Qarīsh (Dim pp.242, 244) in the regions of Cordova and Toledo, and al-Zuhrī claims that Spanish mercury was exported to Abyssinia where it was used in gold mining operations, while Ibn Ḥawqal and al-Masʿūdī also mention the export of mercury from western Islam to the east (IḤ p.97; Mas para.407).

Mas'ūdī in fact claims that the mercury of al-Andalūs was exported to all Muslim and infidel lands. This latter statement is clearly an exaggeration, but Abū'l-Qāsim too talks of western mercury (AQ p.211), saying that the best mercury was Farangī. This literary evidence is not specific enough to prove the point one way or another, but it would be no surprise to find that Spanish mercury reach Iran in small quantities, obvious routes being via Abyssinia and the Yemen (both important gold working areas without their own mercury supplies) and thence to the Gulf, or via North Africa, Syria and Iraq and into the western borders of Iran. On the other hand the known existence of large deposits in Transoxania and smaller ones elsewhere in Iran makes the penetration of foreign mercury far beyond the Zagros fairly unlikely as does al-Jāḥiẓ' assertion that mercury was imported into Iraq from nothern Iran (Jāḥ p.345).

Also on the subject of trade, a comment by al-Birūnī (Bir p.230) should be noted:"The sinjfarīyya .... made with mercury is .... distinguished by the attribution 'rūmī' since in the past it was brought from there". What is meant by "in the past" is not clear, nor should it be assumed that the import of cinnabar or vermilion (sinjfarīyya) also means the import of the metal. Nevertheless, since mercury exists in western and central Anatolia (Ryan 1960 pp.69-72) it may be that a certain amount found its way into Iran from that source.

Gold

Gold is usually known in Arabic as dhahab and in Persian as zar, but the goldsmith of early Islamic Iran, like any craftsman, must have used a fairly large and highly specialised technical vocabulary. Unfortunately our knowledge of this vocabulary is seriously limited by two factors. Firstly, most of the craftsmen were probably illiterate and felt no need to describe their craft for posterity; secondly, the earliest Persian texts relating to the subject date from 600 years after the Arab conquest of Iran. That there was a full Persian technical vocabulary in early Islamic times seems likely from the fact that the gold-working industry was well established in Iran in the Sasanian period (Tafazzoli 1974), and from the appearance of Persian words such as zarsīm (electrum) in al-Hamdānī's work, but to what extent it absorbed Arabic terminology one cannot tell. As pointed out in the introduction, the writings of al-Hamdānī and al-Birūnī are relevant to the Persian scene despite being written in Arabic. A select vocabulary for gold and gold technology based on these two authors, and including the small Persian technical vocabulary of Naṣīr al-Dīn Ṭūsī and Abū'l-Qāsim, has therefore been placed in Vol. 2 (Tables 2 & 3); while it is recognised that this is a very meagre and inadequate list, nevertheless it is a beginning and hopefully may provide a useful basis for future study.

The annotated gazetteer of the sources of gold mentioned by geographers and travellers of early Islamic Iran (Table 4) gives an overall picture of the relative economic importance of the various areas of Iran and Transoxania. Without a doubt the richest was Transoxania. The river

Oxus, its tributaries, and the Sughd were all panned for alluvial gold, while gold mines were scattered throughout large areas. Farghāna was evidently one of the richest regions, and Ibn Ḥawqal takes the trouble to single out three particularly wealthy areas within it - Akhsīkath, Nasyā and Nūqad. Detailed mineralogical surveys of this area do not appear to be available, but Shimkin (1953 p.170) indicates that it is still a very important source of Soviet gold, showing how very extensive the gold deposits must be. Geologically akin to this area, al-Iṣṭakhri and Ibn Ḥawqal emphasise the gold resources of the Hindu Kush and Pamirs, and if their statement that these mountains contained gold mines along their length is rather sweeping it nevertheless emphasises the wealth of the lands on Iran's north-east borders. Gharchistān and Zābulistān also had gold mines.

No survey of the gold resources of Aghanistān has ever been published but one mine has been visited and briefly described, Zar Kashan midway between Kābul and Qandahār (Tylecote 1970 p.286). The veins there carry auriferous serpentine and quartz, and average 4-5 grams per ton of gold or at their best 180 grams per ton. Tylecote mentions how the mined vein-stuff would have been taken down into the nearby valley and there ground on an unusual type of mill with two hemispherical mill-stones turning in a large hemispherical stone basin. This is evidently a classical form and comparable examples have been found in Nubia (Gowland 1912 pl.27 fig.2). Tylecote suggested that Zar Kashan was Sasanian but it may also have been exploited in Islamic times.

Local surveys and observations made in Iran during the last hundred years allow one to distinguish the relative value of some at least of the other gold sources mentioned in the medieval texts. In certain areas no gold has yet been found - Mazandarān and the Persian Gulf, but elsewhere a reasonable picture can be built up.

Mactear located the gold mine near Damghān mentioned by Abū Dulaf and Abū'l-Qāsim (Mactear 1894 pp.25-7), and reckoned that it only required a good supply of water to make this mine, known as Kūhzar, reasonably profitable. According to the then governor of Semnān district the mine had been abandoned about the middle of the last century. Similarly, the Tal-i Iblis expedition visited the gold mines at Muta, not far from Gulpaygān, in 1966, a site which is probably identical with al-Taymara (Caldwell 1967 pp.327-330, 342-7). There they found the remains of old mines and surface diggings in addition to the present workings, and in one of the early workings came across three pots which Wertime suggested were Sasanian, early Islamic and Safavid respectively, though others were more cautious. Iron picks, stone querns and pottery oil lamps were among the implements found nearby. The reserves at Muta are estimated at 1,000,000 tons, making it an extremely rich vein. Its best ores yield 35 kilograms to the ton, its inferior ones 8 kilograms. It is interesting to note that al-Maffārūkhī (Maf p.18) describes the mine as being abandoned in his day. One can only wait for a thorough survey of the mine to establish more accurate dating for its periods of exploitation. In addition to giving some idea of the deposits near Damghān and at al-Taymara, modern surveys also confirm that gold occurs in Kirmān province, near Jīruft (Harrison 1968 p.516), and Jibāl province, near Zanjān (Mactear 1894 pp.27-29; Harrison 1968 pp.514-5).

The distribution within greater Iran of the gold resources mentioned, if compared to the distribution of towns minting gold coins, for example in the 10th century, shows that while some mints like Samarqand were near a gold source, others, like those in Khuzistān and Fārs, were a long way away from the nearest mine. From this one concludes that gold travelled long distances within Iran and must have constituted a highly valued part of numerous caravans, although details of such trading are totally lacking.

Internationally there was also a flourishing gold trade in the Islamic world. This has been extensively studied by Lombard (1974) who highlights East Africa (Zanjbar and Sufāla) and Nubia as important sources of gold for distribution over wider areas of Islam but emphasises that the most important Islamic gold source of all was located in West Africa, in what is now Senegal and Guinea, known to medieval Islam as the western Sūdān (Lombard 1974 pp.205-235). It may reasonably be questioned whether the gold of Ghāna could ever have reached as far afield as Iran, particularly when Iran had its own extensive gold deposits. However, two small pieces of evidence suggest that this may occasionally have happened. al-Hamdānī (fol. 24a), on the authority of the mint master of San'ā' and Ṣa'da, Ibrāhīm ibn Muḥammad ibn 'Abd al-Raḥmān, states that Ghāna mine was the most productive in the world, and gives details of how the gold was acquired. He does not say explicitely that it was brought to the Yemen, but other African gold certainly was (see below), and the possibility should not be ruled out. The flourishing sea trade between Yemen and the Gulf would easily account for its distribution yet further eastwards. al-Birūnī's evidence suggests a different route. According to him (Bir p.241) gold from Ghāna was traded for Baṣran cloth, which implies a far-reaching trade between West Africa and Iraq,

presumably over land, and carries with it the possibility that small amounts of gold, having reached Iraq, then filtered through to the west Persian plateau. It must be admitted, however, that both these pieces of evidence are slight, and the whole issue is considerably confused by the fact that an 11th century Iraqi source talks of the export of gold and gold objects from Iraq to Egypt (Cahen 1951).

In addition to the Sūdān, al-Birūnī specifies two other non-Iranian areas of the world which were renowned for their richness in gold. The first was the Far East, in particular Sumatra, known to the Arabs as the land of the Zābaj (EI_I Zābaj) (Bir pp.239-240). Sumatra was known from much earlier times for its gold mines, and Sumatrans were present in the Indian Ocean and Red Sea in the pre-Islamic and early Islamic periods - in the third century Madagascar was a Sumatran province, and in the 10th century there is a record of a Sumatran raid on East Africa. Trading is therefore to be expected, and al-Birūnī gives details of the methods used by the gold merchants for exchanging goods with the Sumatrans, details which he says were derived directly from the traders concerned. It is therefore highly likely that Sumatran gold reached Iran in the early Islamic period.

The second additional area specified by the same authority, Upper Egypt, was also well known in pre-Islamic and Islamic times for its gold resources. The Wādī ʿAllaqī was singled out as the richest mining area, and authors such as Yaʿqūbī (pp.334-7) and Ibn Ḥawqal (p.31) give details of the mining and the men who worked in the mines. Yaʿqūbī also says that gold was transported from ʿAllaqī to ʿAidhab on the Red Sea Coast, whence it was exported to Mecca, the Hijaz and the Yemen. This is confirmed by the 12th century Andalusian geographer and traveller al-Zuhrī in his Kitāb al-juʿrāfīyya (para.318, 324 and 335) who talks

not only of exporting gold from Upper Egypt to Yemen however but also to Egypt, Rūm, Maghrib and Spain, though he implies that much of the gold came from slightly further south in Abyssinia. al-Hamdānī also knew of the gold mines of Upper Egypt and Abyssinia (fol.24b) and gives a list of them. The sea-trade between East Africa, South Arabia and the Gulf, to say nothing of the presence of Persian miners in the Yemen (Ham fol.24b, 25a), and visits by Khurāsānians to the Yemeni mines (fol.26a), makes the distribution of the gold still further afield to Iran highly likely.

If the evidence of the import of gold into Iran is somewhat scanty the evidence for the export of gold from Iran is even more so. Geographically, the nearest area to Iran without its own gold resources is Iraq, and since the capital of the ʿAbbāsid caliphate was located there for five centuries the demand for gold must have been enormous. The closest gold deposits were those in Jibāl province at al-Taymara, and being situated close to the great Hamadān-Baghdād trade route through the Zagros gold would undoubtedly have been traded thence to Baghdād. Interestingly, however, analyses of silver coins of the Umayyad period from Iraq and Jibāl (Gordus 1972 pp.138-140) indicate that the silver minted at Wāsiṭ came from the same source as that minted in Shāpūr, Ardashīr-Khurra, and Dārābjird, in other words probably from a south Persian source. It would therefore appear that there was an export of precious metal from southern Iran to southern Iraq, as well as a parallel one further north.

Returning to the gold produced within Iran, al-Hamdānī, Abū Dulaf and al-Birūnī all note the existence of native gold and record finds of nuggets of considerable size. Thus al-Hamdānī (fol.27a) mentions the occurrence of pieces weighing between six ūqiya and a mudd, roughly 400 -1200 grams, Abū Dulaf (para.4) of pieces ranging from 1 ḥabba to 10 mithqāl roughly $\frac{1}{2}$ - 40 grams, and al-Birūnī (pp.237-8) of chunks

of quite extraordinary size. However, although sizable pieces of native gold evidently did come to light, these would rarely have formed a significant proportion of the gold in circulation, which as indicated above was either mined as tiny particles of gold in a rock matrix or extracted by a variety of means from rivers.

In the former instance, the gold-bearing rock would be taken out of the mine in chunks, broken by hand and then crushed in a mill (Bir pp.233-4; AQ p.216). The crushed mixture of gold and rock would be then sifted and separated by water, and the gold extracted from any impurities left by amalgamation. al-Hamdānī describes all these processes (Ham ch.10) and gives details of various stages used in recovering the gold from the amalgam. In outline the procedure was to squeeze the amalgam in a leather cloth, thus extracting any unamalgamated mercury, and then heat the residue in order to drive off the mercury as a vapour. The nugget of gold left behind was called dhahab zi'baqī or dhahab muzabbaq, according to al-Birūnī (p.234).

Alluvial gold was usually extracted by panning, but the appendix to Ibn Khurdādhba'ṣ book, which may be later than the main text (IKh p.179), and Naṣīr al-Dīn Ṭūsī (p.212) both mention the use of sheep skins in Transoxania following the principle used in much earlier times, which gave rise to the "Golden Fleece" legend. The river water would have been poured over the fleece, and the fragments of gold which it retained would then have been collected by amalgamation in the same way as gold particles in a panning basin. al-Birūnī records a more unusual method of collecting alluvial gold (p.236): holes were dug in the bottom of a stream or river bed at a point where the current was slack, and were then filled with mercury, thereby trapping any gold particles which sank to the bottom at this point.

The nugget of gold left after amalgamation and vapourisation of the mercury was further purified by melting the gold, a process termed ta'rīq by al-Hamdānī, who gives a detailed description of how it was done (ch.11). On melting, any impurities in the gold came to the surface to form a scum which could be easily removed; this scum was called qalīmīāyi zar by Abū'l-Qāsim (p.217). al-Hamdānī distinguishes two different methods of ta'rīq: in the first the gold was melted in a large crucible along with charcoal, and in this case the impurities remained underneath, a second melting being necessary after regrinding; in the second a small goldsmith's crucible was used, and the dross came to the surface and could be run off by means of a flux such as borax (fol.28b-29a). After purification the gold was hammered out and cut into thin strips ready for a second purification process - cementation, to remove the silver content naturally occurring in gold. This process was termed ṭabakh or taṣ'īd (Ham fol.30a). The gold was placed in a pot on top of a special furnace (fig. 1), and was arranged inside the pot in layers alternating with the cementation compound, known as the dawā'. According to al-Hamdānī this consisted of pyrites, salt and baked brick, pounded up and sifted; Abū'l-Qāsim gives a recipe of 1 part salt, 2 parts baked brick, and 4 parts white clay (p.221) and says that after three days this would produce zar ṭalī. It is clear that al-Hamdānī's recipe is a combination of two different processes for extracting silver from gold: the salt process and the sulphur process, whereas that of Abū'l-Qāsim is the former process alone. al-Hamdānī also implies that this double process involved two separate events - first a smoking of the gold being cemented, and then a firing of it: the significance of this is not clear. Cementing could be done more than once, and al-Hamdānī gives a detailed description of the hand mill used to grind up the dross left at the end of the process (fig. 2) - the resulting powder was reamalgamated with

mercury to extract any gold left in it plus the silver which had been removed from the cemented gold. Among the types of pyrites (zāj) which al-Hamdānī specifies (fol.31a) is al-zāj al-abyaḍ al-martakī, literally white lead sulphate. The presence of lead during cementation would allow the silver sulphide or chloride to be removed in a lead regulus after the sulphur or salt had reacted with the silver in the gold.

The importance of al-Hamdānī's descriptions is substantial. Prior to the publication of his work, the earliest comprehensive accounts of such processes were those of Theophilus (c.1150-1200 A.D.), whom he preceded by some two hundred years. Most of the processes described were of course known much earlier - for example cementation with salt is first mentioned (probably) by Strabo, and if not certainly by Pliny (Agricola pp.458-9 n.21), and amalgamation is described by Vitruvius and Pliny (Agricola p.297 n.12). But it would appear that in al-Hamdānī's description of cementation is probably the first mention, and therefore first evidence, of the possible use of sulphur in this process, otherwise first recorded by Theophilus. The point is not absolutely certain, for al-Hamdānī does not mention sulphur as such, but rather pyrites (zāj), and there is no way of proving that he was aware of the action of the sulphur contained in the mineral. Nevertheless the possibility should be noted. On the negative side it is important to note that although the parting of gold from silver by nitric acid is mentioned in Geber, it does not appear in any of the other Arab or Persian sources, and since it is not clear when the work attributed to Geber was actually written it seems likely that it was unknown in early Islamic Iran.

The purification processes are described by al-Hamdānī in such detail because he was particularly concerned with the use of gold and silver for coins, and the need for them to be of standard purity. Goldsmiths and jewellers would in general have used impure gold for their work, a fact recognised by al-Hamdānī when he describes ṭīb as the gold, silver and copper alloy used by jewellers (fol.28a), and differentiates between the qualities of the latter alloy and pure gold (fol.71b-72a). The gold used for ornament, he says, can be stretched, is firm under the hammer and accepts solder, by virtue of the copper and silver mixed with it.

In the making of gold ornaments and jewellery goldsmiths have from earliest times varied the colour of the gold by the addition of other metals or substances. The Persian goldsmith of the early Islamic period here followed the example of his forbears. The two best known metal colourants are copper for red and silver for white, and the variations possible with these two metals were evidently well-known to the craftsmen, for al-Hamdānī, as noted (fol.28a), identifies ṭīb as a gold-silver-copper alloy used by jewellers, and discusses a similar alloy for use as a gold solder, while al-Birūnī mentions red gold (al-dhahab al-aḥmar) and a naturally occurring green gold (p.233). In the time of Abū'l-Qāsim, however, there were many recipes for colouring gold, and he records nine (AQ p.217-9):

1. Black gold - add copper to molten gold.
2. White gold - add silver to molten gold.
3. Yellow gold - add sulphur to molten gold.
4. Red gold - add malachite to molten gold.
5. Red gold - take 5 dirhamsang of verdigris, 20 of Bukhārī clay, salammoniac, 2 dirham of salt: pound, sift and dissolve it in water, then paint it onto the gold, and fire it and wash it.
6. Unspecified colour - take 10 dirham of silver, 2 of salt,

½ of yellow arsenic; pound, sift and moisten the mixture and spread it on the gold and polish it.

7. Red gold - take 10 dirham of yellow sulphur, 20 of salt, 40 of white clay; pound the mixture, sift it onto the surface of the gold and polish it.

8. Green gold - take 10 dirham of verdigris, 10 of salammoniac, 10 of white clay, ½ of white unbaked brick, 2 of salt; pound it, sift it onto the surface of the gold and polish it.

9. Colourful hue! - 10 dirham of salammoniac, 10 of burnt copper, 20 of burnt burma, 1 of salt; put it lightly pounded into a stone cauldron, warm it and mix it with the gold.

It will be noted that there are two different techniques here for colouring gold. In one (recipes nos.1-4 and 9) the colouring substance is actually mixed into the molten gold, in the other only the surface of the cooled gold is affected. A still more complicated technique is probably alluded to by Abū Dulaf in his description of the various types of gold found at Shīz (para.4). Here he mentions that sījabadhī gold can be coloured with zāj, which is iron sulphate (see p. 423). Experiments to reproduce gold with a rose-coloured surface such as is found in ancient Egypt have shown that this colour can be made by mixing gold containing silver and copper with iron pyrites and soda (Lucas 1962 p.234; Plenderleith & Warner 1971 p.215). Some of the silver and gold combines with the sulphur in the pyrites, rising to the surface as dross and leaving the gold alloyed with the iron. When the gold is hammered into sheets and heated it develops a superficial rose-pink colour. This interpretation of Abū Dulaf's comment is supported by the fact that he defines sījabadhī gold as the kind used in ornamentation and decoration, for example for bezels, suggesting that it was a gold-silver-copper alloy which, with its relatively

high melting point would have been ideal for jewellery (Hoffmann and Davidson 1965 p.23; cf. Ham fol.71b-72a).

In addition to recipes for colouring gold the texts also give recipes for making gold solders. The principle behind soldering is enunciated by al-Hamdānī (fol.72a) when he observes that the solder must melt at a lower temperature than the metals being soldered, and he offers a single recipe for gold solder (fol.68b-69a) - 1 dirham of gold, 4 ḥabba of copper, and 1 ḥabba of silver, though he notes that the amounts of copper and silver in this alloy will vary according to the strength of the gold to be soldered. Since 1 dirham was equivalent to 48 ḥabba (cf. Ham fol.46a) the ratios here are 48/53 gold, 4/53 copper, 1/53 silver. Abū'l-Qāsim gives two other recipes, one for red gold and one for white gold - 4 dāniq of gold, 1 dāniq of copper and 1 dāniq of silver for red gold, and ½ a dīnar of gold, ½ a dāniq of silver and ½ a dāniq of copper for white gold (AQ p.221-2). Since a dāniq was equal to either 1/6 of a dirham or 1/6 of a dinar-mithqāl (Hinz 1955 p.11) the ratio in the latter instance may be 6:1:1. The use of borax as a flux is attested in the earlier period by Ibn Ḥawqal, who says that goldsmith's borax was exported from Lake Urmiya for this purpose (IḤ p.346), and in the later period by Abū'l-Qāsim. The latter specifies its particular use and nature when he comments:"It makes substances flow" (AQ p.196). He also says that the borax used for soldering was called ranravandī or zarvandī borax after a village on the outskirts of Nīshāpūr. Yāqūt on the other hand says that this borax owed its name to a river in Armenia (Yqt II p.922). Stapleton (1927 p.348) suggested that goldsmith's borax was probably calcium borate.

Gold was also used for colouring other metals, a process called gilding. Lechtman (1971) distinguished two types of golding, true gilding, defined as the external application of gold to another surface, and depletion gilding, the enrichment of a surface in gold by the removal of other alloying elements already present. The latter method seems to have been used exclusively in South America and need not be further discussed. In the first method three different sorts of gold can be used - solid (leaf gilding), liquid (wash gilding), or amalgamated gold (mercury gilding). Lechtman's studies of five Byzantine or Sasanian objects suggested that wash gilding was not common - apart from being a wasteful method it is impractical for the parcel gilding generally desired. It would seem that gold was usually applied in leaf or foil form, or with mercury. al-Hamdānī indicates that this situation continued in the Islamic period. He describes the making of gold leaf, relating how it was used in Baghdād for decorating small square teak boxes and small chests, as well as silk, leather, wood, book pages, ring stones and glass (Ham fol.63a-64a), and though the list does not include silver objects it is reasonably likely that it was sometimes applied to them too. He also describes in considerable detail (Ham fol.66a-67a) the method used for mercury gilding. In this the silver object is first coated with mercury, amalgamated gold is then spread over the same surface, and the mercury finally vapourised by heating, leaving a layer of gilding on the object's surface. al-Hamdānī notes that metals differ in their ability to take gilding, pure silver being the best, then poor quality silver, then copper, then iron, and finally steel, and describes how for all but high quality silver the surface of the object was rubbed with alum before the application of the mercury to help the mercury gilding

process work effectively. al-Birūnī and Abū'l-Qāsim also briefly mention mercury gilding (Bir p.230; AQ pp.211-2) indicating that the process remained popular throughout the early Islamic period.

If gilding is done well it is often necessary to use a microscope to discover the method used. In one or two Islamic silver objects, however, the method is perfectly clear due to the craftsman's comparative carelessness. Thus, for example, the gilding on the bowl commemorating the capture of two rebels in 1144 A.D. (silver bowl C/5 illustrated in colour in Sarre and Martin 1912 pl.122) goes far beyond its rightful areas indicating that it is mercury gilded. Only a detailed study of surviving pieces will give an idea of the ratio of leaf gilded to mercury gilded objects.

Turning to the trades involved in the production and embellishment of objects in gold and other precious metals, Tafazzoli (1974) has published the names of various craftsmen known to have existed in Iran in Sasanian times. The list includes the asēmgar and asēm-paykar, both silversmiths, and the zarīgar and zarrēn-paykar, both goldsmiths. Tafazzoli suggests that there must have been two sorts of gold and silversmith, the one making ornaments and the other making vessels and larger objects, and he offers the names nāzokkar and koloftkar as the modern equivalents. Oddly Wulff (1966) does not mention the latter name, and (p.364) gives the former as the title of the worker in ornamental plaster. In his study of the modern industry Wulff makes it clear that the production of objects in precious metals can involve a relatively large number of different craftsmen. Although in small communities a goldsmith may be the only worker in precious metals, large cities have separate goldsmithing, silversmithing and jewellery trades, together with particular specialists like the embosser, fret-worker, gold-beater, wire-drawer and gold-lace spinner (Wulff 1966 pp.32-47). The modern trade it is true probably caters for a greater

demand than the medieval one, but the crafts themselves have probably changed little, and one might suggest that the patronage of a wealthy ruler and his court, or of a wealthy merchant class, would have created a large enough market to keep at least some of these specialists fully employed.

The textual evidence supports this. Thus al-Hamdānī talks of the general work of the goldsmith (ṣā'igh) throughout his book, but towards the end (fol. 63a-b) he notes the fineness of gold leaf and the skill required to make it, and says that it was the particular and exclusive trade of the Jewish community in Baghdād. He also mentions the use of gold thread in clothes (fol.63a), and since numerous Persian manufacturing centres for such garments are mentioned in the sources, including Shustar in Khuzistān, Fasā and Tawwaj in Fārs, Iṣfahān in Jibāl, Sarakhs in Khurāsān, and other places in Ṭabaristān and Kūhistān (Serjeant 1943 pp.74, 80, 82, 84; 1946 pp.102-3, 107, 109, 117, 119) there must have been craftsmen completely devoted to gold lace production to meet this demand. Given the existence of these two specialised gold-working trades it is reasonable to suppose that others existed too, for example gold wire drawers, though jewellers in smaller towns would probably have been able to supply their own needs, and gilders, practised in the uses and dangers of mercury. Too few gold objects have survived to allow one to conjecture fruitfully on the division of more basic activities such as raising and embossing, but the existence of a variety of crafts within the industry becomes relatively certain.

Silver

Silver is generally known in Arabic as fiḍḍa and in Persian as sīm, though there were in early Islamic times many synonyms, some of poetic flavour, others with a more specialised meaning (Table 5). Like gold, silver probably had a large technical vocabulary associated with it dating from Sasanian times, from which, for example, al-Hamdānī's word rūbās (fol.56a) may have come. Knowledge of that vocabulary is even more limited than knowledge of the vocabulary associated with gold, however. The few Arabic or Persian technical terms used by al-Hamdānī, Ṭūsī and Abū'l-Qāsim are given in Table 6.

Silver is won in Iran today from argentiferous lead ores, which occur over large areas of the country. Thus Ladame (1945 pp.276-289) notes the existence of such ores in Azarbāījān, the Miyāna-Zanjān area, the Sāva-Qazvīn-Tehrān region, Khurāsān, Iṣfahān-Kashān area, Anārak-Yazd area and Kirmān, and similar deposits occur widely in Soviet Turkistān (Shimkin 1953 pp.126-7). The actual silver content of such ores varies greatly. The 10th century geographers make it clear that in their day there were two provinces particularly noted for silver, Transoxania and Khurāsān (Table 7). Dekówna (1971) has summarised the results of archaeological research into the medieval silver mining areas of Transoxania (Soviet central Asia), and isolates three important areas - Ilāq in Uzbekistan S.S.R., the River Talus valley in Kirghiz S.S.R., and Pamir in Tajikistan S.S.R. During the Sāmānid period Ilāq was second only to the Panjhīr region in silver production but towards the end of the 10th century seems to have declined owing to the exhaustion of the then known silverbearing ores; both the other two areas were at their most productive during the 9th-11th centuries. Studies of the River Talus area showed how production

was based on three micro-regions, each with its own natural resources and urban agglomerations, the latter being metallurgical centres with agricultural support from the countryside around, and a defensive system of fortresses.

In Khurāsān Panjhīr was renowned for its wealth and was the most important single silver-mining site in eastern Islam. It is mentioned in virtually all the 10th century geographies, and al-Iṣṭakhrī and Ibn Ḥawqal (Iṣṭ pp.279-80; IḤ pp.449, 457) give fairly detailed descriptions of Panjhīr itself and of the neighbouring mining town of Jārbāya - the only contemporary descriptions of early Islamic Persian mining communities. Panjhīr was located a day's journey away from Jārbāya, and the silver mined in both towns was sent to Andarāb before being circulated further afield. Of the two towns Panjhīr was the larger, and had a population of some 10,000 according to al-Iṣṭakhrī (Ibn Ḥawqal says 6,000). The people were noted for their dishonesty and unpleasantness. The town was well-watered; there were gardens along the river, and more distantly some fields. Jārbāya, on the other hand, although also on the river, seems to have been without fields or gardens, and the inhabitants of both towns depended for their livelihood primarily on the amount of riches they could extract from the mines. Panjhīr is known as a mint town between 256-329H./ 871-940 A.D., and Andarāb between 258-426 H./ 872-1035 A.D. (von Zambaur 1968 pp.54, 79), which probably gives a fairly accurate idea of the most fruitful period of silver production in the area, though it should be noted that Balkh, the nearest major city, was minting silver coins from late Umayyad times onwards.

Apart from their particular emphasis on Panjhīr, and their more general emphasis on Transoxania and Khurāsān, as the major silver producing areas of early Islamic Iran, the geographers also indicate that silver was produced locally in other areas of the country. For example they mention particular sites in Kirmān, Jibāl and Fārs, in all of which provinces silver is known to exist today (Ladame 1945 pp.276-289), and the single mention of silver mines in Mazandarān in Ibn Isfandiyār's work also implies exploitation at a very localised level. The silver mines recorded at al-Taymara are of particular interest. al-Taymara is known as a mint name from extant coins dated between 699 and 786 A.D. (von Zambaur 1968 pp.94, 153 - the earliest bear the name Sūq al-Taymara). Ibn Rusta, writing about 900 A.D. (IR p.156), says that Iṣfahān had silver mines abandoned early in the Islamic period of which traces were still visible, and he enumerates shafts, loads, tent sites, posts, the remains of habitations, bits of ingots, and tools and equipment. al-Maffārūkhī, two centuries later, mentions a silver mine at al-Taymara al-Ṣughrā of which traces were still visible (Maf p.18). These references are probably to the same mines, which were supplying silver for the mint in the eight century: the remains enumerated by Ibn Rusta, quite apart from the numismatic evidence, suggest that he may have exaggerated how long they had been abandoned. They have never been sought for in modern times, though the Tal-i Iblis expedition does mention that lead mining had been done near Mūta, the al-Taymara gold mine (Caldwell 1967 p.330). The discovery of the mines is much to be desired. Gordus has proposed a single mining site for silver used in coins minted in Hamadān, al-Taymara, and Mahi (yet to be located) between 708 and 717 A.D. on the basis of the gold content of the metal (Gordus 1974 pp.138-140): analysis of silver from any mine that was located might therefore provide evidence of the actual mine used during this period.

Whereas there is very little information in the literary sources about the movement of gold in Iran and trade with other countries, there is rather more evidence about the movement of silver, and in some cases early Islamic writers give important information about the relations between the government and the individuals involved in the silver business. First of all, it is almost certain that the mines in Iran were privately exploited, and that the government levied a tax on the silver found at source. This is illustrated by al-Hamdānī (fol. 25a) who says that when a nugget of silver was found in Iran the government representative (wakīl) took one third of it, the finder one third, and the people of the town one third. The silver retained by the finder according to al-Hamdānī was either made by him into something or sold to a merchant; the government's share, one concludes, was transported to the nearest town where it was either converted into currency or deposited to await transport to one of the major cities of the area. This would agree with the comments of al-Iṣṭakhrī and Ibn Ḥawqal (Iṣṭ p.279; IḤ p.448) which indicate that the silver collected by the government representative at the two famous mines of Panjhīr and Jārbāya was for the most part taken to Andarāb, the nearest town,where it was stored or minted into dirhams. Surviving dirhams show that a small amount of silver was evidently minted at Panjhīr itself, but none at Jārbāya, confirming the geographers' comments. That some of the silver which went to Andarāb was transported further unminted seems probable from the situation which al-Muqaddasī briefly mentions regarding Sāmānid Transoxania (Muq p.340). In Transoxania according to this author all silver ingots were transported to Bukhārā. This must mean all silver which had not been minted nearer its source (numerous mint sites in Transoxania are recorded for this period), and such silver was presumably carried to the capital to fill the royal coffers and support the dynasty. A similar

situation in Khurāsān is implied by al-Hamdānī's writing of Andarāb (strictly speaking he means Panjhīr or Jārbāya) as "the mine of Balkh" (Ham fol.24b). Balkh is the first major town on the main trade route from the silver mines near Andarāb to the outside world, more particularly the prosperous lands and cities of Khurāsān ruled by the Sāmānids, and hence was probably used as a depositary for such government silver as was not needed for the mints at Panjhīr and Andarāb.

When political and economic conditions were appropriate silver was also transported to Iran from other countries. In this case, however, the trade was probably well beyond the realm of government control and in the hands of merchants and private individuals. The latter were in the business for money, and were no doubt on the look out for more cheaply priced metal which they could take back to Iran and sell at a profit. An instance of this trade is recorded by al-Hamdānī (fol.25b-26a). He says that in 290/903, due to the closing of the mine in Ṣan'ā', the price of silver in the Yemen went up, but that twenty years later it returned to its original price. The exchange rates being favourable merchants then came from Iraq, Fārs, Syria and Egypt to buy silver and take it back to their own countries, where they sold it at a much higher price . al-Hamdānī emphasises the existence of an important trade route between Ṣan'ā' and Baṣra, and by including in the same section of his book a story of two Khurāsānians visiting the Ṣan'ā' mines, shows that Fārs merchants were not the only Iranians to reach the Yemen (Ham fol.26a). Certainly, if al-Hamdānī's figures are correct, and the silver mine at Raḍrāḍ in the Yemen really produced 20,000 dirhams of silver per week (Ham fol.25b) or 1,000,000 dirhams a year, then the vast surplus must have been exported somewhere, and much of the silver in use in Būyid times in Iraq and western Iran may well have come from this source.

In Ummayad times on the other hand silver seems to have been exported to Iraq from southern Iran. This is indicated by analyses already mentioned published by Gordus (1972 pp.138-140) which show that the silver minted in Wāsiṭ came from the same source as that minted in three towns in Fārs, and presumably therefore from a south Persian mining centre.

Silver, as noted above, is extracted today from lead ores. Since this implies a direct link between silver and lead resources it is important to establish whether the same was true in early Islamic times, all the more since there is some debate on this point. Silver occurs naturally in various compounds in the earth, and may occasionally be found uncombined in nuggets of substantial purity. al-Birūnī says that such nuggets were found in Iran but only on rare occasions, and records the use of the word samāna to describe such a nugget and the occurrence of pieces of silver in an iron mine in a Khurāsānī village called Wastānāt (Bir pp.242,244). Abū'l-Qāsim (p.224) also mentions how pieces of silver occur in stones. Such finds must have been rare indeed, and the vast proportion of the silver in circulation in medieval Iran must have come either from silver ores or fom lead ores containing silver. On the basis of analyses of some Iranian lead ores, the lack of lead on archaeological sites and a calculation of the amount of lead that would have had to be extracted to supply the silver needs of Iran in the pre-Islamic and early Islamic period, it has been suggested that the silver in circulation must have come for the most part from non-lead sources (Gordus 1972). It is true that in 1300 A.D. Abū'l-Qāsim makes passing reference to silver being extracted from stones by means of grinding and amalgamation (AQ p.224), but this probably refers to small nuggets of native silver, and neither he nor al-Hamdānī suggest that silver was extracted from an ore by simple

roasting such as would have been required with argentite (silver sulphide ore). In fact both authors show quite definitively that silver was extracted from argentiferous lead ores. Abū'l-Qāsim (p.224) says so explicitly: "lead is mixed with all types of silver in small or large amounts", and both he and al-Hamdānī devote long passages to descriptions of the methods required to extract the silver from the lead. An independent witness is Abū Dulaf who says of the silver deposit at Alarān (ADu para.8) that each mann of litharge from the lead ore produced half a dāniq of silver (about one gram of silver to every 3120 grams of litharge). In the light of these early Islamic authorities Gordus' assertion carries little weight, the more so since the lack of lead on archaeological sites can easily be explained by the lack of archaeological activity in Iran on the great Islamic city sites, and the texts and surviving artifacts show that lead had a large number of uses which would have gone some way at least towards using up the metal extracted from the earth as a biproduct of silver production. A final piece of important evidence is supplied probably quite accidently by the geographers, for a comparison of maps of silver and lead resources shows that most of the places mentioned in the texts as being lead producing centres are also recorded as producing silver.

Turning to the technology utilised in extracting silver from the ground al-Hamdānī begins his description of the methods used (Ham ch.21) by noting that potential sources of silver were first located through the occurrence of lead ores on the surface of the ground (his term al-kuḥl al-ithmid must mean galena here - see Antimony). The lead ore was mined, broken up and roasted in a special furnace equipped with double bellows, and the lead run out through a vent in the rear of the furnace into a tank. The lead was then placed in a dish and put back into the furnace and oxidised to form litharge (martak), from which a

silver ingot could be extracted (Ham fol.56b-57a). Such an ingot still retained a large percentage of lead and this was removed by cupellation. The process was to make a cupel (rūbās) of crushed burnt bones which would absorb the lead and impurities in the ingot, leaving relatively pure silver (Ham ch.22). al-Hamdānī noted that while the people of Yemen used this method of cupellation, others used salt and pulverised brick instead. This latter process must have been used to extract silver from electrum rather than from lead (see above p.31). Cupellation was known to al-Hamdānī as iṣfā' (Ham fol.57b). Particularly impure silver seems to have been subjected to a further process called qalb in a second hotter furnace (Ham fol.57b, 59b) but the details are not clear. The slag from the roasting of the lead ore was also processed to extract some of the remaining silver by heating it with bits of leather and bone, borax and salt, or by heating it with charcoal (Ham fol.62a). The picture given us by Abū'l-Qāsim is similar. In the cupellation process (rūbās kardan) Abū'l-Qāsim describes a cupel made of ash, called a gāh, and he notes that a second cupellation may be necessary for the production of fine quality silver (AQ p.227).

Silver was also extracted from natural electrum, as noted above, but how often it was used is difficult to say. Since it is not recorded by anyone but al-Hamdānī it may well have been a process confined to the royal mint where gold of great purity was desirable, and where every bit of silver would have had an immediate use in the form of dirhams. Since small amounts of silver and copper in gold make the gold more easily workable, jewellers and goldsmiths are unlikely to have purified gold in this way, and the amount of silver generally available from this source is therefore likely to have been very small, if not completely non-existant.

As with gold, the importance of al-Hamdānī's detailed description of the purification of silver lies not in the mention of any previously unknown method or striking technological breakthrough. The methods he enumerates were after all known in classical times (Agricola pp.465-6 n.26). But in his work, once again, are to be found the earliest detailed descriptions of processes for which the earliest hitherto known were those of Theophilus and Geber.

al-Hamdānī and Abū'l-Qāsim both give recipes for silver solders. According to al-Hamdānī (fol.69a) solder for fine silver consisted of 1 dirham of silver and ¼ dirham of brass, while that for bad silver was a silver-copper-tin alloy of 8/15 bad silver, 2/15 good silver, 4/15 copper, and 1/15 tin. The faces to be soldered were filed and rubbed with a type of borax, tinkār (Stapleton 1927 p.348 n.5), with or without salt. Large silver vessels were soldered with lead by means of a soldering iron (kāwiya) and oil or rāsukh - the identity of the latter substance is uncertain. According to Abū'l-Qāsim silver solder consisted of ½ dirham of silver and ½ dāniq of brass (i.e. 6 parts silver to 1 part brass) melted together and mixed with shūr-i būra, borax in some form (AQ p.226).

Finally, turning to the craftsmen who would have been responsible for the production of silver objects, it has already been noted that silversmiths (asēmgar, asēm-paykar) and goldsmiths (zarīgar, zarrēnpaykar) are differentiated in Sasanian sources (Tafazzoli 1974), and that a number of specialised trades within the goldsmithing industry are likely to have flourished in the larger centres of early Islamic Iran. Because silver is a less remarkable metal than gold technically, and because it is of less value, the number of different trades within the silversmithing industry would have been less, though how many less

it is impossible to say. Today the craftsman who raises an object does not seem to decorate it, a job left to the embosser, while the deep cutting of silver objects in preparation for niello work or enamelling is done by the gem-cutter or signet-maker (Wulff 1966 pp.35-8). If a similar situation existed in earlier times then one may assume that many of the surviving objects are the work of two individuals at the very least.

Niello

The black inlay known as niello was used in classical times in the Mediterranean, and continued to be employed as a form of decoration on silver objects in the Byzantine world and Sasanian Iran. An example of the latter is the dish with a flute player riding a mythical beast found at Viatka, and now in the Hermitage (Rosenberg 1924 fig.64). Niello was also used in early Islamic Iran, witness numerous objects below, and both al-Hamdānī and Abū'l-Qāsim give descriptions of how it was made. al-Hamdānī writes as follows (fol.68a):"Silver is burnt with sulphur until it becomes the colour of Indian iron. This is done by stirring the silver in the crucible, and the silver consumes the sulphur bit by bit. It is then cast in a mould and beaten out hot. If it has started to cool it flies about like glass. If they want to inlay(?) silver with this (compound), they pound it up with borax (tinkār) and water, and fill the place dug out of the silver with this pulverised material. It is allowed to flow like solder in the oven, and it does so. Files and rasps are then used on it." It is interesting to note that al-Hamdānī does not name the substance. In Abū'l-Qāsim's terminology it was called sīm-i sūkhta (lit. "burnt silver"), and he describes its manufacture thus (AQp.225): "They take one dirham of pure silver, one dirham of pure copper, and

half a dāniq of pure lead; they melt the copper and silver together and throw onto it, in two stages, half a dirham of yellow sulphur until it all becomes one. The colour ... becomes very shiny black. If they melt it a further time its colour improves and it gradually becomes more solid." From these two descriptions it is clear that chemically the substance used was not the same. al-Hamdānī's niello was silver sulphide, Abū'l-Qāsim's was a compound of silver, copper and lead sulphides (1 part silver, 1 part copper, 1/12 part lead, ½ part sulphur). This is of the greatest interest, for Moss (1952) discovered by experiment that prior to about 1100 A.D. the niello used on Roman, Byzantine and Anglo-Saxon objects was the simpler form, and he suggested that the more complex sulphide mixture was probably not discovered until about the time of Theophilus, who is the first to describe it. Unforunately no analyses of Persian niello have yet been undertaken to test the correctness of al-Hamdānī and Abū'l-Qāsim's writings. However, Moss did a small amount of work on the silver belt fittings with niello inlay from the Nihāvand hoard.

X-ray powder photography showed the mineral present to be stromeyerite (Moss 1952 p.56, Table II, n.15) indicating silver and copper sulphide, but Moss also noticed that on some of the poorer bits of niello on these objects decomposition suggesting silver sulphide had taken place, and he concluded that the niello in the latter instances must be silver sulphide and not the more complex mixture. Hence it would appear that the belt plaques show both types of niello, and since they are probably 11th or 12th century they further support Moss's theory that the more complex niello appeared round about the 11th century.

Chapter 2 - GOLDSMITHS' AND SILVERSMITHS' REPERTOIRE

Introduction

The surviving gold and silver objects have been arranged in three main groups under the headings Household Equipment, Personal and Cosmetic Articles, and Fittings. Within each group the types of object have then been arranged in alphabetical order, and the discussion on the objects, like the catalogue, adheres to that order throughout. The Conclusion to the section brings together the points arising from the various discussions.

Certain general points require comment, however, before individual groups of objects can be dealt with. In the first place there are three objects of gold or silver, published as early Islamic Persian in the past, which are excluded from the following discussions. The reasons for such exclusion must be briefly enumerated here. The first is the gold jug bearing the name of Ṣamṣām al-Dawla Abū Kālījār Marzabān ibn ʿAḍud al-Dawla ibn Rukn al-Dawla, in the Cleveland Museum of Art (Wiet 1947 pp.91-8, pl.20). While the shape and overall decorative style of this jug can be justified, certain other features strongly point to its being a fake. These are the poor quality of workmanship e.g. the crude roundels, and the bad planning of the inscription lay-out, neither of which are fitting for a royal object, certain details of the design which are totally uncharacteristic of art at that time, e.g. the three-dimensional effect of the birds, to say nothing of their solidity, even grossness, and the form of their wings, and the decadence of other parts of the design, e.g. the joints of the body roundels, and the vegetal motifs, which are inconceivable but twenty years after the gold jug of Bakhtīyār (see p. 74). The second object

excluded is the dish of Alp Arslān (Pope 1938 pl.1347-8; Mayer 1959 pp.44-5). This has not been proved to be a fake, nor has it been proved to be genuine. The situation has reached an impasse in which the main arguments are: a) there is no historical record of Alp Arslān bearing the title ʿAḍud al-Dīn as he does on the dish; b) the engraving is extremely careless, particularly in the outlines, and unworthy of an object ordered by a queen for a sultan; c) there are many features of the decoration which are not compatible with what we know of Saljūq art in the 11th century (Dimand 1941 p.211 versus Pope 1942 pp.203-7); d) scientific investigation shows that the engraving is contemporary with the date of manufacture, and Plenderleith could find no reason to doubt the age or genuiness of the silver (Plenderleith 1935 p.159). Not only is it impossible to come to a final conclusion but the object, because of the doubts about its authenticity, can never now be used as evidence of any greater trends or developments. For this reason it can only be a hinderance in any future discussions, hence its exclusion from this thesis. The third object excluded is the silver candlestick in the name of Sultan Sanjar in the Boston Museum of Fine Arts (Tomita 1949 and frontispiece). It is enough to look at the inscription design to see that this object is a modern forgery. Not only are the cartoon-like faces on the tops of the hastae quite out of keeping with 12th century art but they would never have been put on an object destined for use in the Shrine of the Imām Riḍā in Mashhad.

Certain comments are also necessary on the findspots of various of the objects following. Many pieces have appeared on the art market and where they were found remains unknown; others are from excavations which have already been discussed above (see p. 10); still others are from one of four hoards. Only one of these four hoards comes from a

definitely known site, the Chimkent hoard. This was found at a place called Sayram Su in the Chimkent district near the Jaxartes in 1900, and was fully published by Spitsïn in 1906. It is a collection of pieces of silver and coins, including many broken fragments of both, evidently put together for the purpose of remelting. The coins date from the mid 10th to mid 11th century, and since they must by then have been valueless as currency the hoard can hardly have been buried before the mid 12th century. Of the precise date and provenance of specific items in the hoard it is virtually impossible to be sure because of their small size, small scale of decoration, and general fragmentary nature, although they are definitely pre-Mongol. It is perfectly possible that they are all of Transoxanian manufacture, but since many of the same object types occur in excavations in Iran itself they almost certainly represent fashions current throughout the country and have therefore been included in this thesis.

Of the other three silver hoards, that in the British Museum is connected with Nihāvand in western Iran. This findspot is by no means proven, but since Nihāvand is not part of the antique dealers' usual jargon (cf. their use of Gurgān and Nīshāpūr for pottery) it may well be the true source of the hoard. Furthermore the gold bowl in the hoard has an inscription which strongly suggests an origin in that area of Persia (see below p.58). For this reason it is entitled the Nihāvand hoard in this work. Apart from the gold bowl it consists of silver objects - belt fittings, weapon fittings, beads and an amulet case, and its owner was probably the Turkish officer named on the ring-type object of unknown purpose in the hoard (see p.115) as al-ḥājib al-jalīl Abū Shujā'' Injū-takin. The hoard was published by Gray (1938), and he and Ettinghausen agree on an 11th-12th century Saljūq date for the objects.

A hoard of no certain origin is the group of silver objects in the name of the amir Abū'l-ʿAbbās Valkīn ibn Hārūn, which Melikian-Chirvani has reread as Valgīr ibn Hārūn (1968 p.144n.2), now in the Archaeological Museum, Tehrān. According to the 1931 exhibition catalogue, it consists of eleven items, three bowls, two saucers, a ewer, a bottle, a vase, a jar, a cup and a dish (Wilson 1931 no.139 A-L), of which the two saucers and cup have never been fully published. The vase and jar are catalogued in this thesis under jugs. Wiet, who first published the inscriptions on these objects (1933 pp.13-21), suggested a 950-1020 dating on the basis of the epigraphy, and very tentatively identified Abū'l-ʿAbbās as a Daylamite prince living in Azarbāījān round about 957 A.D. The latter point must remain for the moment pure conjecture, but a dating c.1000 A.D. is very likely on the basis of two stone inscriptions from Lūristān published by Eilers (1941 pp.34-5) dated 984 and 1008 A.D. in which the style of script is remarkably close to that on the silver objects.

The fourth hoard was previously part of the Harari collection, and is now in the L.A. Mayer Memorial Institute in Jerusalem. It is reported to have been found stored in an earthenware jar somewhere in northern Iran (Pope 1930), and consists of seven rosewater sprinklers, including two pairs, four handled incense-burners, two dish incense-burners, three jugs, a handled bowl, two caskets, one spoon, and a large assortment of harness-ornaments apparently from two different sets. All but the harness pieces were shown in the 1931 exhibition (Wilson 1931 no.131 A-T). It is greatly to be regretted that the harness pieces have never been published. The dating and origin of the various published items in this hoard are discussed below, but it may be noted here that stylistically the hoard appears to consist of two main groups of objects with some odd intermediate pieces. Interestingly both these main groups include incense-burners, rose-

water sprinklers and drinking vessels, suggesting that the last owner of the hoard amalgamated two sets of similar objects to produce a single more numerous but only slightly fuller set.

All four hoards throw quite different lights on the culture of early Islamic Iran. The Chimkent hoard mainly reflects jewellery fashions, the Nihāvand hoard gives important evidence of the personal equipment of a Turkish officer, the objects in the Valgīr hoard are an amir's personal plate, and show a remarkable emphasis on the consumption of liquid, while the Harari hoard illustrates the more refined side of the life of the wealthy - an abundance of incense, rose-water and presumably wine, and perhaps two caskets full of jewellery. This provides an important background to the study of individual objects and object types to which the discussion now turns.

I Household Equipment

(1) Items connected with food and drink

Bottles

The shape of bottle A/1 is unique in metalwork, and is probably derived from glass. Numerous mould blown glass bottles of this type are known (e.g. Sotheby & Co 8/12/70 nos.59-62; Davidovich and Litvinski 1955 p.111 fig.55) and are generally dated to the 11th or 12th centuries. Since this silver bottle is part of a set which can be dated on palaeographic grounds to c.1000 A.D., and since the shape almost certainly came from glass, an earlier date for many of the glass objects might be suggested.

B/1 is also a shape derived from glass, a fact most clearly seen in the use of projecting flanges as neck decoration, an idea taken from trailed decoration on glass bottle necks. Such derivative flanges also occur on bronze bottles (see p.178). No glass bottle of identical form to B/1 seems to have survived but its various components can be observed in different glass pieces. For example the neck and mouth are close to those of a mould-blown group (Sotheby & Co 8/12/70 nos. 59-62), while the form of foot and shoulder effect occur in a bottle decorated with trailed glass (Christie's 21/5/68 no.187), and the spherical body with a tendency towards a high shoulder is typical of numerous similar pieces. These bottle forms are traditionally associated with Gurgān, and while that association may be of doubtful value, other features of the decoration of this object do seem to point to a northern or western origin. For example, although the palaeography of the inscription is impossible to parallel exactly, it has much in common with the type of kufic found on the brick buildings of western Iran in the early 12th century, and the form of hastae has a reasonably close parallel in the inscription in the dome chamber of

the Friday Mosque at Qazvīn datable to 1113 or 1119 A.D. (Pope 1938 pl.305). Moreover the method of decorating an object with bands of inscription, roundels, and large free areas is found on other silver objects associated with late 11th century western Iran (e.g. silver bowls C/6, D/1-2), as too the tightly spiralled ground-covering in the decorated areas. Hence a west Persian provenance and a date just before 1100 seem likely.

C/1 is also of a form common in glass (Pope 1938 pl.1442A; Clairmont 1972 no.11; Berlin-Dahlem 1971 no.25 and pl.40; Davidovich and Litvinski 1955 p.112 fig.56). Such glass objects are dated variously between the late 8th and 10th centuries, and must be representative of the original medium in which this shape was developed: it is far more suitable for blowing than for any other form of manufacture. Its rather cumbersome nature in metal is illustrated by the clumsy joints visible in the silver bottle at the base of the neck. The decoration and palaeography point to an origin similar to that suggested for B/1.

From the above comments on the three extant bottles it is apparent that in western Iran for about 1000-1100 A.D. silver craftsmen were using forms ultimately borrowed from their glass-blowing contemporaries. When such borrowing began, and the nature of its ultimate source, is discussed below (see p.112).

Bowls

Four distinct shapes of bowl made of silver or gold survive from early Islamic Iran - the first (A) has a rounded body and no foot, the second (B) a truncated conical body and no foot, the third (C) a rounded body with a foot, and the fourth (E) a very deep body and a foot. A fifth group (D) is differentiated from the other four not by the form of its body, which is related to group A, but by the fact that it bears a handle.

Treating groups A,B,C, & E in turn, group A encompasses five objects, of which three (1 - 3) are very similar to one another. Cast in silver, with their rather shallow hemispherical form, they are evidently the direct descendants of a Hellenistic bowl type known from a small number of extant examples in the Hermitage Museum and elsewhere (Trever 1940 pl.15-24; Denwood 1973). The shape is virtually identical, there is an obvious decorative link, and details such as the foot-like ring on the base with a separate internal design, and the pearl rim moulding confirm the connection. Henning (1959) has shown that the two finer bowls (1 and 2) were the property of Windād-ōhrmizd, a famous prince of Ṭabaristān (790-822 A.D.), and that the third bowl must have belonged to an otherwise unknown son of Malik al-J̌ibāl Šarwēn, Windād-ōhrmizd's friend and supporter. The inscriptions do not prove that these objects were actually made for these individuals, but the weights given accord with the early Muslim standard introduced circa 694-6 A.D., and the bowls must therefore be 8th or perhaps early 9th century. The dating of the Hellenistic pieces has never been finally resolved, and the continuation of the style into the 8th century is at present undocumented, unless another bowl of similar shape in the Hermitage (Orbeli and Trever 1935 pl.35) is one of the few surviving Sasanian pieces.

Bowl A/4, to judge by the shape and predominance of external decoration, is derived from bowls like 1-3. Whereas they were fairly large, cast, and decorated in relief, this one is small, of beaten gold, and decorated in a simple incised style. Gray notes that the verses in the inscription come from a 10th century poet, and quoting Guest's opinion that the inscription's palaeography is 11th century, describes the bowl under the title "A Seljuq hoard". In fact the bowl can be

somewhat more accurately dated, and it is not Saljūq, whatever the date of the rest of the hoard. Evidence for this is to be found in the inscription from a bridge over the Kashkān-rūd in Lūristān dated 399/1008 (Eilers 1941 p.35) and another from a bridge at Maʿmūlān near Khurramābād dated 374/984 (Eilers 1941 p.34). Both have features in common with the bowl's inscription particularly the later text, including the form of ʿain (initial), the floral ends to the hastae on various letters e.g. dāl, ḫā', the tendency to make different types of letter look the same when they occur in a final position e.g. nūn, bā', tā', rā' etc., and the general appearance of the text as a whole. If this bowl was indeed foundin Nihāvand, as seems likely, then it would appear that it was buried in the general region in which it was originally made, and that it dates from the late 10th or early 11th century, before the Saljūq conquests. The inscription, in addition to being the means of dating the bowl, also gives important information about its function, for it strongly implies that it was designed for wine-drinking.

Bowl A/5 is similar in shape to those mentioned but differs from them in having all its decoration on the inside, a feature of group C bowls (below). It gives the impression therefore of being a mixture of two styles, suggesting that the silversmith was drawing on a variety of traditions, and the details of the decoration also point to a rather cosmopolitan outlook. For the eagle is not a design found on any other silver bowl, but rather a feature of textile design of the Būyid period. Melikian-Chirvani (1968), after an exhaustive analysis of the inscriptions and decoration,concluded that the object was probably the product of a silversmith's workshop in Marv or Nīshāpūr and that it should be dated to about 1000 A.D. While the dating seems likely enough, it should be noted that such a provenance is

based only on the information given about the owner in the inscription, not on the style of decoration or epigraphy. Melikian-Chirvani himself bases the dating on epigraphic parallels in Lūristān and others on Būyid textiles, reputedly from Rayy, and the lack of any north-east Persian or Transoxanian motifs on the bowl strongly suggests that it represents not Sāmānid art but the Būyid art of western or northern Iran at this period.

Bowls of group B are quite different in shape from those of group A, being in the form of inverted, truncated cones. There are two possible derivations for this form. Either it is a pure metal form created by the simple and obvious method of raising a sheet of silver into a bowl and then flattening the base. Or it is a form derived from a pottery bowl with flaring sides and a flat base or low foot. The closest ceramic parallels to 1-3 are the 9th-10th century Sāmānid slip-painted bowls of Khurāsān and Transoxania (e.g. Wilkinson 1973 p.160 no.2), and the use of an inscription as the only decoration for these pieces emphasises the possibility of such a derivation. On the other hand the epigraphic connection with western Iran which is the basis for the dating of the hoard to c.1000 A.D. (see p. 53) makes it difficult to reach any conclusion on this point. B/4 is slightly different from these first three. In shape it is narrower and has steeper sides, and its decoration is on the outside not on the inside. The narrowness fits with the contents of the inscription which indicates that it was made as a wine-bowl. The inscription once again is the basis for its dating and provenancing. The closest surviving parallels to many of the letter forms are to be found in the 12th century brick inscriptions of northern Iran, for example those on the Chahal Dukhtarān minaret (501/1107) (Pope 1938 pl.361A, 365A; Smith 1936 fig.210), in the mosque at Ardistān (553-5/1158-60) (Pope 1938 pl.319; Godard 1936g fig.190) and on tomb towers at

Marāgha (Godard 1936c fig.90-1, 94-5) dated 1147-8 and 1167-8. The metalwork inscription is probably earlier, and taking into account the forms of leaves in the two decorative bands on the bowl, an 11th century date and a west Persian provenance seems likely.

The third type of early Islamic silver bowl from Iran (type C) has a shallow rounded body, and a low foot-ring. This form is known from large numbers of Sasanian objects, usually of beaten silver with relief decoration, incising and some gilding. The relief designs are prefabricated and attached to the surface of the bowl by means of a ridge of metal cut up from the background and tooled over a flange around the base of the prefabricated piece (Chase 1968 p.91; Harper 1972 pp.153, 167). The details of the decoration are worked from the front with a large variety of tools. There has often been argument about whether particular pieces are Sasanian, "post-Sasanian" or Islamic, the distinction between the latter two titles adding to the confusion. Recent investigation by Gordus (1972 pp.146-7) has emphasised the definitely Sasanian date of certain pieces. Others may be ascribed to the Islamic period with equal certainty, although on different grounds. These latter pieces are sufficient to prove the continued use of the form during the early Islamic period, and it has therefore not been considered relevant to enter into long discussion about those objects which fit into neither category easily. Prolonged art-historical investigation combined with more detailed scientific studies may eventually elucidate satisfactory answers to some of the problems, but for the present Gordus' study of bowls such as that of Shāpūr II (Gordus 1972 pp.146-7; Lukonin 1967 fig.138) may be taken as indicating that observations such as can be fitted into a thesis of this scope are hopelessly inadequate.

The bowls which can with certainty be ascribed to early Islamic Iran are six in number (C/1-6). The dating of the first is based on the inscription which most recent scholarly opinion reads:"This vessel was ordered to be made by Pūr ī Vahman: weight 302 drachmas" (Livshits and Lukonin 1964 pp.162-3; cf. Herzfeld 1932 pp.151-4). The name structure corresponds to the Arabic fulān ibn fulān and was evidently not used in Sasanian times, and Livshits and Lukonin therefore date this piece to the 8th-9th century. C/2-3 have been discussed by Marshak (1971 pp.120,154) who shows how they are related to 8th century Soghdian work, and suggests an early 9th centry date, corresponding to the time when Ma'mūn was ruling in Marv and a revival of Sasanian imperial art in the old Soghdian lands would have been in conformity with the political situation. An Umayyad or ʿAbbāsid date had already been suggested for C/3 by Sauvaget (1940 p.48) on the basis of the crown shown on the bowl. Marshak (1971 pp.147-8) has also discussed C/4 briefly, and, comparing the iconography with Būyid medals and the 11th century Bodleian al-Ṣūfī drawings, suggests that the figure is Maḥmūd of Ghazna who declared himself king of Khurāsān in 999 A.D., and that the bowl itself dates from about 1000 A.D. Of the Ghaznavid origin there seems to be no doubt in view of the two-pointed hats worn by the courtiers, corresponding to the kulah-i dū sākh referred to by al-Baihaqī in his description of a celebration at Masʿūd's court in 1038 A.D. (translated by Bosworth 1963 pp.135-7). The dating of C/5 has been studied in detail by Sauvaget who in 1940 (p. 38) suggested that the bowl could not be earlier than the late 11th century on the grounds of the design of the castle shown, and later confirmed the dating by reference to a specific event recorded by Juwainī for the year 1144 A.D. (Sauvaget 1951). Finally, turning to C/6, whose owner is otherwise unknown, two decorative parallels exist for the seated lute-player in the centre of this bowl. One is on a silver medal of al-Muqtadir (908-932)

(Nützel 1900), the other on a gold medal of al-Ṭa'ī' struck at Baghdād in 976 A.D. (Walker 1958 p.694 fig.2). From these it is clear that the lute player was a royal motif in the central 'Abbāsid lands in the 10th century. The closest parallels to the palaeography, on the other hand, are to be found on the brick buildings of western Iran in the 12th century e.g. the Chahal Dukhtarān minaret in Iṣfahān 501/1107 (Smith 1936 fig.210), the mihrab of the mosque at Zavara (Godard 1936g fig.199) which is pre-551/1156, and that of the mosque at Ardistān 553/1158-60 (Godard 1936g fig.195), and the two Marāgha tomb towers dated 1147-8 and 1167-8 (Godard 1936c fig.90-1, 94-5). Two undated inscriptions in a mausoleum at Mawṣil (Grohmann 1967 II fig.144) show that this palaeographic style was not confined to western Iran and Azarbāījān, and an Iraqi provenance is therefore possible, although a west Persian one is much more likely. The bowl, on the basis of the above parallels,would appear to be late 11th century, assuming that brick palaeographic style lagged behind that of the minor arts.

Looking at these same six objects from a technical point of view there seem to be two groups. C/1-5 are all of traditional Sasanian form, all have parcel gilding, and all have relief designs. Four of them follow traditional Sasanian royal iconographic styles, while the fifth is evidently a special commemorative piece, and four again are of Khurāsānī or Transoxanian origin. C/6 however is different: its form though superficially the same is constructed differently, it has no gilding and instead has niello inlay, its designs point to a western origin.

The fourth group of bowls is something of a mixture, although all four examples are linked by having or having had handles. D/1 is closest in form and general design to A/4, but its decoration is rather different in its content, the inside showing an enthroned

drinking ruler. van Berchem (1909 p.404) adjudged the palaeography to be 5th/11th century, though he felt that the decoration seemed somewhat later. It is the all-over covering of the dresses with tight scrolls which gives this impression, but since these scrolls are used as a ground for the inscription too the decoration must all be of one date. The closest parallel for the palaeography seems to be the inscription on the Gunbad-i Surkh at Marāgha dated to 1147-8 (Godard 1936c fig.90-1), and like C/6 above a late 11th century date and west Persian provenance seems probable. The palaeography and background scrolling on D/2 are so similar to those on D/1 that it must be of a similar origin. The peculiar form of the background scrolling found on such pieces and its significance are discussed below (see p.94). The same type of scrolling appears on D/4 though here it is used for infilling of animals, stems and leaves. Since the form of this bowl is very similar to C/6 a late 11th century west Persian origin again seems probable. D/3 is quite different, both in form - its rounded body begins to curve in at the top – and in its decoration - a bold inscription against a heavily punched ground. Here the plain kufic form of the letters seems to foreshadow that of the 12th -early 13th century Khurāsānian metalworking style, and the strongly defined cross-over form at the base of the ʿain can be paralleled in 11th-12th century contexts (Grohmann 1967 II fig.104, 193). The shape too is more common in ceramics from the northeast than the west (e.g. Wilkinson 1973 p.40). This bowl may thus be a northeast Persian object dating from about 1100 A.D.

The probable use of two of the above bowl forms (groups A and B) is established by inscriptions on two particular examples, and while those inscriptions do not prove the exclusive use of the other pieces in the two groups such a link is likely. In other words they were all probably wine bowls. Groups D and E are not so described in any inscription, and their usage has therefore to be established indepently.

The first of these two groups is not too problematic since objects like this have been described by two particular poets, Abū Nuwas and Abū'l-ʿAbbās al-Nashī. These references have been put together by Krachkovski (1928), and translated into English by Ghirshman (1962 pp.204, 209, 214). The poets talk of gold (perhaps meaning silver gilt) bowls decorated on the inside with human figures, sometimes evidently Persian kings, and describe how wine and water were poured into them and drunk from them. Unfortunately the terminology is a great deal more confused than these straightforward descriptions. Abū Nuwas uses the words ka's, ṭarjahār and ʿasjadiyya for this type of object (Krachkovski 1928 pp.114, 117, 120-1 cf. his references to Arabic texts) without any attempt to discriminate between them, and other authors writing in Arabic use other terms too - qadaḥ (Tan p.261; Tan Faraj pp.215, 230; Hamadh p.128) which was evidently a wine bowl, sometimes of gold, ṭās (Bir p.243) which also appears in the Shāh-nāma, and was a silver or gold drinking vessel, ṣaḥn, a word used by Imru' al-Qais (Krachkovski 1928 p.116), and kūb and kūs (Hamadh pp.128, 182-3). The standard Persian word for a wine-drinking vessel was jām, and the Shāh-nāma specifies both the material used - gold or precious stone, and its function (jām-i mai) but evidently not its shape (Wolff 1935 p.260). This word's usage seems to have varied in different areas, however, since in 10th and 11th century Iraq a jām could be used for food and was often made of glass (Tan pp.23, 61, 124; Ḥarīrī pp.144-4). Two other mentions of jāmāt should be noted. First a list of taxes levied by Sulaimān ibn ʿAbd al-Malik's general Yazīd ibn Muḥallab on Ṭabaristān included four hundred men each bearing amongst other things a silver cup (jām fiḍḍa); second another list of taxed levied in the reign of al-Maʾmūn required Ṭabaristān, Rūyān and Nihāvand to supply amongst other things three hundred cups (jāmāt) (Serjeant 1946 p.98; 1942 p.63). Again the form of these cups

is not clear, and there is no way of telling whether they are the rounded, footless type of Windād-ōhrmizd or not.

From the above it is clear that the nomenclature of the different surviving forms of silver or gold wine bowl cannot at present be reconstructed. However, there are other questions which arise in connection with these objects for which some answers at least can be offered. The first and most obvious question is whether there is some sort of sequence in the usage of bowl types, or whether all of them were in fashion at the same time. The dating established above for particular pieces gives the following overall picture. Group A spans the period up to c.1000 A.D., group B is made up of three pieces dating from c.1000 A.D. and one from the late 11th century, group C spans the period from the Arab conquests to the mid 12th century, and group D consists of four objects all datable to somewhere about 1100 A.D. A fuller picture of the possible range of certain of these groups can be established on the basis of depictions of such drinking vessels on other objects or in paintings. In pre-Islamic wall paintings from Soghdia, the group C style is common, for example at Balalyk Tepe (Frumkin 1970 p.117) and at Panjikent (Belenitski and Piotrovski 1959 pl.8; Yakubovski et al. 1954 pl.7, 10), dating from the 6th century and pre-760 A.D. respectively. It is interesting to see here that the form is used for food as well as drink. A similar style of wine bowl appears on C/3, where it is held according to late Soghdian as opposed to 6th century fashion. Bowls of the same form are probably depicted in the Sāmarrā fresco of the two dancing girls (Herzfeld 1927 pl.2). Herzfeld reconstructed these as footless bowls but close observation of the black and white plate (pl.1) in his publication shows that the bowls were in fact footed, and had a greater diameter than he had allowed for. Finally this bowl form appears on bowl D/1, itself a handled bowl.

The other commonly depicted form of wine bowl is the conical one (type B). Examples occur on two ʿAbbāsid medals, those of al-Muqtadir (908-932) (Nützel 1900) and of Tughrilbeg and al-Ṭa'ī' (Walker 1958), on the wine bowl ascribed to Maḥmūd of Ghazna (C/4) in the hand of one of the servants, and in a Jibāl manuscript dated to 1199 A.D. (Farès 1953 pl.16). Given the immense popularity of this form under the Ayyūbids and Mamlūks, particularly in glass, and the complete lack of wine bowls of type C in those cultural contexts, the evidence put forward above seems to suggest that the surviving objects do not give the true picture. The bowl of Maḥmūd is an obvious paradox - in form type C, depicting type B. The true picture may perhaps be as follows. The most popular form of wine bowl inherited from pre-Islamic Soghdia, and Sasanian Iran, was the footed form (type C), and this continued in use in early Islamic times, and continued to be produced as royal plate in the north-east provinces. Some time in the late 9th century, however, fashion began to change in Iraq, and the conical wine bowl became popular, leading to its depiction on royal medals early in the 10th. By 1000 A.D. this fashion was popular in Iran too, but here tradition was stonger than in Iraq, and when Maḥmūd wanted to have a wine bowl made illustrating his sovreignty his silversmith made it in the traditional form, even though he depicted the current conical style of bowl in the decoration. The depiction of a footed bowl on handled bowl D/1 illustrated the use of an archaicism; the mid 12th century Saljūq bowl is to be explained as a single-issue, commemorative object illustrating an important contemporary event but setting it against the traditional back-cloth of Persian kingship.

The one group which this explanation does notcater for is the handled group (D). These have never been depicted to my knowledge on other vessels, and since their distinctive feature is the handle, some sort

of indication of their origin is to be sought in that direction. Handled cups were known in the Roman Empire, but they always had two handles (Strong 1966 pl.43b, 65a); the Sasanians drank wine from handleless bowls; the only possible area left is Soghdia. Here too wine bowls were often handleless, but Marshak's studies of Soghdian culture (Marshak 1961, Marshak 1971) have shown that it was what one might crudely term a "handle culture". An enormous number of pottery vessels had ring handles, not a feature of many cultures, and the shapes and handles are found too in silver objects, many of them traditionally ascribed to T'ang China (e.g. Orbeli and Trever 1935 pl.52-7). Hence it is highly likely that the handled silver bowl was introduced from Transoxania sometime after the Arab conquests. An indication of when this first began to happen is provided by a ceramic handled cup of Soghdian form, said to be from Nīshāpūr, dating probably from the 9th-10th century (Klein 1973 no.54, cf. Wilkinson 1973 pp.205-6), which shows that the style had by then reached well beyond the Oxus. It is reasonable to suppose, however, that the form only spread throughout Iran when there was sufficient cultural unity and eastern influence to bring that about, and one would therefore hypothesise the Saljūq conquests as the cause for the appearance of this form in western Iran, explaining too the fact that the earliest western pieces are late 11th century.

One silver bowl (E/1) has been left out of the preceeding discussion, for although it is a bowl, it was certainly not designed for drinking out of. Published as an incense-burner, its lid with pierced sunken centre rather suggests that the object was designed to receive liquid from outside rather than exhale beautiful odours from within, and it may be a diminutive ablutions basin. The style of palaeography and the tightly scrolled ground tie this piece in with other objects in the Harari hoard, and a similar winged horse on a 12th century

Rayy lustre bowl (Pope 1938 pl.634B) indicates that it is a west Persian piece of silver dating from a little before 1100 A.D. It should be observed, however, that the shape is reminiscent of north-east Persian ceramic bowls (e.g. Wilkinson 1973 colour pl.9), and it is tempting to see it, like the handled bowls, as a form which came to western Iran with the Saljūqs.

Dishes

Dishes are generally referred to in the Shāh-nāma as khvān but in Arabic a variety of terms are used. The word ṣīnīyya is common (Tan pp.145-6, Faraj p.221), but words such as ṣaḥfa and ṭabaq are also used for dishes of precious metal (Ḥarīrī pp.152-3; K. & D. p.200; Tan p.140). Surviving examples of silver dishes may be divided into two general groups - those with a vertical rim (A) and those with a horizontal rim(B). Group A may further be divided into footed and footless objects. The basic form of Group A is found in Byzantine silver of the 7th century (Dodd 1961 no.36-9), where it is virtually always footed. Such objects generally have a roundel in the centre bearing some sort of symbol, and sometimes a narrow band of decoration at the edge. Beaded rims are also found (Brailsford 1955 pl.1, 2a, 3a etc.). Such parallels suggest that A/1/1, and A/2/1-2 are all part of a tradition which is firmly based in classical silverwork. The details of their decoration, however, illustrate their early Islamic Persian origin, recalling designs on Persian ceramics of the 10th-11th century. Thus A/1/1's central geometric pattern may be compared to patterns on Samarqand slip-painted wares (Tazhkhodzhaev 1967 fig.12, 21, 32), and the four-roundel layout of the other two pieces also appears on such pottery (Tazhkhodzhaev 1967 fig.25). Moreover, the background

punching on these latter two dishes is copied in a type of sgraffiato ware found at Sīrāf and datable to between 1025-50 and 1125-50 A.D. (Allan 1974 p.20). These three pieces therefore combine to suggest a strong classically based tradition of silver-smithing in early Islamic Iran in which, however, the classical decoration was replaced by contemporary motifs.

Such a theory also seems to fit A/1/2 although at first sight not so obviously. Here the influence of classical form is to be seen in the thick upturned rim. This rim, like the whole dish, is made of two sheets of silver, and represents a different method of creating the 7th century Byzantine moulded rim (Dodd nos.57-66, 69-70). The decoration is quite different to the biblical scenes which embellish most of the similar Byzantine objects, and is based on the other classical style mentioned above and found on dishes with simple vertical rims. It has ceased to give the same impression due to a much larger proportion of the area being taken up by the central roundel and edging band. Nevertheless, there can be no doubt of the inspiration behind the piece as a whole. That it is decoratively further from its classical source than the other three dishes may be due to its later date: the style of inscription and of vegetal ornament suggest that it is a late 11th or 12th century product, almost certainly from western Iran.

If the first three dishes are 11th century, and the fourth is 12th century, there is evidently a long gap between the Byzantine products and the Persian pieces. Fortunately, the continued use of the form in the intervening period, although undocumented in silver, is readily visible in ceramics. For example it occurs in early Iraqi lead-glazed wares (Pope 1938 pl. 567A), in 9th-10th century Iraqi tin-glazed wares one example even having a mock beaded rim (Fehérvári 1973 no. 16), and in 11th century sgraffiato ware

(Pope 1938 pl.568A, 622). Given the continued use, and popularity, of the form in pottery from the earliest days up to the 11th century, and the existence of silver pieces of 10th-12th century date, a continuing tradition of silver manufacture may fairly be assumed from which potters constantly drew inspiration.

Dishes B/1/1-2 represent a parallel outworking of classical tradition using a slightly different form, in this case a dish with a flat rim. This again is a common Byzantine form, apparently more popular in the 6th century than the 7th , but known also in the 7th century (Dodd 1961 no.2-4, 20, 29, 73). The Tehrān dish, like all the Valgīr hoard, is datable to c.1000 A.D., while the second extant Persian piece bears a style of naskhi script which suggests a dating nearer 1200 A.D. The decorative stress given to the roundels, and the spacious layout, suggest that it may be a western Persian product, although many of the details would be readily at home in Khurāsān at this period Once again, therefore, there is a substantial gap between the Byzantine pieces and the Persian examples. Here again pottery testifies to the use of the form in earlier Islamic times, and thus to the probability of continued production of the form in precious metal (Pope 1938 pl.569B, 572A, 572C).

B/2/1 is a unique, and very curious, object. Dishes with octagonal edges are found in late classical silver work (Strong 1966 pl.59), but the Islamic piece, with not only an octagonal edge to the rim but also an octagonal joint between body and rim, would have been far more difficult to manufacture. Indeed its angularity suggests that it is a copy of a dish in another medium, perhaps wood, and this is supported by the extraordinary hollow moulding between the

central field and the rim, which is quite out of keeping in a metal object. That the maker was modelling his dish on some other object is further indicated by his evident unsureness in how to do it: he found that he had to support the rim by attaching crude metal strips underneath it. The decoration is also unusual. Senmurvs are common items of decoration in the Sasanian period, appearing on royal garments at Ṭāq-i Bustān for example. The blossoms, however, are more akin to the vegetal ornament on the Brummer ewer (bronze ewer A/1/b/13), which we have elsewhere attributed to 9th century Iraq or western Iran (see p.207). The use of a feather motif also found on a group of northern Iraqi aquamaniles (e.g. Berlin-Dahlem 1971 pl.37) datable to c.800 A.D., and the combination of these various elements with interlacing roundels, suggests that it was made in the 9th century in the west of the country. With its Zoroastrian affiliations in the senmurv it is an interesting example of the strength of traditional Zoroastrian symbols and designs during the ʿAbbāsid period. From a historical point of view it is even more interesting as the only silver dish of its period to have survived, and comparison of its design with designs on 9th century Iraq pottery bears eloquent testimony to the dependance of contemporary Iraqi lead-glazed pieces on their silver counterparts (cf. Sourdel-Thomine and Spuler 1973 pl.148), as surmised above.

Ewers

Objects made of silver or gold and designed to hold and to pour liquid have been divided into two groups, ewers and jugs. This division may appear somewhat arbitrary, but is based firstly on size, and secondly on shape. Thus the jugs are considered to be those vessels up to about 20 cms. high with round mouths, the ewers anything over that height, preferably with spouts. Only one object does not fit this scheme, ewer B/1, which is 39 cms. high and therefore must be functionally speaking a ewer, but has a round mouth.

The three surviving silver ewers reflect the three basic forms of bronze ewer - ovoid-bodied (A), spherical-bodied (B), cylindrical-bodied (C). The only one of the three which may be constructively compared with bronze ewer types, however, is C/1. The significance of the cylindrical form is discussed in connection with bronze ewers C/2-3 and the relationship between the silver and bronze objects is further dealt with on p.395. Judging by its decoration this silver ewer is evidently a product of 12th century Khurāsān.

A/1 bears little resemblance to any other metal object. Its nearest relatives would appear to be bronze ewers of group A/2/b, but the spout has changed considerably and it has no handle. The bronze ewers in question were made from the late 9th century onwards (see p.215) and since this silver piece dates from about 1000 A.D. a relationship between the two is conceivable.

The shape of B/1 has no direct parallel in metalwork nor to my knowledge in any other medium. Its closest relatives appear to be some of the jugs described below, its spherical body and flaring neck being

somewhat akin to those jugs B/1, and its tall foot being similar to those on jugs A/3, and hence probably stems from the same tradition. As published the style of the inscription on the ewer is not clear, but the roundel on one side has much in common with those found on silver objects ascribed to western Iran, and this combines with the ceramic evidence to suggest an 11th-12th century west Persian origin for the piece.

It is not clear whether A/1 is beaten or cast, though one suspects the former. From the published photographs both B/1 and C/1 appear to be beaten, and in the case of B/1 it is interesting to note the way the finial on the handle consists of a pin running right through the handle with a knob at the end. This probably indicates that the handle is made of sheet metal soldered into a cylinder and bent to the correct shape by being filled with sand and hammered, the sand being then run out through a suitably placed hole. Such a method occurs on bronze cylindrical-bodied ewers from Khurāsān (see p.227).

For convenience these three ewers have been included in the section on items connected with food and drink. Since however, there is no way at present of distinguishing between drinking ewers and ablutions ewers, it is not impossible that they were in fact designed for the latter purpose. Indeed if the bronze ewer of fluted cylindrical form in Tiflis may be used as a criterion (bronze ewer C/3/c/7), C/1 may well have been for ablutions, since the bronze piece bears a poem mentioning that specific function.

Jugs

Surviving gold and silver jugs may be divided into two groups, those with ovoid bodies (A), and those with spherical bodies (B). Within those two groups there are further divisions, in group A into jugs with a low shoulder, and those with a high shoulder, and the latter group again may be subdivided into those with a flaring mouth and those with a vertical one. Group B can also be divided into two in terms of the slope of the mouth. Before discussing the origins of these forms it is necessary to date and provenance the surviving examples.

The gold jug A/1/1 is made of beaten gold, and its decoration is worked from the front with a variety of tools. Because it appeared originally on the art market its authenticity has been questioned, and it is therefore necessary to deal with the decoration in some detail. It it is genuine then it must of course date from before the death of Bakhtīyār in 978 A.D., and is likely to have been made in western Iran. The jug bears two inscriptions in a style of kufic script which is hard to parallel exactly but is by no means out of place at the end of the 10th century. One might compare, for example, the inscription on the Sangbast mausoleum dating from c.1000 A.D. (Diez 1918 pl.18.1) or the Lūristān bridge inscriptions of the same period (Eilers 1941 pp.34-5). Elsewhere in the decoration, the seated animals with leaves or blossoms around them occur on Soghdian metalwork of the 8th century (Marshak 1971 T 17-18, 27-8 etc.), and the birds with branches in their mouths are derived from Transoxanian wall paintings (Frumkin 1970 p.122 fig.30), while the possibility of the overall design is proved by the decoration on a goblet in the Nagyszentmiklós treasure which must be based on a virtually identical source (Mavrodinov 1943 pl.29-31). The fleur-de-lys motif is a common transformation of the palmette in the art of Khurāsān and Transoxania, and

it also occurs on the Nīshāpūr sword (sword 1); the punched ground is characteristic of Soghdian silver (eg. Marshak 1971 fig.25). All this evidence seems to point first of all to the authenticity of the object. In particular it is unthinkable that in the early years of this century, before Panjikent had been excavated, the Nīshāpūr sword discovered, or the Soghdian origin of certain parts of the decoration in the Nagyszentmiklós treasure realised, a faker should have been able to produce an object which would fit so perfectly with what we know now. Secondly, the evidence above suggests that although this gold jug was made for a Būyid living in western Iran or Iraq it was almost certainly made by a Khurāsānī or Transoxanian craftsman, a man closely in touch with the cultural traditions of his homeland even if his workshop was in Būyid territory. Of his craftsmanship and artistic ability there is little doubt: indeed it would be difficult to overemphasise the quality of the workmanship of this superb object.

A/2/1 is of silver inlaid with niello, and like all the Valgīr hoard is datable to c.1000 A.D., and probably of north or west Persian origin. A/3/1-2 have decoration which one can now interpret as late 11th century west Persian, on the basis of discussions above in connection with bowls C/6, D/1-2, E/1, bottle B/1 etc. The fact that the roundels and animal frieze on A/3/1 have a criss-cross ground is probably not significant. A/3/3 on the other hand has decoration which suggests a very different origin. There is a close connection with the jug of Bakhtīyār in the leaf patterns on the body which appear to be worked, like those of the latter, from the front, and the double-leaf border at the base of the neck and the single one above the foot are like that on the neck of Bakhtīyār's. Likewise

a punched ground is used for much of the decoration. The main difference lies in the inscription which in the Harari hoard piece is nielloed and of a very plain kufic style, and in the addition of repoussé birds and animals. The inscription seems to have its nearest parallels in the inscriptions found on Ghaznavid high tin bronze bowls (Ettinghausen 1957 fig.14) which has a similarly bleak look to it and closely allied letter forms e.g. dāl and kāf. It would therefore seem reasonable to ascribe this jug to late 10th century Khurāsān.

B/1/1 bears a design which immediately recalls that on the octagonal silver dish B/2/1, and details such as the feather pattern and the punched infilling of the interlacing surrounds stress the close connection. The inscription, however, suggests that the jug may be slightly later than the dish, although there are few enough comparative inscriptions to allow of any certainty on this point. Like the dish it is presumably west Persian or Iraqi work, and probably 9th-10th century. B/1/1 is presumably beaten silver. If B/1/2 was made by the same technique then the embossed birds must either be soldered to the surface or else are most remarkable pieces of repoussé work. Otherwise the decoration appears to be incised using a punched ground similar to that found on Khurāsānī pieces already mentioned. Since the great blossoms are more in keeping with Transoxanian art than any region further west, and since the embossed birds are found in Khurāsān in 12th century brass-work, a north-eastern origin is likely, and a dating in the 10th or 11th century would fit with the inscription.

The last group of jugs (B/2) comprises four objects. B/2/1 from its naskhi inscription can hardly be earlier than 1100 A.D., and the relief

work and middle and lower decorative bands on the body all suggest a Khurāsānī provenance. The style of B/2/2 is quite different, and Pope (1930 p.481) suggested a connection between the layout of the decoration on this jug and that of the carved stone decoration on the castle at Mshatta. A much closer parallel can be found, however, in ossuaries from Biya-Naiman in Uzbekistan, datable to round about the 6th century A.D. (Belenitski and Piotrovski 1959 p.129 fig.27), where a design very similar to that on the neck of the jug occurs, the latter being a simplified version of at least two of the designs on the body. The heart-pattern border design is based on the peacock feather motif found in Soghdian metalwork of the pre-Islamic era (Marshak 1971 fig.17-18), the "panel" border is related to designs found at Pandjikent (Belenitski and Piotrovski 1959 p.124 fig.23), while the trefoil is a relatively common transformation of the palmette in Transoxanian art of the Islamic period as opposed to its rather rarer occurrence in Iraq and western Iran (Belenitski and Piotrovski 1959 p.136 fig.30), and it occurs as the primary decorative motif on the Nīshāpūr sword (sword 1). The trefoil with almost circular tiny leaves is also connected to the three circle motif found on Sāmānid slip wares (Pope 1938 pl.557B). From these comparisons it will be clear that there is good reason to regard this jug as of north-east Iranian or Transoxanian origin, and further confirmation of this is found in the design in one of the triangles on the body (Pope 1938 p.2502 fig.826a, left of centre, lower triangle) which is the precursor of a design found on the inlaid brass ewers of the 12th-13th centuries produced amongst other places in Herāt (see bronze ewers group C/4, Barrett 1949 pl.6-7). Hence it would seem that this jug is of 10th-11th century Khurāsānī or Transoxanian origin.

B/2/3 is very similar in every way to A/3/3 and must be of the same date and provenance. B/3/4 is of the same date and provenance as the rest of the Valgīr hoard, a fact emphasised by the excavation of two bronze lids of similar form at Nīshāpūr (bronze lids A/6-7).

To summarise these results in terms of form. A/1 occurs in a late 10th century Būyid context but is probably Khurāsānī workmanship. A/2 occurs c·1000 A.D. in northern or western Iran. A/3 appears in late 10th century Khurāsān and late 11th century western Iran. B/1 occurs in west Iran in 9th-10th century, and in Khurāsān in the 10th-11th. B/2 occurs in late 10th, 10th-11th, and 12th century Khurāsān, as well as further west c.1000 A.D. If these results show anything, they seem to indicate that jug forms were probably widespread throughout Iran in the early Islamic period. Such a generalisation does not unfortunately help with determining the origin of the forms, to which attention must now be turned.

In the preceding sections it has been shown that silver bottle forms are derived from glass, that bowl forms have a variety of origins, especially prominent being Sasanian and Soghdian metalwork types, that dishes are based on classical prototypes, and that ewers show a variety of influences. None, however, are based on ceramic prototypes. This is important when the discussion turns to jugs, for there are so many parallels in pottery that one is tempted to think that pottery may have been the source for silver jug forms. Thus, for example, flaring-mouthed jugs occur in Susan unglazed wares of the 8th-11th century (Rosen-Ayalon forthcoming fig.23-25), Sāmarrā lustre (Pope 1938 pl.576B), early tin-glazed ware (Lane 1956 no.18), and Samarqand slip ware (Tashkhodzhaev 1967 fig.6), spherical-bodied jugs with vertical mouths in the latter ware (Tashkhodzhaev 1967 fig.6; Wilkinson 1963 pl.25), and ovoid-bodied jugs with high shoulder and

vertical mouth in 12th century monochrome, lustre and silhouette wares (Lane 1947 pl.43B, 52A, 53B; Pope 1938 pl.748A). However, it is much more likely that the pottery pieces are based on metal designs. This is shown in the 12th century pieces by the verticality of the mouths of the pottery jugs, which is far too rigid to be a natural wheel-turned creation. It is also shown in the earlier ceramic pieces by the hard line at the point where the mouth joins the body. Once again this is not a natural ceramic feature, but rather one reflecting the most convenient method of constructing such an object in metal. On these grounds it is unlikely that the silver jugs were copied from ceramic models, and much more likely that the ceramic forms followed metalwork fashions. One particular unglazed ceramic object from Susa indicates that this conclusion is correct - a jug of ovoid body, and high, angular shoulder, topped by a tall flaring mouth with facetting around it (David-Weill 1951; Rosen-Ayalon forthcoming fig.212). This latter feature and the strong angularity of the whole must have been taken from a metal model known to the potter - presumably too the relief style of decoration, which may well reflect repoussé designs on the same object. This object is probably pre-800 indicating that there were already jug forms in use in metal at this period. This being so it is fairly likely that such forms were based on classical or Sasanian prototypes. Unfortunately no exact parallels seem yet to have come to light, although bronze and silver jugs were known in the Roman and Byzantine worlds (e.g. Comstock and Vermeule 1971 no.467-8; Milliken 1958 p.45). It would be interesting to try and reconstruct late classical jug forms from late classical pottery forms in conjunction with the pottery types of the first century or century and a half of Islam, an exercise regrettably beyond the scope of this thesis.

Spoons

The one surviving silver spoon is an extremely elaborate and ornate object. The kufic inscription in the bowl may be a name but it has yet to be deciphered. The other inscriptions of good wishes suggest a late 11th century date for the object and a northern or western provenance. Although a reasonable number of bronze spoons have survived from early Islamic Iran, it has not been possible to pin point the different traditions to which they may belong (see p. 242), and since this is the only silver example, and since it is of a form which appears to be unique, its significance cannot at present be postulated. A large silver spoon in the British Museum (1953.2-18.1) is described as pre-Mongol but its decoration and the form of the naskhi script on its shaft indicate a 13th-14th century date.

(2) Ablutions equipment

Ewers

Ewers have already been discussed above (p.72). Suffice it here to emphasise their possible function as ablution vessels rather than wine decanters.

(3) Furniture

Caskets

The two surviving silver caskets both come from the Harari hoard, and stylistically are closely akin to other objects in the hoard such as the deep footed bowl E/1, and to silver objects in the Hermitage, like jugs A/3/1-2. Since the evidence accumulated above suggests that these are late 11th century west Persian products, there is little doubt that the caskets are of a similar origin. Their size suggests that they were probably designed as jewel boxes.

In order to ascertain the source for such a casket style, it is necessary to take into account surviving bronze boxes of similar form. These are catalogued along with circular, octagonal and semi-circular bronze boxes under Bronze Furniture (see p.298).

The rectangular bronze boxes, with one exception, are of north-east or north-west Persian origin. Of the former are C/1/1, dated to 1197 A.D., C/1/2, C/2/a/1 and C/2/b/1-2, all of which are late 12th or early 13th century. The north-western example is C/2/a/2, which is 13th century in date. C/3/1 on the other hand is probably 12th or 13th century Transoxanian, witness the foral designs which are not found on Khurāsānī pieces of this period, and the seated figures which have their closest parallels in an inkwell from Munçaq Tepe (B/3/6). Closely allied to group C/2 and therefore presumably of the same ultimate origin are the two Harari silver caskets already mentioned. With the exception of C/3/1, for which no exact parallels occur, but which being probably Transoxanian need not detain us, the rectangular box forms can all be associated with surviving ivory boxes from western Islam. The C/1 style with its hinged half lid is known from an ivory box made for the Fāṭimid Caliph al-Mu'izz between 952 and 972 A.D., which also incidently has low feet and a pair of knobs at both ends of the rear wall (cf. C/1/2) (Rice 1958 p.229; Migeon 1927 I fig.167). The C/2 style is a form common in western Islam in earlier times, a notable example being the Cordova box dated to the year 1005 A.D. (Kühnel 1971 pl.22). This actual piece is unfooted but footed examples occur in 11th century south Italy (Kühnel 1971 pl.85). The appliqué figures found on the Boston box (C/1/1) and the silver caskets (cf. also bronze box fittings B) are also strikingly similar to those carved on the corners of an 11th century south Italian ivory box in Maastricht (Kühnel 1971 pl.89). Hence there would appear to have been a direct link between western Islam and the east sometime in the early Saljūq period.

While this may indeed be so it is otherwise undocumented, and one cannot help feeling that such a conclusion has an air of superficiality about it: I certainly do not find it convincing. After all there must have been boxes in ʿAbbāsid times in central Islam. Indeed al-Tanūkhī, for example, frequently mentions them in his writings (Tan pp.161-2, 191-2) and al-Hamdānī talks of small square teak boxes and small chests decorated with gold leaf made by the Jewish community in Baghdād (Ham fol.63b). An interesting additional piece of evidence for the existence of such boxes is the bronze box fitting (A/10) found in a 9th century level at Sīrāf. On this basis one is tempted to suggest that the similarity between Persian metal boxes and Western Islamic ivory ones is due not to direct contact at the appropriate moment in history, but rather to the fact that both areas of the Islamic world inherited objects from a common central source, Iraq, and that the subsequent developments in style in the different areas were never enough to delete the visual evidence of their common origin.

Incense-burners

Silver incense-burners fall into two clearly defined groups. The first (A) is a handled object, known from three examples all in the Harari hoard. While a large number of Islamic objects are referred to in publications as incense-burners, despite the fact that they have no inscription saying they are and no literary references are

ever cited to prove it, there is no doubt that these three objects were indeed for this purpose. This is clear from the fact that two of the hollow handles still retain, attached to their original caps, pairs of tweezers or little tongs designed to pick up hot pieces of charcoal or pieces of the substance to be burnt. Once this function is clear the reasons for the rest of the design become obvious - the handle which remains cool for moving the object, a body on sturdy legs which will not tip over and cause the white-hot charcoal to be spilt, a perforated lid to allow the perfume to ascend into the room but at the same time to hide the untidyness of charcoal and pieces of burning material, and in some cases sides with artistically designed air vents to allow the materials inside to burn freely.

The English term incense-burner is slightly misleading in a medieval Islamic context for such objects were not used solely for the burning of what we today call incense, but for a variety of woods and resins. Their Persian name ʿūd sūz indicates that aloes was probably the most common of such substances, but an Arabic term for a censer mibkhara , related to the Arabic word for frankincense bakhūr, shows that it was not the only one. Another Arabic word used was mijmara, literally a place of burning, and al-Tanūkhī mentions such objects made of gold (Tan Faraj p.224).

The three silver incense-burners in Group A fall very much into the pattern established for other objects in the Harari hoard. 1 and 2 are closely allied in terms both of technique and decoration with the two jugs A/3/3 and B/2/3, and are therefore to be ascribed to late 10th century Khurāsān. 3 is similar technically and decoratively to bowls D/4 and E/1, as well as to other silver objects discussed

above attributable to late 11th century western or northern Iran. Its simpler form is much more appropriate to the medium used.

It is interesting to note the form of leg on the two north-eastern pieces, which is used also on the silver dish-type incense-burner B/4. Such legs have been found in cast bronze forms at three archaeological sites, Rayy, Nīshāpūr and Susa, where they vary in height between 4.3 and 13 cms. (support fittings B/2/b/1-4). Whether they were designed for incense-burners made of bronze or for other objects it is unfortunately not possible to tell.

As metalwork objects the north-east Persian pieces are not very convincing, for both the body-form and the leg-style give the impression of being better suited to another medium. That impression is evidently correct for a logical source for the style has come to light in recent archaeological excavations in the Islamic world, in the form of soapstone objects. The earliest datable soapstone incense-burners are partially complete ones found at Fusṭāṭ and probably datable to the 9th century (Scanlon 1968 pp.5-8, pl.2 fig.2a-b). These were not recognised by the excavator as incense-burners but in view of the clear identity of the silver objects under discussion and the similar shape of the latter pieces there seems little doubt that this is what they are. In Iran an almost complete steatite incense-burner of the same shape and numerous fragments of others were found at Sīrāf in levels attributable to the 10th and early 11th centuries (Whitehouse 1969 p.60, pl.5(b)). A circular-bodied vessel with four tall legs attached to the sides is a complex object when made from metal. Carved in stone, however, it is relatively straight forward, and indeed displays an important logic between medium and form in the strength as well as ornamental character which the legs have,

carved as they are from one block of stone and with maximum area of attachment. Both archaeological evidence and design thus point to steatite or soapstone incense-burners as being the prototypes for the silver pieces.

Incense-burners of group B are essentially small dishes. Two of them (1 and 4) are from the Harari hoard, and of these 1 is decorated in a style close to that of the other late 11th century west Persian pieces mentioned above. The other bears comparison with, but is quite different from, any of its associated find: its legs are in the same style as those on the north-east Persian handled incense-burners, the form of inscription around the sides is similar to that found on west Persian monuments. There is no background work of any sort. This piece in fact gives the appearance of having been made by a craftsman somewhat lacking in skill and experience. The form of the dish is simple in the extreme, the inscription hardly elegant, and the combination of legs and body awkward and ungainly. The inscription suggests a western provenance and a date about 1100 A.D., but it may well have been the work of an apprentice. The Cincinnati dish (B/2) with its naskhi inscription and punched ground is probably to be ascribed to 12th century Khurāsān, while B/3 with its interlacing designs and punched ground is probably from the same region but of an earlier date, perhaps 10th-11th century.

A fuller discussion of these and other related forms of incense-burner is to be found in the section on bronze furniture below. Here it should be noted that a comparison of Parthian and Islamic pieces (bronze incense-burner group F) shows that the dish style is of Parthian origin and also allows confident identification of the purpose of the Islamic objects.

Table-tops

A full discussion of the role of objects such as this is to be found in the appropriate section of this thesis devoted to bronze furniture, where a much larger number of extant examples allows their probable role as tops for small tables to be defined. This one surviving silver example is a problematic piece on account of its inscription which was analysed in detail by van Berchem (1909 pp.407-10). He was unable to reach a conclusion as to whether the inscription referred to a man by the rather unlikely name of Khwārazm-shāh ibn Ibrāhīm, or to an otherwise unknown early Khwārazm-shāh (which does not fit the palaeography), or to a member of a small dynasty that could possibly have been reigning in Khwārazm itself subsidiary to the Khwārazm-shāhs proper. The palaeography seems to suggest a late 11th or early 12th century dating, but the decoration is too scanty to confirm a north-east Persian origin, as suggested both by the contents of the inscription and parallels in bronze.

II Personal and Cosmetic Articles

(1) Personal Articles

Wulff in his discussion of the modern metalworking crafts of Persia says that the work of the jeweller comprises "the usual ornaments, bracelets (dastband), necklaces (gelūband), amulet containers (bāzūband), rings (angoštar), garment pins (sanjāq), and chains (zanjīr), to name only a few" (Wulff 1966 p.32). Surviving personal articles from earlier times show that the jewellers of the day were producing much the same range of objects as their descendants now manufacture: amulet cases, beads, belt fittings, bracelets, chains, earrings, finger-rings, necklaces, pendants, and pins. Of these, beads, chains and pendants were originally parts of larger pieces of jewellery, and belt fittings are inappropriate in modern times. With these removed it is clear that fashion in objects, even if not their style, has changed little. The early Arabic and Persian sources confirm the range of jewellery in use. Four items occur regularly in the Shāh-nāma, bracelet (yāra), earring (gūshvār), finger-ring (angushtarī) and necklace (ṭawq) (Wolff 1935 pp.874, 739, 83, 593). In the Arabic sources one finds, amongst other things, bracelets (dumluj - Tan p.186; siwār - Ham fol.72a; Tan pp.133, 186), finger-rings (khātim - Hamadh p.84), necklaces (ṭawq - Ham fol.63a), silver amulets (taʿwīdh - Ḥarīrī p.40) and female trinkets of precious metal (ḥaly - Ham fol.63a, K. & D. pp.82,237). In addition it is interesting to note the evident existence of horse-harness with gold and silver fittings of which no examples are catalogued here though some are said to survive (see p. 53) (marākib - Tan p.151; lajām - Tan Faraj p.230).

Two jewellery items require particular comment at this point; anklets and nose-rings. There appears to be no reference to anklets in the Shāh-nāma, but they were certainly used in Iraq, witness al-Tanūkhī's

mentioning of such objects (khalkhāl - Tan pp.133, 186), and the discovery of two silver examples at Sāmarrā (Ḥamīd 1967 fig.6). A golden example in a style characteristic of ʿAbbāsid Iraq is in Berlin (Berlin - Dahlem 1971 no.157). It is therefore possible that they were known and manufactured in western, if not eastern Iran as well, though that cannot be confirmed without archaeological evidence.

Turning to nose-rings, the only evidence so far that they were used in early Islamic Iran comes from the exhibition circulated in the United States, entitled "7000 years of Iranian Art" (Washington Smithsonian Institution 1964). Item no.618 includes a "nose-ring composed of three small gold balls and a pearl that slides along its wire". Unfortunately it is not illustrated. The history of nose-rings has yet to be written, but in pre-Islamic times they are known from biblical references in Genesis (24 v.47), Isaiah (3 v.21) and Ezekiel (16 v.12), suggesting that they were a common Semitic ornament. This might explain why in the Islamic world they appear to be essentially Arab adornments. They are used for example among the bedouin of Arabia (Dickson 1949 p.156) and were common in the last century in Egypt (Lane 1908 p.576). There is no evidence to suggest that they were used by the Iranians, and the lack of such objects in Islamic excavations in Iran suggests that if the Tehrān object is a nose-ring it probably represents a brief intrusion of Arab custom into Iran, and is of little importance for the history of early Islamic Persian jewellery in general.

Amulet Cases

As far as one can tell all the surviving amulet cases made of silver or gold are constructed of sheet metal pieces appropriately shaped and soldered. A wide variety of forms has survived, and in length the objects vary from about 1-8 cms. Two of the amulet cases come from excavations in Iran, the silver cylindrical case from Nīshāpūr,

and the gold cylindrical one from Rayy. The popularity of the cylindrical form is confirmed by the gilt bronze case from Susa (amuletcase 1), but the probability that other forms were also manufactured in Iran is indicated by the Nihāvand case which is of slightly bulging rectangular form (D/5), and by the existence of a gold case of three-faced (F/1) and a silver one of six-faced form (B/5) both of which have decoration which may be ascribed to pre-Mongol Iran. For this reason the objects in the hoard discovered near Chimkent in Transoxania in 1900 have also been included in the catalogue. Spitsyn felt that they were of local manufacture, but there is nothing in their decoration or form which proves this, and it is quite conceivable that some were produced nearer the Oxus than the Jaxartes, and even in Khurāsān.

From this range of amulet cases certain points emerge. Firstly amulet cases were obviously an important item of jewellery in pre-Mongol Iran, a point further stressed by the use of much smaller imitation amulet cases as necklace pendants (necklaces B/1-3). Secondly, these forms all probably developed from the cylindrical amulet cases with suspension loops known in pre-Islamic times. Examples are the gold case from Tall Mahuz in Mesopotamia which may be Sasanian (Negro Ponzi 1970a fig.35 no.36), and those found in Parthian contexts at Taxila (Marshall 1951 II p.631 no.84, III pl.191). Thirdly, among these amulet cases are some of the few silver objects discussed in this thesis which are polychrome, that is they are silver, partially gilded, and inlaid with niello. Just under half the surviving silver objects from early Islamic Iran are plain silver, about a quarter are silver inlaid with niello, about an eighth silver with gilding, and the rest are this very exotic combination of all three. Among this latter group are for example jugs B/2/1-2, the spoon, and incense-burner B/2. Such polychromy is laboursome to create, and its rarity is not

perhaps surprising for this reason. Fourthly, it is interesting to notice that while in recent times in Egypt such amulet cases were worn as jewellery by women (Lane 1908 p.575) these were in some cases almost certainly the possessions of men, for example the case found with belt pieces and spear butts at Nihāvand.

Given the Parthian and possibly Sasanian precursors of the Islamic styles it may be assumed that such amulet cases were used throughout the early Islamic period. The surviving objects appear, however, to fall within the 11th-13th centuries. The Chimkent hoard can be dated on the basis of the coins contained in it to post 1050 A.D., and Spitsïn has argued quite rightly that a date somewhat later than this but prior to the Mongol invasions is likely. The Nihāvand piece is probably 12th century and the Nīshāpūr piece 11th or early 12th on palaeographic grounds. The rest on stylistic grounds are probably about 12th century. Hence, although amulet cases were almost certainly manufactured throughout the early Islamic period in Iran no pre-Saljūq examples have survived to give direct evidence of the fashions of the earlier times.

Beads

These are discussed below (see Earrings and Necklaces)

Belt fittings

In the pre-Islamic and early Islamic Near East there were a number of forms of belt in use. Statues of the Parthian period show two particular ones. Firstly there was a leather or material belt tied in a knot in the front (Ghirshman 1962 fig.91); secondly there was a belt apparently made of linked metal plates (Ghirshman 1962 fig.100, 105, 110). This latter style seems to have continued during the Sasanian period, being

found for example at Ṭāq-i Bustān on the figure of Shāpūr II (Fukai and Horiuchi 1969 II pl.69), along with various other less important forms. This same Parthio-Sasanian form is probably the basis of the jewel-studded belt found on the figure of the Caliph at Khirbat al-Mafjar (Hamilton 1959 p.228,pl.55). But at Ṭāq-i Bustān is also found a quite different belt form which is of particular significance. It appears on figures in the royal deer hunt and royal boar hunt, and evidently consists of a leather belt with tongued buckle, and pendant straps with applied decorative plates (Fukai and Horiuchi 1969 I pl.35-6, 43, 57, 64-6, 90-1). It is worn by both the king and his attendants, and the number of pendant straps would appear to have been significant in terms of rank, the greatest number occurring on the figure of the king (Fukai and Horiuchi 1969 I pl.64). The actual form of the decorative plates is difficult to ascertain, and while round ones certainly occur other forms may well have been used too. It will be observed that the figure of the mounted king bears a sword hung by twin straps from such a belt.

This belt form, and the twin-mounted sword, have both been discussed byscholars, and the sword type is discussed in some detail elsewhere in this thesis (see p.432). It is generally agreed that both belt and the sword are of Altaic Turkish origin (Mavrodinov 1943 pp.177-200), and that they spread across Asia and Europe with migrating peoples such as the Huns and Avars. Complete sets of belt plates have been found in Avar graves, and the reconstructions of the original belts give a good idea of the variety of design that was possible and of the occasional use of two belts (László 1955 fig. 47, 60, 79, 80, pl.59). From these survivals, plus the huge numbers of belt plates that have come to light in Europe and Asia, it is clear that the plates catalogued here are part of this tradition, and confirmation, if needed, will appear in the discussion of individual forms found.

Before entering upon such discussion, however, the following points should be noted. First, there are evidently sets of belt plates in Cairo and Jerusalem (Gray 1938 pp.75-6), details of which are unfortunately unavailable. When finally published they may add greatly to the picture delineated below. Secondly, in what follows gold, silver and bronze belt fittings are all treated together. This is not only convenient but logical, since large numbers of the bronze pieces are gilded indicating that they were intended as cheaper substitutes for such objects in precious metal. To aid easy identification of different forms, bronze and precious metal examples have been catalogued according to the same system of numbers and letters. In the text any particular example being discussed may be assumed to be silver unless otherwise stated. The bronze examples are catalogued on p.781.

The surviving Islamic Persian belt pieces consist mainly of metal plates with hollow backs, which were usually fastened to the leather belt by a pair of lugs. Both cast and beaten examples occur - it is often difficult to tell which any particular piece is - and while many are purely ornamental, some have particular functions, and are as much items of equipment as ornaments. Thus there are round and square double-plates in which the upper decorative plate is attached to a plain lower plate by four corner pieces (A/1/1-3, A/2/1-2), which were evidently designed to cover joints in the belt - the places where the pendant straps joined the parent leather. Then there are plates with rings attached to one end (A/3/10-11), which are also double and have a rivet hole in both front and back plate. They were designed for the end of pendant straps and would have held items of equipment needed by the wearer. There are also objects designed as sheaths to fit the end of a piece of leather, like the bronze plate from Sīrāf (bronze A/?/7)

which is probably a sheath for a pendant strap, and the Chimkent piece (A/7/2) which was probably designed to be fixed to the end of the strap that is pushed through the buckle. Certain other pieces may have had similar roles though the lack of precise published information makes this difficult to ascertain (e.g. A/7/1).

The dating of the various belt pieces is difficult to pin point accurately. Basil Gray suggested that the Nihāvand hoard was Saljūq, Ettinghausen the 11th or 12th century, and such a date fits the style of scrolling stems on some of the pieces, and the kufic inscription on the amulet case. (For the significance of the date in relation to the type of niello used see above p. 49). The dating of individual pieces in the Chimkent hoard is open to question, but one would guess that these are probably of much the same date as those in the Nihāvand hoard. Almost all the Nīshāpūr pieces were found in Tapa Madrasa, which, with the lack of detailed information available, allows a dating somewhere between the 9th and 13th centuries. The only pieces more accurately datable are those with inscriptions which are probably 11th or 12th century (A/3/3-5). The Rayy examples are undatable. The dating of the Sīrāf piece has yet to be worked out. The gold plate in West Berlin (A/7/5) about which more will be said later is probably 12th or early 13th century.

On the various belt plates certain distinct styles of decoration can be distinguished. The most obvious, and incidently the rarest, is that which is Islamic in tone. Three examples occur, all gilt bronze plates from Nīshāpūr (bronze A/3/3-5), and all bear kufic inscriptions of which the one legible example reads: al-mulk lillāh.

A second distinct style consists of bevelled designs (A/4/1-9), to which are related designs which are superficially rounded but probably owe their origin to the bevelled style (bronze A/5/2-4). This style, as Ettinghausen has shown, is of Central Asian origin (Ettinghausen 1961

pp.129-131), and therefore represents a different cultural tradition from the Islamic style just noted. The same is true of another distinct style, also noted by Ettinghausen (1961 pp.131-2), the linear arabesque design of even width. This appears on large numbers of pieces of the Nihāvand hoard, and in fragmentary form on some of the Chimkent belt pieces. Whereas the bevelled style derives from metal or woodwork, the linear arabesque designs derive from appliqués of leather or felt, hence the even width, but both emphasise the Central Asian and more specifically Altaic origin of the culture of the men who brought the designs into Iran.

Another group of belt plates display styles which are neither purely Islamic nor of obvious and immediate Altaic descent. Examples are the Nīshāpūr gilt bronze plates (bronze A/3/2; A/5/1,7; A/6/7; A/7/1,3). Certain of these have designs which are probably to be traced back to Pazyryk art forms. Thus A/3/2 if turned upside down is apparently based on the horns design of Pazyryk saddle pendants (Rudenko 1970 pl.94, F-I). But it has come a long way from that design. Another (A/5/1) has no parallels known to me in Central Asian or Islamic art, but is similar to a belt plate of the migration period found in Russia (Arne 1914 fig.127). The other four have no satisfactory parallel pieces. Yet another group of plates (bronze A/6/1-6) are of a type which is widely known from Russia to Scandinavia (Arne 1914 fig.194-204) in migration period finds. These facts suggest that while there was certainly direct Central Asian influence on Iranian belt ornament styles there were also more complex influences at work. The evidence at present available does not suffice to show the extent of other influences from cultures to the north of Iran, nor to trace the development of forms and motifs first adopted in the Sasanian period, but both are probably important.

The lack of information on these points is relevant not only to the belt ornaments in fact. For the same linear arabesque designs of even width appear on large numbers of silver objects already described, in particular those ascribed to late 11th century western Iran. Since there are no pieces with such designs which are definitely pre-Saljūq, as indeed there are no belt pieces, it is tempting to suggest that it was the Saljūq invasions which brought these designs from Central Asia into Iran. But this is probably a rather naïve assumption. Since the Central Asian belt form had been in use since late Sasanian times it is quite likely that Pazyryk type decoration had been in use too, particularly since the bevelled style is found very early in Islamic decoration, for example at Sāmarrā. All that is lacking is evidence.

To summarise, a survey of the styles of belt plate designs found in early Islamic Iran suggests that the major influence and source was the art of the nomadic peoples of Altaic origin, although the possibility of more complex cultural influences from the north and of the continuing development of styles already in use along with the Central Asian belt form in late Sasanian times should also be noticed. The Islamic intrusion into the art form is noteworthy primarily because it is on such a small scale.

The double-sided belt plate from a grave near Tiflis, now in Berlin (A/7/5) is something of a mystery, for the way in which belt ornaments are worn makes a double-sided object irrelevant, and unlikely. Since this object has been consistently published as such, and since I have had no opportunity of making a detailed study of it myself, I have reluctantly catalogued it in this way. Nevertheless, it seems possible to me that it is in fact a pair of plates, one with ring designed as a terminal plate and suspender for an object, the other designed merely

as an ornamental plate. Zick-Nissen (Berlin-Dahlem 1971 no.373) notes that the backs of the plates have some sort of fittings, and it may be that these are to fix the plates to the leather belt rather than join them together. That they should be a pair in size and shape would be no surprise in view of the uniformity found in the belt fittings of the Nihāvand hoard.

Two other types of belt fittings occur in Islamic Iran in addition to the plates already discussed. These are rings - to hold the free end of the leather belt strap, and buckles. The former are of little interest since they are absolutely plain metal, but the latter have two distinct forms. The most common is the tongued type (B/1 in both bronze and silver) which is the form used throughout the world today. Within this group two main styles can be differentiated. In one style the belt passes round a bar behind the tongue of the buckle and is then riveted to itself (B/1/a); in the other the strap is riveted to a plate which is attached to the rear of the buckle (B/1/b). Both types have their origin in pre-Islamic times, but the former was more popular in the classical world, and the latter during the migration period in Asia and Europe (e.g. Arne 1914 fig.151, 152, 248-9, 251). It would probably be unwise, however, to see any particular significance in their appearance in Islamic Iran, for Corinth contained a like mixture of types during Byzantine times and the small numbers of surviving Persian examples makes any statistical discussion impossible. The parallels among the Corinth finds incidentally include not only the plainer forms with bar attachment, like the bronze buckles from Nīshāpūr and Sīrāf, (bronze B/1/a/2-3 cf. Davidson 1952 no.2202-3, pl.114), and buckles with straightforward plates (bronze B/1/b/3 cf. Davidson 1952 no.2185-6, pl.114), but also that with a plate made of a metal sheet folded round the buckle ring and then riveted onto either side of the leather strap (bronze B/1/b/1 cf. Davidson 1952 no.2237-9, pl.115).

Quite different is the buckle from Nīshāpūr (bronze B/2/1) with an interlocking boss-and-circle mechanism. Such a form is more primitive than the tongue type in that the length of the belt cannot be adjusted at will, and has to be pre-set, and since I have been unable to find record of any pre-Islamic examples of the type it would seem to have been very rare. However, the principle was well-known, being used for clothes fasteners in the Roman empire (Wild 1970), and its extension to belt-buckles is therefore no surprise.

The dating of all the above buckles is tentative. The Rayy objects are in general undated; the Nīshāpūr examples from Village Tapa (1/b/1, bronze 1/a/2) and the unusually styled piece from Tapa Madrasa (bronze 2/1) may be anywhere between 9th and 13th centuries on the basis of available information (Wilkinson 1973 pp.xxxiii-iv, xxx-xxxii). The two Kalai-bolo pieces (bronze 1/b/4-5) are dated by the excavators to the 10th-12th centuries, the Sīrāf find (bronze 1/a/3) may be early 12th century and the Nihāvand piece (1/a/1) like the rest of the belt fittings in the hoard, is probably 11th-12th century.

Bracelets

Surviving gold and silver bracelets may be divided into two main groups. In the first (A) are those which are round in section; in the second (B) those which are flat in section. Within group A four different types can be distinguished. A fragmentary bracelet from Nīshāpūr with a snake's head terminal (A/1/1) is the only surviving Islamic example of a very common Achaemenid bracelet type with overlapping animal-head terminals (Amandry 1958). It is unfortunately undatable. The second type (A/2) consists of an open circle of metal with pointed terminals. This type has an extremely long history in the Middle East, occurring

at least as early as the 18th century B.C. (Maxwell-Hyslop 1971 pl.76b), and it is only the context of the finds catalogued here that makes it possible to distinguish them as Islamic products. The Chimkent pieces, like the rest of the hoard, are pre-Mongol Persian or Transoxanian, the Bākū pieces were found in association with pre-Mongol beads of similar origin, and two silver examples excavated in the Qaṣr al-ʿAshiq at Sāmarrā (Ḥamīd 1967 fig.5 top left and centre) show that such bracelets were also probably manufactured in Iraq. The latter are probably 9th or 10th century. A/3 is more elaborate than A/2 in that is is hinged in the centre, but all the surviving examples of the style are undecorated.

A/4 is one of the most important Persian Islamic varieties. In origin it would seem to be based on a bracelet form known from Assyrian bas reliefs, and inherited by the Achaemenid empire. The former consisted of a bracelet with a large rosette which appears on the back of the wearer's hand looking rather like a watch. In the latter case the bracelets had animal-head terminals on either side of the rosette-shaped, or disc-like, focal point. This type of bracelet is found in the Parthian period at Dura-Europos, where it occurs without animal heads (Amandry 1958 pl.30-1; Pope 1938 pl.139C). The Islamic pieces are elaborations on what went before in that they have a hinged body and a highly ornamented disc at the focal point which opens down the middle, acting therefore as a clasp. Such a form was not confined to Iran. An example was found at Raqqa (al-ʿUsh 1969 fig.116; cf. Atil 1975 p.41), another was bought on the art market in Egypt (Segall 1938 no.225 pl.44), and a third derivative example in the Benaki museum is probably 14th century Egyptian or Syrian (Segall 1938 no.319 pl.53). The Raqqa bracelet on epigraphic grounds can be dated to the late 11th or 12th century. The specifically Persian examples of the Islamic

period would be difficult out of context to place, and vary little from the more westerly pieces, but the Islamic examples as a whole illustrate the taste for elaborate and finely detailed ornament in filigree or granulation which seems to have been characteristic of at least part of the early period.

One other type of bracelet of circular section should be mentioned in passing since it is sometimes thought to be Persian. This is a form characterised by a curving triangular face on either side of the clasp. Examples have been found at Sāmarrā (Ḥamīd 1967 fig.5 top right and bottom three), and others are in Detroit and Berlin (Eastman 1926, Kühnel 1970 fig.150). However, since none of them have decoration which demands a Persian provenance, and since none of them were found on Persian soil, they have not been included in this survey.

A quite different group of bracelets (B) are those with flat as opposed to round sections. In their simplest form they consist of a sheet of metal bent to fit round the arm or wrist, and such were used in the early historic times (Maxwell-Hyslop 1971 fig.127). The pair from the Chimkent hoard (B/1/1-2) show the continued popularity of this style in the Islamic period,the only elaboration consisting of three ridges running round the bracelets. A variation used in the Roman period (Marshall 1911 pl.164 no.2798-9) if not earlier consisted of making the sheet out of separate plates and then linking them together with hinges. This style too is found in the Islamic period e.g. the silver and niello bracelet from the Chimkent hoard (B/2/1). The most elaborate and important bracelets with a flat section, however, are the four related pieces distributed among certain American museums (B/3/1-4). These have been studied in detail by Rosen-Ayalon (1972) who has shown how individual motifs and decorative techniques are

based on much earlier usages in Iran and the Middle East. She attributes the four bracelets to the 10th-late 11th century, and suggests that Daylam was their source.

Rather different from any of the above, though still with a flat section, are the pair of bracelets with triangular bosses in the British Museum (B/4/1-2). They represent a type which was apparently unknown in pre-Islamic times, but which may have been widespread in the Middle East under Muslim rule. Thus in the Louvre (no. MAO 418A and B) is a pair of such bracelets heavily decorated with filigree and granulations in a formal vegetal design which appears to be based on the bevelled Sāmarrā style. They came from Maspero's collection, and may well be Tulūnid or early Fāṭimid. The British Museum pair have no known provenance, but the roundel designs make a Persian origin highly likely, and the calligraphy suggests a date in the late 11th or 12th century.

Yet another style is represented by the Freer bracelet made up of sections of different forms (D). Such bracelets were known in the Roman world (Marshall 1911 pl.64 no.2797), and this piece is probably based on the classical tradition. Its decoration is purely Islamic, and the rather cursive kufic script suggests a 12th century Persian origin. Finally, a bracelet in the Victoria and Albert Museum (C) appears to be an amalgam of a variety of different styles - it has a triangular section, like two parts of the Freer bracelet, it has a triangular or pyramid-shaped boss very like those on the flat British Museum pair, it has animal-head terminals, like those on the round section bracelets, and it has a hinged part the tip of which fits into the boss, a clasp form not otherwise found. Its decoration again points to pre-Mongol Iran as its source.

From the above discussion certain conclusions may be drawn. Dealing with form first, most of the bracelets are based on much earlier Middle Eastern prototypes, suggesting a strong sense of tradition in the industry. On the other hand bracelet C/1, with its exotic mixture of forms, indicates that there was no lack of creativity in Islamic times, and that other novel types of bracelet may still await discovery. In terms of decoration the bracelets show a wide range. Relief work in sheet metal, elaborate wire work, gilding, niello inlay, settings with precious stone, filigree, and granulation are all found. Together they constitute impressive evidence of the skill and imagination of the jewellers of the period.

Chains

The surviving pieces of silver chain in the Chimkent hoard are all that remains of other more elaborate objects. Pieces 1-12 probably come from earrings (see below). The larger set of links (13) is probably part of a necklace.

Earrings

The most extensive group of earrings from early Islamic Iran are those decorated with beads (A). The large numbers of silver beads in the Chimkent hoard, the pair in the Nihāvand hoard, the two gold ones from Rayy, and a gilt bronze example from Sīrāf (see p.322) all show how popular beads were in the jewellery of greater Iran in this period. More specific evidence of the style of earring in which they were used comes from the rather plain, one-beaded, silver earrings from Chimkent (A/1-9), a twin-bead gold earring from Nīshāpūr (A/11), and a gold

earring made up of three beads and a central double-triangle from the excavations at Rayy (A/10). In addition there are two multi-bead earrings from near Bākū (A/14-15), plus the evidence of Caucasian finds in a similar style (Spitsin" 1906 fig.56,58). On the basis of these objects, complete and incomplete, of known provenance, and taking into account a further group which are said to be from Iran, or are on show in the Tehrān Museum (A/16-19), it is possible to attribute another five to Iran with fair certainty (A/20-24).

Caution is required at all times in such attributions, however, for bead earrings were produced throughout large areas over immense periods of time. For instance they have been found in 1st century graves in Greece (Marshall 1911 no.2565-6, pl.53), indicating a possible classical origin, and medieval graves in Kiev (Botkine 1911 pl.92), while in Islamic Spain have been found necklaces made of such beads (V&A Jewellery Gallery case 92/11/D). The plainer designs are difficult to attribute with certainty, but the evidence of surviving Persian pieces seems to suggest that while plain forms were used many early Islamic pieces are characterised by an abundance of filigree and granulation. The pre-Mongol dating of these objects is certain from the evidence of the Chimkent hoard, and the designs of Il-Khānid earrings, which from the evidence of a hoard found in Kazan (Spitsin" 1906 pl.5) are rather different in conception and execution.

It is interesting to observe the variety of loops or hooks used for suspending the earrings mentioned above. Some have a loop which joins at the top with a simple s-joint (A/1-9), others have loops with a joint at the side (A/10-11, 16-17), still others have hooks (A/23-24). The significance of these different means of suspension is not clear from the limited number of objects surviving, but it should be noted that Roman earrings were produced with a similar variety, and it may well

be that the Islamic products simply continue classical practice (cf. Siviero 1954 pl.189, 192, 194-5).

A variety of other earrings (B) may also be attributed to early Islamic Iran. The discovery of a hollow gold crescent at Nīshāpūr (B/2), and of a set of five crescents with plaited chain at Rayy (B/3), indicates that an earring in Berlin with three pendants of crescents and stars (B/4) is almost certainly pre-Mongol Persian, and a pair in the Birch collection with no pendants but the same body form as the latter, decorated with rosettes with seven circular petals, may also be assumed to be of similar origin (B/36-7). So too B/38-9. An earring from Rayy with an oval setting at the front and openwork bead at the back indicates that another like it with a central disc bearing an incised bird of very Persian style in Berlin (B/6) is also Persian. An earring with crescents (B/7) is reported to have come from Sāva, while another of open crescent form in New York bears a design of confronted birds either side of a palmette tree which is based on Sasanian art but in an Islamic style. Four almost identical earrings with pendant birds in Boston and Baltimore are also probably Persian (B/9-12), as are four pendants from similar earrings (B/30-33). All of the above are based on traditional forms. For example, earrings with various pendants occur in the classical world and in Parthian Iraq (Marshall 1911 pl.51 no.2356-7; Pope 1938 pl.139A, B, H), earrings with stones in oval settings on the front and earrings of crescent form were popular classical types (Marshall 1911 pl.55 no.2677-8, pl.53 no.2451-2, 2458, 2461-2). Pendant birds also occur (Rosen-Ayalon 1972 fig.28).

Important evidence of a style of earring that has not otherwise survived intact from early Islamic Iran is provided by the group of chains and the group of conical or hemispherical pendants in the Chimkent hoard (B/23-9). Such pendants are found in a variety of forms in later

Persian jewellery (Pforzheim 1974 no.137, 144-6, 151), and were known in the Roman and Parthian world (e.g. Pope 1938 pl.139 A,B,H). Each served as the central item of an earring, hanging from the suspension loop, and providing the necessary hanging space for other smaller items. That complete earrings of this type should not yet have been found intact in Iran is hardly surprising in view of the lack of scientific excavation and the fragility of their make-up, including as it does large amounts of fine gold or silver chain. However, an interesting comparative example is the pair of gold earrings found at Aleppo and now in the Damascus Museum, which show that this style may well have been widespread in Islam (al-'Ush 1969 fig. 117). The latter probably date from the period just before the Mongol invasions.

Mention should be made at this point of a certain type of crescent earring. Crescents in the form of complete circles with an offcentre hole are common in Iran among surviving bronze pendants, and their findspots make their Persian origin virtually certain. It might therefore be assumed that many of the earrings of this shape made of precious metal, generally agreed to be of Islamic origin, are in fact Persian, and two are indeed illustrated in the Survey of Persian Art as such (Pope 1938 pl.1344 F,G.), While it is possible that this attribution is correct, the evidence at present seems weighted against it. In the first place almost all the other gold crescent earrings known were acquired in Egypt, for example the large collection of them in the Benaki Museum (Segall 1938 no.284-293). In the second place, the Birch collection which largely seems to have been acquired through the Persian art market, does not include a single example. They have therefore been excluded from the discussion, assuming them to be characteristically Egyptian objects until evidence arises to the contrary. One pair of earrings in the form of open crescents are,

however, included in the catalogue (B/34-35), since they bear an extremely close likeness to certain bronze pendants (e.g. A/5), and since no others have ever been published from any other source.

Certain other earrings, published as Persian of the early Islamic period, or labelled as such in museum displays, have not been included in the catalogue or above discussion, for example a pair on show in the Boston Museum of Fine Arts (Boston 25.585). These have been left out because there seems to be no way at present of deciding on an appropriate date or provenance for them, and because their inclusion here would therefore be misleading.

The only earring type which remains to be mentioned is that in the shape of a lion-like animal. Ten examples are known to me (B/13-22), indicating that such earrings were relatively popular. The animal recalls the lion bronze incense-burners, although the difference in scale of manufacture does not allow close comparison. The general resemblance, however, plus the fact that the New York example (B/13) has an openwork rosette of seven round petals, a motif typical of Khurāsānī 12th century metalwork, suggest that an attribution to 12th century Iran would be appropriate.

This latter earring form is of particular interest since it is virtually the only style which owes its origin to the culture of Islamic Iran. Almost all the other forms are visibly related to classical ones, and an Islamic as opposed to classical attribution is often only possible on the basis of the motifs used in the decoration, or failing that, the application of a general, and dangerous principle, that the Muslim jewellers of Iran tended to use filigree, granulation and openwork in abundance.

Finger rings

The number of surviving finger rings in all metals from excavated sites is large compared with many other objects, but tiny in relation to the enormous numbers of rings which must have existed in early Islamic times. It might therefore be considered inappropriate to use such a small sample as evidence of greater trends and fashions. The fact is, however, that certain specific types can be discerned among surviving finger rings, and the sample, however small, cannot therefore be without significance, particularly since these types apply for bronze as well as precious metal. The groups or types concerned are rings with flat faces (A), rings of oval appearance with narrowing circular bezels (B), and rings with flaring bezels (C). In addition, of course, there are a variety of other forms (D). In group A there are three silver and twelve bronze rings, in B five gold, two silver and three bronze and in C thirteen silver and two bronze.

Of the origin of the flat face group little need be said - such a form is too obvious and common to be attributable to a particular cultural source. So too with most of the forms in the amorphous group D. Rings of oval appearance (B) are a common classical type (Marshall 1907 type XV p.xli), and may well have been used in Sasanian Iran, though about that there is virtually no information at present. The flaring bezel form (C) contains what appears to be a rather individual style of ring with a tall flaring bezel and flat shoulder (silver C/3-4, bronze C/2) which was evidently known both in the north and south of the country (Nīshāpūr and Sīrāf). Without knowledge of Sasanian forms it would be dangerous to assert that this was a particularly Islamic Persian form, but it is possible.

Three rings from Shahristān should be noted in passing (Negmatov and Khmelnitski 1966 pl.22). Made of silver, of slightly varying bezel form, they are all clearly by the same maker and therefore probably of

local manufacture. The same form occurs, however, at Ḥamā (Riis 1969 p. 73 fig.28 no.11), and was evidently more widespread. No examples have yet come to light in a Persian excavation and for this reason the Shahristān pieces have been excluded from the catalogue.

Certain other rings, for example three in the Harari collection (Pope 1938 pl.1344 B,D,E), are generally labelled Persian, but are probably not so. For one is paralleled by a ring in the Benaki Museum (Segall 1938 pl.60 no.311), and the other two by other rings in the same collection (Segall 1938 pl.58 no.296, pl.59 no.300-1). The Benaki rings were almost certainly acquired in Egypt, and the heavy filigree decoration has much more in common with Egyptian crescent pendants and with a group of beads from Caesarea Maritima (Katz, Kahane and Broshi 1968 pl.111), than with items of jewellery of known Persian origin. For this reason it seems appropriate to ascribe them as also a finger ring in the British Museum (1954.4-12.1), to a more westerly Islamic source.

Necklaces

For convenience necklaces, like earrings, have been divided into two groups - those primarily made up of beads (A), and those primarily made up of other ornaments (B). In both cases, however, it should be noted that any single necklace may well be an amalgamation of ornaments of varying date and origin. As a result one can only try and pinpoint certain ornaments that were commonly used in early Islamic necklaces: how they were combined will remain unknown until necklaces are found intact by trained archaeologists, and recorded in situ. For this reason only one drawing of a necklace is included.

As with earrings, attributions of necklaces which appear on the art market have to be based on other finds of known origin, for example pieces from the Chimkent hoard, or others from archaeological excavations. Thus A/1 and 2 have gold beads which can closely be paralleled by silver beads from the Chimkent hoard, while A/3 has polyhedric beads which are a straight forward and plausible variation on known early Islamic bead types. Beads decorated with little more than granulation occur in the gold earring from Rayy (earring A/10), and pomegranates being common finials on bronze objects (e.g. ewers), A/4 may also be attributed to early Islamic Iran. A/5-7 have an openwork and filigree bead style which has no parallels in objects of known origin, and the three-petalled unit is unusual. However, once again such bead forms seem plausible variations of known examples, and the necklaces have therefore been included. A/8 and 9 both contain beads with openwork very like those in an earring from Tehrān (earring A/16), but here combined with a crescent ornament to make sets of very striking pendants. Such crescents occur commonly in bronze jewellery (p.322) and this combination thus rings true. However, the other pendants in necklace A/9 do not. While profile bird-heads do occur on lampstands and ewers in bronze these strike an alien note both in form and decoration. Whether they are fakes or of some other origin is not relevant here, but there seems no reason to regard them as early Islamic.

A/10 includes beads with filigree circles like those on Nihāvand and Chimkent examples, and since there is a certain unity among the beads of the necklace despite the differences in design they are all probably pre-Mongol Persian. Another gold bead with a bird or animal design of similar type, and possibly originally from the same set, is in Berlin (bead 72). Further necklace beads of Persian Islamic origin occur on a made-up necklace in Tehrān (A/11) and on the Cincinatti necklace (B/4).

Turning to non-bead necklaces (B), the commonest ornamental form appears to have been a capsule-like unit similar in shape to a variety of amulet (type A), which indeed it was probably intended to imitate. The three necklaces in the Birch collection all show fine examples, the most delicate being those of B/1. Another such capsule occurs in the Tehrān necklace mentioned above. Another pendant form was evidently the medallion or escutcheon-like shape but the genuineness of the Cincinatti medallions will probably always remain a source of contention. It may be that this form is an Il-Khānid one, for the Birch collection example has rather nebulous decoration, and a piece in the Boston Museum of Fine Arts and an object of similar shape from Russia are both later (Boston 65.248; Spitsïn 1906 pl.8 no.15).

Pendants

Certain pendants are catalogued separately since it is not clear what sort of object they were originally attached to. The largest is a gold diamond-shaped piece with a kufic inscription which suggests a Būyid date. It is very large and could well have been used as an ornament on a chain round the neck. Perhaps the same function should be ascribed to the crescent-shaped pendant with two birds and a floral vase, also probably Būyid. Pendants 3-5 are all, it seems, fairly small, and could have hung from earrings, necklaces, or head-dresses with equal ease. The other small items in the Chimkent hoard (6 onwards), which Spitsïn suggests may have been buttons, were probably used for a similar purpose.

Pins

Bronze pins with ornamental tops are discussed elsewhere (p.324), and it is sufficient here to notice the existence of a single silver example excavated at Rayy, indicating that such items were made in precious metal as well as cheaper alloys.

(2) Cosmetic articles

Flasks

The exact purpose of this flask is not clear, but it may well have been designed to hold cosmetic or holy water, or possibly the early Islamic equivalent of brandy. The two rings indicate that it would have had a cord carrying-strap, and was probably meant to be worn attached to one's belt. Although the identity of the man named on the flask is not known, the style of decoration and the palaeography suggest that it was produced in the north-east of Iran or in Transoxania in the 11th century. Compare for example jugs A/3/3, B/2/3. No other example of this shape in metal is known to me, but it is probably based on leather drinking bottles, for which this would be a logical form.

Rosewater Sprinklers

These long-necked silver bottles are traditionally referred to as rosewater sprinklers (e.g. Pope 1938 pl.1350), in Persian gulāb-pāsh or gulāb-zan. Perfume or incense and rosewater have been associated in Islamic society from earliest times, and the regular pairing of mushk ū gulāb in the Shāh-nāma (Wolff 1935 p.732) is but one example of this association. Since seven of these bottles were found in a hoard alongside incense-burners, and since it is from such bottle forms that the modern Arabic qumqum is obviously derived (Lane 1908 p.209), there seems little doubt that the traditional nomenclature is correct. Furthermore the Chimkent hoard included an openwork cap from such a bottle which would have made an ideal sprinkler top (see p.113).

The Harari hoard rosewater sprinklers form two pairs and three single pieces. The two pairs, although their decoration differs, may both be associated with late 11th century western Iran on the basis of other pieces of silver already discussed. Likewise 6 and 7 with their

repoussé designs are both to be ascribed to late 10th century north-eastern Iran. 5 does not fit into either group, although it has punched grounds to the medallions on the body which are like those found in the north-eastern style. Its closest relative is in fact the jug in the hoard (B/2/2) to which has been ascribed a 10th-11th century Khurāsānī or Transoxanian origin, for like the latter it bears self-enclosing palmette designs within geometrically designed panels even though the details are not identical. 7 which comes from an unknown source, is a larger and more spectacular piece than the rest, but its main interest lies first in the fact that it seems to be the product of a merging of the two main styles so far outlined. It has for example the prominent inscriptions and the tightly scrolled grounds of the western style, and also the relief work and punched ground, the leaf borders and animal styles, associated with the north-east. The arabesque of even width and the niello ground also strongly recall the decoration of some of the belt pieces in the Nihāvand hoard (see p. 94) for which an originally Central Asian source has been suggested. Such a source is in fact further emphasised by the form of some of the animals in the roundels on the body, for example the lion/bull whose head has been set full face above its back in a way much more appropriate to felt appliqué work than the decoration of precious metal (Rudenko 1953 pl.90). Since its inscription suggests a dating round about 1100 A.D. the piece as a whole seems to indicate that at this time there was a coming together of the eastern and western styles of silverwork, and a significant overlay of Central Asian influence. Such a mixing of cultures could be convincingly explained as the effect of the uniting of the old Sāmānid or Ghaznavid and Būyid domains under the new dynasty of Central Asian origin, the Saljūqs. Whether such objects can with any validity be ascribed to the early 12th century Grand Saljūq capital, Iṣfahān, is debatable, but certainly conceivable.

In form these sprinklers, like the spherical-bodied silver bottle already mentioned (bottle B/1), must be based on glass objects. The actual body shape is the perfect blownglass one, the step shoulder is readily explained as being derived either from trailing or cameo work, while the tall neck with projecting flanges is again copied from glass bottle necks with trailed decoration. The only non-glass item is the lid or cap which on glass bottles would probably have been of wood or metal or a combination of both. How far back the form goes in metal in Islamic Iran is not clear. The surviving silver examples, as has been noted, are 10th-12th century, and comparable Persian glass bottles are traditionally given similar dates (Smith 1957 no.467, 488; Sotheby & Co. 8/12/70 no.41-4, 59-62; Christie's 21/5/68 no.187 which could as easily be Persian as Syrian). Interestingly glass bottles of such a style seem to have been unknown in the Sasanian empire although they were used in Byzantine Syria, witness the lack of them in Iraqi sites (Negro Ponzi 1968-9 and 1970-1) and the relative abundance of them in Syrian and Palestinian excavations (Crowfoot, Crowfoot and Kenyon 1957 fig.94-5, pl.25; Delougaz and Haines 1960 pl.50, 59; Kraeling 1938 p.533 no.57; Virgilio and Corbo 1964 fig.59-60). With the lack of surviving Byzantine bottles made of metal it is not possible to say whether the Islamic pieces continue an established Byzantine metalworking tradition based on Byzantine glass shapes, or whether such glass objects were first copied in silver in the Islamic world.

It should be noted, however, that already in the late 8th century this bottle form had found its way into bronze, for it is the basis of the north Mespotamian spherical-bodied ewers of that date e.g. the so-called ewer of Marwān (see p.219). It is therefore quite probable that it had found its way into silver too, and that silver rosewater

sprinklers of this form were already in use in early ʿAbbāsid if not in Umayyad times. Even if they do not go back so far the ultimate classical origin of the form is readily apparent.

III Fittings

Handles and Lids

Only one other silver ring hand survives from early Islamic Iran, that on bowl D/4, one of the pieces in the Harari hoard, though another silver bowl (D/3) has a bronze handle. The commonest bronze objects with ring handles are the oil-lamps, and a wide variety of such handles occur. This cast silver one is similar to the handle of a bronze lamp from Nīshāpūr (B/1/1) which does not however have the protruding beak at the rear, and to a bronze handle found at Rayy though this does not have the bird finial. Neither of the latter two objects are accurately datable; the date of the silver one must therefore remain undetermined for the time being. It would be interesting to know if this was a lamp handle, since silver lamps are not otherwise known.

The silver lid or cap from the Chimkent hoard probably comes from a rosewater sprinkler (cf. silver sprinkler 3), and with its openwork form it would have allowed the liquid to be sprinkled with ease. The two small holes in the side probably fitted some sort of projection in the neck of the bottle to prevent the cap falling off when the bottle was in use. The decoration does not allow it to be dated with any accuracy.

Weapon Mounts

The Nīshāpūr sword with its gilt bronze furnishings (sword 1) indicates that precious or semi-precious metal was probably widely used for the ornamentation of weapons in general. The only surviving pieces in silver or gold, however, are a sword pommel in Tehrān (1), and a number of weapon fittings in the British Museum and the Hermitage (2-6). The sword pommel is made of sheet gold which has been raised and then worked from both sides to produce animals standing out boldly from their background in a style found in Iran in much earlier times e.g. in objects from Marlik (Rosen-Ayalon 1974 pp.172-3). The form of the lions indicates that the object is almost certainly Islamic, and a Būyid dating is generally ascribed to it.

The weapon fittings are all of sheet silver strengthened with soldered bands, and niello decoration was used on all but one, which instead was inlaid with stones. The hollow cylindrical form of 2,3,5 and 6 suggests that they may have been spear mounts, and the brackets soldered to the two Nihāvand pieces would have then enabled the owner to carry the spear over his back leaving his hands free. Simple spear mounts are depicted in later Persian miniatures (Russell Robinson 1967 fig.19D). Alternatively they may have been mounts for cylindrical arrow-cases, although in later times arrow-cases were flat. Mount 4 is pear-shaped rather than circular in form, making its function more obscure. Since one end of it is narrower than the other it seems to have been designed as the tip of a weapon, or it may have been the end piece of an arrow-case or of some sort of sheath. All five objects are probably 11th or 12th century.

IV Unidentified

The purpose of one silver object is the Nihāvand hoard remains totally unclear. Half of it looks like a buckle, but it never seems to have had a tongue; the other half is a large round ring bearing the name of a Turkish officer; the two parts are joined by a hinge. Gray (1938 pp.73-4) suggested that it might have held a seal, but it may have simply been an ornamental attachment to its owners belt. Its importance lies in the fact that it identifies the probable owner of the Nihāvand hoard.

CONCLUSION

Some important conclusions may be drawn from the above survey, but it is necessary first to emphasise one particular limitation of the study as a whole: the small number of surviving objects. Due no doubt to endless remelting of precious metals, a feature common to almost all metalworking cultures, the lack of surviving pieces is shown in two ways. First of all there are types of object which no longer survive at all. The most obvious examples are the large and elaborate objects which adorned rulers' palaces, like the silver tree with mechanical silver singing birds in its branches which stood in al-Muqtadir's palace in Baghdād, but there are other smaller items too like the silver and gold saddle trappings which were reportedly worn by the troops of al-Muqtadir (Le Strange 1897 pp.37,40,42). Secondly, those objects which do survive are but a tiny proportion of the original total made. A vivid illustration of this situation is given by the lists of taxes imposed on Ṭabaristān in late Umayyad and early ʿAbbāsid times, in which the province was required to provide three or four hundred silver bowls at a time (Serjeant 1942 p.63, 1946 p.98). Today not one tenth of that number survive for the whole period from the Arab conquests to the Mongol invasions. This paucity of objects inevitably affects all conclusions for which they are relevant data. It is particularly visible in two ways: there are usually too few surviving objects to pin point contrasts in style between different regions or workshops; where enough objects do happen to survive to allow this to be done it is not necessarily rewarding. Thus the three bowls of Windād-ōhrmizd may be typical of Ṭabaristanī work of the 8th or early 9th century, the Berlin octagonal dish and jug B/1/1 may be typical of Iraqi or west Persian work of the 9th century, but the lack of other contemporary silver objects makes such attributions tentative and generally unfruitful, and they shed little light on the situation as a whole.

This situation is aggravated by the lack of textual information as to the whereabouts of production centres of the silver and goldsmithing industries. Since 10th century geographers and others mention the production of less valuable metal objects in particular places in Iran, their silence on gold and silver production is very surprising. The most likely explanation seems to be that such objects were made in the most obvious places - the dynastic centres or capitals - and hence deserved no special mention. In this case one might postulate in the east Nīshāpūr as the centre of any Ṭāhirid silver or gold work, Bukhārā as the Sāmānid centre, and Ghazna as that of the Ghaznavids, but in the west the situation cannot have been so clear cut. For example in the 10th century there were branches of the Būyids in Fārs, Kirmān, Jibāl and Iraq, and there is no way of telling whether textual silence means there were silver and goldsmithing industries of equal size in all the relevant capitals or only perhaps in Rayy and Baghdād. The same problem is relevant to the Saljūqs.

Only in the 11th century do we have a selection of silver objects which can be creatively contrasted: those associated on stylistic grounds with north-east Iran, and those adduced to be of west Persian origin. Here there is a marked difference in decorative motifs - large blossoms and stems in the north-east, tiny spirals and numerous inscriptions in the west, and a difference in the use of space and the alternation of decoration and plain surfaces. Here too there is a marked difference in technique, the north-east preferring relief work, the west incised designs in a single plane, and niello inlay. The importance of these two quite different metalworking schools, for want of a better term, becomes more clearly visible when the products of the bronze industry have been discussed.

The fact that many gold and silver objects now in museums throughout the world can be attributed to early Islamic Iran, and occasionally to

a more localised area and period, shows that these objects display characteristics which distinguish them from any objects which went before them. In other words they are in some definable way distinctive and original. Now in certain aspects they are very firmly rooted in tradition. For example, although Muslim writers were often the first to record in detail the processes used for the purification of the metals, there is no evidence to suggest that Muslim craftsmen invented any methods of metal production which affected the final objects. Likewise, the objects in shape and technique of manufacture tended to follow established practices of pre-Islamic times. Many of them were based on classical or other pre-Islamic forms, for example bottles, rosewater sprinklers, various bowl types, jugs, incense-burners, amulet cases, and most types of jewellery, and all of these were manufactured and decorated using inherited techniques - casting, beating, relief working from front and back, incising, punching, filigree work, granulation, open-work, gilding and niello, to name the most important.

At certain points however the industry went beyond, or utilised in a different way, the customs of its predecessors. First of all it produced different quantities of specific objects. For example, in the Valgīr hoard there is a predominance of drinking vessels, and in the Harari hoard a predominance of incense-burners and rosewater sprinklers. This shows that the culture of the day, as personified in the patron and his needs, created a demand which lead to emphases on particular object types and thereby to an intensity of production of those items in a way which did not necessarily follow pre-Islamic practice.

The industry also went beyond what it had inherited in its adoption of a variety of forms from a variety of cultural backgrounds and in its continued production of those forms simultaneously. This depended of course on the goodwill of the patrons, or more positively on their needs and

their taste, and it probably reflects the eclecticism of the latter more than that of the industry. Be that as it may, it is clearly visible in the fact that the traditional Sasanian wine bowl, the Soghdian handled wine bowl, and the Islamic conical wine bowl for a period of time all existed simultaneously in Iran. So too the industry was allowed to seek, and sought, inspiration in other media - in ivory or wood for caskets, in stone for handled incense-burners, in glass for bottles and rosewater sprinklers, building up thereby a wider range of shapes to fulfil the demands of its customers.

Another area in which new developments were apparent was in decoration and decorative techniques, specifically in the purposes for which they were employed. Here the all-important word is "colour", for the craftsmen and presumably their patrons seem to have had a desire for, and a sense of, colour which is unknown in surviving silver and gold objects of classical or pre-Islamic Persian origin. At an obvious level this occurs in the widespread use of gilding and niello inlay on silver, creating a splendid three-colour effect which is richer than the bichromality of most Sasanian objects, which tend to have but gilding, and far richer than the monochromality of most classical objects, which are usually plain silver and if nielloed only sparsely so. Paradoxically, the colourfulness of early Islamic Persian objects is most clearly visible in the smallest pieces - the amulet cases for example, where gold, silver and black are so closely juxtaposed as to make it impossible to overlook the richness of the contrasting shades. Closely tied up in this use of colour is the extraordinary ability of many of the smiths to inlay niello into cracks which are too small for the naked eye to study with ease. This skill is most clearly visible in the belt fittings from Nihāvand and in the Freer rosewater sprinkler where the niello forms the background for tiny scrolling stems.

This same feeling for colour was the inspiration behind the widespread use of another style of decoration which at first sight is purely monochrome - relief decoration. Relief designs are common on late classical silver, for example objects in the Mildenhall treasure. There relief work is used to make figures stand out from their background, to make them more important, to give them strength of character. In early Islamic Iran relief work is used in a similar way to carving in stucco - to give light and shade contrasts. Thus the gold jug of Bakhtīyār, incidentally worked with the most astonishing precision and skill, is decorated in such a way that first of all there is an interplay of light between the recessed ground and the upstanding design on the body. That interplay is then emphasised by leaving the almost identical design on the upper half of the object in one plane, and finally by using other tools to heighten the contrast on the body. The background is extremely accurately and finely punched, while the stems and leaves have strongly angled sides and form-details, as well as finely punched edging for extra stress. The whole gives an enthralling impression of light or colour contrast. That this was not a unique piece in its day from this point of view is clear from surviving silver objects of the north-eastern school mentioned above in which the same effects are obviously being sought, though less successfully.

Many similarly inherited characteristics are to be seen in the products of the coppersmiths' workshops in early Islamic times, as will be shown below. These latter products being so much more numerous than those so far described, there has been a tendency for them to overshadow their more exotic but less known compatriots. The last characteristics enumerated in connection with the silver and gold objects are therefore of the greatest importance. For they highlight the extraordinary way in which the finest products of the Persian bronze industry were dependent upon craftsmen working in precious metals, a fact which will increasingly emerge as the discussion proceeds.

PART 2 COPPER AND ITS ALLOYING METALS

Introduction

The root of many problems connected with copper and bronze in early Islamic times lies in the terminology used in the sources for the relevant metals and alloys. It is therefore essential to sort out these terms before attempting to draw more general conclusions about the industry as a whole. Aga-Oglu (1944) went some way to bring order into chaos, but his article was an abbreviated version of part of a work which he sadly never finished, and as such it omits much of importance. For reasons which will become apparent in due course, this attempt to present an even fuller and more watertight picture must begin with a summary of the evidence for and against the existence of tin deposits in Iran.

Although Iran today produces no tin, four areas of the country have been mentioned in previous publications as having tin deposits: cental northern Iran, Khurāsān, Sīstān, and Azarbāījān. In addition much has been made of the Caucasus as a possible source. Starting with this last area, Jessen (Field and Prostov 1938) suggested five possible tin-producing regions in the Caucasus in pre-historic times, offered a possible location for tin-bearing copper ores, and added that tin production probably ceasedin classical times. It is important to note that his conclusions are derived primarily from artifactual evidence: the distribution of bronze objects and their analyses. The geological evidence is vague in the extreme, and since there is no mention in modern surveys or Soviet publications of Caucasian tin deposits it is difficult to take Jessen's suggestion seriously.

Khurāsān has been quoted as a source of tin on the basis of a very circumstantial account given in a posthumous note of von Baer, quoted by

Crawford (1938 p.80). The information reached von Baer via a Russian friend of another Russian with whom von Baer was acquainted, and he heard it from an inhabitant of Mashhad and had it confirmed by an inhabitant of Bukhārā who claimed to know the region well. According to this information, "at a distance of 1.20 farsangs (7 versts) from the town of Utschan-Mion-Abos occur the richest mines of tin, iron, copper, sulphur and lead; and ... at 2.6 farsangs from Mashhad is a tin mine called Rabodje Alokaband." I can find no trace of a town by the name of Utschand-Mion-Abos. Perhaps one should read it as "the town of Quchan, at Miānābād", though in this case the distances are hopelessly incorrect, for Miānābād is about 70 miles west of Quchan, whereas a farsakh is about three and a half miles. Perhaps the distance of Rabodje Alokaband mine from Mashhad is wrong too, for it seems incredible that a tin mine within 10 miles of Mashhad and still in use until quite recently should be otherwise unrecorded particularly when the copper mining areas near Mashhad and Sabzavār are so well known (Curzon 1892 II p.517; Ladame 1945 pp.226-233). Altogether, von Baer's informants seem thoroughly unreliable and the possibility of tin deposits in Khurāsān may be ruled out.

Turning to central northern Iran, according to de Launay (1911 p.661) "Asterabad district appears to contain a little tin", and according to Fateh (1926 p.33) tin is found between Shahrūd and Astarābād. The source of this information is unknown and neither proposition has been confirmed by later surveys. An assertion by Bémont (1969 p.198) that Hamadān region has tin mines appears to have no foundation, for the authority he quotes (Fateh 1926) makes no mention of tin there, only of graphite.

The evidence for Sīstān as a tin source comes from Strabo, who claimed that "the Drangae ... have tin in their country" and Muhly suggests that this ties in with a late third millenium text which seems to indicate a tin source in the same region as the lapis lazuli mines i.e. in

the Afghanistān-Sīstān area (Muhly 1973 p.260). However, this latter text is open to other interpretations, as Muhly admits, and since there has been no mention of tin in the region in any work published in recent times known to me such evidence must be regarded with extreme caution.

The original basis for assertions that tin is found in Azarbāījān seems to be a report sent by a Dr. Riach to Lord Palmerston in 1837, which is quoted by Mactear (1894 pp.3-6; see also Crawford 1938 p.80). Riach claimed that a mine located on the stream of Anngert to the north of Tabrīz was a tin mine, and quoted the superintendent of the works and a foundry worker on the site, the latter having evidently been brought up in a Cornish mine. The ore was described as "a greyish stone, heavy, and almost every piece examined has numerous brownish-coloured crystals in it". This could certainly refer to cassiterite, but it is interesting to note that neither Mactear, nor another of the Institute members (Mactear 1894 pp.6,31-2), were convinced that this information was correct. Furthermore, Stahl in the same year wrote that tin should have been produced in Angert the previous year but that nothing more had been heard of it (Stahl 1894b pp.882-3). Recent scholarship continues to be intrigued by the possibility that tin did exist in Azarbāījān, even if it no longer does. Muhly (1973 ch.5) has shown that early historical evidence points to an ultimate source of tin somewhere in north-west Iran, and recent surveys by Wertime and others seem to indicate that suitable geological structures exist near Tabrīz for tin though no tin has yet been identified (McDonald and Rapp 1972 p.231). The situation is summarised by Muhly and Wertime (1973 p.119) as follows: "There are enough analytical evidences available at present to warrant the belief that in the early Bronze Age the Black Sea mountains and the Zagros mountains

north of Hamadān afforded alluvial tin as much as they afforded alluvial gold - and that the tin was quickly exhausted".

The above discussion may be summarised as follows. Tin is not exploited today in any region of Iran. If it ever was the only possible areas seem to be Sīstān and Azarbāījān. Of these the evidence for the former is absolutely minimal; the evidence for the latter suggests that tin was produced there only in Bronze Age times. In the light of this, it is possible to be reasonably certain that wherever a word like raṣās, ānuk or usrub, which can mean either tin or lead, is used by a medieval geographer in relation to a mine of such a metal in Iran, it should be translated as lead, and that wherever a word like ṣufr, which can mean copper or bronze, is used in similar contexts it should be translated as copper. On this basis tables showing sources of lead and copper in Iran have been constructed (Tables 8 & 9).

Proof that the above supposition is correct in the case of lead can be found in certain texts by comparison of the use of the word used for the mine and its use for other objects. Thus Yaʿqūbī and al-Muqaddasī both of whom mention mines of raṣāṣ also talk of water conduits of raṣāṣ, which must therefore mean lead (Yaq p.316; Muq pp.225,279).

In many cases too it can be independently shown that ṣufr was intended to mean copper and not bronze. For example al-Iṣṭakhrī is recorded by al-Qazvīnī (II p.362) as mentioning the existence of ṣufr near Shāsh. Now the text of the Kitāb masālik al-mamālik does not include this information, and it would appear that Qazvīnī transferred it from Farghāna, which is certainly mentioned by al-Iṣṭakhrī as producing the metals and substances Qazvīnī lists. al-Iṣṭakhrī twice notes the products of Farghāna (Iṣṭ pp.313, 334): the first list is somewhat longer and mentions naḥās, the second is shorter, mentions the most important

items from the first list, but excludes naḥās and adds ṣufr. The most plausible explanation for this is that the two words were synonyms to al-Iṣṭakhrī and it is therefore proper to translate ṣufr as "copper" in this instance and to acknowledge Farghāna as a medieval copper-producing region. There is one other reference in al-Iṣṭakhrī to ṣufr in his description of Sardan, on the borders of Fārs and Khuzistān (Iṣṭ p.155). It is repeated by Ibn Ḥawqal (p.300) and interestingly enough the word ṣufr is translated by the anonymous author of Ḥudūd al-ʿālam as rūd or rūdh (ḤA para. 29.49), the only instance of his use of this word, the word he usually uses for copper being mis. It may therefore be that this latter author thought that al-Iṣṭakhrī meant something other than copper when he used the word ṣufr, but in view of his use of ṣufr in connection with Farghāna this is probably not the case, and Sardan should be taken as a copper-producing area. Ibn Ḥawqal gives another source of ṣufr - Nasyā, in Farghāna (IḤ p.515), but since the list of products he gives is almost identical to that given by al-Iṣṭakhrī for Farghāna (Iṣṭ p.334), it would appear that he has taken al-Iṣṭakhrī's list and applied it to the most productive area in the region. Hence, ṣufr probably means copper here. Two other sources of ṣufr are mentioned in the texts. Ibn Rusta (p.156) records a ṣufr mine near Iṣfahān from which the state apparently took a tax of 10,000 dirhams, and the 11th century author al-Māfarrūkhī mentions ṣufr mines in the ristāq of Quhistān, an area of Jibāl not far from Iṣfahān (Māf p.18). Neither author unfortunately gives any indication of the meaning he attaches to ṣufr, but since copper deposits exist in the Iṣfahān region - mostly to the north and east (Curzon 1892 II p.519; Fateh 1926 p.32; Ladame 1945 map), and since it has never been even suggested that there might be tin in this area, it seems likely that

both medieval authors are referring to copper. It is also very unlikely that a mining area producing sufficient bronze to pay a tax of 10,000 dirhams would have disappeared without trace in a country where tin is so rare. Ibn al-Faqīh's reference to ṣufr as a product of Damandān in Kirmān province is misplaced (IF p.206; see p.150 below).

Having established the meanings of these various words in geographical texts, it is also necessary to elucidate their usage in technical texts. The details of the references for the following information may be summarised as follows. al-Hamdānī uses the following words to mean lead: usrub, usruf, ānuk and raṣāṣ. When al-Hamdānī wants to talk about tin he on one occasion uses the term raṣāṣ, but otherwise uses raṣāṣ abyad, raṣāṣ abyad qal'ī, qal'ī, or raṣāṣ min al-qal'ī. al-Birūnī's usual term for lead is usrub, and he equates it with usruf and ānuk. For tin he uses raṣāṣ or raṣāṣ qal'ī. Abū'l-Qāsim's general word for lead is usrub though he also uses abār, and arzīz. Tin he calls qal'ī or raṣāṣ, though the latter word he also sometimes uses as an umbrella term to cover both tin and lead (see Table 10).

On the basis of the above definitions it is now possible to discuss the metals in turn and be certain that one is using the data correctly.

Tin

The evidence already cited and discussed has shown that it is unlikely that tin, known generally in both Arabic and Persian as raṣāṣ or qal'ī (see Table 10), was mined anywhere in Iran in the early Islamic period. The question immediately arises as to where it came from, to which the

same, unequivocal answer is given in virtually every relevant text - Kalah, in south-east Asia. This was the case at all periods from the 9th to the 13th centuries, witness, for example, the general comments of Ibn Khurdādhba (p.66), and al-Masʿūdī (para. 375), and the more specific comments of other writers: Abū Zayd in the 9th century says that Kalah was the centre of commerce for tin (Abū Zayd p.90); Abū Dulaf in the 10th claims that there was no other mine in the world apart from that at Kalah (Yqt III p.453); al-Birūnī in the 11th says specifically that tin comes from Kalah (Bir p.248).

There has been some discussion as to the exact location of Kalah. It has usually been considered to be Kedah, on the west coast of the Malaccan peninsula (EI_1 Kalah), though Ferrand thought it was Kerah or Kra in north-east Malacca. More recently Wheatley (1961 pp.222-4) has offered new evidence to suggest that Kalah was located on the Tenasserim coast near the mouth of the Tenasserim river, in what is now Burma. Although some writers, including Abū Dulaf (Yqt III p.453) have connected the Arabic word for tin qalʿī with qalʿa, it has generally been taken as being derived from the Malay kaleng or kaling meaning "tin". Even if the latter derivation is not correct the use of the word is instructive, for there is another Arabic word for tin, kasdīr, derived from the Greek kassiteros. Had tin been imported into Iran from the west during the early Islamic period one would have expected kasdīr to have become the usual term for the metal. Its rarity seems to confirm that Europe did not serve as a source of tin for Islamic Iran at least in early times.

In the Il-Khānid period, however, there were sources other than Kalah available, for Abū'l-Qāsim specifies two in addition to the Far East (AQ p.232): the borders of the Bulghārs and Farangistān. Unfortunately

he does not clarify either of these terms. The ruins of the town of Bulghār are situated some 115 km. south of Kazan on the left bank of the Volga (ḤA p.461), but there is no record of tin in this area in modern surveys. It is possible that it was traded across the steppes of central Russia from the tin deposits of the Transbaikal area and Kazakhstān and then down the Volga, but there is no other evidence of this at present. As to Farangistān, it is not clear whether Abū'l-Qāsim means central, southern or western Europe, all of which had tin resources (i.e. Bohemia/Saxony, Spain, and Cornwall). Though in theory the former would appear more likely, it is possible that tin reached Iran from Spain or England, for in the 13th century Yāqūt (Mushtarik p.357) says that tin from Spain reached the Near East, and Ibn Sa'īd (cited Ashtor 1971 p.55) that copper and tin were imported into Egypt from England via Toulouse or Narbonne and Alexandria.

The most important use of tin was for bronze (see p.155), but one object from Afghanistān indicates that it was also alloyed with lead to make pewter (Table 21 no.67), though this was obviously uncommon. Occasionally the pure metal was used, an impressive Iraqi example being a tank and conduit in the Jawsaq al-Muḥdith, al-Muqtadir's palace in Baghdād, the appearance of which in 917 A.D. was reported as "more lustrous than polished silver" (Le Strange 1897 p.41). Pure tin is also found on one Persian object in place of silver inlay (stem bowl B/3/1) presumably as a less expensive alternative to silver. The oxide was a common colourant for ceramic glazes and a common constituent of ointments.

Lead

The nomenclature for lead in Arabic and Persian is given in Table 10, and has been discussed above (p.124). A list of the areas producing lead referred to in the texts is given in Table 9. It should be noted, however, that in a sense it is incomplete. For it has been shown above (p. 44) that in early Islamic Iran lead was the primary source of silver. Hence areas mentioned in the texts as producing silver must also have produced lead. That only silver is named in so many cases is no surprise, since it was that metal which was particularly sought, but for a complete picture of the location and exploitation of lead deposits in Iran according to the literary sources the tables of silver (Table 7) and lead resources (Table 9) should both be consulted.

From these two tables it will be immediately apparent that lead was widely distributed in Iran in early Islamic times, but that, as with gold, the richest areas were Transoxania and Khurāsān. It will also be apparent that since our knowledge of the wideness of its distribution comes not from the general geographers but rather from local travellers, and geographers with a specialised knowledge of particular areas, like the author of Ḥudūd al-ʿālam, lead, like copper, was produced in many areas on a purely local scale. Modern surveys confirm the widespread occurrence of lead ores in Iran. Ladame (1945 pp.276-289) records seven main areas of lead deposits - Azarbāījān, Miyāna-Zanjān, Sāva-Qazvīn-Tehrān, Khurāsān, Iṣfahān-Kāshān, Anārak-Yazd, and Kirmān. Shimkin (1953 pp.126-7) records the existence and exploitation of lead deposits in the Uzbek, Tadzhik and Kirkiz Republics of the USSR, and of others further north in Turkistān and Kazakhstān. In Afghanistān there have been no comprehensive surveys but various lead mines have been studied in recent years, for example those at Ghurband

north-west of Kābul, known as the Farinjal lead mines, the Chilan lead mines just to the south, and those of Bibi Gawhar north of Qandahār (Collins 1894;Tylecote 1970 pp.286-7).

The only relevant early Islamic description of the extraction of lead from its ore is that given by al-Hamdānī (fol.56a-b), where it is included by the author because it was the first step in obtaining silver from the ground. al-Hamdānī describes in outline a furnace with a vent and tank at the back, and one or two pairs of bellows, each worked by two men. The bellows were often separated from the furnace by a wall in order to prevent the men working them from being exposed to the lead vapours coming out of the furnace. The lead ore was laid in layers inside the furnace, alternating with wood, and the furnace was then fired and kept going by pumping the bellows for the next 24 hours. The vent was then opened and the lead metal run off into the tank.

Such a description accords with lead smelting furnaces in use in central Iran to this day. Wertime and Pleiner have published details of such furnaces either abandoned or still in use in the Nahlak and Tars areas. These seem to average about 2 m. in height, to have an inside diameter of anywhere between about 20 and 100 cms., and a clay wall thickness of about 20 cms. Twin bellows, situated a short distance away, are connected to such a furnace by means of an iron tuyère, and there are generally two vents at the back, one low down for running off the lead, the other higher up for running off slag, (Caldwell 1967 pp.332, 348, 363, figs. 4(2), 8(3) and 12).

Elsewhere in recent times in Iran the type of furnace used has been basically the same, though the details and actual dimensions vary somewhat. Mactear (1894 pp.9-10) gives details of the furnace type

then in use in the village of Zarachī, near Ganjābād, in northern Kurdistān, not far from Takht-i Sulaymān. The men working the bellows occupied a small mud hut, against the frontwall of which was built the furnace. The hollow portion of the furnace, from the tap-hole to the top, was 3 ft. deep, and the diameter of the furnace at the top 1 ft. On each side of the furnace there were mud walls enclosing semi-circular spaces which served as bins for the ore and charcoal, and at the same time as buttresses to strengthen and support the furnace. Little different was the type of furnace seen by Collins (1894 p.454) at the Ghurband lead mines in central Afghanistān. Collins describes it as follows: "The furnaces used resemble the Scotch hearth in principle, and are very simple in construction. A rubble wall, 5 feet long, 5 feet high and 18 inches thick, is built along the hillside, in a position best adapted for carrying off the fumes by the wind, and a rough roof is carried from the top of the wall back to the hillside to shelter the workmen producing the blast. The actual furnace is a rounded cavity in the bottom of the wall, lined with refractory steatite-clay, 18 inches by 14 inches by 7 inches ... and it is worked entirely from the front. There are two tuyères of clay, $\frac{3}{4}$ inch in diameter; the blowing apparatus being two sheeps' skins ..."

From these descriptions it is clear that the type of lead furnace used in Iran and Afghanistān in modern times is almost identical with that described by al-Hamdānī, and it may be assumed with certainty that such furnaces were standard all over medieval Iran.

The main lead ores in nature are cerrusite (lead carbonate) and galena (lead sulphide), plus anglesite (lead sulphate) which is usually associated with galena and formed in its upper layers by oxidation of the sulphide. Mactear's description of a smelting

operation at Zarachī (Mactear 1894 p.10) shows that it was a reduction process designed to extract lead from the local carbonate ore, whereas the smelting operation at the Ghurband mines recorded by Collins (1894 p.455) was designed to extract lead from galena by oxidation. Both techniques have been known since earliest times - the reduction of lead ores was practised as early as the third millenium B.C., if not earlier, and the art of smelting sulphidic ores had been acquired by at least 500 B.C. (Agricola p.354 n.). The brief descriptions of the furnaces used in modern times given above show that methods have not changed substantially since they were first introduced. It is worth noting here one of the problems that arise in smelting lead ores - the prevention of the precipitation of the lead due to the presence of zinc. This problem was encountered by the Tal-i Iblis expedition who did some experimental smelting to try and establish the extent of the problem when using traditional equipment. Unfortunately the details published are incomplete (Caldwell 1967 pp.336, 371). Local lead-workers have for long been aware of the problem, and Mactear (1894 p.9) describes the washing floors used at Zarachī for the removal of some at least of the zinc. The floors were of very simple construction with a flat stone as a bottom placed at a slight slope and surrounded with other stones set on edge and banked up with clay. "A small stream of water is brought in at the head, and a portion of the lead ore, having been thrown upon the bottom, is worked about with a tool formed of a piece of flat stone, or, in exceptional cases, with a piece of sheet iron. The mineral is turned over and over and continually scraped from the bottom of the slope to the top... and the washing operation is repeated four times". This washing process is of course designed to concentrate

the ore in every way, but the figures given by Mactear (1894 p.13) show that the washed ore not only contains three or four times as much lead by percentage but also only a quarter or half as much zinc.

As with copper smelting, the lack of fuel seems to have meant that furnaces have often had to be built somewhat distant from the mine itself. For example in the area of Tars and Anārak the slag heaps show that the lead ore was taken to the edge of the desert, where there was enough scrub available to fire a complete furnace (Caldwell 1967 pp.322-3), and at Ghurband in Afghanistān only a quarter of the total output of the mine was smelted on the spot, the rest being transported to other small furnaces located near separate fuel supplies. The main fuel was a small prickly bush, though dried camel dung was also used (Collins 1894 p.454).

As the sizes of the furnaces vary, so also the sizes and constituents of their charges vary from place to place. According to Pleiner (Caldwell 1967 p.348), the low shaft furnaces previously in use at Nahlak were charged with about 100 kg. of lead ore, 30 kg. of iron ore, and 35 kg. of charcoal, from which after 12 hours smelting came some 15 kg. of lead (though Caldwell 1967 p.332 gives a figure of 30 kg. for lead ore). Such ores contain somewhere in the region of 400-1600 grams of silver per ton (Caldwell 1967 p.348). At Ghurband (Collins 1894 pp.454-5) on the other hand a charge consisted of 20 lbs. of ore and 24 lbs. of dry wood, and this yielded $7\frac{1}{2}$ lbs. of lead. In the Nahlak case, iron ore was added to aid the smelting of the galena.

The picture given above of a very localised lead producing industry would appear to rule out any question of trade in the metal over long distances. It is therefore interesting to read in Abū'l-Qāsim that

in his opinion the best lead came from the lands of the Bulghārs, and the worst from Rūm, implying that in Tabrīz there were various qualities of lead from different places on the market (AQ pp.340-1). Another curious piece of evidence for trading of lead is a story related by al-Birūnī about a merchant taking a bucket of lead to China on behalf of an Iraqi stranger (Bir pp.260-1). The actual details of the story do not matter, but al-Birūnī prefaces it by saying that because lead is expensive in China they use tin in its place wherever it is necessary, and that for this reason it is carried to China in merchandise. He also relates how, when this particular ship arrived at its destination, a man came to the captain asking for lead. China in fact has ample lead resources, and the story must be referring to some country or island on the way, but the implications are clear. However, since there seems to be no other evidence for trade in lead, either by sea or land, it is difficult to take the words of either al-Birūnī or Abū'l-Qāsim as pointing to a general situation.

It may well be that large amounts of lead were extracted from the ground simply for their silver content, and that such lead was subsequently dumped. However, lead itself had a variety of uses in medieval Iran as is clear from both literary references and analyses of metal objects.

Under the Achaemenids lead was widely used to secure the iron clamps which reinforced the stone work at palaces such as Pasargadae and Persepolis. This practice, though less common, probably continued under the Sasanians, as is suggested by Abū Dulaf's description of the Qanṭāra Khurra Zād on the road between Idhaj and Iṣfahān (ADu para.72; Hansman 1973 pp.46-54), and this same description suggests that lead (raṣāṣ in the Arabic text) was used in a similar way when the bridge

had to be reconstructed in the 10th century. It should be pointed out however as Hansman noted, that the use of metal dowels and molten lead has not been reported in known Sasanian or Islamic bridges, and that the author may have introduced mythical details based on what was known of ancient structures of earlier periods. On the other hand ʿAḍud al-Dawla, the Būyid ruler, is recorded by al-Muqaddasī (p.444) as having built a great dam between Shīrāz and Shāpūr for which the foundations were lead (raṣāṣ). In view of the reliability of the information provided by al-Muqaddasī in general it may be that Abū Dulaf's statement is also correct, and it thus seems quite possible that lead was used in this way in medieval Iran. On the other hand a much more restricted use than in previous eras is clear both from the tone of the geographers' comments and from the fact that so much of the Islamic architecture of Iran is brick architecture, in which such a metal is quite out of place.

Lead was also used in the Islamic period as the lining material for canals and water-courses, though here also the geographers give the impression that such a use was by no means common. Again the idea seems to have stemmed from pre-Islamic times. For instance, the Shādharvān or Great Wier built by Shāpūr at Tustar in Khuzistān is reported to have been paved with lead - balāṭ bi'l-raṣāṣ (Yqt I p.848), and the Tazāristān bridge mentioned by Ibn Rusta (IR p.164) as having a lead aquaduct (nahr muraṣṣaṣ) on top of it may well have been Sasanian in origin. 10th century Samarqand had a lead-lined aqua-duct which was noted in some detail by Iṣṭakhrī (p. 316):nahr min raṣāṣ ... wajh hadhā'l-nahr raṣāṣ kulluhu) and Ḥawqal (pp.492-3 : nahr baʿdahu raṣāṣ), and is also mentioned by al-Muqaddasī (p.279: qanāt min raṣāṣ) and the author of Ḥudūd al-ʿālam (para.25.13:az arzīz).

Lead had one further architectural use, as a roofing material. Lead roofs were relatively common on important buildings in Syria, for example in Jerusalem on the Dome of the Rock (IḤ p.171:raṣāṣ.), the Aqsa Mosque (Muq p.169:raṣāṣ), and other buildings around the Ḥarām (NK p.26:arzīz), but much less common in Iran owing to the widespread use of mud or baked brick with or without wood. In fact the only reference to a lead roof in greater Iran appears to be Iṣṭakhrī's description of the Treasury at Bardhaʿa in Azarbaijān (Iṣṭ p.184: muraṣṣas al-saṭḥ) though it may be that they also occurred on other stone buildings of importance in areas of greater Iran where stone architecture was the norm.

Outside architecture, lead was commonly used in alloys for metal objects (see p.163) where its advantages include the fact that it aided casting, gave an object weight, and probably brought about cheaper production costs. Otherwise it was a common constituent of compounds used in painting pigments and ointments. Three compounds were particularly popular, litharge (yellow lead monoxide), red lead (Pb_2O_3), and cerruse or white lead (lead carbonate), and details of their manufacture are given by al-Birūnī and Abū'l-Qāsim (Bir pp.259-260; AQ pp.234-5; 344; Allan 1973 para.21).

Copper

Copper is generally known in Arabic as naḥās, and in Persian as mis, though other words are occasionally used (Table 10). Various sources of the metal within Iran are mentioned by the geographers and others (Table 8), but compared to the recorded sources of silver and gold (Tables 4 and 7) these are strikingly few. Thus, although in the 10th century copper was evidently exploited in Transoxania, Khurāsān, Kirmān and Fārs on a large enough scale to have attracted the attention of some of the geographers, their references are brief, and only in the case of Transoxania is one left with the impression of a reasonable amount of production. If copper was as popular then as it is today for everyday objects, whether in a pure or alloyed state, there must either have been many more mines in use, or substantial importing of copper. A comparable situation is mentioned by Curzon in his description of Iran at the end of the last century (Curzon 1892 II p.517):"... though Polak declared that every district in Persia had its own copper mines, and ... though there is not a village in the country where copper vessels and utensils are not a sine quâ non of domestic existence, even among the peasants, yet the local manufacture of the metal is insignificant in the extreme, the output of the Persian mines now worked hardly exceeding 3000 l. yearly in value and almost the whole amount consumed in Persia being imported in sheets, principally by the Gulf from England." It is important therefore to establish whether medieval Iran faced the same problem, or whether there was in fact sufficient copper and copper exploitation to meet the country's needs.

First of all it should be pointed out that, whatever Curzon claimed, all geological surveys undertaken in Iran since his time have shown that very large areas of Iran have extensive copper resources. Ladame's

survey is the most comprehensive yet published, and he picks out seven particularly rich areas: Karadag, Miāna, Ţārum, Sāva-Tehrān, Abbāsābād-Sabzavār, Kūpāya-Anārak-Yazd, and Kirmān (Ladame 1945 pp.197-248). Harrison (1968 p.501) confirms the general copper wealth of northern and central Iran. Other surveys have indicated that copper is not, however, confined to the above areas. Tipper (1921 pp.73-4) records the presence of large numbers of small copper slag heaps scattered over Kūhistān, and of carbonate ores in the Jurassic shales of the area, while Hughes (1877 p.22) noted that large quantities of copper were reputed to have been found in the Las district of Balūchistān, in modern Pakistan. Tylecote (1970 p.286) records old copper mines in Afghanistān, near Zar Kashan, 75 km. south of Ghazna, Muhly (1973 p.234) mentions important copper deposits at Shāh Maksud in Afghanistān, Sykes (1902 p.80), records ancient workings at Buanāt, east of Pasargadae, in Fārs, and an important source of modern Soviet copper is the area around Almalyk in Uzbek S.S.R., part of the medieval province of Ilāq. Other rich copper ores are found further north in Kazakhstān (Shimkin 1953 pp.118-9; Maxwell 1962 p.36). In theory, therefore, there should have been enough copper available in Iran to meet demands, provided the ores were exploited.

To discover to what extent the ores were exploited, however, is a much more difficult problem. Numerous travellers and survey expeditions have noted the existence of ancient workings, but none of them have managed to date any of these workings within five hundred years let alone pin them down to a century. Hence although we can say that a mine was in use before the date it was first recorded as "ancient", it is quite impossible to say more than that. On the other hand, one of the characteristics of copper workings, and those of lead, in Iran

is that the workings tend to be small, and their use dictated by the presence of fuel nearby. Hence the slag heaps dotted about the Kūpāya-Anārak-Yazd area, the Kirmān area and Kūhistān (Caldwell 1967 ch.15-16; Tipper 1921 pp.73-4). In view of this, it is probable that there has been for many centuries a tradition of detecting the presence of lodes in very isolated areas, using them while fuel was available nearby, and then perhaps rediscovering them some years or centuries later when the area once again had enough plant life to provide fuel. If this was indeed the case in medieval Iran then it is likely that many more localities were producing copper than the texts would have us believe, and the lack of information is quite easily explicable: small out of the way mines with itinerant smelting sites, the mines themselves only being in use for a few years, could hardly be expected to leave their imprint on the written works of urban scholars and travellers of the main trade routes.

Given then that copper ores are more widespread in Iran and that copper exploitation was probably more extensive than the texts suggest, it remains to determine whether copper consumption was as high in medieval Iran in terms of everyday objects as it is today, and whether the copper produced was sufficient for the needs of the land, whatever those needs might be. It is difficult to imagine Iranian villages and towns where copper vessels were not, in Curzon's phrase, the sine qua non of domestic existence; it is even more difficult to imagine Iranian towns without copper bazaars. Nevertheless, it should at least be noted that there is always the possibility that copper objects were then much less common and much more expensive than they are today, and that the demand for them may have been very much less. It is certainly interesting to observe how few plain copper objects have come to light in excavations, though such a lack may be due to other factors as well.

As to the sufficiency of copper production for local and wider needs, two relevant points emerge from a study of the literature. First of all, there is no record that I have been able to discover to indicate that copper was being imported into Iran from elsewhere, although it clearly must have moved around locally. Secondly, there is evidence of the export of copper, for al-Iṣṭakhrī and Ibn Ḥawqal both make the point that the copper mined at Sardan, on the border of Fārs and Khūzistān, was taken to Baṣra "and other places" (presumably in Iraq) (Iṣṭ p.155; IḤ p.300). This should not necessarily be taken as meaning that Iran produced a surplus of copper, since it was not a commercial and political unit in the sense it is today; nevertheless if the metal from a rich mine close at hand was diverted to Iraq it seems likely that the towns of the western plateau must have had sufficient copper for their needs available from other sources nearby, a point which would not necessarily be clear from the texts.

To summarize: few sources of copper are mentioned in the texts, but others were probably exploited too. Although the extent of copper consumption in medieval Iran is not clear it seems that there was sufficient being produced to satisfy demand.

The commonest ores of copper are cuprite, malachite and azurite in the oxide-carbonate range, and chalcopyrite and chalcocite in the sulphide range, and all of these occur somewhere in Iran. The smelting of both ranges of ore had been mastered by Roman times, despite the problems involved in extracting copper from sulphide ores due to the variety of metal impurities usually present, and one can assume that both were utilised in early Islamic times. The only commonly mentioned copper mineral in early Islamic texts is malachite, dahnaj or dahna. Although known to be a source of copper, malachite was primarily used for ornamental purposes (Bir pp.195-6; Dim p.83), and

both al-Birūnī and Abū'l-Qāsim single out Kirmān province as the main source of the mineral (Bir p.196; AQ p.134). al-Birūnī (p.245) mentions two other substances which may be copper minerals: "There is a type known as siyāh mis, the fracture of which is a delightful red colour, varying from very dark to very light. Brass is made from it. It is not confined to a special mine, and its redness is obtained in proportion to the blowing in melting. Another type is mis-i kalān i.e. adulterated (ḥumlān) copper. This is found in Khurāsān in the border country of India. It is extremely soft, and only slightly black when heated, and one cannot solidify silver when it is mixed with it. It is said that this is on account of the gold in it." The second of these minerals is almost certainly chalcopyrite, the compound copper and iron sulphide ore. The iron in it explains its being "adulterated"; chalcopyrite is so soft that it can be cut with a knife; the sulphur in it would have a very damaging effect on silver; the reference to gold is probably due to its natural colour, whence its name "fool's gold". Siyāh mis is not so easy to identify, but is probably chalcocite, the blackish copper sulphide ore. True it does not have a red fracture, but copper can be produced from it with the greatest ease over charcoal, and itis a likely associate of zinc blende (see p.152).

No descriptions of the smelting of these ores survive in any of the texts, and one therefore has to try and reconstruct the picture from records of more recent times. It has already been pointed out that much copper exploitation was probably carried out on a very local scale in early Islamic Iran, and the slag heap finds in the Anārak-Kupāya-Yazd area , the Kirmān mountains, and Kūhistān indicate that the critical factor was fuel. A lode of copper could only be exploited so long as there was fuel near enough to make its exploitation economical, and once the area nearby had been denuded of shrubs, the mine would have

had to be abandoned until a new supply of fuel had had time to establish itself. Given this situation furnace manufacture would inevitably have remained primitive, since there was no object in building or developing sophisticated furnaces if their use was so short-lived. This style of expoitation has only changed with the discovery of coal and oil which allowed large quantities of fuel to be brought from other areas. Its existence in the 1890's is shown by Mactear's account of copper exploitation near Samnān (Mactear 1894 p.22). He says that the ore was dressed by hand at the mining site and then carried a couple of miles to the local village on mules, where it was smelted in small mud-built furnaces. Two, each 4 ft. high and 18 ins. in diameter, still existed when Mactear visited the village, though they were rapidly falling to pieces owing to the fact that fuel was no longer available, and other furnaces had had to be built along the base of the mountains where brushwood could still be collected. Mactear also mentions two small roasting kilns in the village, but gives no details of their construction.

Further east, near Abbasābād, Mactear also watched local metallurgical operations in progress for extracting copper. He describes what he saw as follows (1894 p.24):"In the case of the sulphide ores, after hand-dressing, the ore is roasted in a furnace built of mud, forming a cone about 7 feetin height, in which holes are pierced for the admission of air. At the bottom there is an opening closed with a door through which the roasted ore can be drawn and the draught regulated; about 35 per cent of fuel is required. The smelting is conducted in a small blast furnace, its dimensions being about 18 inches in depth and 9 inches in diameter. The blast is produced by the usual type of Eastern bellows, the chief peculiarity being that instead of the tuyere passing through the wall of the furnace near the base, it consists of a clay pipe led down the centre of the furnace;

lasting for one operation. There are two tap-holes, one for the slag and the other for the copper. The copper produced is of poor quality and is not suitable for anything but the rougher classes of work." The Tal-i Iblis expedition came across various lead furnaces similar in form to the above in the Anārak-Sahchangī area (see above p.130) and concluded that the copper furnaces would also have been of this type, though Wertime also mentions a wind furnace (falaqa) used in desert areas, apparently a large roasting and smelting device 5 metres high and 2 metres in diameter (Caldwell 1967 p.332

The production of copper from sulphidic ores is complex, and it is not surprising that the method described by Mactear produced poor results. Five processes may be distinguished in the production of good quality copper from sulphidic ores - a) roasting to remove at least part of the sulphur b) smelting with siliceous fluxes to produce copper matte, a mixture of copper and iron sulphides, together with a slag which is run off c) resmelting to extract iron sulphide as an oxidised slag d) refining by oxidation to remove remaining sulphur e) further refining by reduction to remove oxygen, a process which includes polling. In addition the silver in the copper may be removed by liquation. Except for liquation, it would appear that all these processes were known in classical times, even though the references to them in classical literature are far from clear (Agricola pp.402-5 n.42). The first comprehensive account appears in Theophilus in the 11th century, and it is therefore highly likely that the processes were known in early Islamic Iran, even though they are never mentioned in the literature.

Equally little is recorded of the way copper was made into objects in medieval Iran. One interesting description is given, however, by Mactear, who watched copper being worked for the making of trays, basins, cooking pots etc. in Iran at the end of the last century

(Mactear 1894 pp.24-5). He noticed that instead of using rolled sheet copper as would be done today, local craftsmen were still using small ingots of copper which looked as if they had been cooled in a ladle. After annealing such ingots were forged out by six or eight workmen standing in a ring and striking in turn to a musical rhythm. The chief workman, with a couple of pairs of tongs, kept moving the metal as the forging progressed. Despite the gap of up to 1000 years, such a method would undoubtedly have been used in medieval times for the production of sheet copper, bronze or brass.

Remarkably few copper objects have in fact survived from early Islamic times, and in comparison with the number of bronze and brass objects this may at first sight seem strange. Two alternative reasons for this may be adduced. One concerns the quality of copper. Pure copper is not particularly suitable for casting. Hence copper objects would have been sheet. Since copper is less durable than brass or bronze and in itself is poisonous, such sheet objects would not have been worth decorating elaborately, and would not have been valued in the same way as copper alloys. Tinned they would probably have been used in the kitchen, like the objects Mactear saw being made, and when their life was over they would perhaps have been sent back to the coppersmiths for use as scrap or remelting. If thrown away and left to rot in the ground their ability to withstand corrosion would be very limited, and when found by an antique dealer in some clandestine excavation would be discarded as valueless. An alternative reason for the lack of surviving copper objects could be that virtually all non-ferrous metal objects were made of copper alloys. This would have depended on the relative values of the metals used in such alloys. If there was an abundance of old bronze scrap it

would obviously have been cheaper to remelt that alloy and reuse it. If the local copper mines also produced zinc, as is often the case in Iran, brass would have been as cheap, if not cheaper, to produce than pure copper. If society was wealthy enough to demand an abundance of metal it would probably have been wealthy enough to demand good quality metal even at extra expense. Which of these suggestions is nearer to the truth there is no certain way of telling, though a widespread use of alloys rather than pure copper seems on the whole more likely.

Apart from being used as the pure or alloyed metal substance of a complete object, copper was also used in solders - for gold solder (see p. 35), and silver solder (see p. 47), and for inlays such as those on the Bobrinski bucket and numerous other bronze and brass objects, while its compounds were used for painting (verdigris), for colouring glazes (copper oxide), and for medicines. The full descriptions of its various alloys will be given below (p.145-166).

Zinc and brass

Although zinc was not isolated as a metal until the 15th century (Werner 1972 pp.138-9), brass, which is an alloy of copper and zinc, has been known at least from Roman times. The first account in Islamic Persia which establishes beyond any doubt the identity of zinc oxide and its use for this alloy is that of al-Birūnī in the 11th century. He begins his chapter on shabah with the words: "Shabah is copper made yellow by mixing into it tūtīyā with sweetened things (ḥalāwāt) etc. as additives until it becomes like gold", and he later describes how the tūtīyā was produced (Bir. pp.262-3): "The tūtīyā used in this business is the vapour (dukhān) of (a type of) earth (ṭīn). Its ore is put in a furnace (atūn) in which are things like baked pottery pegs. The fire is lit under the furnace floor. The tūtīyā rises and attaches itself to the pegs and covers them like a wrapping, so that the pegs cool looking as though they have scales on them."

The manufacture of tūtīyā had in fact been described a century earlier by al-Muqaddasī, who did not however indicate the relationship of tūtīyā to brass. In his description of the province of Kirmān he writes as follows (Muq p.470):"Among their specialities is al-tūtīyā al-marāzibī. It is called marāzibī because they use things like fingers made of baked clay as important elements. They pour the tūtīyā onto them, and it clings to them so that there remains the equivalent of iron bars (marāzib rather than text's marāzīb). I saw them gathering it from the mountains, and having built amazing long furnaces (akwār), they purify it as iron is purified. I did not see it except in the villages." al-Muqaddasī's description is not as

clear as that of al-Birūnī, particularly as regards what exactly happens in the furnace, due to the use of pronominal suffixes, but the same methods are obviously being referred to.

The same technique of extracting and collecting zinc oxide was still in use in the late 13th century and was described by Marco Polo and Abū'l-Qāsim. Marco Polo says that zinc oxide was trapped by an iron grid (Polo I p.125), but in view of al-Muqaddasī's comment that the pegs covered with zinc oxide looked like iron bars this is probably not to be taken literally. Abū'l-Qāsim writes as follows (AQ p.188): "They obtain Kirmānī tūtīyā as follows. They make a furnace and fix earthenware pegs in its walls, pour the tūtīyā ore on to a shelf there and make a strong fire. Fumes from the burning of this ore rise and attach themselves to the earthenware pegs. When they remove the fire and it is cooled they separate the sublimated tūtīyā from those pegs." Abū'l-Qāsim, like al-Birūnī, firmly links tūtīyā with brass (birinj) (AQ p.244).

These four descriptions contrast strongly with that of Mustawfī, who, writing in the mid 14th century, claimed that the bars in the furnaces were actually made of zinc ore (Mustawfī p.205, trans. pp.196-7). "Tūtīyā is got from the mine as a heavy ore, which being moistened is made up into the form of bars, each an ell in length. When dry these are put in a furnace, and the action of the fire extracts the tūtīyā which remains in the shape of bars, and like sword sheaths, which are then taken out". As it happens Mustawfī was not the first to describe such a process. A more detailed account appears in the Kitāb al-mukhtār fī kashf al-asrār written c.1222 A.D. by the wandering scholar al-Jawbarī for the Urtuqid al-Malik al-Mas'ūd (Jaw p.37, quoted by Wiedemann 1910 p.315):"To produce tutty one builds a square oven

(tunūr), and puts a shelf in the middle. One then makes a fitted lid to go over it, and makes clay sticks and fires them. When these are completely fired like earthenware, one takes yellow earth and kneads it carefully with hindabā water, and covers the sticks with it. Then one takes a large white earthenware vessel pulverizes it like millett and rolls (marragha, not faragha) the sticks in it. One lays the sticks in the oven on the shelf, leaving space between them through which the vapour can go. Then one puts the lid over the oven again and kindles under it wood from the green tamarisk: no other is so satisfactory. When the sticks are red hot one takes them out and quenches them in hindabā. This one does thrice and after the third time one rolls the stick in the earthenware vessel. Then one lays it in the oven in the above described way. One heats it further till it is smelted. Then one stops the heating and leaves it to cool. Then the stick is taken out and hit lightly with a hammer; plates of tūtīyā fall off it of the highest excellence. I know seven methods for this operation and know them well."

Bars which would appear to fit either of the methods described above have been found on a number of sites in Iran (see p.151). They are generally about 30 cms. long and 2-4 cms. wide. In shape they are approximately cylindrical though they narrow at both ends. Barnes (1973) has investigated some of these bars in detail to try and discover how they were made and used, and thereby to establish the reliability of Mustawfī's description of the process. He concluded that those which he had investigated were expendable surfaces for the collection of zinc oxide, that in other words they conform to the descriptions of the process given by al-Birūnī, al-Muqaddasī and Abū'l-Qāsim.

Were Mustawfī's description the only one of its type it would be relatively easy to write it off: the author had never seen the process, did not understand it, and had put together his description from hearsay. But in view of al-Jawbarī's very full description of the process (and his claim, for what it is worth, to know more than he writes) it is difficult to ignore this possible alternative method of producing tūtīyā. Only extensive scientific investigation of more bars from a wider range of sites will ever prove that such a method was used. In the meantime, however, the textual evidence for such a supposition should at least be recorded in full.

Once produced, the primary use of zinc oxide was in the manufacture of brass. The earliest description is that of al-Hamdānī (fol.64b), who does not, however, name the alloy. He writes:"The best of al-iqlīmīyā is the pure clustered type. If it is pulverised and spread over molten copper one may produce from it tūtīyā which is sublimated from its vapour onto the surface of the molten metal." al-iqlīmīyā is used by al-Hamdānī to indicate a metal compound, usually an oxide, and tūtīyā must mean zinc oxide in vapour as opposed to solid form. The fullest description of the process however is that of Abū'l-Qāsim (p.189):"If they bray half pounded tūtīyā with raisins without seeds until it becomes soft, and it is roasted without burning over a low fire, and if copper is melted and they throw onto it a certain amount of that prepared tūtīyā and cover the top of the crucible for a moment until the tūtīyā has had its effect, and it then cools down, copper results the colour of red gold." Abū'l-Qāsim adds that this was how Syrian brass was made, in his estimation the best brass and the most like gold (AQ p.244). This method of brass production by mixing molten copper and zinc oxide in a crucible is the one assumed to have been used in classical times suggesting that

there was little or no innovation in Islamic Iran in this field. If Iran made any contribution at all in brass technology it was presumably in the relatively simple and efficient method of collecting zinc oxide by condensing it on clay bars, instead of scraping it off the walls and roof of a collecting chamber above the furnace as described by Dioscorides and Pliny (Agricola pp.395-6 n.26).

In the above references tūtīyā could have been generally translated as zinc oxide, though on some occasions it refers explicitly to the vapour as opposed to the sublimate or vice versa. It has however other meanings which will be discussed below (p.153 and Table 10), and the use of the word when it appears in a text has to be carefully analysed before it is translated. This is important when one tries to discover where in Iran zinc was mined: the only reliable references are those found amongst descriptions of the processes outlined above. As a result the only area of Iran which is definitely recorded as producing zinc oxide is Kirmān (Muq p.470; AQ p.188; Polo pp.38-9). It is worth pointing out that the evidence that tūtīyā was produced in Kirmān as given by Yāqūt, and quoted by Schwarz (1969 p.252) and Wulff (1966 p.12), is highly unsatisfactory. Yāqūt (II p.600) is in fact quoting Ibn al-Faqīh (pp.206-7), but he substitutes tūtīyā for ṣufr and then changes the order of the minerals listed so that what should be a description of a salammoniac mine grammatically becomes a description of a tūtīyā mine for which it is totally inappropriate. The location is also probably wrong for the salammoniac mines known to al-Iṣṭakhrī and other authorities were in the Buttam mountains in Transoxania (Iṣṭ pp.327-8; IḤ p.488; Mas para.383), where they are attested by Tomaschek in the mid 19th century (1877 pp.88-9).

Modern surveys, far from confining the zinc deposits of Iran to Kirmān province, show that zinc is extremely widespread in the country. Thus Ladame (1945 pp.276-289) indicates that there is zinc in almost all the lead ores of Iran, and this is confirmed by Harrison (1968 pp.505-8). The recorded finds of clay rods on smelting sites help to pin point some of the areas of zinc oxide production in earlier times. Such clay rods have been found at Sāvand near Tars, north-west of Kirmān, at Kushk, between Yazd and Sāvand, at Dah-Qala, south-west of Mashhad, and at Saycha, south-west of Kirmān, and are also reported to have been found at Anārak (Caldwell 1967 pp.321, 364 fig.9(1); Barnes 1973 p.8). Zinc oxide production would therefore appear to have been more widespread than the textual evidence suggests, though the smelting sites cannot be dated with any accuracy.

The fact that most of the zinc resources of Iran yet surveyed occur in lead deposits confirms Abū'l-Qāsim's statement that <u>tūtīyā</u> comes from lead (AQ p.344). Wertime (Caldwell 1967 p.334) assumed that Marco Polo's tutty factories were probably lead furnaces yielding zinc oxide as a by-product, but Barnes' investigations of Kushk material indicated that this was not necessarily so. The low-level of lead in the slag analysed by him showed that the latter site was either for the treatment of zinc ore from which the galena had been picked by cobbing or hand-sorting, or for the refining of a zinc-rich secondary product from another process, such as the residues and flue dusts from a lead furnace. His analyses also showed that the smelters of the day were unable to removed all traces of lead, and that the zinc oxide which condensedon the furnace bars probably contained up to about 0.2% lead. This may account for the small quantity of lead found in the sheet brasses analysed (Table 21 e.g.: nos. 8,9,12).

Although the main source of zinc oxide in Persia was lead ore, certain remarks of early writers suggest that it was not the only one. al-Khwārizmī in his Kitāb mafātīḥ al-ʿulūm, written for a Sāmānid vizir in Nīshāpūr just before the end of the 10th century, describes tūtīyā as the vapour of copper and the vapour of kuḥl (here probably lead, see p.168)(Wiedemann 1911 p.95), while Abū Dulaf is reported by Yāqūt as writing in his first risāla (Yqt III p.456):"In Kulam is a mine of yellow sulphur and a mine of copper, from the vapour of which is extracted excellent tūtīyā; all types of tūtīyā come from the vapour of copper, except Indian which as we have mentioned comes from the vapour of tin (raṣāṣ qalʿī)." Likewise al-Birūnī mentions that brass is made from a copper ore called siyāh mis (probably chalcocite)(Bir p.245). In modern times copper ore has been cited as a source of zinc in Iran: Sykes (1902 p.272) writes that,"sulphate of copper is found in the hills to the east of Kuhbanan and it is from this that tutia is prepared". Although this observation was not confirmed by the Tal-i Iblis expedition, copper sulphide and zinc sulphide minerals are sometimes found in association, and Lucas (1962 p.223) noted such occurrences in Egypt, Georgia and the Caucasus. Hence, Persian tūtīyā was extracted not only from the minerals found in lead mines but also from those found in copper mines.

Abū Dulaf's statement that Indian tūtīyā comes from tin vapour is not so easy to accept. He affirms it elsewhere in his first risāla: "That which is extracted from ṭabāshīr plants is exported everywhere (from Mandura-patan) and is sold as being Indian tūtīyā but this is not so for Indian tūtīyā is the vapour of tin (raṣāṣ qalʿī)"(Yqt III p.455). Zinc is certainly present in the sulphidic ore of tin, stannite, and in theory therefore it is not impossible that a type

of tūtīyā was produced in India from such a source. However, Abū Dulaf himself says that the only source of tin (known to him) in the world was at Kala in South-East Asia, and since this was in all probability alluvial tin (cassiterite) it is unlikely to have contained zinc as the sulphidic ore might have done. Abū Dulaf is not the only writer to mention Indian tūtīyā, but other references to it unfortunately tend to confuse rather than clarify the picture. Al-Thaʿālibī (p.125) and Ibn al-Faqīh (p.251) both include tūtīyā among the specialities of India but tell us nothing of its identity. The lapidary of Pseudo-Aristotle on the other hand suggests mines on the coasts of India and Sind as its origin (Pseudo-Aristotle para.52), while the Fārs-nāma records the clay mounds around Persepolis as a source of the substance (FN p.127). Abū'l-Qāsim, however, says that Indian tūtīyā is the same as tūtīyāyi dīkak and that it comes from the Indian sea and is brought to the shore on the waves (AQ p.188).

Indian tūtīyā is, in fact, only one of a number of varieties of tūtīyā mentioned in the texts. al-Rāzī also mentions a green type, a yellow type, a yellow type called khazarī, and another type called maḥmūdī (Stapleton et al. 1927 pp.350-1); Abū Dulaf records maḥmūd and ḍafādʿī tūtīyā and says that they were both mined in Ḥīzān (probably somewhere in Armenia)(ADu para.19); Abū'l-Qāsim records tūtīyāyi faidī, an opaque, soapy green substance found in river sand in Arabia, tūtīyāyi paykānak, a white, mined variety, and two other un-named types, one white, the other yellow. Too little information is given about any one of these types to identify it, but it is quite possible that some of them are forms of zinc oxide or zinc ores. The carbonate ores of zinc are still today known by their colours:"white calamine" contains a large amount of clay; "red calamine" contains iron and manganese oxides. Almost all the authors quoted above link

their various varieties of tūtīyā with eye medicaments or kuḥl, for which zinc oxide is an ideal ingredient. Nevertheless, Abū Dulaf's comment on the use of plant extracts suggests that other substances were given the same name, and with so little information to go on it is impossible to be sure of the correct translation and interpretation of the term tūtīyā in medieval Arabic or Persian sources if the context does not make this obvious.

Other Copper Alloys

A number of terms are used in early Islamic texts to indicate copper alloys, but since they are rarely explained in any detail it is best first to assess what alloys were used on the basis of analyses of actual objects, and then decide what the most appropriate equivalents for the terms used are likely to be. The analyses available to the writer for study are given in full in Table 21. Nos. 1-7 were analysed at the Metropolitan Museum of Art by dispersive X-ray fluorescence, and will be published in Melikian-Chirvani's forthcoming article on the "white bronzes of Khurāsān". Nos. 8-11 were analysed by the British Museum Research Laboratory by atomic absorption. Nos. 12-30 were analysed by the Laboratoire de Recherche des Musées de France by emission spectrometry. Nos. 31-65 were analysed at the Laboratory for Archaeology and the History of Art in Oxford by X-ray fluorescence. Nos. 66-7 were analysed chemically by Professor Caley at Ohio State University and published by Dupree (1958 pp.291-2).

From these analyses certain typesof copper alloy stand out. First there are brasses, containing from just under 20% to over 30% zinc and only minute quantities of lead or tin: nos. 8,9,19 (neck), 21, 23,25-6,30,38. These objects are mostly, but not all, sheet metal. Secondly there are objects made of copper with 20% or more tin and only traces of lead or zinc: nos. 1-7,10,46 (concave side). The Metropolitan Museum report suggests that these are mostly forged. Thirdly there is an enormous group made of a quaternary alloy consisting of copper, lead, tin and zinc. As a general rule these contain over 20% lead, and more zinc than tin, though there are a number

of exceptions. They are all cast objects. Finally, there is one pewter item containing two-thirds tin and one-third lead: no. 67.

Of the brasses little more need be added to the discussion above (p.149) except to point out that although brass is very good for sheet working, it can also be cast. An obvious use of cast brass, though as yet unproven by analysis, was for astrolabes.

High tin bronze requires more detailed comments. Professor Cyril Stanley Smith of M.I.T., in a private communication, gave the following information about this alloy. A copper-tin alloy with a content of c.22% tin becomes plastic at c.550°C, melts at 725°C, and is very plastic between those two temperatures. Fully molten at 800°C, it is easy to cast. It can be red-hot forged; if cooled slowly it will shatter if hammered; if quenched it becomes moderately hard and reasonably malleable, though not as malleable as ordinary bronze. With time it acquires a black patina. Comparative studies of the mechanical properties of bronzes containing up to 30% tin have been made by Goetzel (1937) and Chadwick (1939).

High tin bronzes are known from earliest times in China, where they were used for ceremonial vessels, weapons and mirrors (Pope et al. 1967 II p.54; Arne 1914 p.217; Caley 1971 p.110). The highest tin content occurs in mirrors where it is in the 25-30% range. In other objects it tends to be less than 20%, 20% tin bronze also occurs in Siberian objects (Arne 1914 p.218). In the Middle East it is known at least from the 3rd century B.C., and was probably the object of a comment recorded by Nearchus, Alexander the Great's admiral, that the Indians at the time employed only cast bronze, not hammered, so that their vessels broke like earthenware if they fell. The Taxila excavations produced at least nine high tin bronzes dating from the

3rd-century B.C. to the 1st century A.D (Marshall 1951 II p.567 Table II, p.570): three bowls, a dish, two mirrors, a bell, a goblet and a pan. The continued use of the alloy is indicated by three unidentified artifacts dating to circa 300 A.D. and one dating to circa 500 A.D. excavated at Ghar-i Mar, 100 km. south of Mazār-i Sharīf (Dupree 1964; Caley 1971 pp.108-9), and a bowl and mirror from a tomb in Dailamān, datable to the fourth century A.D. (Egami et al. 1965 II pl. 43 no.5, 49 no.29, pp.9-10). In the classical world high tin bronzes were used by the Romans for mirrors, though the subsequent history of the metal in the West is not clear (Aitchison 1960 I p.198).

High tin bronzes from early Islamic Iran can be recognised outwardly by a number of features. First they are very silvery in colour. Secondly they often have pieces missing leaving sharply defined edges, or clean breaks across areas of the body. Thirdly they are generally very simple in form - hemispherical bowls, or stem bowls of the most straight-forward style. The clean breaks or missing pieces are due to the brittleness of the alloy at room temperature, and are unlike the equivalent types of damage on a brass, low tin bronze, or more composite alloy. The simplicity of form is due to the fact that they have generally been forged at red heat, a condition which does not allow for the subtelty of contour possible on sheet alloys of other compositions.

The Persian and Arabic name for high tin bronze was pointed out in 1927 by Stapleton in his commentary on al-Rāzī (pp.324, 408), by reference to Abū'l-Faḍl's ʿAin-i Akbarī. Since this latter text is well outside the period of this thesis, it is necessary to show that the same term - safīdruy or isfīdruy, was used in earlier times for the same alloy. al-Hamdānī's comments on isbīdrūj (fol.68b) indicate that the alloy was bronze but give no hint of its composition. The

first information on that point comes from al-Birūnī (pp.264-5), who comments that the Zanj add raṣāṣ (tin) to copper and it becomes like brass and yields to hammering whereas asfīdhruy does not. From this it is clear that asfīdhruy was not a low tin bronze such as could have been beaten in the normal way, like sheet brass, nor indeed could it be hammered at all. Given the fact that high tin bronze is best cast or forged at red heat there seems little doubt that this is the alloy in question. Abū'l-Qāsim (pp.244-5) notes how white safīdruy is, and follows al-Ṭūsī (p.228) in pointing out that while copper and tin are both very soft, when mixed they become hard, "so that there is no softness left" - again an indication of some special quality which made hammering extremely difficult. Furthermore al-Birūnī, al-Ṭūsī and Abū'l-Qāsim all tell the story of the introduction of the alloy into the Islamic world, according to al-Birūnī under al-Ḥajjāj, when it was substituted for gold and silver. Had it not been of the appearance of silver - and low tin bronze certainly is not - the story would not have been relevant. Finally al-Birūnī (p.187) tells a story which includes a description of Muḥammad ibn Ṭāhir as governor of Khurāsān drinking out of a vessel of asfīdhruy and then throwing it onto the ground. The vessel is described as giving out a ringing sound, again a characteristic of high tin bronzes like bell metal. It is therefore clear that in the early as much as in the later Islamic period the high tin bronze described above was known as safīdruy or some variation of that name.

The details of the stories just mentioned indicate that safīdruy was used for drinking vessels. al-Birūnī in fact gives a list of objects for which it was employed in his day (Bir p.264): vessels in general (awānī), drinking vessels (mashraba), water jugs (kūz al-mā'), amphorae (ijjāna), and washing basins (ṭass ghasl al-thiyāb). Its particular merit for vessels designed to hold water, he notes, was that it did not produce verdigris.

At this point it is relevant to discuss a substance referred to in a number of Arabic and Persian texts by the name of khār ṣīnī. This has received various translations in the past, or simply been transliterated. Thus Wiedemann (1911) never translated it, Laufer (1919 p.555) followed by Aga-Oglu (1944 p.220) suggested that it was a Chinese nickel alloy called pai-t'ung, and Stapleton (1927 pp.405-7) that as used by al-Rāzī at least it was zinc. This latter translation was followed by Dozy in his Supplément aux Dictionnaires Arabes, by Mehren in his translation of al-Dimashqī, and others.

The basis for the latter translation is the fact that al-Rāzī includes khār ṣīnī among the basic metals, not the alloys. al-Rāzī was too good a practical chemist to have classed it among the basic metals unless he had satisfied himself that it was actually one of them, and not one of the five artificial alloys he mentions", and since al-Rāzī says it resembled the metal of which mirrors were made but was softer Stapleton (1927 p.407) concluded that the only likely metal was zinc. While I would not dispute al-Rāzī's skill, it seems highly unlikely that he had ever seen pure zinc, since there is no other evidence to suggest that this metal was identified for another 500 years at least. Moreover, if he had, he would hardly have compared it to mirror metal.

Laufer's association of khār ṣīnī and pai-t'ung is at first sight confusing. A number of authorities (e.g. Cheng and Schwitter 1957, 1962) have attempted to identify pai-t'ung with a nickel alloy used in the 2nd century B.C. for Bactrian coins and supposedly mined in China. It was certainly the name of a nickel alloy in 18th century China, but there seems to be no proof that such a nickel alloy was known in earlier times, nor is there any reason for dismissing the traditional translation of pai-t'ung as "white copper" or "white

bronze", which is its literal meaning and presumably indicates a tin-rich copper alloy (Cammann 1958, 1962). Hence, if Laufer's identification of khār ṣīnī with pai-t'ung is valid, khār ṣīnī was probably bronze with a relatively high tin content. Conversely, if khār ṣīnī was really a nickel alloy it has nothing to do with pai-t'ung.

The information given in the various Persian and Arabic texts on khār ṣīnī, in addition to that of al-Rāzī, can be summarized as follows. In colour it varied from black to yellow to red to the colour of tin (Bir pp.261-2; AQ p.240; Dim p.55; Qaz I p.208); it came from China (AQ p.240; Dim p.55; Qaz I p.208); it was either like Chinese mirrors or was used for making Chinese mirrors, with or without the addition of tin (Bir pp.261-2; AQ p.240; Dim p.55; Qaz I p.208); it was a mined substance (AQ p.240; Dim p.55); it was heavier than gold but was purified in the same way (AQ p.240); it broke like glass and could not be hammered (Bir p. 262; AQ p.240); it was a good metal for bells (Dim p.55); and it or a substance rather like it was used in India for amulets etc. (Bir p.262); it was used in arrow-heads, fish-hooks and tweezers (Qaz I p.208, though tālīqūn was the metal used for these according to Bir p.267 and AQ pp.245-6); particular types of metal vessel were said to be made of it in Kāshghar and Barshkhān (Bir p.262). This picture is confusing, and it would be absurd to suggest that one substance could have all the qualities listed. This does not, however, prevent one trying to establish what is behind the idea of khār ṣīnī - why it existed as a term at all. The most striking point about the descriptions of the metal or alloy as given by the various writers is their unanimity in connecting it with Chinese mirrors. The Chinese mirrors found in Iran are mentioned elsewhere in this thesis (see p.341), but here it is worth pointing out that despite extensive

official and illicit excavating in Iran they are very rare. This would suggest that writers such as those quoted would have had little opportunity of studying them at close quarters, and confused descriptions of the metal alloy used for them is therefore to be expected. A reasonably large number of Chinese mirrors dating from the Han period to the T'ang has been analysed (Swallow 1937 pp.64-5; Rupert and Todd 1935 p.22), and all have much the same composition. For example two T'ang ones analysed contained 68.4% copper, 26.15% tin and 3.07% lead, and 70.4% copper, 22.93% tin and 5.61% lead respectively, along with various trace metals and other impurities. Theyare in other words high tin bronzes with a small amount of lead deliberately added. Furthermore other Chinese objects, including arrow heads, were made of high tin bronze in early times (Arne 1914 p.217), and the brittle and thus characteristically mortal properties of these objects may have become legendary as a result of the occasional battles with Chinese troops on the north-east frontier in the 8th century. Hence, while al-Rāzī's use of the term may be exceptional, it would seem that khār ṣīnī was generally used by early Islamic authors to indicate an alloy associated with China, and especially Chinese mirrors, i.e. a variety of high tin bronze. The fact that the Chinese objects often had more tin in them than Persian high tin bronzes, and that the mirrors at least also contained lead, would have made the identification of the alloy difficult. The lead content could also have accounted for the fact that al-Rāzī described them as being "softer than (Islamic) mirrors", for the only Islamic mirror so far analysed, that from Sīrāf, has only 1% lead in it (Table 21 no.46). Finally, as has been noted, their rarity would have meant that they were not readily available to be melted down or otherwise destructively analysed by an Islamic

scientist. It is therefore somewhat ironical that Laufer should have suggested that khār ṣīnī was the same as pai-t'ung: if pai-t'ung was high tin bronze, not a copper-nickel alloy as he claimed, that may well be correct.

Two substances closely associated in the texts with khār ṣīnī are ṭālīqūn and ḥadīd ṣīnī. Ṭālīqūn is first mentioned in Pseudo-Aristotle (para. 59) where it is ascribed many magical properties. It is included by al-Rāzī as an alloy (Stapleton et al. 1927 p.324). al-Birūnī (p.267) repeats some of its magical properties but says that he has never been able to verify any of the information given him about it, and al-Qazvīnī and Abū'l-Qāsim add little more (Qaz I p.230; AQ pp.245-6), except that al-Qazvīnī does offer an alternative name, haftjūsh. Judging by the etymology of the word, from the Greek katholikon, ṭālīqūn evidently indicated a multiple alloy, and this too is the meaning of haftjūsh. Haftjūsh is today used in Iran by metalworkers of Kirmān to describe what, if one may judge by a bowl in Professor Cyril Stanley Smith's possession, is in reality high tin bronze, even though they claim that their products are alloys of copper, silver, tin, antimony, lead, gold and iron (Wulff 1966 p.18). Interestingly this same confusion is visible in earlier times, for Ibn al-Baiṭār says that ṭālīqūn is a yellow copper, distinguished from other copper by the fact that when one takes it out of the fire and hammers it it can be spread, and then when it is cold it is yellow and brittle (Wiedemann 1911 pp.90-1). Here he is describing nothing but high tin bronze. Likewise ḥadīd ṣīnī, in Persian āhan ṣīnī, said by Abū'l-Qāsim to be compounded of khār ṣīnī or alternatively of the seven metals, is described by the same author as being used for church bells - again a characteristic use of high tin bronze, resulting in its European name "bell-metal". There is only

one instance in early Islamic Iran when a multiple alloy is known to have been produced, which was when Ghiṭrīf ibn ʿAṭā introduced Ghiṭrīfī dirhams into Bukhāra, compounded of gold, silver, brass, tin, iron and copper (Nar pp.34-6). Judging by the cool reception they received they are hardly likely to have been ascribed magical properties. None of the authors quoted seem to have had a personal knowledge of ṭālīqūn or ḥadīd ṣīnī, and therefore in a sense it is futile to try and decide what exactly they meant. But the evidence put together above suggests that both words arose alongside khār ṣinī to meet the need for a name to describe the type of alloy used in Chinese objects, particularly mirrors, an alloy which was never properly analysed by Islamic scientists, but was ascribed, through various factors, a variety of magical but mythical properties.

Another alloy term which appears in al-Birūnī (pp.266-7), al-Ṭūsī (pp. 228-9) and Abū'l-Qāsim (p.245) is batruy. This term was transliterated in the translation of al-Rāzī as tabrūyah (Stapleton et al. 1927 p.408). The first three authors agree that it was a mixture of copper and lead (usrub) and that it was used for mundane objects such as mortars (hāvan or mihrās), casseroles (ṭanjara) and cauldrons (harkāra or garmāva). According to al-Ṭūsī and Abū'l-Qāsim it was also called tāl. al-Birūnī continues his short chapter on batruy with a description of another alloy, compounded of batruy and brass, and called shabah mufragh. From this were made candlesticks (manāra) lampstands (masraj), furnace equipment, and water basins for religious buildings. The only other alloy mentioned in any of the main texts is darāruy, described by Abū'l-Qāsim as a mixture of safīdruy, tāl, mis and birinj, and evidently of the poorest quality.

If one compares these three alloys to the analyses none of them have satisfactory equivalents. But in view of the range of objects analysed, it is difficult to imagine how these three authors could

have been describing the everyday alloys in use and how no examples of them could yet have been found. The most logical explanation would be that al-Birūnī, al-Ṭūsī and Abū'l-Qāsim were all using naḥās, copper, to mean low tin bronze. In this case batruy would be the equivalent of the lead bronzes analysed from Shamshīr Ghar, and shabah mufragh of the numerous objects made of a quaternary alloy of copper, lead, zinc and tin. Darāruy would still remain unidentified, but the low opinion of it expressed by al-Ṭūsī and Abū'l-Qāsim indicate that it is unlikely to have been used for most of the quality objects which survive.

If this is correct, then an interesting point emerges, namely that, as regards terminology, it would appear that sheet copper and sheet low tin bronze were not generally differentiated. And yet it seems extraordinary that a word for low tin bronze is never specified or used, since traditionally in the Middle East such an alloy was common. I can only conclude that the word which al-Birūnī equates with asfīdhruy, ṣufr, which is generally linked with the Arabic aṣfar, meaning yellow, is in fact derived from the Akkadian sipparu meaning (low tin) bronze, and that it is the only tangible remnant of the low tin bronze tradition in early Islamic Iran. This might also explain why the geographers talk of objects made of ṣufr rather than specify any other alloy - not because the objects were yellow but because this was the traditional term for the traditionally commonest alloy, bronze, and even when low tin bronze ceased to be produced the term continued for the then commonest alloy shabah mufragh, which outwardly looked much the same.

One would have hoped, on the basis of the above analysis, to be able to construct some sort of picture of the main centres of manufacture for particular alloys using the references in the geographical texts.

These are given in Table 11. Unfortunately, however, one is immediately faced with the problem of nomenclature again. For although al-Birūnī must mean high tin bronze when he says that the people of Sīstān were particularly skilled in the manufacture of asfīdhruy, there is no way of being certain either that al-Muqaddasī could identify a high tin bronze vessel when he saw one or that if he could he would have given it the same name as al-Birūnī. As it happens there is some evidence to suggest that his use of the term coincides with al-Birūnī's. For example, when talking of copper mines he always uses naḥās, and when talking of lead, whether mined or in use, he uses the word raṣāṣ (Muq pp.225, 279, 324), suggesting that he was particular in his use of technical terms. In his description of Jerusalem (Muq pp.166-9) he appears to distinguish between naḥās and ṣufr and since ṣufr is described as gilded, and gilding is purposeless with brass, ṣufr presumably means some sort of bronze alloy, perhaps the shabah mufragh discussed above. Admittedly it seems unlikely that large pots were made of pure copper in Samarqand particularly if they were as big as those (metal unspecified) mentioned by Ibn Khurdādhba at Baikand (IKh p.157). But when al-Muqaddasī introduces the term asbīdruy it does seem likely that he is using it to mean a different and particular alloy, and therefore presumably high tin bronze. But of course this cannot be proved. Similarly while Ibn al-Faqīh probably means brass when he talks of shabah, his term ṣufr could mean any of the bronze alloys, and in the case of al-Qazvīnī could mean either bronze or brass, both of which appear to have been inlaid in Herāt. To summarise, references to the production of copper or copper alloy objects in geographical texts should be treated with the greatest caution. They certainly suggest that north-eastern Iran was the main area of production in the 10th century, but the location of specific centres producing specific alloys remains virtually impossible to establish.

Antimony, Arsenic, Nickel, Cobalt & Chrome

Modern Persian and Arabic dictionaries give a variety of terms for the metal antimony. Aryanpur (1963) gives sang-i surma, tūtīyāyi ma'danī and antīmūn, for example, while Doniach (1972) translates antimony as ḥajar al-kuḥl, ithmid, or antīmūn. In the light of such modern usage it has generally been assumed that where they appear in an earlier text such words as sang-i surma, ḥajar al-kuḥl and ithmid also mean antimony. Lists of places in ancient and medieval Iran associated with antimony production, such as that published by Forbes (1964 IX p.162), are presumably based on this assumption.

The list of early Islamic references to sources of these substances is given in Table 12: the texts leave no doubt that the most important source was located near Iṣfahān. Now modern surveys record only three sources of antimony in Iran - at Patyār (7 miles east of Anārak), at Turkmanī (25 miles south-east of Anārak), and at Shūrāb (about 100 miles north-west of Birjand)(Ladame 1945 pp.189-191; Harrison 1968 pp.512-513, fig.119). Since none of the medieval sites listed above are anywhere near these deposits it would appear that the mineral or metal referred to is not the same one. This is strengthened by the fact that in no instance in a medieval text which I have yet come across must any of these words be translated as antimony: in all cases there is an equally or more acceptable alternative rendering. Furthermore, in some cases medieval texts contain small fragments of information about the substance described by these names which suggest positively that the substance is not antimony. This will be most easily seen if each word is discussed in turn. For convenience sake kuḥl will be dealt with first.

The word kuḥl was used in two particular ways in medieval Arabic and Persian texts. First of all it was used as a general term for any eye

cosmetic. Such eye cosmetics were prepared from numerous different substances, as is made clear, for example, in the Lapidary of Pseudo-Aristotle, where turquoise, lapis lazuli and tūtīyā are mentioned as ingredients of akḥāl (Pseudo-Aristotle paras. 11,12 & 52), and al-Qazvīnī and al-Dimashqī also note a variety of stones and other substances which could be included (e.g. Qaz II pp.229-234). The word kuḥl was still used in this way in the last century - for example Sanguinetti gives the constituents of three types of kuḥl - kuḥl aghbar, kuḥl aṣfar, and kuḥl ʿazīz, the latter being composed of eleven different substances (Sanguinetti 1866 pp.320-1).

But kuḥl was also used to mean a particular substance specially mined as an eye cosmetic. For instance al-Iṣṭakhrī talks of a mine of kuḥl at Iṣfahān (Iṣṭ p.203), and al-Thaʿālibī (p.110) relates a relevant story about al-Ḥajjāj. al-Ḥajjāj is reported to have given one of his special followers the provincial governorship of Iṣfahān with the words, "I make you governor of the area of which the stone is kuḥl", and al-Thaʿālibī adds that he talked of Iṣfahān in these terms because the kuḥl stone there is described as being of excellent quality. Clearly kuḥl in these instances is something more specific than eye cosmetics in general, and the word must refer to a particular substance, mineral or metal. In view of the Iṣfahān evidence listed previously the identification of kuḥl with the ithmid of Ibn Rusta would seem probable, and is confirmed by al-Qazvīnī, who says (Qaz I p.210):"Ithmid ... the best mine is at Isfahān ... it helps the eyes as a kuḥl (iktiḥālan)". Hence the identity of kuḥl as a specific term is tied up with the identity of ithmid, to which the discussion must now turn.

That ithmid is also identical with surma is made clear by Abū'l-Qāsim (p.189) who equates the two in his chapter on ḥajar-i ithmid The earliest useful description of ithmid occurs in the 9th century Pseudo-Aristotle Lapidary, where it is described as follows (Pseudo-Aristotle para.51):"This stone has mines and the best of them are in the mashriq. It is a stone whose body is mixed with raṣāṣ. It is used for the eyes ... If it is put into silver and the silver is melted, the silver melts quickly on account of its raṣāṣ content." Raṣāṣ, from the description given of it in the same work (para.60), is lead, and hence ithmid was a mineral containing lead. al-Hamdānī, writing a century later, also indicates that ithmid was such a mineral. For he says (fol.21a):"Mines of silver are indicated by kuḥl, for whenever it occurs there is a silver mine with it, since kuḥl is produced by the vapour which forms the silver ore," and (fol.23a), "The indication of a silver mine is al-kuḥl al-ithmid ...". Clearly, the substance must have lead in it, for lead mines were, as noted above, the primary source of silver. Towards the end of the 10th century al-Khwārizmī, in his Kitāb mafātīḥ al-ʿulūm, describes kuḥl as the substance of lead (usrub) (Wiedemann 1911 p.93). Three centuries later Abū'l-Qāsim ascribed the effect ithmid had on silver when added to it to the usrub contained in the ithmid, and also said: "From the substance of usrub come ithmid, tūtīyā, mardāsang and shangarf", both of which statements clearly relate ithmid to lead (AQ pp.190,344).

Hence, not only is there no evidence to show that ḥajar al-kuḥl, sang-i surma and ithmid meant antimony, but there is positive evidence to the contrary: the textual evidence shows that these words definitely referred to a lead mineral. Furthermore, since the antimony mined in Iran today is not found alongside any lead ore, it is unlikely that the lead mineral in question contained any antimony,

except perhaps as a trace element. It is interesting to note a parallel to this situation with regard to the use of antimony in ancient Egypt. It had generally been assumed that the eye paint used in ancient Egypt had an antimony base, but Lucas (1962 pp.195-199) showed by analysis that it in fact consisted of galena, pyrolusite, brown ochre or malachite, and that only in one instance was it antimony sulphide. Apart from this latter instance any traces of antimony sulphide were due to natural impurity in the mineral used. The basis for the assumption that such eye-paint was antimony seems to have been the use of antimony compounds for such purposes in the Greek and Roman worlds, and it is this fact which must have influenced students of Islamic culture too. On the basis of a single sample certain authorities had previously suggested that the usual translation of the Arabic words in question was wrong (e.g. Prax, quoted in Dozy 1881 under "kuḥl", who said that kuḥl was in reality galena) but such warnings seem to have passed unnoticed or unheeded.

One further observation should be made about the nature of the mineral and its uses. Wherever a particular place is cited as a source of the mineral, that same place is cited as a source of lead . This fact in a sense confirms the identification of ithmid etc. with a lead mineral, but at the same time it suggests that the mineral was not used for its lead content. In other words, there was a particular type of lead mineral which was not exploited for its lead content when it was found but instead mined as an eye cosmetic. Hence, it is wrong to say that a place which produced ithmid, surma or kuḥl was necessarily a lead producing centre. That fact should only be adduced from a direct reference to lead itself.

The true metal antimony was almost certainly unknown at this period despite a statement of Dioscorides which has sometimes been taken as

indicating that he had seen the metal (Agricola pp.428-430 n.). The earliest detailed accounts are 15th or 16th century. The presence of antimony in early Islamic copper alloys is no doubt due to the presence of that metal as a trace element in the original ore bodies.

Arsenic (zarnīkh) was equally unknown as a metal, although its naturally occurring and highly coloured minerals, orpiment and realgar, had been used from earliest times (Agricola p.111 n.). Although arsenic-rich copper minerals were smelted in prehistoric times to give arsenic bronzes, the only recorded metallurgical use of an arsenic compound in early Islamic times was to whiten copper (Pseudo-Aristotle para. 27; Qaz I p.211; AQ pp.191-2). Its occurrence in some of the analysed objects is due, as with antimony, to its having been a trace element in the original ore body.

Three other metals should be briefly mentioned for the sake of completeness: nickel, cobalt and chrome. All three occur as trace elements in some Persian metal objects, though the only one which had any metallurgical significance before modern times is nickel. This was used as an important constituent in Bactrian coins round about 170 B.C. and its significance has been the subject of considerable debate (Cheng and Schwitter 1957, 1962; Cammann 1958,1962). No stones described in Islamic texts have yet been identified as nickel ores. Cobalt and chrome are metals which were first utilised for their metallic qualities in modern times. Ores of both were exploited in earlier times, however. Cobalt ores were exploited in early Islamic Iran for the ceramics industry, the sang-i lājvard supplying the blue glaze colourant so common on Rayy and Kāshān 12th and early 13th century products. The details of the production of cobalt given by Schindler (1896 pp.114-6; Allan 1973 pp.116-7), who watched the process

at Qamşar near Kāshān, indicate that the ore was converted to the metal oxide which was then ground and added to a glaze, and that the metal itself was not produced. If it occasionally was it was certainly never used for its own metallic qualities. Chrome oxide seems to have been used as a pigment for ceramic decoration, the relevant mineral being called muzarrad or siyāh qalam. This is still mined today near Nā'īn (Wulff 1966 pp.163, 166; Allan 1973 p.117), but again the metal was unknown.

Chapter 2 - COPPERSMITHS' REPERTOIRE

I Household and Business Equipment

(1) Items connected with Food and Drink

Aquamaniles

Before any constructive discussion of the role of Persian zoomorphic aquamaniles can take place a certain amount of elimination must be undertaken. For there are a number of objects which have in the past been described as Persian but which are probably of rather different origin. First there is a goose, frequently referred to as Persian (Sarre and Martin 1912 pl.133) but which Mr. Simon Digby assures me is a late Indian product. Secondly there is a very important group of cast bronze birds, one in the Hermitage dated 180H./796-7 A.D. (Sourdel-Thomine and Spuler 1973 pl.XVI and p.187), one in West Berlin (Berlin-Dahlem 1971 no.234, pl.37), one in St. Catherine's monastery Mt. Sinai (Weitzmann 1964 p.122), and one in Lucca (Bertolini and Bucci 1957 no.19 and pl.11). The first of these has a number of times been associated with eastern Iran, but although the inscription mentions a town call al-fas this has yet to be proven as Persian, and other features contradict such a provenance. For example, the use of fine-lined incised designs, the motifs used in those designs, and features such as the dolphin on the Berlin piece, all tie the group in with a group of spherical-bodied ewers, which are Mesopotamian or Syrian (see p.220). For these reasons the above group of bronze birds are not included in this thesis.

This leaves the four objects catalogued here - a goose, a creature looking like a deer, a zebu group, and a cock. These were discussed in some detail by D'yakonov (1947a) but a reconsideration is desirable.

Among these four two different sorts of aquamanile will be noticed. One type, consisting of the goose, deer, and zebus, has its filling opening located in a handle which forms a loop between the lower end of the back and the upper end or neck. The goose has lost its handle but this seems to have been of the same sort as the other two. The cock, on the other hand has its filling opening on its tail, and appears to have never had a handle. Sarre and Martin suggested that the cock was not in fact an aquamanile, but if one reconstructs legs as found on the Mesopotamian group of birds, and imagines the small hole in its chest as having been filled with a piece of silver or copper, it then has but two openings, the cylindrical one for filling it and the beak opening for pouring the contents out, and is thus perfectly acceptable as an aquamanile. The Mesopotamian group, although they probably all had handles, had their filler openings set into the tops of the necks of the birds, and if it is possible to establish a relationship between them and any of the examples catalogued here it will therefore be with the cock, although the filler opening is at the opposite end of the bird. If one turns to the decoration one finds that that rather distant relationship is a true one, for the decoration of the cock has much in common with that on the birds. For example, two of the wing patterns on the cock occur on the Berlin bird, and the background blossoms and stems in the medallion on the cock's chest are virtually identical with some of those on the Berlin piece. But other features of the decoration which do not occur on the Mesopotamian products show that it is from a different workshop and probably later in date, for example the enthroned prince with animals in the medallion on the chest, and the harpie on the side, as well as the "water" motif on the wings. This latter is particularly significant since it occurs regularly on the wings of partridge incense-burners and incense-holders of 10th-11th century date, whose wing patterns indeed can be seen as direct descendants of those on

this cock. On the basis of the Mesopotamian birds and the later partridges a 9th or 10th century date seems possible for the cock, and this would fit with the medallion showing an enthroned figure. A seated drinking figure and a seated lute player appear in their first datable context on a silver medal of al-Muqtadir (908-932 A.D.) (Nützel 1900), indicating that these images were by then fashionable. The figure on the cock has nothing in his hands and for this reason may well be a slightly earlier depiction of royalty, confirming the ninth century date suggested above. To summarise this discussion, the cock, on the basis of its decoration, is intermediate between a group of Mesopotamian bird aquamaniles datable to c. 800 A.D., and some north-east Persian objects of the 10th-11th century, and is probably of 9th century date itself. The intermediate position established suggests that it might have been made in western Iran. It thus stands as evidence of a movement of ideas eastwards in early ʿAbbāsid times in the metalworking field, a movement further indicated by certain groups of ewers discussed below.

Turning to the other three aquamaniles, only one is decorated - the zebu group dated 603/1206. It is clearly a product of a north-east Persian workshop (its decoration may be compared for example to that on the Bobrinski bucket), but the date and provenance of the other two, the goose and deer, are not so easy to establish. Indeed, since they have no decoration, apart from the necklace on the deer, there is no realistic way of deciding on either point. Since they are based on the same concept of a pouring vessel as the zebu group they are presumably part of the same tradition, and therefore Persian, and since they are undecorated they are more likely to be early products. More than that would be mere speculation.

The zebu group, consisting of zebu, calf, and lion, is of sufficient general importance to require additional comment, quite apart from its relationship to other aquamaniles. Its inscription tells us the names of owner, caster and decorator, emphasising once again how there were so often two different men involved in the production of any one object, as evidenced also by the Bobrinski bucket (for the argument for the second name in the inscription being the caster and not the patron see Gyuzal'yan 1968 pp.102-5). Its inscription also tells us that it was made in one piece, perhaps by the lost-wax or cire perdue technique of casting, emphasising the ability of early Islamic craftsmen to cast objects of the highest artistic quality. For the zebu and calf are certainly of artistic merit, and were the product of a skilful artist's fingers. Because of their appearance, and the contrast between them and the lion, D'yakonov suggested that they were moulded in wax, but that the lion was based on a wooden model, probably kept as a standard form of aquamanile handle by the maker and utilised on this ensemble perhaps for reasons of speed. One can only regret that the caster did not consider specially designing a handle more in keeping in scale and mood with the other two animals (D'yakonov 1939 p.47). The other aquamaniles discussed may also have been cast by the lost-wax method (see p. 382).

Bottles

Amongst the variety of bottle forms which have survived from early Islamic Iran are two particularly large groups. The first of these consists of both ovoid-bodied and spherical-bodied pieces (groups A/1-4 and B/1-4), and totals some 19 examples. The categorisation followed in the catalogue indicates that a variety of different and specific designs were made, but common features of pieces in different

categories shows that they are all basically variations on a theme. Thus the same tall foot appears in groups A/3, and B/2, a very similar mouth on A/2 and B/1, and an emphasis on bosses on mouths throughout. In a sense therefore the form of the body itself is not of prime importance, for whereas a spherical body may sometimes indicate a glass origin for an object form as opposed perhaps to a metal origin for an ovoid body, here the spherical form is probably the result of a desire for variation in shape in a tradition based on a single prototype.

There seems little doubt in fact that the origin of the form is the common Sasanian silver bottle style, of which examples found in Perm, Bākū and Kharkov are in the Hermitage, and numerous others of unknown origin are in other museums throughout the world (Orbeli and Trever 1935 pl.39-41, 44-5). While many of them bear decorative designs derived from the Roman cult of Dionysis (Ettinghausen 1972 pp.3-10), there are also a number with designs which utilise bosses as important elements (e.g. Orbeli and Trever 1935 pl.41). It is at present virtually impossible to be sure whether such pieces are late Sasanian or early Islamic, and because of this problem they have not been included in the section on silver bottles above. The continued use of the form in early Islamic times does seem to be indicated, however, by a ewer in the Nagyszentmiklós treasure, datable to the 9th century (Mavrodinov 1943 pl.3-6, pp.207-8), which though a ewer does in fact follow the same bottle form. One may therefore suggest that there was a continuous tradition of bottle manufacture in early Islamic times, in one metal or another, based on the Sasanian form mentioned, and that the surviving bronze examples under discussion are part of that tradition.

The dating of type A of the Islamic examples is extremely difficult for none of them have any decoration apart from the almond bosses and shoulder ridges. In B, the most easily datable is B/4/V.1, which has decoration typical of late 12th century Khurāsān, and a 12th century date would also fit the decoration of B/2/1-2, B/3/1, B/4/1-V.1, though the lack of comparative dating for the styles associated with Sīstān and Ghazna make an earlier dating conceivable in some cases. Hence it would appear that types B/2-4 were current between say the late 11th century and the Mongol invasions. Assuming that a lack of decoration or the use of almond bosses alone tends to suggest an early dating, bottles of form A must be the early examples of the style, perhaps 10th-11th century. Given the Sasanian prototype for the form this dating seems correct, for the ovoid-bodied pieces are certainly nearer the Sasanian shape than the spherical-bodied pieces. Whether, however, type A go back prior to the 10th century it is impossible to say.

The findspots for the various types should be noted. Examples of A/1 come from Ghazna and Fārs, of A/2 from Ghazna, of B/2 from Ghazna, Sīstān, Afrāsīyāb and Rayy, and of B/4 from Ghazna. In addition a bronze bottle neck and mouth was found at Maimāna in northern Afghanistān (Scerrato 1964 p.705 no.26), though the published description of it is not full enough to allow one to place it in any of the above categories with certainty. Scerrato (1959 pp.105-6, 1964 p.705) also draws attention to other examples from Ghazna in the Kābul Museum, and another bottle in Qandahār. All this suggests that the objects were particularly popular in the east, but the Rayy, Fārs and Afrāsīyāb finds show that it would be naïve to ascribe every

example found to an eastern workshop. It should also be noted that a bottle identical in form to B/1 type, and another like it but with a squat cylindrical body and three small feet, were found in Egypt (Wulff 1909 I pl.51 no.1046; Strzygowski 1904 pl.30 no.9094). Presumably modelled on the Persian style, they appear to indicate that such bottles were manufactured in other Islamic lands in addition to Iran itself.

Just as the large group of bottles discussed above contains pieces with different body shapes which are nevertheless closely connected and stem from a common origin, so the second large group of bottles to be discussed also contains different body forms - plain domical (C/1), lobed domical (C/2), and polyhedral (D), and yet is united in the tall flaring form of mouth used, and, as will be shown, in having a common origin. All surviving examples are of cast bronze, and all were made in one piece plus a base plate. In the case of the domical examples the base plate was a small disc, about 4.5 cms. in diameter, which would have been soldered into a central hole in the base after the casting core had been scraped out of the inside. In the polyhedral piece the base plate was soldered in at the bottom of the foot.

The origin of the simplest of these forms, C/1, is to be sought in eastern Islamic glass, where such a bottle style was relatively common. Thus Lamm (1929 pl.12 no.13, pl.58 nos.12-13) illustrates three glass bottles of this form, one of which was acquired in Tehrān, one in Kirmānshāh, and one in Baghdād. Other examples of unknown provenance are in the British Museum (Pinder-Wilson 1963 pl.16, pp.36-7). Not only is the form derived from glass, so too are certain aspects of the decoration. Thus the facetting on 1 is copied from the facetting on cut glass objects, while the projecting flanges on C/1/2 and

C/2/1-3 are based on the trailed decoration so common on glass bottles of rosewater sprinkler form and are similar to those found on silver rosewater sprinklers. The objects with lobed bodies are an elaboration on the simpler shape, and reflect the influence of the metal-beating traditions of Khurāsān, in which alternately rounded and pointed sides are common (e.g. beaten bronze ewers C/3/d). The polyhedral-bodied bottle (D/1) is presumably a metalworker's attempt to create a novel form within a specific tradition. A copy of such a piece in turquoise glazed ceramic dating probably from the 11th or 12th century is in Berlin (Erdmann 1965 fig.6).

The most easily datable of the three forms are C/2 and D. C/2/2-3 bear decorative designs typical of 12th or early 13th century Khurāsān, while C/2/1 is probably 12th century. D/1 on the other hand bears knot patterns and palmettes which suggest an 11th century date. The two Nīshāpūr pieces are decorated in a manner quite untypical of north-east Iran in the 12th century, and must be earlier, though whether they are 10th or 11th it is impossible to say. It would therefore appear that the glass bottle form was being copied in north-east Iran sometime within the latter timespan, that it was soon being adapted by metalworkers to produce more exciting objects, and that in the 12-13th century a lobed form more characteristic of the beaten metal industry of the period was utilised. In view of the fact that both pieces in C/1 come from Nīshāpūr, that C/2/2 is signed by a craftsman with a Nīshāpūrī nisba, and that there is an obvious decorative connection in both Groups C/2 and D/1 with the north-east of Iran, there seems little doubt that this was the main area of production. The continued use of the form in the post-Mongol period is indicated by an example in the British Museum (1964.6-15.1 unpublished).

It should be noted that bottles of similar form but with particular characteristics were also produced in Egypt in early Islamic times. One example found in Egypt and now in Berlin (Wulff 1909 I pl.51, no.1045) has a more cylindrical body and taller neck than the Persian pieces, and also has a hinged domical lid, and the same characteristics occur on another piece in the Coptic museum (Strzygowski 1904 pl.30 no.9095). Three other examples in the de Unger collection, and one in the Louvre (Migeon 1922a I pl.21 no.63), have sufficient points in common with these two to be ascribed to Egypt with confidence.

Two bottles remain to be discussed. The first, a beaten bronze spherical-bodied piece, with birds around the shoulder, and with its neck missing (B/5/1), is related to the silver spherical-bodied bottle (C/1) and to the silver rosewater sprinklers. It may indeed have been a rosewater sprinkler, though it is rather larger than the silver examples and has therefore been included here as a bottle. The repoussé birds, the use of inlay, and the fact that it is of sheet metal, connect it with the bronze or brass beating school of Khurāsān in the 12th and early 13th centuries, but the knot patterns, which appear to be elaborations of those found on Samānid and related ceramics of the north-east, suggest that it is probably earlier, perhaps 11th century.

The second bottle, with a flat, circular body and tall neck (E/1), is a unique piece, and was found in the Punjab. Its decoration suggests that it is a late 12th or early 13th century Khurāsānī piece, but the origin of the form is not so easy to establish. Metal objects with disc-shaped bodies are almost as rare in pre-Islamic times as at a later date, and those that do exist are constructed on a rather different principle - a body formed of two flat discs joined by a

straight edge, with a foot and neck added at bottom and top respectively (e.g. Odobesco 1889 II fig. 19; Matzulewitsch 1929 pl.19-20; Pope 1938 pl.247). The Islamic piece is much more refined, for its body and neck are conceived as a unit, and its body is a very sophisticated and beautiful form. Its closest parallel seems to be a green glazed bottle in Ettinghausen's collection (Pope 1938 pl.193B) dating from the 8th or 9th century. Whether the form continued to be produced throughout the early Islamic period is unknown, for at present there seem to be no other surviving examples. Mr. Simon Digby has suggested verbally that this bottle could have been made by a Khurāsānī craftsman working under the Delhi sultanate - a possibility which should not be overlooked but which is beyond the range of this thesis.

Bowls

Whereas all silver bowls, footless and footed, were grouped together, the characteristics of the two forms of object in bronze are such as to demand separate treatment. Here, therefore, only footless bowls will be considered. Footed pieces are discussed under Stem Bowls (below).

Footless bowls may be divided into four groups: A, approximately hemispherical bowls of forged high tin bronze; B, hemispherical bowls of cast high tin bronze; C, flattened hemispherical bowls of high tin bronze; D, rounded bowls of some other sort of bronze. In more detail, the first group (A) is characterised by a form which is slightly less than a hemisphere, by a body of approximately uniform thickness and curvature throughout, and by the use of incised decoration only, in the form of outlines and background intermittent punching. The second group (B) is characterised by a form which is slightly deeper than a

hemisphere, by a body of varying thickness, by the use of relief cast designs, and by the use of incised designs involving the removal of background metal in addition to simple incised outlines. The identification of the alloy used as high tin bronze depends upon two factors. First of all, unpublished bowls almost certainly of type A have been analysed (Table 21 nos.6-7) and contain over 20% tin. Secondly, A/1 and B/2 have cracks and missing fragments consistant with the fact that high tin bronze shatters easily when cold. As regards the method of manufacture, there seems little doubt that bowls in Group A would have been hot forged, for they have a perfect, smooth form, whereas Group B have rims of variable widths, and in two cases arcading or gadrooning on the exterior for which casting is the only satisfactory technique.

Turning to a more detailed study of Group A, it must first be emphasised that the inclusion of the Maimāna pieces is somewhat conjectural since Scerrato, although his cataloque entries strongly suggest that they are part of this larger group, does not illustrate them, and describes them as beaten bronze. Secondly, it must be noted that the purity of shape of these pieces makes it impossible to determine their origin without using other evidence: a hemisphere is after all one of the simplest shapes that can be raised from sheet metal or, as in this case, forged from high tin bronze. It is therefore necessary to consider at once the findspots and the style of decoration of the various examples known.

A/1 comes from Afghanistān, A/2 from Ghazna, and A/3-5 from Maimāna. These findspots strongly suggest an origin in Afghanistān for the style in general, and this is emphasised by certain details of the decoration. Firstly, both ruler and attendants on A/1 wear the two-peaked cap typical of the Ghaznavid court in the first half of the 11th century. Secondly, theoutsides of A/1-2 bear an interlaced

six-pointed star which is a motif found on Samarqand 10th-11th century slip ware, and on 11th century slip ware from Lashkarī Bāzār (Tashkhodzhaev 1967 fig.12; Gardin 1963 pl.21). The scrolls used to infill unused space are also characteristic of such pottery. Palaeographically no dated and provenanced parallels for the inscriptions are known, but the fact that the style of lettering finds its most accentuated form in the piece most closely associated with the Ghaznavids (A/1) suggests that Ghazna may well have been the focal point of production. Hence it would appear that A/1 and A/2 are products of a workshop or workshops in eastern Sīstān, perhaps in Ghazna itself, and that a date in the first half of the 11th century is likely. A/3-5, though characterised by less imaginative designs using similar geometric and vegetal designs plus inscriptions, are probably of like origin.

Turning now to Group B, B/1-2, in addition to the various characteristics already described, have a decorative design which emphasises the exterior of each bowl, and what is more includes the base as well as the sides. This is a usage which is sufficiently rare to be taken as significant where it does occur, and noting the form of rim on B/1 there seems good reason to suggest a link between these two bowls and a silver bowl style typified by the pieces in the name of Windād-ōhrmizd of 8th or perhaps early 9th century date (silver bowls A/1-3). The significance of this connection will become apparent once the dates and provenances of the two high tin bronze pieces have been established. The difference between the external and internal decoration on the first bowl is striking, and it can be argued that they are in fact of different periods. The arcading on the outside is not a common decorative style in Islamic Iran, and recalls the elaborate pillars and arches depicted on Sasanian bottles with

Dionysiac scenes (Orbeli and Trever 1935 pl.44-5). This connection is confirmed by the use of partially sunken discs above the arcading on the bowl, virtually identical discs, only in relief, appearing on a particular example of those bottles (Orbeli and Trever 1935 pl.45). This would suggest that the bowl is very early Islamic or at least dates from an era when the Sasanian tradition was still apparent in the arts. The internal decoration on the other hand has rather later parallels. The rotating bird/fish motif, for example, should be compared to designs found on Samarqand slip-painted wares of the 10th-11th centuries (Ettinghausen 1957 fig.19; Tashkhodzhaev 1967 fig.30), together with a rather more elaborate design involving birds' heads in a stucco plaque from Nīshāpūr, dating from 961-981 A.D. (Dimand 1938), while the bird form occurs on a type of Persian sgraffiato ware now known as "hatched" sgraffiato, common in South and East Persia from the second quarter of the 11th century for about 100 years (Pezard 1920 pl.20-23; Allan 1974 p.20). The latter ceramic style is probably derived from designs current elsewhere at that time or slightly earlier, and a north-eastern provenance for the bowl's internal decoration is most likely.

Bowl B/2 has a decorative design which indicates a much later date. The animal frieze, the zodiacal signs in roundels, and the scrolling stem pattern all suggest a north-eastern provenance and a date in the 12th or early 13th century. Trying to pin down the provenance more closely one should note that the use of a geometric pattern such as covers the base is unusual alongside these other features in Khurāsān in this period, and that the pseudo-herringbone pattern below the rim is virtually unknown. Since the former type of pattern is common on Transoxanian ceramics and occurs on some Transoxanian bowls (discussed below) and Transoxanian high tin bronze dishes (e.g.

Melikian-Chirvani 1974 fig. 19, see p.200) and since the latter is characteristic of earlier bronze partridge incense-burners and incense-holders, which are also probably Transoxanian, the bowl is probably Transoxanian itself, rather than Khurāsānī.

The information known about B/3 is insufficient to allow any pertinent comments to be made, but B/4 requires and deserves particular attention. For this piece does not coincide at all levels with B/1-2. With its facetted exterior and smooth rounded interior it is certainly a cast object, a fact reflected also in its rim. But decoratively it has much in common with group A pieces: not only is the techniqueoutline incising, but the inside, not the outside, of the bowl is the part emphasised. Furthermore, the style of calligraphy is just like that found on A/1-2. Since the latter are probably early 11th century pieces this bowl must be of a similar date. The decoration inside is, however, quite different from that on the other two bowls. It depicts a mounted swordsman, apparently being attacked by a lion, with a variety of animals of the hunt filling the ground around the horse's feet. The picture is based on traditional Sasanian hunting scenes, and the continuing Sasanian tradition is also visible in the winged crown worn by the swordsman, although the Islamic milieu is visible in the animals around the horse, which are more varied and numerous than occur in Sasanian metalwork decoration and include animals such as hares which are virtually unknown in pre-Islamic hunting scenes. A winged Sasanian-type crown also appears on the silver bowl depicting Maḥmūd of Ghazna (silver bowl C/4), which incidentally bears other Sasanian-derived features. From the above points, a first conclusion about B/4 is that it is a link between B/1-2 and A, based in method of manufacture on B/1, but leaning in its decoration towards the Ghaznavid taste. The fact that Muḥammad ibn Aḥmad, its maker, bears a Sīstān nisba should probably be taken as

indicating therefore that he was working in Sīstān.

To summarise the Group B situation, B/1 was probably made during the first two hundred years or so of Islam, and its interior decorated in the north-east about 1000 A.D., B/2 is probably Transoxanian and 12th-early 13th century, B/4 is probably early 11th century, and to judge by both decoration and nisba a Sīstānī product. Returning now to the general form of B/1-2, and bearing in mind these attributions and the fact that the hemispherical silver wine bowls with which they have been compared were used if not made in Mazandarān, it is tempting to see B/1 as a north-eastern product, like its later successor. If that attribution is correct some interesting and important conclusions follow. For the north-east, particularly Transoxania, was responsible for the production of high tin bronze dishes from earliest Islamic times up to the Mongol invasions (see p.200) and one might thus conclude that it must have had a very stong tradition of manufacturing in this medium prior to Islam. Yet the features of the high tin bronze bowls in question indicate that the inspiration was silver - silver bowls with external decoration, and decorative designs derived from silver bottles, both of late Sasanian or early Islamic date. The question immediately arises as to why craftsmen working in high tin bronze should be adopting silver forms or silver decorative features. Here the story told by al-Birūnī (p.264) of the origin of asfīdhruy is important. He tells how al-Ḥajjāj broke the golden and silver vessels used in Iraq and Persia, and violently forbade drinking, and records the comment of a certain Fīrūz who said that drinking vessels had normally been made of a silver-copper alloy but that after that event the silver was replaced by tin. If there is truth in this story a connection between high tin bronze and silver objects is indeed to be expected. Moreover it would be appropriate

that Soghdia, producer of so much silver in pre-Islamic times (Marshak 1971), should be a main manufacturing area for the high tin bronze alloy.

What is more, the story would explain why high tin bronze bowls existed at all. In early Islamic Iran the growth of a strong tradition of decorated ceramics led to a virtual monopoly by the pottery industry of certain forms of object, of which the most important was bowls. Only three ordinary bronze bowls have survived (Group D), and although there may have been, and must have been, others, nevertheless the enormous number of pottery bowls littering every Persian Islamic site show that the bronze workers only catered for a tiny portion of the market. A tradition of manufacturing bowls in high tin bronze throughout the period therefore demands particular explanation. Part of that explanation may well be that such bowls were originally produced as imitations of silver ones, and that due to their very silvery bronze colour, they retained a rather exclusive position, continued to be in demand from a certain section of society, and competed successfully with the lavishly ornamented glazed ceramic products. That they were probably very expensive to produce, and therefore beyond the means of the masses, is indicated by the large proportion of tin they contained. The cost of importing this metal in such quantities as to provide one fifth of the weight of every object manufactured must have been considerable.

One final comment about these high tin bronze bowls. al-Bīrūnī, writing for the Ghaznavid al-Mawḍūḍ, who died in 1048, notes how the Sīstānīs were particularly skilled in the manufacture of asfīdhruy, and includes in his list of their products drinking vessels and clothes-washing basins. Group B tend to be 20-26 cms. in diameter, A/1 on the other hand measures over 40 cms. The former,

though perhaps rather large for drinking vessels are not much bigger than many silver wine bowls, and the Sasanian-style hunting scene on the bowl of Muḥammad al-Sijzī would certainly be in keeping with such a use. The bowl depicting the Ghaznavid court (B/1) on the other hand may well be one of the basins referred to, presumably designed in this case for ritual hand-washing before meals. That being so, al-Birūnī's list of high tin bronze objects, which includes in addition ewers and amphorae, shows that this alloy was used for the three most important items of court ceremonial - drinking bowls, ewers for wine or for ritual washing, and ritual washing basins. The status of the alloy is thus in little doubt.

One further high tin bronze object remains to be mentioned, bowl C/1. This is of a form which although basically hemispherical is rather different from that of any of the pieces mentioned so far. It is a slightly flattened hemisphere, with a rim which just begins to curve inwards, and a small flattened area forming a base. The decoration is all on the outside, but it does not cover the base, and the style of the scrolling stems with their rhomb-shaped leaves indicates that the bowl is a north-west Persian piece of 13th century date (c.f candlestick B/1). Being the only one of its type, and being in fact the only high tin bronze footless bowl attributable to the north-western 13th century school of metal workers, its significance remains for the moment unclear.

The three bowls of more ordinary copper alloy (D) are all of rounded form though they vary in detail. All were probably raised from sheet metal and therefore represent metalworking at its simplest. From their form and the simplicity of their decoration it is clear that they were designed for ordinary homes and everyday uses, though they would still have been more expensive than the cheapest ceramic products. None of

the three are accurately datable from their archaeological context, and dot and circle designs are common enough on metal objects of most periods to make any dating on decorative grounds impossible. The fact that such objects are not common in museum and private collections should probably not be taken as indicating that they were rare: from the fact that both Rayy and Sīrāf excavations have brought them to light they may well have been fairly common everyday objects. Their lack of impressive decoration or interesting form would combine with heavy corrosion, however, to make them relatively worthless objects from the point of view of a clandestine digger or dealer, and would thus account for their rarity on the art market. It is interesting to note that such objects were used elsewhere in the Islamic world e.g. Spain (Gómez-Moreno 1951 fig.395e), but in view of the simplicity of their form it is hardly necessary to seek a common origin for such widely distributed examples.

It is necessary to round off this survey of bowl types from Iran by briefly mentioning certain Transoxanian groups. Ivanov (1970) in his survey of some Khurāsānī and Transoxanian bronzes of the pre-Mongol period, draws attention to three Transoxanian bowls (his 16-18), two from Ketmen-Tyube in Kirghiz SSR, and one from Chor-Pulat, which he ascribes to the 10th or early 11th century. He also identifies two 11th century Transoxanian bowls, one from a Tashkent collection, and both now in the Hermitage (his 14-15), and a group of 12th-13th century ones (6-11). As he points out, although there are similarities between this latter group and products of Khurāsān, there are features which suggest a quite different origin, for example the extraordinary tomato-coloured inlay used, and the range of geometric motifs, and I would follow him in attributing this significant group of objects to a Transoxanian workshop. To those he lists, which includes the

Victoria and Albert Museum piece M.388-1911 (Grohmann 1959), I would add another Victoria and Albert piece 1948-1899, published by Melikian-Chirvani (1973 pp.32-3) as Khurāsānī, a piece also mentioned by the latter as having been found in Badakhshān and now in Kābul museum, and another unpublished piece in Melikian-Chirvani's own collection recently on loan to the Victoria and Albert. Since M.388-1911 and the loan piece are both high tin bronze, and 1948-1899 is beaten bronze of some sort, the Transoxanian craftsmen were evidently working in a variety of alloys. Although the limitations of this thesis prevent a detailed discussion of all these objects, the importance of the attribution of this group to Transoxania should be stressed, for upon it depends the attribution of other groups of objects including some important dishes, and as a result of this the primary location of the high tin bronze industry in pre-Mongol times.

Cauldrons

All but one of the surviving early Islamic cauldrons from Iran are hemispherical. That one (B/1) is a cylindrical cauldron which was found in the lowest Islamic levels at Susa in association with a set of ceramic crucibles. Rosen-Ayalon(forthcoming p.120) suggests that the group may have been part of the equipment of a metal caster, but does not give enough details of the cauldron or the findspot to allow development of her brief comments. Historically this cauldron is more relevant to the study of buckets since it is part of the same classical legacy, and further discussion of it is not necessary at this point.

Hemispherical cauldrons (A) were used in medieval times in two main areas of the Islamic world - Dāghistān and north-eastern Iran, and there has sometimes been confusion in the past as to which are which.

Those catalogued here as Persian, for reasons enumerated below, have the following characteristics. They have bodies which are just less than hemispherical, three short conical feet, and a flat rim with four protruding flanges with pointed corners. Two of these flanges usually bear vertical handles, and one an open pourer or shallow spout. One handleless example is A/13. All the cauldrons are of cast bronze, the alloy, if one may judge by the Ashmolean example (Table 21 no.35), being a compound of about 60-70% copper, 6-8% zinc, 15-25% lead and 2-6% tine i.e. shabah mufragh. Originally they may have been "tinned" for the sake of appearance for the Ashmolean piece has traces of tin and arsenic on the surface which would have given a silvery appearance, though the arsenic would also have produced some unfortunate side effects! The cauldrons were probably cast in six pieces - the body with rim and flanges in one piece; the two handles and the three feet separately. The knob of bronze on the outside of the bottom of the Ashmolean cauldron shows the position of the pouring cup for the casting; the object was thus cast upside down. The handles and feet were soldered on.

The provenance of these hemispherical cauldrons is relatively easily established. Two objects of the same shape from Nīshāpūr, one of stone, the other of pottery (Wilkinson 1944 p.288 top), the signatures found on some of the bronze pieces - Abū Bakr b.Aḥmad al-Marwazī (A/1, see also Mayer 1959 p.24 for two other cauldrons of unknown form by the same man), and Khājakī Ṭūsī (A/5), the tie up between certain of the motifs used in the decoration and those of Transoxania or Khurāsān - for example the interlaced six-pointed stars on A/4 which are like those on a Transoxanian bowl (Melikian-Chirvani 1973 pp.32-3; see p.190), and the occurrence of two undecorated examples in the Maimāna hoard, all point to a provenance in Khurāsān or Transoxania.

With regard to date the 13th century seems most likely. The Maimāna hoard was probably buried at the time of the Mongol invasions, so that the two undecorated cauldrons can hardly be later than about 1220 A.D. But some of the undecorated examples may be later if Melikian-Chirvani's dating of the calligraphy to the late 13th or even 14th century is accurate (Melikian-Chirvani 1973 p.43). In fact the calligraphy seems to be as far away from that on the great bronze cauldron in Herāt datable to between 1308 and 1328 (von Niedermayer and Diez 1924 pl.152; Mayer 1959 pp.43-4) as that on inlaid bronze objects of the early 13th century, and to try and date the hemispherical cauldrons more accurately within the 13th century is thus virtually impossible for the time being.

The Dāghistān cauldrons, which at first sight are very similar to these, are distinguished by some or all of the following features: they are deeper than a hemisphere, they bear applied decoration, they have a more elaborate handle form with a more pronounced floral top and animal feet, and their rim, sometimes cusped, is set below the top of the cauldron's edge. That they are Dāghistānī is born out by the fact that almost all of them were brought from Kubachi or elsewhere in the region, by comparison with the three-quarter-spherical cauldrons from the same area, and by the fact that there was still a cauldron making industry in Dāghistān in the early 20th century (de Zichy 1897 I, pls. 94, 95; Shilling 1949 fig.26; Ferenczy 1963; Scerrato 1964 pp.692-696). (It may be noted in passing that Scerrato's fig.60 cauldron is now in the Ferenc Hopp Museum of Eastern Asiatic Arts cf. Ferenczy 1963 fig.1.) On the basis of the above points it is necessary to exclude from further discussion certain examples, listed by Scerrato in his discussion of cauldrons (Scerrato 1964 pp.689-692), which certainly must be from the Caucasus. Thus his no.31 (Victoria and Albert Museum no.1416.1903), although it is said to have been

acquired in Bukhārā has the characteristic Dāghistānī positioning of the rim, as well as a stark decorative style which would be quite in keeping with Dāghistānī ornamental tradition, and his no.32 is probably similar. His no.24 came from Dāghistān, and, with its Dāghistānī handles and the bars which join the flange corners to the rim, a feature found on the Kubachi cauldron in the Hermitage (Orbeli 1938 pl.57), is also probably Dāghistānī. Finally his no.25 (Scerrato 1964 fig.58), although possibly signed by an artist from Marv (Maḥmūd Marwazī or Qazvīnī - see Mayer 1959 p.59 and Scerrato 1964 p.691 n. 86) also came from Kubachi, and has the full circular rim unknown on proven Persian objects, as well as handles which are quite different from the Persian style.

In addition to these Dāghistāni hemispherical cauldrons, it is necessary to exclude certain other pieces listed by Scerrato. The reason for this is not that they can be attributed to another area of the Islamic world but that the published information about them is so scanty that they cannot be catalogued properly on the basis of either shape or decoration. The cauldrons in question are Scerrato's nos. 2 (Berne Historical Museum), 3 (mentioned by van Berchem, 4-6 (Hermitage), 7 (Kiev), 9 (ex Demotte collection), 16-19 (Tehrān art market), 20 (U.S.A. private collection), 22-3, 27-30 and 33 (Tehrān art market). Finally, it should be noted that the only dated cauldron found in Armenia and bearing an Armenian inscription giving the date as 1232 A.D., or perhaps 1238, is of a form which corresponds neither to the Dāghistānī style nor the Khurāsānī, though it has more in common with the former (Orbeli 1938 p.312; Arakelyan 1956 fig.3; Scerrato 1964 fig.62).

Scerrato, in his fairly detailed discussion of the Persian cauldrons and their Dāghistān relatives, suggests that they derive from cauldron

types used among the nomads of the Central Asian steppes. Such a theory had previously been propounded for the Dāghistān type by Strzygowski, who compared these cauldrons to certain nomadic ones found in Hungary or Siberia (Strzygowski 1930 fig.225-7; Scerrato 1964 fig.64-8). Since this thesis is not concerned with Dāghistān objects the arguments put forward in what follows are only designed to relate to the Persian pieces, though they may incidentally apply to others. First of all, in consideration of the Hungarian and nomadic objects cited by Scerrato a few comments need to be made. First, the Hungarian cauldrons (Scerrato 1964 fig.64-5) have virtually nothing in common with the Persian objects: they are not hemispherical, they have no feet, they have no rim, and although they have vertical handles these are very different from the Persian ones. Furthermore, and this is very relevant, they are clearly derived from a leather shape - witness the vertical bands on the body and the way the handles and rim are formed and joined. The same arguments apply to two of the Russio-Siberian objects illustrated by Scerrato(1964 fig. 66, 68), leaving only two Siberian pieces (Scerrato 1964 fig.67). Both are deeper than a hemisphere, both have a circular foot, neither has a rim, and their form should perhaps be derived from the other ones just mentioned. It is certainly difficult to see how a three-footed hemispherical bowl with a broad rim could be related to them, in any but the remotest way. But, it must be admitted and noted, they do have vertical handles which seem to be like the Persian ones, despite the fact that they are complete circles and are attached sideways to the outsides of their parent objects. In summary, while the handles may suggest some sort of relationship between nomadic steppe products and those of Iran, no other features of the former group point in that direction.

A far more likely origin for the cauldron form is, in my opinion, suggested by an object already cited from Nīshāpūr (Wilkinson 1944 p.288 top left). This is a stone cooking vessel of hemispherical form with three small feet and a rim made up of four wide flanges, which according to Wilkinson is of 9th century date. When one sees this stone object one realises that stone must have been the original medium for the shape, a perfect hemisphere being difficult to produce in any other material but relatively easy in stone where coarse and fine abrasives can be utilised to give the absolutely regular and smooth finish desired. The flanges are an equally apposite design for stone and would probably have originated in simple rim nicks leading to the removal of small square or trapezoidal areas. Such rim nicks continued to be used on the bronze objects, incidentally (e.g. A/1). Three small feet of simple conical shape would be easily left by the carver and are thus equally apposite for stone work. A pottery cooking pot of the same form from Nīshāpūr (Wilkinson 1944 p.288 top right; Wilkinson 1973 pp.318, 350, no.89) shows how ill-adapted the form is to normal ceramic techniques, and its rim decoration clearly indicates the stone carver's influence, with its simple lines and circles, as indeed may some of the simpler designs on the bronze cauldrons. Seen in the light of these two objects the metal hemispherical cauldrons are as out of keeping with their body materials as the pottery example, and one is forced to conclude that they are derived from a style of stone cooking pot used in the same area earlier in the Islamic period.

The handles, however, are not so easily explained, for they are certainly not of stone origin. Various facts stand out. First, it will be noted that if one compares the handles with those on the Dāghistān cauldrons they are apparently simplified versions of the latter, the

animals at the base of each upright having become mere projections where the heads once were, and the floral tops have degenerated into rather crude trefoils. It may therefore be that the handle style was imported from the Caucasus. But the Persian handles can equally be seen as developments in their own right from the metal ring handles for leather objects and bronze copies used in Siberia by nomadic peoples, as mentioned above. The Siberian form of handle (Scerrato 1964 fig.67) has a knob on top and in one case two shoulder projections, and is soldered to the side of its bronze parent object. Both these features occur in the Persian pieces, the latter perhaps not so obvious but evident from the positioning of the handle in such a way that the lower half of it, had it been a full circle, would have been in the correct position for like attachment. Hence, far from being derived from the Caucasus, it is possible to claim that the handles are of steppe origin, and to suggest that the Caucasian pieces are elaborations on the Persian style. The influence must in other words have been moving westwards, not eastwards.

At this point it is worth returning briefly to the ceramic hemispherical object from Nīshāpūr. Wilkinson (1944 p.290) says that this object, and its stone relative, came from 9th century houses on the site, and he also draws attention (1973 p.318 no.89) to the possibility that the ceramic example originally had handles like the bronze cauldrons. If he is correct, it would appear that handles of this form were already known in the 9th century, and this, in its turn, would strengthen a nomadic origin for the handles rather than a Caucasian, since no-one has ever suggested that the latter cauldrons could be much before the 12th century. If correct it would also provide an interesting example of the influence of steppe culture in Iran at a time when Turks were being imported in ever larger quantities for the caliphal armies.

Dishes

Wide, circular, flat-bottomed vessels made of metal occur in early Islamic Iran in sizes varying from 14.4 to 74.5 cms. in diameter. In literary texts a wide variety of words occur indicating such objects. Thus al-Hamadhānī mentions a jafna rawḥā', a shallow dish used for butter and dates (Hamadh pp.74, 176); a khivān, some sort of table, according to al-Tanūkhī with enough depth to have food placed in it (fīhi), and therefore probably with a metal tray-like top (Hamadh pp.74, 114-5, 179; Tan Faraj p.221), a sukurraja/ sukurrajāb, evidently a dish for eating out of, and a ṣaḥfa, a dish for laban, used in the terminology of al-Ḥarīrī for a large dish for sugar and honey sweetmeats, and in Kalīla wa Dimna for a golden dish holding rice (Hamadh pp.115, 188; Ḥar pp.152-3; K. & D. p.200). He also mentions a ṭabaq, a large dish on which wafers or bread were placed, used in al-Tanūkhī's terminology for a dish holding grapes, or herbs and water-lilies (Hamadh pp.60, 180; Tan pp.140, 144), a ghaḍāra used for serving maḍīra (a sour milk and meat dish), or according to al-Tanūkhī harīsa (an almond and mutton dish) or other foods (Hamadh pp.104, 189; Tan pp.55, 63, 124). Sīnīya is the word commonly used today in the Arab world for a copper dish used as baking tin, serving tray and table-top, but al-Tanūkhī uses the word to mean something a bit deeper, capable of holding pounded camphor, gold dinars or even wine (Tan pp.145-6; Tan Faraj pp.210, 224, 228). The same author mentions a type of dish of unspecified nature called a ṭīfūrīyya (Tan p.249).

There is no English word which can comprehend an object designed for so many and various uses, nor is it possible to draw a line and say that examples of more than a particular diameter should be considered as trays, and those of a lesser diameter as dishes. All these objects are therefore catalogued and discussed under the title dish, a word which is probably appropriate in its normal usage for a reasonable.

proportion of the surviving examples, but which should be understood in this thesis as including objects of dish-like shape whose function was probably more that of a tray or table-top. On the other hand, since dishes with feet are more emphatically designed for standing than those without, footless and footed dishes have been differentiated in the catalogue.

The simplest form of dish from early Islamic Iran (A) has a flat base and upturned sides, but surviving examples point to two different traditions, one involving workers in beaten bronze, the other workers in forged high tin bronze. It should be stressed here that up to now none of the dishes catalogued as high tin bronze have ever been analysed, and that their attribution is therefore based upon their outward characteristics, such as the type of fracture associated with the high tin alloy. Of ordinary sheet bronze are two dishes in the Hermitage (A/1/1-2), both decorated with repoussé work and incised designs. The first bears lobed arches with pearl borders reminiscent of the alternating round and three-lobed arches from Khirbat al-Mafjar (Hamilton 1959 fig.124) and of early Islamic stucco work from northern Iraq (Sarre 1933 fig.1), and is perhaps early ʿAbbāsid in date, even though its animals are difficult to parallel. Where it was made is impossible to tell. The second is decorated in a style that immediately recalls the third Sāmarrā stucco style or that of the mosque at Nā'īn, though the closest equivalent to the five-leafed plant form on this dish seems in fact to be found in stucco work from al-Ḥīra, of late 8th century date (Talbot Rice 1934 fig.11). The third ordinary bronze dish of this style is a much later piece, bearing decoration which connects it with a group of Sistānī basins attributable to the late 11th or early 12th century (see p.253).

The origin of this dish form is without doubt a Sasanian dish type, similar in style to dishes 1 and 2, of which three particular examples are noteworthy. Two in the Hermitage were found in Dāghistān (Orbeli and Trever 1935 pl.64-5), the third belonged to the Martin collection in Stockholm (Sarre and Martin 1912 pl.139). Their Sasanian attribution is based on a variety of decorative features which include figures, peacocks, costumes, and scenes with classical origins and close parallels in Byzantine art, and it has been suggested that they may all depict the paridaeza theme connected with Anahita in Sasanian tradition (Ringbom 1967).

Further mention will be made of the third Islamic bronze dish in this group later, but the great span of time which separates it from its earlier relatives can scarcely be overlooked. A similar problem arises with the second type of dish with simple upturned sides, this time made of high tin/bronze (A/2/a). In form these dishes differ slightly from the first group in that they are probably forged, and have a rounded rim which rises in a perfectly even curve from the base, giving the object a much more finished appearance. The earliest example (A/2/a/1) appears to be the famous dish in Berlin decorated with a domed building. This dish was discussed at length by Sauvaget (1940 pp.19-33) who dated it to the post-Sāmarrā and pre-Saljūq period on the basis of the vegetal ornaments which fill the arcades. Pointing out the close connection between the architecture of the Samānid mausoleum at Bukhāra and the building on the tray he suggested that an East Persian or Transoxanian provenance was appropriate. Judging by the more recently published Panjikent murals, in which a type of mausoleum even closer to that on the dish than the Bukhāran example is depicted (Pugachenkova 1972 fig. on p.370), the Transoxanian provenance is probably correct.

The other dishes in the high tin bronze group are all much later. They fall into two sets on the basis of their decorative styles, one consisting of 2-7, the other 8-9, with 10 an odd one out, being totally undecorated. Four of the first group have been recently published in some detail by Melikian-Chirvani (1974), who ascribed them to early 13th century Khurāsān. Despite this scholar's studies I am unhappy about this attribution. Ivanov (1970) suggested a Transoxanian source for various bronze bowls mentioned above (p.189) together with various ewers and dishes, including our 2-3. That attribution I find more convincing. Most of the ornaments in the central roundels of the dishes are foreign to any proven Khurāsānī pieces, but occur on the Transoxanian bowls, as also the three-dimensional effect given by much of the ornament, and the decoration as a whole is quite different in its general character from that on dishes 8 and 9 which has everything in common with known Khurāsānī styles (cf. incense-burner F/2/11). This being so, the existence of a single dish datable to about the 10th century and of six datable to the late 12th or early 13th suggests that there may well have been a continuing tradition of high tin bronze dish manufacture in Transoxania between those two times. At this point the Maimāma footed pieces (A/2/b/1-7) are extremely important, for while two (2-3) have interlaced geometric forms in the centre which could well indicate a Transoxanian source, a third (1) has a star with specifically placed dot-and-circle's around, reflecting the use of these motifs on bowl B/1, and palmettes tending towards the exuberance so common in Transoxanian slip ware ornaments. The kufic inscription on this latter piece suggests an 11th or early 12th century date, and a continuing tradition of dish production within Transoxania is therefore virtually certain. As a result it becomes clear that footless dishes A/2/a/8-9 should be seen as off-shoots of this tradition, answers to local demand

within Khurāsān for dishes of Transoxanian type. How the Rayy piece (10) fits into this picture it is impossible to tell, though the thinness of the metal suggests that it is from a quite different workshop or area.

Following on these attributions one particular point requires further comment. As has been indicated above the sheet bronze dishes of the early period are direct descendants of Sasanian pieces. The form of high tin bronze dish being manufactured in Transoxania by the 10th century is very close in style to the sheet bronze pieces, and it may be therefore assumed that there is a connection between the two. The fact is, however, that in many ways the Transoxanian dishes are much closer to the classical silver tradition - in size, in decorative scheme, and even perhaps in details of shape, though A/2/a/1 has much in common with the large sheet bronze pieces. Furthermore silver dish A/1/1 is identical in shape to the high tin bronze pieces, and decoratively there is every reason for seeing it as a Transoxanian piece too. From this it would appear that, as with certain hemispherical high tin bronze bowls, there was a very real connection between high tin bronze objects in early Islamic times and their silver counterparts, yet again confirming al-Birūnī's story, and stressing the initially derivative nature of the high tin bronze industry.

A/1/3 is of some sort of low tin copper alloy but follows the style of high tin bronze dishes. It thus shows how the form was occasionally copied by Sīstānī craftsmen in the different medium, and it is to this latter medium, in the form of group B, that attention must now be turned. Dishes of form B only occur in the less sophisticated alloy, and are characterised by a flat base, low sides, and a flat out-turned rim. The plainest in form are those with foot rings (B/2/1-2), of

which the earlier (1) is decorated with a geometric interlace pattern similar to those found on early sgraffiato pottery bowls from Sīrāf datable to 950-1050 A.D. (Allan 1974 p.20). Since such decoration on pottery is probably based on metalworking techniques it is not necessary to assume, although it was acquired in the Yemen, that the metal dish is south Persian; on the contrary strapwork and palmettes probably indicate a north-eastern source. The Sīrāf pottery does, however, indicate that the 10th-11th century date given by Barrett (1949 p.xxi) is correct. The second footed dish is much later, as its naskhi inscription, of a form common in the late 12th or early 13th century, indicates. The combination of inscription, central interlaced star pattern, and roundel forms,all point to a Khurāsānī origin. Its analysis (Table 21 no.12) indicates that it is another example of shabah mufragh.

The footless dishes (B/1) of this form are slightly more elaborate in that they have fluted sides. Two different styles may be distinguished within surviving examples. The first (1-3) is characterised by a fairly narrow flat rim, and all three examples have a mythical beast in the central roundel with an inscription or some other decorative band around. They are evidently 12th century Khurāsānī products. Four and 5 have a wider rim and are more sophisticated objects in their more refined shape and more stylish decoration. Probably slightly later than the first three they are also north-east Persian products. Six cannot be attributed on the basis of the published photograph since all the decoration is hidden but the standing birds above the fluting would certainly fit 12th-13th century Khurāsān. Seven, which is of similar form to the latter three, has a central rosette which connects it with dish A/1/3 and with the only known basins from early Islamic Iran which are almost certainly late 11th or early 12th century Sīstānī products.

The classical origin of the plain dish form with horizontal rim has been noted above (p. 70), and the fluted form is an obvious elaboration of this style. It is interesting to find the latter being copied in the wares of Kāshān in the early 13th century, witness a lustre dish in the Freer Gallery of Art dated 607/1210 A.D. (Atil 1973 no.28). This piece is in fact closer to the style of dishes 4 and 5 than 1-3 which suggests that 4 and 5 are indeed representative of the later form. It is noteworthy that it is the flat-rimmed, bronze dish style with or without fluting, not the vertical-rimmed high tin bronze style, that became the common north Mesopotamian type in the 13th century (Pope 1938 pl.1331, 1334; Sarre and Martin 1912 pl.145,153).

In conclusion three dishes remain to be mentioned. The first is dish C/1, a unique object previously published as a basin. Since its body proper is only about 10 cms. wide, and its depth only 4 cms., its use as a basin would be extremely limited and limiting, and it is much more probable that it is a dish comparable to those manufactured by 10th century Samānid potters (Atil 1973 nos. 7,8,11), in which a similar relationship between rim and body is apparent. The decoration on this bronze dish indicates a north-eastern 12th-13th century origin, and it therefore seems that the craftsman was copying a form of earlier times; it is even possible that the knot pattern on the silver inlay of the camel on the dish, and the z-pattern, were both introduced by the inlayer as "antique" motifs to reflect that "antique" shape.

Next a word about A/1/V.1. As Scerrato observed this dish seems to be part of a set of vessels within the Mimāna hoard which illustrate the less sophisticated types of object in everyday use in provincial Iran in the early Islamic period. The other pieces are three bronze ewers (C/2/8-10) and a bronze bucket (C/1). It is easy to see why so

few have survived, for the thinness of the beaten metal would have limited their working life, and once damaged they would generally have been remelted to provide bronze for other objects of similar quality.

Finally, there is the small pentagonal, handled dish from Nīshāpūr (D/1). This piece is unparalleled in metalwork or any other medium in early Islamic Iran, and its purpose and date remain obscure. The closest parallel in any other relevant culture is a type of leaf- or heart-shaped stone lamp found in 2nd-5th century contexts at Taxila (Marshall 1951 II pp.500-1, III pl.141). The Islamic dish, however, would not have functioned at all well as a lamp, though its design with its corners slightly indented and rounded on the inside may well be based on a stone prototype.

Ewers

Ewers and jugs have already been differentiated in the discussion of gold and silver objects above, the basis for such differentiation being firstly size and secondly shape. These two aspects characterise the division of bronze ewers and jugs, except that there is a range of objects here which have spouts but are less than the limit of approximately 20 cms. which was set for ewers. Such are for example some of the objects in groups A/2/c, e, f, g, and C/1. The spouts on these objects indicate a primary purpose of pouring liquids, and their forms suggest a close connection with larger pieces, and for these reasons they have been included here as ewers. All objects of the smaller size with round mouths will, however, be found in the section on jugs.

It must be emphasised that the function of these ewers, except for one particular example, is uncertain. The famous Tiflis ewer (C/3/c/7 below) bears an inscription which makes it quite clear that it was designed for ablutions, but other large ewers may have been used for wine or other drinks, and sotoo the smaller ones. In a sense therefore the discussion below applies to a survey of ablutions equipment as much as to a survey of objects connected with food and drink.

Ewers are divided into three main categories: A, ovoid-bodied; B, spherical-bodied; C, cylindrical-bodied. They will be discussed in that order. Within A two different forms of pouring mechanism may be distinguished, a round mouth (A/1), and a spouted mouth (A/2), and the first of these forms is further divided into five categories: A/1/a pear-shaped with a low foot; A/1/b pear-shaped with a high foot; A/1/c bulbous-bodied; A/1/d high-shouldered, squat; A/1/e high-shouldered, tall. A/1/a-c are all similar in form, and it is only in the last few years that enough examples have been published or entered well-known collections for the three subdivisions to be made with confidence.

In more detail the form of ewers A/1/a is as follows: a pear-shaped body on a low foot is topped by a wide mouth with flat mouth plate, and bears a curving handle with lower terminal in the form of a stylised animal head and a thumb-piece in the form of a palmette. The objects are all cast with or without relief work, but exactly what metal alloy they are made of is not certain. The British Museum study of 1 suggested that the alloy was brass, but this was only on the basis of observing its colour, and none of the pieces have been analysed (Pinder-Wilson 1960 p.92). The base plates were evidently made separately in most cases, and soldered in position at the base

of the foot ring afterwards. The ewers vary in height from 29.6-44.0 cms. Ewers in this group and the two groups following have been variously ascribed to Sasanian and Islamic Iran, and in all cases it is necessary briefly to reassess the dating evidence for individual pieces.

The senmurv which appears on A/1/a/1 is used in both Sasanian and Umayyad art and is not in itself accurately datable, but the acanthus scroll, as Pinder-Wilson (1967 p.3062) pointed out, has a fairly close parallel on the high tin bronze dish in Berlin (A/2/a/1) which is probably early 10th century, and may well be late 9th or early 10th century on these grounds. Ewer 2 is extremely difficult to date on a decorative basis, but the close similarity of the technique used to that of 3 suggests a date comparable to the latter (9th century) though the small leaf with an inlaid disc in it and the inlay technique generally might indicate a late 8th century date (cf. tubular-spouted ewer A/2/a/3). The dating of 3 depends on two particular motifs in its decoration - the cross with trefoil-ended arms and the winged motif. The cross form is found on another ewer (A/1/d/1) found in Baghdād, and this findspot suggests a late 8th century date at the earliest. The winged motif on the other hand is similar to those on the early 10th century Berlin dish mentioned above, and a 9th century date may be near the truth. The style of kufic on 4 suggests that it may be a 10th-11th century piece, while the kufic inscriptions and medallions on 5 and 6 suggest an even later date, probably 12th century. V.1 has a palm-tree design recalling that on ewer A/2/a/3, which is probably 8th-9th century (below). Where ewers 1-3 were made is difficult to tell, though the comparison with the ewer found in Baghdād suggests that 3 may be Mesopotamian or west Persian rather than east Persian, and the palm-

tree suggests a like origin for V.1. Four- six on the other hand would fit well into a north-east Persian setting. Seven is undecorated.

Group A/1/b differs from A/1/a mainly in the form of foot used, which is taller and much more splayed than in the latter style. The two extant examples of this group also have feline handles, like that on V.1 above. The dating of 1 depends on the dating of ewer A/2/a/1 (below), to which it is closely connected in the way cast ridges of metal are used to define the decorative units and in the form the plants take, showing a similar stylisation development to those on the latter ewer. For this reason, as well as the fact that it has the same style of handle as V.1 above, a 9th century date is probably correct. A/1/b/2 may also be 9th century on the basis of handle form, but it would be difficult to prove that it was not 7th, 8th or 10th for the history of the use of almond bosses on metal objects remains very obscure. For this reason its provenance is equally mysterious, though 1 probably comes from Mesopotamia or western Iran.

Group A/1/c is very akin to A/1/a but the objects have a higher foot and a more bulbous body which quite changes the balance and impact of the form. The alloy used would appear to be similar to that used for the latter group, and the method of manufacture is evidently identical. As with A/1/a there seems to be a range of dates represented by the extant pieces, and a variety of provenances. A/1/c/1 is a 12th-13th century north-east Persian piece, so too are 4 and 6, to judge by the forms of inscription and medallions used. Seven has a style of kufic which is probably 10th-11th century, and its use in bands round the neck suggestsa Persian origin too. The rest are probably earlier, and the key piece is obviously the Tiflis ewer which bears the name of the maker Abū Yazīd, the place of manufacture Baṣra, and the date 69. The year 69 has been disputed recently by

Marshak (1972 pp.65, 69-72) who, while agreeing that that is the year mentioned in the inscription, maintains that the word mi'atain, two hundred, has been left out, and that the date should therefore read 269 H./882 A.D. His reasons may be briefly summarised as follows: the tracing used seems to be derived from 8th century Soghdian pieces; the decoration itself has links with Sāmarrā stucco styles; the calligraphy could be 9th as much as 7th century; the text is carelessly construed and written and it is quite conceivable that the hundred number had to be omitted for lack of space. I find his arguments convincing, and would therefore date ewer 8 to the late 9th century too, since the decoration on the base and on the body are extremely close to those on the Tiflis piece. Ewer 3 has also been discussed at some length by Marshak (1972 pp.68-72), and while I would disagree with his arguments for the sword worn by the horseman having to be 10th century, nevertheless a 10th century date would seem appropriate for the scrolling stem and tendril designs which have every appearance of being slightly later than those on the Tiflis and de Unger pieces. The decoration on the Ghazna piece (5) is too scanty to allow one to make any firm suggestion as to its date.

Ewer A/1/c/v.1 is a unique piece in that it follows the body form of that group, but has a very low instead of rather high foot. It has every appearance of having been produced in the same centre as A/1/c/5 i.e. probably Ghazna, and it has therefore been included here as a variant. It should be noted, however, that it is possible that it represents yet another style, though confirmation will have to await the discovery of other examples.

From the above discussion it seems that both A/1/a and A/1/c span almost the whole early Islamic period, but that the area of manufacture for both groups seems to have changed, probably in the 10th-11th

century, from Mesopotamia to north-eastern Iran. The earlier groups appear to be A/1/a-b, and it is presumably from a ewer of A/1/a type that a thumb-piece palmette dating at the latest from the third quarter of the 8th century must come (Marshak 1972 pp.81, 89 n.61). A/1/c is evidently derived from A/1/a and may be a variant form first produced in southern Mesopotamia in the 9th century.

The origin of A/1/a, and therefore of the other groups, can be traced back to a form of oinochoe" current in Italy in the Roman imperial period (Pinder-Wilson 1967 p.3061, cf. Strong 1966 fig.28a). This form was common as a jug shape in the 4th and 5th centuries in the Eastern Empire, the gold jug from the Petrossa treasure being perhaps the finest example, but at what point the form came into the Sasanian world is not known (Odobesco 1889 II pp.5 ff.; Strong 1966 fig.37a,c). Both the feline and the curving handle probably derive from Roman types too. The curving style can be traced back to late Hellenistic pieces such as the jug of Arcisate in which the origin of the silhouetted ornamental edge of the mouth plate is also to be seen (Strong 1966 pl.34). The other handle type probably has its origin in another important late empire jug style with a pointed mouth and a handle which arched above the level of the mouth before elegantly curving down to the mid point of the body (Strong 1966 fig.37b, pl.56A). The curve is so similar to that of the feline handles in question that a connection is hardly to be doubted, even though the idea of an animal as a handle may have come from Parthio-Sasanian tradition and in some cases have had particular Dionysiac connotations (Ettinghausen 1972 fig.27-9, pp.9-10).

The form of the next two groups of ewers (A/1/d-e) is rather different from those already discussed, for although their bodies are ovoid, they have high shoulders, thus making a quite different impact on the

observer. Furthermore the necks of group A/1/d at least are cylindrical, and there are significant differences in detail, such as the use of pomegranate finials. All the objects in group A/1/d are cast; the method of manufacture of A/1/e/1 is not clear. The decoration and findspots of the individual pieces in A/1/d give an overall picture of the areas and periods in which the form flourished. Ewer 1 can hardly be earlier than the late 8th century in view of its findspot, though the winged leaves could well be 9th century (cf. ewer A/1/a/3 above). Two has vegetal designs which must be pre-11th century, and later than Sāmarrā, and is therefore probably 10th century as Dimand (1947 p.137) suggested. The Nīshāpūr ewer (3) has been discussed at some length by Marshak (1972 pp.77, 88 n.38) who concluded that the most appropriate dating for it would be 11th-12th rather than 12th-13th century. Ewer 4 from Ghazna has too little decoration to allow any dating, the details of 5 from Samarqand are unknown, and 6 is undecorated. Seven has a stylised rosette pattern which gives the appearance of being a much corrupted form of the cross style on the Baghdād ewer, and a 10th-11th century Iraqi provenance might be appropriate. Eight has decoration characteristic of north-eastern Iran in the 12th-13th century, while 9 is probably marginally earlier, but of similar provenance. Given the range of findspots, it would appear that the form was already in use in Iraq in the 9th century, and that it had spread eastwards into Khurāsān, Transoxania and Sīstān by the 12th. The proportions of the Ghazna piece seem to indicate that the Sīstānī products were more provincial than those of the more northerly provinces.

A related group of ewers which are not catalogued here should be noted in passing. Of a very similar shape to A/1/d, they are beaten rather than cast, and since all those with known findspots came from

Transoxania, and since all the decorated examples may be attributed to the 12th-13th century, it is evident that they are local Transoxanian copies of the cast form made during that period. Examples of this style are a ewer in Dahlem (Berlin-Dahlem 1971 no.226), five in the Hermitage (Marshak 1972 fig.8,10, pp.73-5), and three previously in the Martin collection (Martin 1902 pl.28, 1897 Schrank 7).

The origin of the high-shouldered ewer form must be the same as that of silver bottle A/1 ie. glass. For the cylindrical neck and high shouldered body are common in glass in Islamic times, and if the surviving pieces are generally considered to be 11th century or later blown glass bottles were already in use in late Roman times in Syria and by the 9th century probably in Mesopotamia. An equivalent but slightly earlier Islamic ewer form derived from glass is the spherical-bodied type, epitomised by the so-called "Marwān ewer", which is briefly discussed below.

A/1/e/1 is at present time the only known metal example of its form, which is a much taller, slimmer-bodied ewer style than A/1/d but of the same basic shape. Its decoration suggests a Persian 11th-12th century date, and it is noteworthy that a similar body form occurs in two pottery ewer styles of the 12th-13th century, one with a short body, vertical neck and short handle found in Rayy lustre ware (Pope 1938 pl.649; Caiger-Smith 1973 colour pl.C), the other with a much taller body similar to the above, a wide cylindrical mouth and short handle, in minai ware (Pope 1938 pl.676). If the latter piece is complete, and if all parts of it are genuine, then A/1/e/1 was probably of the same form originally.

The next main class of ovoid-bodied ewers (A/2) are those with a spouted as opposed to round mouth, and within this large class the first group consists of objects with a horizontal tubular spout

(A/2/a). The bodies of these pieces are pear-shaped, they have tall feet with annular ridges, and a curving handle with animal head terminals. The bodies are usually divided by ridges into three zones - the neck, the main part of the body, and the lower body, and the decoration or lack of it follows this division. All the surviving examples of this group seem to be cast, and provide notable testimony to the use of relief casting in early Islamic times.

Three at least of the objects in this group have been variously described as Sasanian and post-Sasanian, but my own belief is that they are definitely early Islamic. This belief is based first of all on the origin of the form and earlier examples of it, and secondly on the style of decoration found on the pieces catalogued. As regards the origin, there seems little doubt that ultimately the form goes back to a Roman bulbous-bodied, narrow-necked, horizontal-spouted style, such as was used in the 4th and 5th centuries, examples being known from Syria in the Eastern Empire and Kerch on the eastern tip of the Crimea, as well as Italy itself (Strong 1966 fig.37b, p.190, pl.56A). This Roman form was adopted by the Sasanians, and slightly modified to produce objects like the Poltava ewer (Orbeli and Trever 1935 pl.61) to which attention must now be turned. The Poltava ewer provides a half-way stage between the Roman style and A/2/a: the wide foot, knopped stem and mouth ally it with the earlier form, the length of stem, the pear-shaped body, and neck ridge indicate a link with the later form. As to the dating of the Poltava ewer, Marshak, in a letter to me in 1973, said that it was now possible to date the burial of the hoard in which it was found to just after 654 A.D., and he suggested that the ewer might well be part of the gold and silver ware taken by Heraclius in Dastakert in 628 A.D., and then presented to his friend the Khazar prince. In this case the ewer was probably made round about 600 A.D. or perhaps slightly earlier. Such a dating

would also fit a second ewer of the same shape from Kharkov (Orbeli and Trever 1935 pl.48) the elaborate decoration of which may be compared with that at Ṭāq-i Bustān (Sarre 1922 pl.90,92,94). The handle form of the Poltava ewer is also significant. It was obviously not made for that particular ewer, but it appears to have been found in position, suggesting that such handles were still considered appropriate at the time. The animal-head terminals are very life-like, and are similar to those found on the fork associated with the bowls of Windād-ōhrmizd (Ghirshman 1957 fig.14), and hence probably in use c. 800 A.D. The animal-head terminals on the tubular-spouted ewers are stylised versions of those forms, and therefore most likely to be of later date than the latter. Since Mazandarān was a back-water culturally in early Islamic times, retaining old Sasanian traditions long after they had been superseded elsewhere in Iran, the continued use of life-like animal heads in that region should not be taken as indicating the situation in Iran as a whole. However, it is difficult to conceive of the stylisation process being so complete before the early 8th century. This comparison of general form and handle details in relation to Roman, late Sasanian ewers, and the ewers of group A/2/a, therefore suggests that the latter are most likely to be 8th-9th century.

On this basis the decoration of the various pieces in the group may now be profitably discussed. Ewer 1 appears to depict on one side Bellepheron and Pegasus, and on the other the mirror-image of the same scene. Ettinghausen (1972 pp.10-16) has discussed the classical Pegasus and the specifically Iranian transformation of the motif in Sasanian art, and it might at firstbe thought that the design on the ewer is close to the classical style. However, certain significant stylisations, like the wings of Pegasus and the various leaf forms depicted, and a lack of vitality in the plant forms in general,

combine with the incised palmette design on the spout to suggest a date well beyond the end of the Sasanian period. Ewer 2 bears a design which can be paralleled on an alkaline glazed storage jar of a type generally attributed to Sasanian or early Islamic Iraq, or coastal Iran, but known to have been used well into the 9th century, if not later (Wilkinson 1963 pl.17; Whitehouse 1968 p.14). The stylisation displayed by the ewer design may be paralleled by the formality adopted in stucco designs during the 9th-10th centuries, and a 9th century date may well be appropriate therefore. For the dating of ewer 3 the most important decorative element is the palm-tree. Palm-trees are found in the mosaics of the Dome of the Rock (691/2 A.D.) (Creswell 1969 I pt.1 pp.263-5 fig.207-10) and ovals foreshadowing the bar across the tree occur on the upper trunks of trees carved at al-Minyā (705-15 A.D.) (Creswell 1969 I pt.2 pl.65j). The base of the ewer's palm-tree is also like the transformed "cross-on-steps" found on the reverse of some Umayyad coins prior to 77 H. (Walker 1956 pp.xxxii-xxxvii). The type of inlay should be compared to that on ewers A/1/a/2-3 above, and on the basis of these various factors an 8th century date may well be correct. The other three ewers are vitually impossible to date, for 5 and 6 have no decoration at all, and that on 4 is invisible in the published photographs. The two-tier almond-bosses on the latter, however, could point to a rather later date than those above. As regards provenance, the close connection still visible between the Pegasus scene and the classical style suggests a west Persian or Mesopotamian source for 1, which would also be appropriate for 2. Melikian-Chirvani (Sourdel-Thomine and Spuler 1973 no.145) has suggested that 3 is Samānid, but all the parallels cited here point to a more westerly origin probably in ʿAbbāsid Mesopotamia. Ewer 4 on the other hand, may well be Persian, perhaps even from eastern Iran.

V.1 differs from the other pieces in its smaller size, in its smoother body line, and in the details of its spout form and neck design. But it is clearly connected with the group, and since its kufic inscription and decoration suggest a late 10th or early 11th century date (cf. the style of inscription on A/2/b/1 below) and a Persian provenance it would appear to indicate the continuation of the form in Iran. Hence 4 and V.1 indicate that the form which was used in 8th-9th century Mesopotamia was carried into Iran and continued to be used at least until about 1000 A.D.

The ultimate origin of the next group of ovoid-bodied ewers (A/2/b) with their pear-shaped bodies, horizontal spouts, and handles with animal-head terminals is undoubtedly the same as that of A/2/a, but the intermediate style far from being Sasanian is almost certainly Soghdian. For in the 7th-8th centuries Soghdia developed its own ewer style based on the classical prototype but characterised by a lower foot, a simpler handle, and a rimmed mouth (Marshak 1971 T.8, 11,13,22,24), contrasting markedly with the Sasanian form mentioned above. It is therefore to be expected that the Islamic examples will be east or north-east Persian, and not Iraqi, and such an attribution certainly applies to the two decorated pieces which survive, and is attested by the findspot of a third. This latter (1) was found in Herāt and bears an inscription which Ettinghausen, after very careful analysis, dated to the period "from the last two decades of the third to the first half of the fourth century H. (end of the ninth to the middle of the tenth century A.D.)", though it should be noted that the ewer may be earlier than its inscription. Ewer 3 has decoration attributed by Sauvaget (1951 p.131) to the 12th or 13th centuries, but by Marshak (1972 p.77) to a slightly earlier period. Certainly the vegetal ornaments predate the great flowering of incised and inlaid

metalwork in Khurāsān in the 12th and early 13th century, and an 11th century date seems much more likely. The decoration on 2, on the other hand, is typical of 12th-early 13th century Khurāsān. The surviving examples thus point to a continuing tradition of manufacture between about 900 and 1300 A.D. and a north-eastern provenance for the style. It is important to note, however, that it was also used in Ghaznavid times in Sīstān for a ewer of identical form to 1 appears in the silver bowl showing Maḥmūd of Ghazna (Marshak 1971 fig. 29; silver bowl C/4).

The next three groups of ewers (A/2/c-e) are characterised by their curious spout forms. The first group has a simple pear-shaped body and low foot topped by a spout in the form of a bovine head. The second has a larger body and tall foot with a similar spout. The third has a body-shape akin to the first but its spout is in the form of an open beak-shape, which however, from the details, seems to be derived from a bovine head. Only one object in these three groups is of known findspot, A/2/c/3, which is from Ghazna. The form of its inscription and interlace band suggest that it is probably 10th-11th century, and A/2/c/4 and 5 are probably of similar date. The scrolling stem on A/2/c/1 indicates that it is also Persian but does not allow it to be dated with accuracy, but the overall impression of this group is therefore that they are Persian, probably from the east, and 11th century or thereabouts. In group A/2/d ewer 1 has incised designs and a kufic inscription which suggest a date prior to the 12th-13th century, i.e. 11th-12th; the decoration on the other two is too indistinct in the reproductions to allow one to date them. The designs on V.1 on the other hand include a knot motif which appears on 10th-11th century Transoxanian pottery (e.g. Tashkhodzhaev 1967 fig.13,39), and since the large lower foot may be regarded as an elaboration of the foot style found on a

particular group of Transoxanian ewers (see below), it is possible that this piece is Transoxanian too (cf. support fittings B/3). In A/2/e the only piece approximately datable is 1, which has a kufic inscription which is very similar to that on the Ghazna ewer and hence probably east Persian and 10th or 11th century.

How exactly these spout forms developed will not be clear until many more examples come to light. It is tempting to see A/2/d as a development on A/2/a, and A/2/c and e as developments on A/2/b, but the relationships are too obscure to offer any certainty on this point. It is clear, however, on the basis of the dating established above, that in the 10th-11th century Persian bronze workers developed and elaborated traditional forms of ewer to produce more exciting variations, in which zoomorphic forms were introduced. It is possible on general and technical grounds, and indeed quite likely from comparison of A/2/c/3 and A/2/e/1, that A/2/c and A/2/e were manufactured in the same workshops, perhaps in Sīstān. On the other hand, the way in which A/2/d ewers are cast in a number of pieces and then soldered together shows that they were probably the products of different workshops, perhaps further north.

Another spout elaboration is to be found in the next group of ewers A/2/f, where the pear-shaped body and splayed foot is topped by a mouth and spout in the form of a tubular oil-lamp, similar to lamps A/5. These latter pieces are probably Sīstānī products of the 10th or 11th centuries, but the ewers appear to be rather later, one example (2) being dated 1190-1 A.D., and the decoration of the others pointing to a 12th or early 13th century Khurāsānī workshop. They are cast objects, and probably made in a number of pieces - body, base plate, handle, neck and spout. The base plate on 2 is a replacement, for example, suggesting that the original was soldered in, while a joint

between neck and body is clearly visible in 4, and carefully hidden by the ridge in 1 and 3. In their method of manufacture, therefore, these ewers are more akin to group A/2/d above than to any of the other groups so far discussed. Two antique features of these ewers should also be noticed - the form of lid which is very like that on ewer A/2/a/5, and the feline handle and feline-shaped handle on 3 and 2 reminding one of the handles on A/1/b/1-2.

Finally among the spout-mouthed ewers is a single object with an open pointed spout and cusped edge (A/2/g/1). This spout form has something in common with the beak-spouted ewers already mentioned, but it makes no pretence of being zoomorphic and has therefore been given a separate identity. The row of shallow dents around the lower neck and the simple scrolling stems suggest a north-east Persian provenance and a date somewhere between the 10th and 12th centuries.

Before going on to consider spherical- and cylindrical-bodied ewers, it is necessary to digress briefly to consider certain groups of ewers which are not Persian, but which for that very reason serve to highlight the Persian styles. The first group has already been mentioned in passing and has a pear-shaped body, an awkward angle at the base of the neck, a cylindrical neck, a spherical mouth with a tall curving spout, and a high foot with a low stem. Two examples were in the Martin collection (Martin 1902 pl.29), and a full list of such objects is given by Ivanov (1970 nos.20-27). Datable to the late 11th-early 12th century their production was evidently confined to Transoxania, where all the known examples have been found, and as such they have not been included in this thesis. Many of the known pieces have yet to be fully published, but it is important to observe a style of inlay on some of the published pieces which is evidently

confined to Transoxania - the piercing of a hole with a narrow centre through the body of the object and the filling of it with a piece of silver or copper, rather than the setting of the piece of inlay into an undercut area in the surface of the object.

Another group of ewers to be noted are the bulbous-bodied pieces with spouts projecting from the shoulders, of which two complete examples from Dāghistān are in the Hermitage and a third in Ani (Orbeli and Trever 1935 pl.74, 78; Arakelyan 1956 fig.1). Although Marshak (1972 p.88 n.36) draws attention to the existence of the upper part of such a ewer found in Central Asia in the Samarqand Museum, it seems highly unlikely that these are Persian products. The prime reason is that no body-spouted ewers are known from early Islamic Iran, and in view of the wide range of forms utilised by Persian craftsmen they are hardly likely to have given up such a style if it was already in use. This fact, together with the style of decoration on one of the Dāghistān finds, suggests that they are Mesopotamian objects of the ʿAbbāsid period.

A like origin may be attributed to a style of ewer with many features similar to the above group but with a cylindrical body. Examples are in Dahlem (Pope 1938 pl.244A), in Boston (Erdmann 1950 fig.15), and in the Hermitage (Orbeli and Trever 1935 pl.77).

A fourth, and very important group of Islamic ewers which require comment are those of the same form as the so-called "Marwān ewer". Six such ewers are known, of which five are illustrated by David-Weill (1948 pl.1-3), and the sixth is in the de Unger collection. In view of the fact that Melikian-Chirvani (Sourdel-Thomine and Spuler 1973 no.70) has attributed them to Iran it is necessary briefly to point out why they are not Persian and hence exclude them from further

detailed consideration. As regards their date first of all, it is certain that they are late 8th-early 9th century on the basis of the Hermitage bird aquamanile (Sourdel-Thomine and Spuler 1973 no.XVI) dated 180 H./796-7 A.D., and the similar bird in Dahlem, which bears decoration almost identical to that on the Cairo ewer. The following points are relevant to their provenance. Their form is based on a glass bottle style which is the specific product of Syria and not the lands further east in late Sasanian and earliest Islamic times: one may compare the types found on many sites in Syria or Palestine with the complete lack of them in Iraq (e.g. Crowfoot et al. 1957 fig.94-5, pl.25; Negro Ponzi 1968, 1970). The dolphins found on both ewers and aquamaniles are creatures typical of Roman art forms in a Mediterranean environment, and are unknown in proven Sasanian objects. The closest analogies to the palmette forms are to be found in the Dome of the Rock and the ʾAqṣā mosque in Jerusalem. From this it is clear that these ewers are North Mesopotamian or Syrian products.

Returning to the ewers of Persian origin, the next group to be considered (B/1) is characterised by a spherical body, a short straight cylindrical neck, a low foot, a plain handle, and a curved spout which rises at an oblique angle from the upper half of the neck. This spout, which is the most outstanding feature of these objects, is very long in proportion to the rest of the ewer, and has a diagonal band where it joins the neck, which gives its form and size added emphasis. The spout often carries a number of knobs or eyes, which would appear to have been used for attaching covers to the open mouth and upper spout - the lower spout has a cover cast with the surrounding parts. The function of the eyes which sometimes occur on the handle terminals is unknown.

Five of the ewers in this group are cast (1-4,7), and evidently consist of four different pieces cast separately and then soldered together - neck and spout; body and foot; base plate; handle. The two Maimāna pieces differ from the rest in being made for the most part of beaten bronze, their bodies for example being made in two hemispherical halves and joined together round the circumference. Their handles on the other hand may well be cast. A curious feature of 2 is its base plate, which is not a flat disc as one might expect, but a concave plate whose edges have been hammered up onto the outside of the foot to hold it in position. This is very strange for a cast object, recalling the base plates used on beaten cylindrical-bodied ewers made in Khurāsān (group C/3/b-d).

al-'Ush ascribes ewers 1-3 to Iran, and suggests that 1 is 12th century, 2 is 10th-11th century, and 3 is 11th century. Marchal by implication ascribes 4 to Sīstān and dates it to the 12th century. Epigraphically, the dating is difficult, the exact changes in style during the period from 1000-1200 being generally uncharted. However, comparison of the kufic of 1 with early 12th century architectural kufic in the north and west of Iran suggests that 1 could well be 11th century rather than 12th, and that both 2 and 3 could be 10th-11th century. The interlace patterns on 4 suggest a dating about a century later than the latter two, and the vegetal designs of 7 seem to point to the 11th century. The Maimāna pieces are virtually impossible to date. If the decoration of the objects seems to indicate a fairly small time span, say late 10th to early 12th century, it also seems to indicate a minimum of three different production centres. Ewer 1 is a unique piece because of its relief casting, which makes it an outstanding object by any standard but does little to help establish its provenance. Two and 3 bear decorative motifs which are typical

not so much of north-eastern Iran as Transoxania, for they can profitably be compared to the designs on Samarqand slip ware (Tashkhodzhaev 1967) or those on the bronze bowls and high tin bronze dishes manufactured beyond the Oxus mentioned above. The two Maimāna pieces, on the other hand, appear to be provincial products reproducing objects manufactured in a larger metalworking centre - hence the fact that they are beaten, which is not a suitable technique for the shape, and bear such poor quality decoration. The knot motif on 7 suggests that it too may perhaps be Transoxanian. If, then, 1 is an Iranian piece, it would appear to represent a very high quality cast style which was copied by bronze casters in Transoxania and by bronze beaters further south, perhaps in Sīstān.

The curious form of these ewers requires some comment. The spherical body and cylindrical neck may easily be explained as originating in a glass bottle style (e.g. Smith 1957 no.579). The spout, however, which also appears on C/1/b/1 below, is more problematic. al-'Ush and Scerrato both suggested that its form was ornithomorphic, but this does not seem to me to be at all convincing; its curious construction seems rather to suggest that it represents a removable spout for a glass bottle, and would originally have been made of leather or metal. Unfortunately, this suggestion will have to remain a mere hypothesis until such a fitting is found. Be that as it may, one should note in passing that the form was copied in ceramics in 12th century north Iran, in both monochrome ware and lustre ware (Wilkinson 1963 pl.65; Lane 1947 pl.42d). Perhaps more interesting is the fact that the same body and neck shape occur in bottles of the same period in monochrome, lustre, underglaze painted and minai ware (Pope 1938 pl.768,645; Bahrami 1949 pl.46, 84-5, 87-90, 27,32), showing that that basic bottle shape was extremely popular.

A curious and unique object is ewer B/2/1, which has an approximately spherical body, no foot, a thick neck and a wide, circular, lidded mouth. Found at Ghazna, its decoration suggests a 12th or early 13th century date, and a provincial workshop. The lack of comparative objects makes the origin of the form impossible to establish, and it may well be a conglomeration from a variety of different sources.

Having dealt with ovoid-bodied and spherical-bodied ewers it is now necessary to turn to cylindrical-bodied ewers, the last of the three main categories. Almost all Persian cylindrical-bodied ewers are of beaten metal, for reasons which will be explained later. There are two groups, however, which are cast, and these will be dealt with first. Group C/1/a ewers have a squat cylindrical body with rounded shoulder and base, and no foot, and a short neck with an obliquely rising spout. The end of the spout is decorated with projecting bird forms, and on either side of the neck is a knob or eye. While their cylindrical bodies demand their inclusion in this particular ewer category, it would appear that they are related to the last group of spherical-bodied objects, to which their general proportions and form are reasonably closely allied. More than that unfortunately is difficult to say about them, for they are virtually undecorated and none of the three examples known are of proven findspot.

C/1/b is represented by a single piece, which appears to be an amalgamation of a simple cylindrical ewer type (C/2 following) with the mouth and spout of the spherical-bodied ewers (B/1) discussed above. The particular ewer concerned is evidently the product of a fairly second-rate workshop located somewhere in the north-east of Iran in the 12th century. It adds little to the general overall picture of Persian ewers, and is mainly notable for its ugliness.

Turning to the beaten cylindrical ewers, there are two main groups (C/2 and C/3). The simpler form is that of C/2, in which the ewers have a cylindrical body, with slightly sloping base and shoulder, the centre of the base being concave, and a vertical neck with slightly flaring round mouth. A handle is soldered or rivetted onto the neck and body, and a metal strip runs round the neck of the object and is then wound round the handle opposite. The part of this metal strip on the neck is often wide and lobed, and occasionally decorated. Rings are attached to three of the ewers, either to that metal strip between the neck and handle (1), to the front of the strip (7) or to the base of the handle (8). V.1 is of slightly different form in its handle and mouth style, and has a domical cover. This is attached to the metal strip in question by a chain, and it may well be that the other ewers also had caps or covers of some sort similarly attached: this would explain the rings on 1 and 7. The ring on 8 and the eye for a ring on 9 were presumably designed to allow the objects to be hung up.

That sheet metal should have been used for these ewers is no surprise: there is nothing in metalworking easier than bending a sheet of metal into a cylinder and soldering it at the joint. Six different sheets of metal are in fact used in these objects - base, body, shoulder, neck, handle, strip joining neck to handle, and obvious evidence of these separate parts appears for example in the castellated and simple soldered joints between base, body and shoulder on 8. Given the simplicity of constructing such a form in sheet bronze or brass it is not necessary to seek an origin for the form in some earlier or related culture, though it would be interesting to know the origin and purpose of the metal strip running round the neck and handle, which is such a notable feature of the style.

Wilkinson dates 2 to the 9th century, though he does not give reasons for this. The decoration on the ornamented pieces is sufficiently individual to prevent effective dating on this basis, and the Maimāna pieces from their findspot could be of virtually any date prior to the Mongol invasions. The Susan piece is not dated by its excavator. A 9th-10th century date for the style seems likely, however, from the fact that ewers of this type reached Sweden (e.g. 11), for it was during those two centuries that trade up the Volga and across Russia into Scandinavia was at its height. Oxenstierna (1959 p.89) claims that five of these ewers have so far been found in Sweden, three on the islands and two on the mainland, but unfortunately gives no more information. His suggestion that they are Khwārazmian may not be far from the truth. In view of the movement of these objects from their homeland it would be simplistic to say that they were cheap everyday objects of north-east Iran and of little value. Although they have little artistic merit they were evidently sufficiently valuable and useful to be carried thousands of miles along the great trade routes of the migration period

The largest group of cylindrical-bodied ewers is a spouted form with fluted or facetted body (C/3/b-d). This is related to a simpler form with plain cylindrical body (C/3/a) of which four examples are known. These four pieces fall into two pairs. One and 2 are similar to silver ewer C/1 and are clearly made of sheet metal, witness the castellated patch on 1 and the repoussé decoration and general unevenness of 2. Three and 4 differ from 1 and 2 in their strong contours, in their horizontal mouth rims, and in the apparent solidity of their construction. As I have not had an opportunity of handling either piece, and as Arakelyan maintains that the Ani ewer is beaten metal, it would be rash to give these two a separate category. Nevertheless

I feel that they may be cast, and that they may therefore be copies of the beaten style; the fact that they may be worthy of a separate identity is also suggested by the numerous ceramic ewers with cylindrical bodies which seem to have more in common with these two ewers than with 1 or 2 (e.g. Ventrone 1971 fig.1-12). In any case it should be noted that their decorative layout is quite different from that on 2, pointing to a different workshop, although like that for 1 and 2, it was probably located in the north-east. Ewer 1, which is undecorated, is datable from the context of its findspot, associated with coins of ʿAlāʾ al-Dīn Muḥammad the last Khwārazm-shāh (1200-1220 A.D.) in a castle abandoned in the early 1220's, and the decorative motifs on the other three point to a late 12th or early 13th century date for them also.

There are three distinct styles of more elaborate cylindrical ewer. In one (C/3/b) the objects have twelve flat or slightly concave faces; in the next (C/3/c) they have twelve convex sides, or occasionally twenty or twenty-four alternately wide and narrow; in the third (C/3/d) they have alternately convex and triangular sides numbering either twenty-four or twenty in all. The two analysed examples (C/3/c/2 and 5) are both brasses with about 19 and 25% zinc content respectively, and virtually no lead, and it is likely that most of the others are of a similar alloy. They have nevertheless been described as bronze in the catalogue since a number of them are of a brownish colour which does not have an obviously brassy nature, and may indeed be low tin bronze sheet metal. Be that as it may, these ewers are the finest sheet metal objects produced in early Islamic Iran, and as such call for some detailed comment on their mode of manufacture. As already pointed out cylindrical-bodied ewers of sheet metal will tend to consist of at least five parts - base; body; shoulder; neck; handle. In these objects the quality of the

workmanship tends to be so good that the joints are extremely difficult to discover. The most visible one is usually that running up the back of the neck, indicating that the neck was made of a sheet of metal rolled into a cylinder and soldered. The spout was probably made separately and then soldered to the neck, and the spout cover with its repoussé lion was also made of a separate sheet. The neck typically fits into a low cylinder protruding from the centre of the shoulder and it would appear that the shoulder is therefore one piece with a hole forced through its centre, the metal produced being shaped into a short cylinder. The shoulder joint is usually hidden by the repoussé birds, but even where they do not exist is rarely readily visible. The body itself is probably made of a sheet formed into a cylinder and soldered down the side, and the foot and base plate are yet further additional and separate pieces. Whereas most handles are cast, these are not, and are once again fashioned from a flat strip of sheet metal. The soldered joint is usually visible on the inside of the handle all the way up, and a hole is often seen in the corner of the curve of the handle indicating the use of lead or sand filling to enable the handle to be bent without the metal splitting or folding. The craftsmen in a number of cases covered this hole up by an ornamental pin or by using silver solder (C/3/c/2 and d/1). From this brief analysis of the various parts of such a ewer it is clear that as many as eight separate sheet metal forms may have gone into its manufacture.

The skill involved in the manufacture of these objects is quite remarkable. All the sheet metal had to be beaten out by hand, and it must have been a great problem to produce sheets of absolutely even thickness which would follow the raising hammer to produce the perfectly even shape desired. Add to that the skill of the repoussé work on these objects, in which the lions on neck and spout cover

are simple compared to the birds which so often decorate the shoulder edge, and one realises that one is looking at the products of craftsmen whose technical skills were certainly unrivalled in their own time, and have probably never been surpassed.

The subdivisions used in the catalogue of the cylindrical-bodied ewers suggests that there was probably a development of form - from a pure cylinder to one with facettes to one with convex sides to one with alternate convex and triangular ones. Such a development is certainly logical but it cannot be proved by extant examples, since the plainest form (C/3/a) is known from a piece datable to the early 13th century, while one of the most complex styles (C/3/c) is known from a piece dated 577/1181-2. By the second half of the 12th century at any rate therefore, all forms must have existed side by side.

Aga-Oglu (1943) suggested that the various forms were derived from architectural models, and cited four tomb-towers to prove the point. While it is highly unlikely that architects utilised metal models, it is not necessarily true either that metalworkers followed architectural designs. After all, a metalsmith living and working in a bazaar might not have studied a wide variety of buildings, and the forms of ewer are quite satisfactorily explained as logical elaborations of a simple cylinder in sheet metal, fluting being an age-old and world-wide metalworking art. But his point should be noted.

The Tiflis ewer (C/3/c/7) is a most important object in this category of ewers for two reasons. In the first place its Persian inscription shows that it, at least, was designed for ablutions and not drink (Gyuzal'yan 1938 p.231). Secondly its inscription indicates the place of manufacture, Herāt, and combined with the Bobrinski bucket (bucket B/3/1) it thus eloquently affirms the statement of al-Qazvīnī that Herāt was particularly noted for its objects of <u>ṣufr</u> inlaid with

silver (Qaz II pp.322-3). Whether Herāt was the centre for the production of all such ewers is another matter. The Ghazna examples suggest that another workshop in Sīstān was producing copies of a lower quality, but whether other cities in Khurāsān were also manufacturing the inlaid pieces there is no way of telling. The form was copied in Mesopotamia in the early 13th century (e.g. Pope 1938 pl.1324,1327), and was also utilised by potters in northern Iran (e.g. London Victoria and Albert Museum 1969 no.77, 117).

This rather prolonged survey of the different ewer types known in early Islamic Iran brings certain conclusions in its wake. The first is that in early times there was a movement of forms eastwards from Mesopotamia across Iran, forms which had been popular in the heartlands of the ʿAbbāsid empire being adopted and adapted by Persian craftsmen. The outstanding examples of this movement are groups A/1/a and A/1/c-d. A second conclusion is that classical forms were initially the inspiration for the Islamic metalworkers: in some cases they were utilising forms which had been changed little since imperial times (A/1/a-c), in others they were utilising Sasanian adaptations of Roman forms (A/2/a), in yet others they were utilising Soghdian adaptations of imperial styles (A/2/b). But if the classical traditions continued, there were also innovations, and these are mainly to be seen in the spout styles developed, the zoomorphic forms being the most popular (A/2/c). These variations in spout form are primarily associated with the smaller ewers, and are evidently products of the imagination and skill of Samānid and Ghaznavid bronze casters in the east and north-east of the country. Underlying all the above forms is the tradition of bronze casting, and often forgotten, the more taxing skill of relief casting. Mainly visible in the Mesopotamian examples of groups A/1/a-b, A/2/a, and therefore like the forms of

those ewers, probably based on a classical tradition, it appears again in a single ewer of group B/1. The sheet metal ewers which are all cylindrical-bodied are evidently the products of a quite different tradition with its own separate history, although this is for the time being difficult to chart accurately. In earlier times this industry seems to have supplied the most menial metal objects for household use; in Khurāsān by the late 12th century it was supplying the ewers of the wealthy, sumptuously inlaid with silver and copper. Such a change in fortunes calls for explanation, which will be attempted later in this study. Finally, if the Samānid and Ghaznavid lands were responsible for variety of cast form, the above study of ewers indicates that in later times certain areas of these same lands had a definitely provincial role, witness the Transoxanian beaten copies of A/1/d, the Sīstān local copies within the C/3 groups, and such wierd conglomerates as B/2/1.

Forks

All the forks which have come to light on excavations in Iran, three from Susa and one from Rayy, are of known Sasanian types. The more common (1,2 and 4), with its broad neck and prong tops, and its animal head finial occurs in bronze at Qaşr-i Abū Naşr (Hauser and Upton 1934 fig.32), and in silver in a hoard from Mazandarān (Ghirshman 1957 fig.14). The other form (3), with prongs and almost circular joint at the neck of uniform thickness, also occurs in Sasanian Qaşr-i Abū Naşr (Hauser and Upton 1934 fig.32) Assuming, therefore, that the forks excavated at Susa and Rayy were found in Islamic contexts it would appear that early Islamic forks follow the Sasanian tradition, itself based on the classical style. The fact that no forks came to light at Sīrāf or Nīshāpūr and that virtually none of recognisably

Islamic type have appeared on the art market suggests that bronze forks may have ceased to be manufactured fairly early in Islamic times.

Jugs

The relationship between silver or gold jugs and those made of pottery has been discussed in some detail above (p.78). The conclusion reached there that pottery styles followed precious metal styles is important when one turns to bronze, for once again there are numerous parallels to the bronze shapes in the ceramic medium which could be interpreted as sources for the former. Given the fact, however, that both silversmiths and coppersmiths work in metal and that a cross-fertilisation is therefore much more likely between them than between coppersmiths and potters, and given too the fact that many of the forms of bronze jug can be paralleled in silver or gold, one may safely assume that shapes which have no surviving precious metal parallel nevertheless reflect forms utilised by silver or goldsmiths. In other words, unless there are good reasons to the contrary, it may be assumed that most of the known bronze jug forms are derived from gold or silver jug forms, and that ceramic parallels are copies from one metal or the other.

The grouping of surviving pieces in the catalogue illustrates the point. In the precious metal there are three ovoid-bodied groups - low-shouldered, with a flaring mouth; high-shouldered, with a flaring mouth; high-shouldered, with a vertical mouth. In bronze low- and high-shouldered forms (A) occur with vertical and flaring mouths, and moreover in cast and beaten styles. Again in precious metals there are two spherical-bodied groups, with flaring or vertical mouths; in bronze the parallel forms are what we have termed bulbous-bodied (B) which occur with vertical mouths only. In bronze there is also an extraordinary style (C) which will be discussed separately.

A brief comment on the dating and provenancing of individual pieces will give some idea of the relevance of different forms. In the low-shouldered style (A/1-4), A/1/1 is virtually undecorated, and its dating is best established by comparison with ceramic types copied from pieces like it. Among the ceramic survivals there is a noticeable change of form between the jugs of the 9th or 10th centuries from the north-east or Iraq, and those of the 12th-13th from northern Iran (compare Pope 1938 pl.576B with Fehérvári 1973 no.53). Since the form of the bronze jug is closer to the latter style, an 11th-12th century date would seem appropriate. For similar reasons A/2/1, which is again undecorated, is probably 10th-11th (cf. Wilkinson 1973 p.354 no.129). In the vertical-mouthed style the decoration on A/3/1 suggests a 12th century date but an indeterminate provenance, while that on A/3/2 which is an altogether superior object points to Khurāsān in the late 12th or early 13th century. This latter piece is in fact the cast, simplified equivalent of the two beaten jugs of the same shape with lappets around their bodies (A/4/1-2). The first of these, from its appearance, is almost certainly brass, and they are both, from their decoration, part of the sheet working tradition which produced the magnificent cylindrical-bodied ewers for which Herāt was a major production centre. The high-shouldered style is represented by a single cast object (A/5/1) which is evidently a smaller version of the A/1/a ewer style. Since, however, the form has lost its definition and elegance in this particular piece, it is unlikely to be contemporary with the earliest and most splendid ewers. Perhaps a 10th century date would be approximately correct. In the equivalent beaten style, in practice quite different looking objects, the form of A/6/1 is closely paralleled by unglazed jugs from Nīshāpūr of a style popular in the 10th century (Wilkinson 1973 pp.300-1, 338-9). This piece may well therefore be of the same period. A/6/2,

included here as a jug though it may in fact never have had a handle, is closer in style to 11th-12th century ceramic styles at Nīshāpūr than 9th-10th century ones (Wilkinson 1973 pp.304-5, 340-1, no.37,40), and is presumably therefore to be placed in the later period.

In the bulbous-bodied style, the earlier piece is the beaten one (B/2/1). Since the form has a tendency to angularity which is particularly obvious in group B/1 it was evidently not copied so much by the potters, and the dating of this piece depends upon its decoration. Here the form of the lions and the punched ground point to a 10th-11th century date, if not earlier. The two cast pieces on the other hand are much later. The naskhi inscription on 2 links it with the late 12th-early 13th century Khurāsān, while the interlace ground and pointed leaves on 1 indicate a north-west Persian provenance in the 13th century (cf. candlesticks E), indicating once again the transfer of forms westwards in the early 13th century. Possible lids for such jugs are noted elsewhere (lids B). Jug C/1 is an extraordinary piece in shape, and the source of its different aspects is not easy to see. It would appear, however, that the neck and top part of the body are derived from a jug such as B/1/1, to which has then been added a flat base and tall stem foot. The decoration, for example the rhomb-shaped leaves, is once again characteristic of the north-west in the 13th century and this piece therefore illustrates a fact which will become more and more apparent, that the north-western school of metalworkers in the 13th century were extraordinarly ingenious and imaginative in their use of shape, combining and re-combining parts of different types of objects to create new forms of great quality. Aesthetically this is one of the least successful pieces, however, and it is no surprise that only one example is so far known.

From this brief survey it therefore appears that forms taken from gold and silver were utilised by bronze casters and beaters for jug styles from the 10th to the 13th century. Most of these were fairly modest and not intended to compete with the precious metal objects, but in the late 12th and early 13th century the sudden appearance of heavily incrusted and decorated jugs suggests that a change had come about in the industry in which such objects were made or in the culture or society for which they were produced. The nature of this change is discussed below (p.394).

Mortars

Bronze mortars occur in early Islamic Iran in a number of profile forms. These display a logical progression from a rimless cylinder to a cylinder with a flaring rim, then to one with flaring rim and flaring foot, and finally to one with a broad horizontal rim and foot. In addition to occurring with round bodies, mortars with flaring rim and foot also occur in octagonal and 9-sided forms. The classification used for the catalogue of mortars is based on this logical progression of profile forms and the objects subdivided according to whether they are round, octagonal, nine-sided or ten-sided, according to whether they have no handle, or one, two, or four handles, and according to the lack of, or the nature of, the bosses used to decorate them. The system has the great advantage that virtually any mortar which comes to light in the future can be accomodated into the scheme, by being fitted either into a category already existing, or into a category which can be logically inserted at any point.

Although generally described as "bronze" most of the mortars catalogued, on the basis of two analyses (C/1/a/2/1 and C/2/b/1/1) are probably composed of a quaternary alloy, containing copper, tin, zinc and lead.

The copper is the dominant metal in the alloy but the proportion of lead is often fairly high, and the alloy corresponds therefore to shabah mufragh as described by al-Birūnī (see p.164). This is confusing, for virtually all the early Islamic authorities say that mortars were made of batruy, lead bronze. Whether other examples in fact have no zinc in them only further analyses will disclose: for the present this confusion cannot be sorted out satisfactorily. Whether zinc is included or not, the high lead content probably stems from the needs of casting, lead making the alloy run more easily, from the needs of weight, to prevent the mortar moving about when in use, and from the needs of cheapness, lead being such a common metal in Iran. The high lead content also has some serious disadvantages, however. Most important, such mortars, if used for food, would have given rise to lead poisoning, and from a structural point of view the quantity of lead, although adding weight, also adds weakness, witness the number of mortar bases not only knocked well out of shape by the pounding of the pestle but also sometimes partially destroyed (e.g. C/1/a/3/2, C/2/b/2/1, C/2/c/2/2). As regards manufacture the mortars are without exception cast, and in most cases the handles were cast as one with the bodies. Occasionally, however, they seem to have been made separately (C/2/c/1/1). Rings were inserted into the handles after the objects had been cast.

On the basis of the decoration virtually all the mortars in groups B and C can be assigned to the 12th or 13th centuries, with an odd piece for which a date just pre-1100 A.D. could be suggested (e.g. C/1/b/2/1; C/1/a/3/3). A number in group B have known provenances Ghazna, Bukhāra, Mazār-i Sharīf, and Herāt, and the decoration on two others (B/1/a/2/1-2) strengthens the likelihood that this form of mortar was a north-eastern and eastern Iranian product. In group C only one object has a definite provenance, C/2/b/2/3, which is from

Rayy, and only one other example can be attributed with any certainty to a place or area, C/2/c/1/1, which has decoration and inscriptions in silver inlay which are strongly reminiscent of that found on objects associated with Herāt (e.g. jug A/4/2). Whether the rest of the objects in group C were made in the north-east or whether craftsmen in other centres were also producing them, it is not possible on decorative grounds to say.

Two or the mortars in group D come from known sites - Maimāna and Ghazna (though there is certain doubt about this - Scerrato 1964 p.686 n. 62), which suggests that they are eastern or north-eastern products. Assuming that the Maimāna hoard was buried at the time of the Mongol conquests the Maimāna mortar must be early 13th century at the very latest. The two unprovenanced objects in this group are both considerably larger than the Maimāna piece. The Victoria and Albert example, from its decoration, is north-east or east Persian dating from about 1200 A.D., but the Louvre example may well be post-Mongol, for its inscription is in a very curious style for which I can find no adequate parallels.

Group A provides the greatest problems with regard to date and provenance due to the dearth of decoration on the objects. Only one of the three pieces (A/1/a/2/1) has any decoration at all, and that is so simple as to make any attribution extremely hazardous. Certainly it would be out of place in the 12th or 13th century, but there is no way of telling when the mortar might have been made prior to that, and the simpler form of the group merely echoes the fact that the objects are likely to be earlier than the other groups. In order to try and throw more light on these pieces, it is necessary to make some observations about mortars in general.

Two facts stand out with regard to the origin of the bronze mortar form. The first is that no pre-Islamic bronze mortars have yet come to light in the Near or Middle East, nor apparently did they exist in the classical world, in India, or in China. The second point is that the shape has no surviving parallels in the Sasanian or early Islamic period in Iran. Melikian-Chirvani's observation (1973 p.19) that the shape of group B is similar to the shape of a particular type of ceramic vessel in prehistoric Iran adds nothing to the history of the mortar form, since there is absolutely no evidence to suggest a cultural or historical link. Hence, it would appear that the cylindrical bronze mortar form is an invention of the early Islamic period. Such negative evidence does not of course prove that the invention was an Iranian one, but here there is a certain amount of textual information which may be helpful. Al-Rāzī, writing in the early years of the 10th century, uses two words for mortar, the Arabic mihrās and the Persian hāvan (Stapleton et al. 1927 p.325); al-Tanūkhī in one of his short stories written in southern Iraq at the end of the century, mentions a story of al-Jāḥiẓ about a man who collected 200 havāvīn (Tan p.191); Abū'l-Ḥakīm Muḥammad al-Ṣāliḥī al-Khwārizmī al-Kāthī in a treatise on alchemy written in Baghdād in 426/1034 A.D. mentions a hāvan of stone for the pounding of sulphur and similar substances (Stapleton 1905 p.61); al-Birūnī, writing for the Ghaznavid Mawdūd (died 1048 A.D.), talks of havāvīn made of batruy (Bir p.266); Muḥammad b. al-Ḥasan al-Kātib al-Baghdādī, who in Baghdād in 623/1226 A.D. compiled a cookery book, writes that for pounding meats a stone mortar (hāvan min ḥajar) is preferable, but that seasonings should be pounded in a copper one (hāvan naḥās) (Bagh p.8). It should also be noted that the word used today in the Levant for a mortar is hāvan.

Such scattered references to mortars should be treated with caution, but certain points do emerge. The first is that there seems to be an emphasis on the Persian word hāvan as opposed to the Arabic mihrās which could be interpreted as meaning that the mortars used in Iraq and elsewhere from the late 10th or early 11th century were in some way characteristically Persian. The second point is that the alternative material for mortars was evidently stone. Stone of course is an excellent material for such objects: solid and strong it is fairly easily carved out and should last for a long time. Given, however, that a round hollow in a piece of stone is the most appropriate shape for the action of pounding or grinding with a pestle, a round exterior would be a logical addition, and it is this very form, cylindrical and rimless, which characterises the earliest extant Persian bronze mortars, regardless for the moment of their precise date. In other words, far from the form having an origin in prehistory, it is taken directly from contemporary stone objects. This surmise cannot be proved owing to the complete lack of published stone pieces. But the lack of the latter is easily explained since such stone objects would break if dropped or treated harshly, and would then be used in buildings and the like, and very easily become unrecognisable.

A third point which emerges from the textual information is an approximate date for the emergence of metal mortars in Iran, or at least a terminus ante quem. For al-Birūnī writing in the first half of the 11th century specifies lead-bronze mortars as a product of his day, and makes no hint of their being a recent addition to the range. Hence, it is a fair assumption that metal mortars were in use in Iran already in the 10th century. However, it is also tempting to suggest that the story of al-Jāḥiẓ quoted by al-Tanūkhī indicates that in Iraq in the 9th century metal mortars, if known at all, were very unusual, since the story is based on the very common nature of mortars,

as worthless objects such as would only be collected by someone who was very eccentric, which seems to point to stone as the material rather than the more expensive and beautiful bronze. It may well be that this is reading more into the text than it can sustain, but if the conclusion is correct a 10th century date for the introduction of metal mortars may well be near the truth.

A final small point on the basis of the texts quoted above concerns the use to which these mortars were put. As the size of surviving pieces would have in any case suggested, they appear to have been designed for use in culinary matters, for small amounts of food-stuffs, spices and herbs, in alchemy, for pounding small amounts of substances, and in pharmacy, for medical recipes, and an illustration of this last use occurs in the 1220 A.D. Mesopotamian manuscript of Dioscorides (Martin 1912 pl.7 top). It was incidentally for these same purposes that bronze mortars were used in medieval Europe, where the form and the connection with alchemy and pharmacology shows that they were adopted direct from the Islamic world. In view of these uses the number of handles on any example is probably not very important. The larger the mortar the greater the pounding presumably expected, and the four-handled examples are all large (e.g. C/2/d/1-2); the handles could either have been staked or held to facilitate the work. A handle or two on the smaller mortars would no doubt have been useful but would not have been imperative.

It remains to make a few short observations about the mortar manufacturing industry of Iran from the 11th to the 13th century. First of all, according to al-Bīrūnī mortars shared with large cooking pots (ṭanājīr) the distinction of being cast from the poor quality alloy, batruy, which emphasises, if nothing else, the cheapness and probable crudeness of the objects. In the following century, to judge by the extant pieces, the quality of product seems to have increased, as

indeed the quantity of objects produced. In particular they are almost always fairly fully decorated. But this decoration in one instance only comes up to the standard set by other products, like ink-wells and ewers. This instance is the octagonal mortar in the Metropolitan Museum (C/2/c/1/1) which has a very fine design inlaid in silver. The reason for the generally less elaborate decoration on mortars is presumably due to their being kept in the kitchen quarters of a house, where they would not be seen and admired by guests or visitors. This raises an interesting observation about the Metropolitan Museum mortar. It will be noted that this object, in addition to being inlaid with precious metal, has no handles, although it has places designed to accomodate them. It seems apposite to suggest that this object though cast as a mortar was then decorated for a customer who wanted it for show and not practical use, and that its handles were therefore removed or never added to give it greater elegance.

Pans

Pans are known in Arabic and Persian as ṭinjīr. Of the two surviving examples little can or need be said. Both are purely functional objects and made in the cheapest possible utilitarian manner.

Pestles

Cast bronze pestles have been found at three of the major excavation sites in Iran - Rayy, Susa, and Nīshāpūr, and have also come to light at Ghazna and Kalai-Bolo (Farghāna). Apart from the handle form, which varies from one individual pestle to another the only feature which is not common to every pestle is the thick band or ridge protruding from the shaft just above half way up. The purpose of this band appears to be to prevent the hand of the person doing the work from hitting the edge of the mortar. The ridge only occurs on the large size of pestle 18 cms. or more in length, though it does not always, the Susan examples being obvious exceptions. Whether this indicates that it was an eastern feature there is not yet enough evidence to say. With the exception of the Kalai-Bolo piece, which is said to be 11th-12th century, none of the excavated pestles are datable. Without knowing the circumstances of the finding of the pestle and mortar from Ghazna it is impossible to be sure whether the pestle is contemporary with the mortar or not, and the same is true of the example in Berlin.(When I visited East Berlin in 1973 there was no sign of this pestle) One can only assume that the two pestle styles, unbanded and banded, are in general terms contemporary with the surviving bronze mortars. An interesting and highly decorated pestle of the banded type, which is almost certainly a Syrian product of the 13th century, is in the Louvre (Paris Orangerie 1971 no.142).

Spoons

Since a history of spoon forms in the pre-Islamic Near East or Mediterranean world has not yet been written, it is very difficult to be sure of the significance of those forms found in early Islamic Persia. They have therefore been catalogued in one group. It will be noted, however, that they fall into two types - those with long bowls (1-8) and those with wide bowls (9-12). A number of comments may be made. First, the spoon from Susa (6) stands out in the form of its long oval bowl and high curved neck, and clearly belongs to the late classical early Christian spoon form, called a cochlear (Sherlock 1974). Second, the excavations at Corinth brought to light two main spoon forms in the Byzantine period, the cochlear form already mentioned and a spoon type with a long handle and relatively small bowl (Davidson 1952 p.189, whose nomenclature does not agree with Sherlock 1974). This latter type would appear to be much the same as a group of spoons in our catalogue - 2,9,10,12, even though the bowl shape varies somewhat in the Persian examples. It could therefore be argued that there is a link between Byzantine and early Islamic Persian spoon forms, both presumably being based on classical models. Spoons 1,5, and 11 are rather different, in that they have broad flat handles, in the cases of 1 and 5 broadening towards the top. Whitehouse dates 5 to the 9th century; the Nīshāpūr spoon is undated; the inscription on 11 suggests a 12th-13th century date. The origin of this broad-handled form remains at present unclear. Spoon 3, from Rayy, is decorated with a bird in profile on the end of the handle. As noted elsewhere in connection with cosmetic objects, the use of flat animal or bird forms is unusual in Iran and certain shallow toilet dishes may be attributed to the influence of Egypt (see p.347). It is tempting to see this spoon in the same light. Spoon 13 has a handle top which suggests at first sight some sort of connection with the

one surviving silver spoon, but its bowl shape is totally different, and the excavators are disappointingly vague about its date. Spoon 7 is the only one with a handle that curls over at the end to enclose a ring. Again no parallels present themselves, and one can only assume that it was designed to be hung on a man's belt. If so it may to some extent reflect nomadic practice, though the seated drinking figure in the bowl indicates that it also reflects the more general urban culture of pre-Mongol Iran.

Stem bowls

The surviving stem bowls have been categorised primarily on the basis of the alloy used: in group A are all stem bowls of high tin bronze, in group B all those of other types of bronze. Five forms of high tin bronze stem bowl survive, of which two are particularly numerous and important, A/1 and A/2. A/1 stem bowls have an almost hemispherical bowl, a plain edge curving slightly inwards from the vertical, and a short splayed foot. The bowl and foot are cast in one piece, but without any base to the bowl, and a circular base plate is soldered in afterwards. A/2 stem bowls have bowls of similar shape, but with a rim, which is sometimes decorated along the edge. They also have much taller feet, splayed at top and bottom, with an annular knop. The complete object is cast in one piece. There are therefore fundamental differences in form and method of manufacture between the two groups, although they look superficially alike, and these differences call for more detailed investigation.

Turning then to a more detailed study of A/1 it is first necessary to establish the dating and provenance of the objects. Ettinghausen's very lengthy and detailed study of the Wade Cup (Ettinghausen 1957) shows that this particular piece was made in Khurāsān sometime between

1163 and 1221 A.D. A/1/3-4 are identical in shape and method of manufacture, though 3 has a lid, and their decoration may be used to attribute them to the same source. Two on the other hand has a stylised scrolling stem with a rhomb-shaped leaf and a heaviness of decorative conception which are characteristic of north-west Persian metalwork in the 13th century. Too little is known of 5 to allow any certain attribution.

The next point that requires investigation is the method of manufacturing these bowls. The obvious way to cast a stem bowl is in two pieces - the bowl, complete, and the foot, and then solder the two together. That they are not made in this way seems to suggest that they are probably not based on a cast hemispherical bowl, but rather that they are based on a hemispherical bowl that has been made by some other technique and that they were manufactured by a workshop not previously involved in casting bowls. The discussion of hemispherical bowls above indicated that in the 11th century Sīstānī craftsmen were forging high tin bronze pieces of hemispherical shape, while Transoxanian craftsmen were casting objects of a similar type. It is tempting therefore to attributestem bowls of Group A/1 to a tradition based on the Sīstānī workshop, and to see it perhaps as a 12th century development brought about by craftsmen now closely acquainted with Khurāsān metalworking schools of the period. Evidence to back up this suggestion is found in the decoration of the objects, for all the stem bowls have plain rims like those of the Ghaznavid forged bowls, and the pattern on the Wade Cup, consisting of an interlacing system of bands forming a six-pointed star, is directly paralleled by designs on two of the forged bowls (A/1-2). This is not to say that all the decorative motifs and designs on these stem bowls are particular to this special tradition, for like all objects they bear a mixture of decorative influences, but the interlacing bands are

otherwise virtually unknown in Khurāsānī decoration and therefore require some sort of explanation.

There is, however, another quite different way of understanding the form and the method used in its manufacture. This becomes apparent if one poses the question why such objects should be in demand at all. For so far there has been no suggestion as to the motive behind putting a stem on a hemispherical bowl. Nor indeed would the above discussion help in any way in explaining the presence of a covered stem bowl - the Vaso Vescovali. Pinder-Wilson (1951 p.86) tentatively suggested that there might be a connection between the covered form and the medieval ciborium which seems to have appeared in Europe sometime in the 12th century. Ettinghausen (1957 pp.334-7) on the other hand compares the form to two Sasanian stem cups and Buddhist reliquaries of a similar shape in the Shosoin collection. But another possibility is that the stem bowls are related in some way to the footed silver wine bowls which were the descendants of the Sasanian wine bowls and still being produced in the mid 12th century. Two particular points indicate that this might be so. First the form of stem bowl in question is very similar to that depicted on the Bobrinski bucket (Ettinghausen 1957 fig.18), which in its turn is related to that on a silver wine bowl (C/3) dating from about 800 A.D. This suggests that the 12th century high tin bronze pieces must be the earliest surviving non-silver examples of the stemmed wine bowl tradition. Second, it has already been pointed out (p.62) that the Berlin wine bowl (C/6) is manufactured in a very curious way, the base being at the bottom of the foot, and not where the foot and body join. It could be that the way the stem bowls in question are cast reflects the influence of silversmithing practice of the day, although the base was then inserted at the more logical place. Such an influence would further emphasise the role of the stem bowls as wine

bowls in 12th-13th century Khurāsānī society, and the lid of the Vaso Vescovali could be explained as an elaborate addition to such a wine cup so that it could stand as ornamental object in the house of its wealthy patron, ready to be uncovered and used for ceremonial drinking when the time was appropriate. Furthermore, in view of the quite clear influence of silver objects on high tin bronze bowls and dishes, as discussed above (pp.186 and 201), a connection between high tin bronze stem bowls and silver wine bowls is not only not particularly surprising, but is almost to be expected.

Group A/2 stem bowls, as has been indicated, are quite different from Group A/1 in the details of their rim and stem shapes, and in the method of manufacture, and it is the stem shape which pin-points their quite different origin. For this symmetrical stem with flaring top and bottom, and annular knop, can be nothing other than a copy of a type of stand on which hemispherical or round-bottomed bowls would have been placed. In other words the stem bowl form is an amalgamation of two objects, a bowl and a pot-stand, which have been cast as one to give the final product. Now it is true that no independent metal stand of this form survives from early Islamic Iran, but this does not rule out the possibility that such a stand existed, and an important piece of later evidence that it in fact did so is a Mamlūk brass stand of similar shape now in Los Angeles (Pal 1973 no.306). Thus it becomes apparent that high tin bronze casters took two current object forms and combined them to produce a completely new style of stem bowl. Since these men were obviously inventive and original it is important to discover who they were, information which the decoration alone can give us. Certain decorative features suggest a Khurāsānī origin - the inscriptions on the rims and the interlace pattern on the inside of 2, for example, but the bodies of 2 and 3 bear rosettes and strapwork designs which are quite uncharacteristic

of Khurāsān, and which occur for example on candlesticks identified as north-west Persian products of the 13th century (candlesticks E/1), and the stylised naskhi inscription and rhomb-shaped leaves on 2 are also characteristic of the latter metalworking school. A more exact dating for the three pieces is not possible on the limited decorative evidence they offer, but a study of two ordinary bronze stem bowls related to them (stem bowls B/1 below) suggests that both the high tin bronze and ordinary bronze pieces are early to mid 13th century.

The third group of high tin bronze stem bowls, group A/3, are in every way less impressive creations. Squat and somewhat ugly, with an inscription their only decoration, they give the impression of being the poor brothers of Group A/1, an impression confirmed by the fact that A/3/3, at least, is made in three pieces instead of two - body, foot and base plate, the requirements of casting body and foot in one being evidently too rigorous for the craftsman involved. The fact that 1 was made for a Khurāsānī official, and that 2 was probably found at Ghazna, indicates that they are east Persian products, but they must have been well known in central north Iran by about 1200 A.D., since there are numerous examples of the shape in north-Persian pottery. For example there is an extremely accurate copy in 12th-13th century monochrome ware (Pope 1938 pl.769B), and two lustre bowls of the same form are dated 1203 and 1219 respectively (Ettinghausen 1957 fig.3; Pope 1938 pl.707A,B).

Other stem bowls on the other hand appear to be based on pottery types rather than the inspiration for the latter. For example, A/4/1 is evidently a metalworker's imitation of the pottery form just noted. To the potter the curving foot of Group A/3 stem bowls was a problem, and it was replaced by a straight flaring foot in virtually every case (e.g. those mentioned above). A/4/1 stem bowl too

has a straight flaring foot, and with its more exaggerated body and rim form, must be a copy of such bowls. The roundel with enthroned figure testifies to the influence of the Khurāsānī decorative tradition, but the leaf forms and pseudo-inscription point to the north-western school already mentioned.

A/5/1 is another stem bowl based on a ceramic shape, again a shape common in north Iran just before the Mongol conquests (Rice 1953 pl.5). Rice attributed this object, which bears the name of an officer of Badr al-dīn Lu'lu' (1210-1259 A.D.), to Mawṣil, but admitted that the fact that it was a cast piece made it unique as a Mawṣil product. Certainly the four medallions and the naskhi inscription are very much in the Mawṣil style, but the rosettes are like those on stem bowl B/1, and the inscription on the foot could happily be north-west Persian. There is inevitably something of a dilemna in attributing this bowl. My own inclination is to ascribe the object itself to north-west Iran in the first half of the 13th century, and to suggest that it may have been decorated in northern Mesopotamia to a Mawṣil design by a Persian craftsman. Certainly, whatever its decoration, it is impossible to deny the Persian ceramic origin of its form.

Given the ceramic basis of A/4/1 and A/5/1 it seems highly likely that A/6/1 is also based on a pottery design. Melikian-Chirvani (1973 p.29) suggests that it is based on an archaic shape such as is found in a Samānid tin object in the Kābul museum, but until the latter object is published such a suggestion cannot be proved or disproved. A pottery shape very similar to this, however, was common in northern Iran in the 12th-13th centuries in a variety of decorative styles (e.g. Atil 1973 no.29,35), and this high tin bronze piece can be convincingly explained as a formalised adaptation of that shape

suitable for cast metal. But if the shape is north Persian, the inscription is in a style typical of Khurāsān, and to offer yet further contrast the bowl bears the name of a Tabrīzī merchant. How best one can explain three such diverging characteristics depends upon the amount of reliance one feels able to place on each of them individually. My own feeling is to place the main emphasis on the origin of the shape. To me the bowl is first and foremost a copy of the pottery form mentioned above, and its strongest links must therefore be with northern central Iran. Following on from that, the mention of a Tabrīz merchant seems significant. For a metal working centre in the north-west certainly existed in the 13th century (see p.263), and what is more it may well have been located, at least, in the later part of the century, in Tabrīz. The Khurāsānī style inscription seems less important, for many north-western objects have styles of calligraphy which can ultimately be traced back to the north-east, and its significance must then be that it indicates the origin of the craftsman who decorated the bowl, and not the actual area where he did the work. In other words, this bowl appears to be an object made by a Khurāsānī craftsman working in central northern or north-western Iran, having presumably but recently migrated thither.

If that conclusion is correct certain other important conclusions follow. The various forms of stem bowl made of high tin bronze discussed here seem to provide tangible evidence of the movement of craftsmen westwards just before the Mongol conquests. For stem bowls A/1 are totally east Persian, stem bowls A/2 are north-west Persian, and in between are Groups A/3-6 which have features relating them to some or all of the east, the north and the north-west. These features often make the attribution of a particular piece a problem, but when taken together give a strong impression that the objects concerned are a transitional group: to propose a migrant group of

craftsmen moving from Khurāsān westwards round about 1200 A.D. would in fact explain that situation very satisfactorily. Another point which emerges is the impact of north Persian pottery on these metalworkers. In the north-east the strength of the metalworking tradition mean that metal forms developed with comparatively little reference to forms in other media. But the demand encountered in the north was evidently for ceramic forms, at least at the start, presumably because the superb decorated ceramics of Rayy and Kāshān were the yardsticks by which the local populations judged artistic objects, and the migrant craftsmen were compelled to vary their products accordingly.

Turning now from high tin bronze to more ordinary bronze alloys, it becomes clear that the five groups of bronze stem bowls (B) are all based on high tin bronze types. Thus Group B/1 is of a form which must be based on A/2 even though it has lost the symmetry of the foot, has a rather shallower bowl shape, and in at least one case is cast in two pieces instead of one. The source of the inspiration for the object is also visible in the decoration, both examples having an inscription round the outside of the rim, and the rosettes and interlace patterns on 1 being similar to those on north-western objects. However, there is a rather stronger link with north Mesopotamian styles than in the high tin bronze group, for example in the breaking of the inscriptions by roundels or swastika hexagons, in the overall pattern made by the roundels, band and rosettes on the body of 1, and the background body pattern on 2, all of which can be paralleled in the British Museum incense-burner dated 1243-4 A.D. of north Mesopotamian origin (Barrett 1949 pl.15c). What is more the same bowl shape occurs without a stem inscribed with the name and titles of an early 13th century Atābak of the Jazīra (Sarre 1906 no.19 pl.6), suggesting that the workshop producing these objects in the first half

of the 13th century may have been in north Mesopotamia rather than north-west Iran. They have been included here in spite of this possible attribution because the form is so obviously derived from the high tin bronze one.

The two cast bronze bowls in group B/2 are very similar to the high tin bronze piece in the name of Najm al-dīn ʿUmar al-Badrī (A/5/1). The less impressive decoration on the Louvre piece, which serves to attribute it to north-west Iran in the early 13th century, and the almost total lack of decoration on bowl 2, suggest that such objects were not intended for patrons of high rank, and that the bronze casters may have been producing second quality pieces copied from high tin bronze objects of the highest quality. A close connection is certainly suggested by the approximately uniform size of all three pieces.

The form of the body and foot of B/3/1 suggest that it too is based on a high tin bronze stem bowl form, in this case A/1, and this is interestingly emphasised by the way the centre of the inside of the bowl has been deliberately shaped as a separate concave area. This allows the foot to be soldered on more firmly perhaps, but visually reminds one of the separate base plates used in the high tin bronze group. Shapewise the bowl form has been embellished by the addition of facettes, but decoratively it has been greatly simplified, for it bears only a rim inscription, and the relative cheapness of the object compared with the heavily encrusted high tin bronze pieces is clearly indicated by the fact that the bronze stem bowl's inlay is not silver but tin. (This was recently discovered when the inlay was put under an X-ray fluorescence machine in the Laboratory for Archaeology and the History of Art in Oxford)

B/4/1 is more elaborate, with its two rows of ten polygonal panels made by repoussé work on a previously raised shape. This technique suggests a link with the Khurāsānī craftsmen producing beaten metal objects like the cylindrical-bodied ewers (C/3/b-d) and enormous candlesticks (A) discussed elsewhere, but the generally poor quality of the work in this stem bowl probably indicates that it is the product of a provincial school, perhaps the same school as produced certain cymbal-like sheet bronze objects (objects C unidentified) which was probably located in Sīstān.

B/5/1 at first sight appears to be a copy of a ceramic form rather than of a high tin bronze style. However, the resemblance between it and A/6/1, particularly in the fact that it has its base plate at the bottom of the foot, and not in the logical position at the top, seems to suggest that it too is a copy of a high tin bronze type. The paucity of decoration shows, however, that it was a very much cheaper product.

The above survey of the bronze stem bowls of the pre-Mongol period in Iran suggests two particular conclusions. The first is that such stem bowls were based on high tin bronze forms already available. The second is that the objects were not intended to compete with the high tin bronze products but were designed for a less wealthy clientel. From these two conclusions one can but assume that in this case at least the bronze industry was the poor brother of the high tin bronze industry.

(2) Ablutions Equipment

Basins

Only one form of basin survives from early Islamic Iran. It has a form of character, with flat base, rounded and inward-curving sides, and a lobed rim, and is generally considered to be a beaten bronze product. Whether it really is is a point of debate, for surviving examples although they have a body which would be extremely difficult to cast so thin, have a very thick central rosette, and a thick rim, which would not have been easy to create from sheet metal. Scerrato (1959 pp.103-4) has encountered many more of these objects than are listed in the catalogue of this thesis. He mentions examples from Ghazna (Kābul 58.2.43-46), a piece in the Tehrān Museum, other examples from Girishk and Namzāt near Qandahār, and yet further examples from Maimāna and Herāt. Taken in combination with the Louvre piece from Afghanistān (5), and the two Qandahār pieces fully published by Scerrato (1-2), one is left with a strong impression that, despite certain decorative motifs usually found on Khurāsānī work, these are primarily Sīstānī products. The general impact of the decoration is certainly rather different from that of the Khurāsānī school, and an important piece of evidence for a Sīstānī provenance is the thick, silver-inlaid rosette in the centre of the base of most examples. This has its only direct parallel in a tile found at Ghazna (Scerrato 1959a fig.28), which shows a rosette of absolutely identical form. As a result it is possible that these basins, at least until the sack of Ghazna in 1149, were produced in that city. After that date the artisans must have moved elsewhere for surviving examples (e.g. Enderlein 1973; Sarre 1906 no.23, fig. 15; Pope 1938 pl.1358) show that the form continued to be popular in 13th century Mesopotamia and Il-Khānid Iran.

Bowls

For the use of certain types of bowl for washing purposes see above p.187-8.

Buckets

There are two distinctive forms of metal bucket surviving from Islamic Iran, one a cylindrical type with flat base (A), the other a rounded type, with or without a foot, and with a variety of profiles (B). All examples of these two forms appear to be cast in two pieces, body and handle, or three pieces if they also have a foot. The alloy used, to judge by the Ashmolean piece (Table 21 no.34), is quaternary, comprising copper, lead, zinc and tin, and thus corresponding to al-Bīrūnī's shabah mufragh. The first form is known from but one example, a piece from Marv with decoration pointing to a north-eastern provenance and a 10th-11th century date. Of type B, on the other hand, almost thirty examples are known, and this number is sufficient to allow four distinct profiles within the group to be differentiated.

B/1 has a rounded lower body and almost straight inward-sloping upper body ending in a thickened rim. Neither of the surviving pieces has a foot. B/2 has a more rounded or bulbous body and a thick rim with a stronger profile: it occurs with a splayed foot, with three small feet, and in a footless form. B/3 has an almost spherical body and a thick slight everted rim very like B/2, and occurs usually with a splayed foot, though in one instance without a foot. B/4 has a spherical but rather angular body and flat projecting rim. Like B/3 it occurs without a foot, but usually has a splayed foot of the type encountered in B/2 and B/3. These four types appear on the basis of shape alone to have developed in the order in which they have been put, and the form of handle also points to such a progression. There are two distinct handle types. B/1 has a semi-circular type, the two

ends of which are hooked through the holes in the rim flanges and then brought back upwards until they follow the curve of the rest of the handle. In B/1/1 the ends of the handle are evidently meant to imitate the tail of a serpent or some other reptile and the same is probably true of B/1/2. In groups B/2-4 the handles are different. Instead of serpent tails, they usually end in the head of a bird or animal; more important the two ends are cast as open forks. The flanges on the rim are thinner at the top and this would have allowed these forks to be forced open slightly and then snap back into position when they had reached the hole in the flange. B/1 therefore has a handle style which is more primitive than those on B/2-4, suggesting that it was an earlier style of bucket than the latter types.

Given that bucket body and handle forms suggest a stylistic progression it is now necessary briefly to examine the decoration to discover whether it confirms or contradicts this. B/1/2, according to Ettinghausen, is 11th century. Unfortunately the reproduction given of it is too bad to allow the decoration to be made out in any detail. There is no reason, however, for thinking 1 is as early as that; its naskhi inscription rather suggests the 12th century. Group B/2 seems to be a late 11th or 12th century set of objects, and the connection between certain individuals is clear. Buckets 1,2,3,5 and 6 all have a decorative system which is based on a wide central band with varying ornament with above it a narrower band of inscription, and below it an even narrower band of ornament. Buckets 1,2 and 5 are further connected by the incised designs in their middle registers where animals run freely in front of scrolling stems without any cartouches or other forms of enclosure. This style reminds one strongly of the Nīshāpūr ewer, even though the technique used is there rather different

(bronze ewer A/1/d/3). The incised designs in the middle register of bucket 3 is also somewhat similar in this way. All the decoration points to a late 11th or 12th century date: it is difficult to be more precise.

B/3 generally has decoration based on the same fundamental principles as most examples of B/2 i.e. it is arranged in three bands, the top being a fairly wide band of naskhi inscription, the middle being a wide band in a variety of styles, and below that being a fairly narrow band usually containing a kufic inscription. The Bobrinski bucket (1) despite its extravagance is based on this pattern, the middle register being further subdivided into three. Amongst the rest 2,3 and 8 have much in common with their middle register consisting of a band of inscription broken by cusped medallions, but otherwise there is a wide variety of designs. The only piece which has a totally different layout is 6. The key piece for the dating of this group is inevitably the one dated example, the Bobrinski bucket, made in 559/1163. Being far more elaborate than any of the other examples, one should be wary of using its details for purposes of comparison, but certainly the decoration of the other pieces would happily fit a date within fifty years either side of it.

The decoration of objects in B/4 is again based on three registers, the top containing a naskhi inscription of bold proportions, the bottom a narrow band of kufic, and the middle a wide band with a variety of motifs. Certain designs stand out and suggest a link between individual objects: both 5 and 6 have in their central band zodiacal signs within a framework of knot patterning; 3,4,8 and 9 have all their registers composed of alternating cartouches and roundels; 2 and 7 have middle registers consisting of alternating roundels and medallions containing sphinxes and harpies. Such connections between

objects do not, however, prove that those pieces were made in the same town or workshop, although naturally such a conclusion is quite likely; the true significance of such comparison, as so often, is elusive.

From the above comments it appears that B/1 was a form used in the 11th and 12th century, B/2 in the late 11th-12th, B/3 and B/4 in the 12th-early 13th. This therefore backs up the logical progression of forms as the progression which actually occurred. Given that the cylindrical form (A) is earlier than the earliest rounded example one might be tempted to suggest that the origin of the latter is to be sought in that cylindrical form - a point to which discussion will return later.

Here it is necessary briefly to point out the probable provenance of the various buckets mentioned. The only piece of certain provenance is again the Bobrinski bucket which was made in Herāt. Bucket B/3/6, however, was also made by a craftsman with a Herātī nisba. B/2/2 was found in Marv, B/2/6 in Khwārazm, B/3/5 and B/4/3 in Tadzhikistan, and B/4/8 was acquired in Bukhāra. Given this range of findspots it seems unlikely that all the buckets were produced in Herāt, and the stylistic variations both in form and decoration seem to indicate a number of different workshops or manufacturing centres. The location of these, however, although clearly somewhere in the north-east of the country, remains for the time being completely unknown.

Two important questions arise in connection with these buckets, the one concerning their origin, the other concerning their use. Taking the question of origin first, there are three other bronze bucket forms known from the early Islamic world. Two examples of a three-legged form with fairly low cylindrical body were found with the Marwān ewer and another ewer at Abū Ṣīr in the Fayyūm and if the

former ewer is Mesopotamian the buckets may be also (Rubensohn and Sarre 1929). Another form is evidently Egyptian - a slightly tapering cylindrical body with a simple loop handle on swivel pins, of which a number of examples are known but none have ever been published (de Unger collection; Louvre 6022; Victoria and Albert M25-1923). A third form is similar to the second but has a rounded base with or without a foot (Ettinghausen 1943 fig.5; Louvre 6714). This is also probably Egyptian. The second of these forms is a direct continuation of the classical design of bronze bucket, of which particular examples were probably manufactured in Byzantine Egypt, for example the Cuddesdon bucket (Dickinson 1974 pl.3), and the third form is an obvious development of the second by the alteration of the flat base to a round base and the addition of a low foot.

In this situation it is perfectly possible that the cylindrical Persian form also derives from the classical style adopted in Egypt, and that it differed from its Egyptian counterpart in developing in a more individual way by frequent modification. But there are other factors which have to be considered, and these concern the use to which these objects were put. Aga-Oglu (1945 p.29 n. 14) followed Pope (1938 p.2485) in suggesting that the Persian buckets were used in bath-houses, and he proposed that their correct Arabic name was <u>satl</u>, since the latter is described in the early Arabic dictionaries as being a bucket or pail used for carrying hot water in a bath-house. Buckets of a similar size are certainly shown in bath-house scenes in later Persian manuscript illustrations (Gray 1961 p.117) but three factors seem to be at odds with this straight-forward interpretation of their use. The first is the decoration on the Bobrinski bucket, which is so elaborate that it seems far too grand an object to be used for carrying hot water, even for a great merchant, in the confines of a bath-house. The atmosphere of the bath-house would in any

case have been disastrous for the metal. The second is the large number of surviving examples. True every quarter of every town or city would have had a bath-house, but it seems unlikely that they would all have had decorated or inlaid buckets, and no plain buckets of the style have ever come to light. Thirdly, the two ewers and two buckets found in the Fayyūm are an incongruous quartet if the ewers are for pouring water over people's hands, or for pouring drinks, and the buckets are for use in a bath-house. The most obvious use of the latter buckets is, as Ettinghausen (1943 p.196) pointed out, to receive the water poured out of the ewers. Ettinghausen discounts this use on the grounds that the opening in the top of such a bucket is not wide enough, but it must be remembered that washing before a meal in the Islamic world is not a matter of rolling up one's sleeves and smothering one's hands and arms in hot water and soap: it is far more a ritual or symbolic washing. Hence it seems much more likely that the buckets found in the Fayyūm were for washing, in conjunction with the ewers, and that the Persian bucket types were primarily for this purpose too. If this is so there seems all the more reason to suggest an ultimately classical origin for the bucket forms of Iran: the Muslim ritual of washing required objects into which the washing water could run, and the object-type adopted in the conquered Byzantine lands was one of the standard late classical water-containers, the cylindrical bucket, the style of which then spread eastwards and became general throughout the Islamic world.

Against this theory it must be admitted there are important arguments. First, there is a post-Mongol bronze bucket in the British Museum (1969.6 19.1) which bears an inscription in Persian in which the object is described as a <u>satl</u>; that particular example must have been used in a bath-house, unless the word had a different meaning in Iran

at that period. Secondly, there is a more general problem of nomenclature. Today, and probably ever since the Mongol invasions, the washing equipment combination has been ṭisht and ibrīq, basin and ewer, and the word ṭisht as found in early Arabic is generally agreed to be a Persian word. This implies that the basin is a Persian concept, and the use of the word ṭisht by such authors as al-Hamadhānī and al-Tanūkhī further implies that basins were already in use in the 10th century. At this point the investigation into the origins and uses of the Persian bronze buckets comes to a full stop, for the only way forward is thorough investigation of the meaning of the word ṭisht in all its early uses, and an equally thorough study of the occurrences of the much rarer, and probably purely Arabic, word saṭl. Without that the problem will remain unsolved.

My own hypothesis is as follows. The Muslims at the time of the conquest of the Byzantine lands adopted traditional bucket styles for washing purposes. These spread eastwards, and in Iran, in combination with ewers, became the standard items of washing equipment. The large numbers of highly decorated ewers and buckets from 11th and 12th century Khurāsān and Transoxania reflect the widespread use of this combination of objects in the houses of the reasonably well-off in that region. A different custom arose in Sīstān, where under the Ghaznavids high tin bronze bowls were used in place of buckets, and in the post-Ghaznavid period beaten bronze basins.

After these rather splendid buckets and their important implications for cultural traditions it is something of an anticlimax to turn to the one surviving bronze bucket of beaten metal (C/1). Found at Maimāna, it illustrates the everyday object type which might have been used in small towns and villages, or by the poorer members

of society in the larger urban centres, and emphasises that the metalworking industry was not there for the service of the wealthy alone. On the contrary, as already noted for bowls and ewers, there was probably an industry producing cheap utilitarian objects, with no pretensions to being works of art, to satisfy the everyday demands of the great bulk of the population.

Ewers

Ewers are vital for the performance of ablutions in the Islamic world, but, as already noted, it is virtually impossible to distinguish ablution ewers from those designed for drink. They have therefore been discussed as a single group above (p.204-231).

(3) Lighting Equipment

Since earliest times two distinct forms of lighting have been used. One consists of a wick burning above a pool of oil, the other a wick burning above a solid mass of fat or wax: the one give rise to the oil lamp, the other to the candle. Both forms, naturally enough, were known to the early Islamic world. The oil lamp was called in Persian charāgh, in Arabic miṣbāḥ, qindīl or sirāj, while the candle was known in Persian as sham', and in Arabic as sham'a, both from sham' meaning beeswax. The oil lamp could not exist without a container, and the same word was used for the container whether in use or empty. A candle, being a solid, could exist without a container, so that when it was stood in or on something that object received a separate name - sham'dān, candlestick. On the other hand oil lamps were often wanted at a height some way above the floor, and were therefore placed on a stand which in Persian received the name charāghpāya.

Candlesticks

Prior to about 1250 five forms of bronze candlestick are found in Islamic Iran. The first (A) is of beaten bronze or perhaps brass, and is notable for the large size of some of the surviving examples and for the superb repoussé bands of lions, and birds which adorn them. The last aspect, plus the motifs used, indicate that they were produced by the same workshop or group of workshops as manufactured the famous beaten ewers (bronze ewers C/3) with fluted bodies and repoussé birds or lions on the shoulder, neck and spout cover. In other words they are products of Herāt or some other Khurāsānī workshop in the second half of the 12th and early 13th century.

The single candlestick in group B is also of beaten bronze, but its shape is quite different, being more akin to that of D/1 which like C/1 is of cast bronze. The attribution of all these three groups depends upon the attribution of the rather better studied and more numerous group E, to which therefore attention must first be turned.

Rice has discussed this group of objects at some length, although he had hoped to publish them all in much greater detail before he died. In his publication (Rice 1954) he attributes them to Azarbāījān or slightly north of Azarbāījān, and dates them to the second half of the 13th or early 14th century. The attribution is based on the Persian quatrains which occur on two of the candlesticks, the palaeography's resemblance to Caucasian palaeography, the nisba of the one artist who signed his work, Shīrīn ibn Awḥad al-Quwaī (Quwa being between Azarbāījān and the Caucasus) and the description which al-Qazvīnī gives of Tabrīz mentioning how the inhabitants, amongst other things, used candlesticks as currency in the late 13th century. The dating he based on the palaeography, the use of gold inlay and the form of the decoration, for example the background scrolls and the labours of the month. These conclusions and the evidence on which they rest still stand, though one should point out the possibility that one or two of the objects in the group may have been made by the middle of the 13th century, and hence fall within the scope of this thesis. One particular candlestick suggest itself, that in the Turkish and Islamic Museum in Istanbul no.2556 (Rice 1954 pl.7d). The main part of the decoration of this object is virtually identical to that of high tin bronze stem bowl A/2/2 and the evidence for an early or mid 13th century date for this latter object through a related group of stem bowls B/1 is discussed above (p.247). If that dating is correct, then it would suggest that this form of candlestick was

known by 1250 A.D., although it flourished and was most widely used during the following hundred years or so.

A comparison of the various decorative forms and styles used on candlesticks of type E allows one with confidence to attribute those in groups B, C and D to early 13th century north-west Iran. Thus B/1 has alongside its Khurāsānī rosettes and styles of inscription a scrolling stem structured around four centres with a rhomb-shaped leaf which can be paralleled on another candlestick of group E in Istanbul (Rice 1954 pl.7c), and which is not common in Khurāsānī products. The western or north-western origins of C/1 and D/1 are discussed by Melikian-Chirvani (1973 pp.49-51). F/1 has rather different decoration of a much lighter and freer type than most of that found on group E candlesticks, and some of it, for example the inscriptions, is very close to the Khurāsānī style. On the other hand the use of large figures and the form of background stems and leaves suggest again a more westerly origin, which is supported by the findspot of F/1 (Hamadān) and the fact that its shape was that adopted by the metalworkers of Fārs in the Il-Khānid period.

This brief survey thus suggests that the earliest extant bronze candlesticks are those manufactured in beaten metal in the north-east in the second half of the 12th and early 13th century. All the other groups catalogued appear to be the products of a north-western, or in one case perhaps western, group of workshops in the first half of the 13th century. Out of these facts various questions arise in connection with the origin of the earliest form and its very late appearance in the early Islamic period, and also in connection with the relationship of the north-eastern form to those of the north-west.

Candles, as already pointed out, must have been known and used from earliest Islamic times, and evidence of this is provided by ceramic candlesticks dating from the 8th-9th centuries found at Susa, and others from the 10th century or later found at Nīshāpūr and Marv (Rosen-Ayalon forthcoming p.132; Wilkinson 1973 pp.306, 342 no.44-5, pp.314, 349 no.73,75; Lunina 1962 p.357 fig.80). All these objects are extremely simple and were obviously designed for a very humble market. The first metal candlesticks on the contrary are extremely elaborate objects, requiring great skill on the part of the metal beater and inlayer. Their form also indicates that although no earlier pieces survive they could not have been the first such products. Basically, of course, the form is extremely simple - a sheet of bronze formed into a cylinder with one end wider than the other and soldered down the joint; a circular flat sheet of metal with a hole cut in the centre soldered across the top; a neck and socket formed equally simply soldered into the hole in the centre of the shoulder. That simplicity, however, is very much obscured by the decoration, particularly the repoussé work. In the study of beaten ewers it was clear that the simple cylindrical style existed alongside the fluted forms, and that the former must have preceeded the latter originally. So too with these candlesticks: a simple truncated conical form must have existed in beaten metal at some point before this elaborate style came into fashion. In theory one imagines that that simpler form would have been in beaten bronze, brass or copper and would have compared with the simplest style of beaten ewers found at Nīshāpūr (C/2). But given that the pottery candlestick style was so rudimentary, and that enormous numbers of fairly simple cast bronze oil lamps have come to light, in practice that may not have been so. On the contrary, it is perhaps more likely that there were three standards of lighting - at the bottom the crude

candles in crude candlesticks, in the middle more expensive but unassuming oil-lamps, and at the top large candlesticks made of beaten precious metal suitable for throne-rooms and palatial residences. The elaborate form of the beaten bronze products would then easily be explained: they are copies of candlesticks made of gold or silver, and the craftsmen, in order to give the objects a richness which would compare with that of the original metals, managed, through the skilled techniques of repoussé and inlay, to draw the eye of the purchaser and user away from the cheaper metal of the body to the richer form and texture of the surface. If this explanation is correct, the beaten bronze candlesticks of Khurāsān, far from suggesting that metal candlesticks were first made in the late 12th century, offer positive evidence that they existed before that date.

Having thus, in so far as it is possible, placed the beaten north-east products in some sort of context, it is now necessary to focus attention on the north-western pieces to try and discover how, if at all, they relate to them. A glance at any of the other candlesticks suggests that there is little or no connection in shape, except perhaps in the socket form of B/1 which is like the A group socket form. Apart from that none of them are truncated cones like A, and all of them instead are in a style in which an almost vertical base is contrasted with a concave-sided body. This being so a different origin has to be sought, and here a valuable clue is provided by group A/2 high tin bronze stem bowls. These, which come from the same area at the same period as the candlesticks under discussion, are based on the union of a hemispherical bowl with a symmetrical bowl stand. The craftsmen who made them, although probably acquainted with the Khurāsānī stembowl form, preferred to invent their own and created it in a completely original way. If one considers the candlesticks bearing this sort of creativity in mind it becomes obvious that they

too are based on other types of objects. Thus the body of type C is almost certainly based on a cylindrical style of bowl-stand to which has then been added a vertical foot or base, and a sunken shoulder, the latter being suggested by the hollow centre of such a stand. Equally the body of style D is based on the octagonal bronze stands of the period (stands B), which not only have eight flat and inward-sloping sides, but also a cusped rim with sharp points, re-emphasised in the candlestick form by the use of bosses. Furthermore, the octagonal stand style, in which the central hole does not appear as an empty chasm as it does in the cylindrical form, is reflected in the candlestick's shoulder which is less sunken than in C. In both cases the sockets are miniature copies of the body forms.

B style is thus a copy of D in a medium considerably less appropriate to the angular form and for this reason B/1 has lost some of the latter's more striking features. F is a geometric development on D. E is a refinement of C, possibly but not necessarily via a simplified beaten metal intermediate version. This latter form E was destined to become the most popular style, judging by the numerous surviving examples (34 are listed by Rice 1954 p.14), and this is no surprise. Its simplified form, its fine proportions, its smooth curves and decorated surfaces, give it a strength and balance which is unmatched by any other Islamic candlestick type, and which may be acclaimed as being as near to perfection as is humanly possible.

As a postscript certain aspects of the above discussion should be brought out. Firstly, despite a general lack of surviving beaten bronze objects from north-west Iran in the early 13th century such work was evidently done, witness B/1. Secondly, the comparison of the candlestick development in the north-west with that of stem bowls should one day be taken further by chemists. For it is tempting to

think that the cast candlesticks of the north-west, like the stem bowls, are of high tin bronze, witness their pale colour, and analyses of various examples would allow additional conclusions to be drawn about the nature of the high tin bronze as opposed to ordinary bronze industry of that area at that time. Thirdly it cannot be emphasised too strongly that these north-western objects are the products of men of an imagination and creative ability unsurpassed by any of their contemporaries or predecessors in the early Islamic metalworking industry of Iran: they had a feeling for form and a courage in adopting and reusing extant shapes which is of the highest merit.

Lamps

Lamps may be divided into five main groups: A, those with round bodies and spouts; B, those with open, pear-shaped bodies; C, those with dish-shaped bodies; D, those with bodies of zoomorphic form; E, hanging lamps. The most numerous and diverse group is A, in which nine particular styles may be singled out (1-9), within almost all of which there are variations in detail. Apart from group E, all the lamps are cast. The only pieces which have been analysed (A/1/3, A/2/1, A/4/V.1, A/7/3, C/1) suggest that a quaternary alloy of copper, zinc, lead and tin was usually used, though the Sīrāf piece is an alloy of copper and lead. The detailed differences of form in group A are given in the catalogue and will not be repeated here, but it should be pointed out that A/7-9 have certain features which do not appear on A/1-6, and the latter groups will therefore be discussed first.

Comparison of the general form of groups A/1-6 with other metal lamps known in the Near and Middle East shows that they derive either from Greeko-Roman lamps of an earlier era or from their Byzantine successors. Group A/5 provides the closest parallels to such classical pieces,

A/5/1 being very similar to a Roman lamp in the British Museum (Walters 1914 pl.8 no.105) and to a Parthian lamp from Susa (Ettinghausen 1965 pl.13-14 and p.219), and A/5/2 and 3 being very like an early Christian or Byzantine lamp in the British Museum (Walters 1914 pl.6 no.104). Group A/3 too has much in common with classical types, and A/1 and A/2 can also be explained as evolutions from the classical form, the spout having developed an ever larger mouth, until the mouth and central opening in the body joined up.

Comparison with the classical lamp forms brings to light certain characteristics relating to the way lamps were used in pre-Islamic and Islamic times. Many Roman lamps have a ring foot and these were obviously made to stand on something; many on the other hand have eyes attached to their bodies which were designed to take chain hooks to enable the lamps to be suspended. This latter use seems to have been unknown in Islamic Iran, or at least no such eyes have survived - where eyes do occur they are in positions which are useless for suspending the object, and their purpose remains an enigma (e.g. A/6/1).

Featured on many lamps are small flanges or bosses which occur on either side of the body. Such additions are not normally found on Roman bronze lamps but do occur on one type which was suspended by means of a solid bronze bar with a hook at the top and a fork at the lower end, each prong of the fork fitting onto a projection on either side of the body of the lamp (Walters 1914 pl.4 no.97). It is possible that the Persian flanges or bosses are derived from these projections, and A/5/2-3 are tempting evidence to support this, for they both have a decorative ridge running from boss to boss around the back of the body, and the curve of this ridge around the boss, especially on 3, strongly suggests that it is imitating a bronze wire hanging mechanism. On the other hand the flanges which more

normally occur on the Persian pieces are far from such practically conceived projections, and probably indicate that if such a hanging mechanism was used in Islamic Iran it went out of fashion very early.

Almost all the lamps in groups A/1-6 are undecorated, and attributions of date and provenance must therefore be based on other factors. Fortunately 12 pieces come from known findspots, or at least findspots within known areas: A/1/1 Nīshāpūr, A/1/3 Sīstān, A/1/4 Herāt, A/1/5 Nīshāpūr, A/2/1 Sīstān, A/2/2 Nīshāpūr, A/3/1 Shahristān, A/3/3 Dandānqān, A/4/V.1 Sīstān, A/5/1 Maimāna, A/5/2-3 Ghazna. Since a great deal is known about the styles of metal objects produced in Khurāsān and Sīstān in the 12th and early 13th century, particularly with regard to their decoration, it may be assumed, with perhaps one exception A/3/4, that these objects are not the products of this later period: most of them have no decoration at all which would be most unusual, and those that have decoration bear motifs which are not common at this period but rather represent 10th-11th century tradition, for example the knot patterns on the two lamps from Ghazna. A pre-1100 dating for groups A/1-6 is also suggested by the existence of lamps of type A/7 which are definitely post 1100 (see below), and by the fact that ceramic lamp types related to groups A/1-6 occur at Nīshāpūr in the 9th and 10th centuries (Wilkinson 1973 pp.233-4, 245 no.14-16). A 10th century dating is confirmed by finds of similar lamps at Paikand near Bukhāra, and at Samarqand (Kondrat'eva 1961 pl.8; Tashkhodzhaev 1967 fig.9).

Given that the origin of the spouted form is classical it might be postulated that some of the undecorated lamps in the groups in question are very early Islamic or perhaps even late Sasanian. This can be discounted on two grounds. First of all a number of lamps were found on particular sites where such a dating is highly unlikely.

Secondly, the widespread use of a ring handle with a thumb piece of varying size and elaboration (cf. handles C) seems to indicate a late 8th century date at the very earliest. This is for the following reasons. The classical bronze lamp form had a long spout and a rounded body, but it very rarely had a ring handle, usually being suspended by chains from small eyes, or else having a handle of tall, curved form ending in an animal head. Nor were such ring handles at all widely used for other classical objects: they appear in pairs at certain periods on cups but remain very uncommon. The widespread use of such handles for lamps must therefore be dependent on another tradition, and this other tradition seems to be that of Soghd, where ring handles with or without thumb-pieces were widely used not only in metal but in pottery for a variety of vessels (Marshak 1961,1971). Infact pre-Islamic Soghd might aptly be described as a "ring-handle" culture. In this situation it was probably only with the conquest of Soghd by the Muslims and the spread of its inhabitants and craftsmen in the 8th century that such features would have begun to appear in the the neighbouring territories. Hence, lamps of types A/1-6 are probably to be dated between about 800 and 1100 A.D., though where any particular example falls within those 300 years it is impossible at present to say.

The shape of lamps in group A/7 differs from that of all the preceeding groups in the way the body and spout have become almost one unit of form. The rear of the body is rounded, the front curves smoothly inwards ending in the spout, and it is impossible to say where the spout begins or ends. Only on the flat top, which usually drops by a millimetre or two before the open mouth of the lamp, is there any hint of a division. While the flat top and hinged lid may be explained by reference to group A/4, where are also to be found

examples of projecting bosses below the spout and a similar shape of mouth, the unification of spout and body goes far beyond anything visible in any of the groups hitherto discussed. The source of this style seems to be ceramics. As already noted, the most notable pottery lamp form in 9th-10th century Nīshāpūr was similar to the earlier metal groups, with a longish spout and large loop handle, but in that and later periods another form appeared, bearing a small, pointed spout formed by pressing the rim of the ceramic body outwards. This latter type appears to have taken over from the long-spouted form during the later period, the join between spout and body becoming ever more pinched in appearance, and the long-spouted form had virtually disappeared by about 1100 (Wilkinson 1973 p.245 no.17,18,22 p.278 no.5,9). If this association of the later pottery style with group A/7 lamps is valid, it is no surprise to find that the decoration on the metal lamps points to a date after about 1100, since by that moment the pottery fashion had changed in the north-east. One concludes that spouts were considered a necessary part of metal lamps in the north-east, and could not be abandoned altogether, but that lamp styles were modified to suit prevailing ceramic taste.

The decoration on lamps of group A/7, as already implied, points to east or north-east Iran in the 12th or early 13th century, and their provenance is emphasised by the findspots of certain examples. Thus there are three known pieces from Ghazna, one from elsewhere in Sīstān, and one from Swat. The finding of a handle of a type associated with these lamps at Rayy (bronze handle D/1) indicates, however, that they were known elsewhere in the country, though whether they were made there or not one cannot at present tell.

Group A/8 is closely related to A/7, but has a spherical body with vertical ribbing. The decoration of A/7/1 is sufficiently non-descript to make the dating difficult, though it is probably 12th century. Presumably too it is north-east Persian. The great thickness and weight of the two known examples, and the pale alloy used, combined with their particular form, point to their being products of a single workshop whose other products have yet to be encountered (though cf. lamp D/4).

The last round-bodied, spouted bronze lamp to be discussed is the piece with a baluster stem and dish base found at Rayy (A/9/1). Pottery pedestal lamps were known in classical times, though they were not common (Walters 1914 pl.11 no.398), but they became popular in early Islamic Iran, and for example occur in fairly large numbers at Susa (Rosen-Ayalon forthcoming pp.129-30). The closest parallels for baluster stems in conjunction with dish-bases, however, are north-east Persian, for example in Nīshāpūr 9th century splashed ware and monochrome ware, and 11th century or later alkaline-glazed wares (Wilkinson 1973 fig. on p.56; pp.234, 245 no.17; pp.267-8, 281 no.25). A similar style is found at Balkh in the 11th-12th centuries (Gardin 1957 pp.66, 68) and at Lashkarī Bāzār (Gardin 1963 pl.28 no.548). All these, however, bear open lamps with pinched spouts. The only published ceramic examples of a round-bodied lamp with tubular spout are a lamp from Qaşr-i Abū Naşr near Shīrāz, which could be of early Islamic date, and an alkaline-glazed lamp from Nīshāpūr (Hauser and Upton 1934 fig.24; Wilkinson 1973 p.267 fig. at bottom right). One cannot ignore the Qaşr-i Abū Naşr piece, but the popularity of the baluster stem and dish-base in the north-east and east of the country suggest that this is a more likely source of the form as it appears at Rayy, and in view of the decline of popularity of traditional style spouted lamps after about 1100 this particular piece is probably 11th century.

In type A lamps two different influences have so far been discerned. Group A/1-6 are all based on pre-Islamic bronze forms: A/7-8 are primarily continuations of that tradition but in one important aspect have been modified by ceramic tradition; A/9, although its lamp form ultimately derives from the same classical bronze tradition, is a copy in bronze of a ceramic type of baluster-stemmed, dish-based lamp. Ceramic influence is once again apparent in the pear-shaped lamps of type B and dish-shaped lamps of type C.

In group B all the objects are by no means identical, but all have one important feature in common - an open and approximately pear-shaped body. In 1 it is partially covered by the inturned sides; in 2 it is very open and shallow; in 3 it has three feet; in 4 and 5 its stylish rim, flanges and handle give it great elegance and dignity. All the pieces appear to be cast bronze, the handles and feet in the cases of 1-3 probably being cast separately and then soldered on. The use of these objects has only been discussed by Scerrato (1964 p.685), who suggested that 3 was a guttus or lamp-filler, apparently on the basis of D.S. Rice's feelings on the subject. (Rice incidently claimed to know of others in Leningrad of this type and to have bought one on the London art market.) While such a possibility cannot be denied, and while indeed the point with which all these objects terminate would be useful for pouring purposes, they could have been used just as successfully as lamps, the wick lying in the point. No one has after all felt the need to suggest that pottery objects of a similar form (Wilkinson 1973 p.245 no.20-21) are anything but lamps, and the lamp-fillers of the classical world were of a quite different shape, with a round body and the spout at right angles to the handle.

The ceramic influence on the pear-shaped form in general is best seen by discussing the objects in turn. Thus 1, with its rather rounded

pear-shaped body and ring handle is paralleled by excavated Nīshāpūr lamps with a green glaze, a yellow glaze, and with black slip-painting (Wilkinson 1973 p.245 no.18, p.211 no.10-11, p.125 no.75), all of which are in a size close to the bronze object, and 2 is of virtually the same shape only lacking the rounded shoulder and with a flat handle instead of the ring style. From these parallels the Nīshāpūr bronze lamps are likely to be 9th-11th century in date.

Four and 5 do not relate so closely to Persian ceramic parallels, owing to their wide rims, flanges, and lobed handles. Lobed handles and flanges are of course found on Persian cosmetic mortars (see p.348) so that their presence does not indicate a non-Persian provenance, but rather that they are further away from the ceramic origin of their basic form. On the other hand there is a striking parallel to their style in a ceramic lamp in the Museum at Sanchi (Hamid et al. 1922 no.c.612, pl.21) which is said to be Gupta or medieval: it is very similar in shape but has a less elaborate spout and a handle consisting of an "ornamental fantail projection". One object is not enough to allow the accurate provenancing or dating of these two bronze objects, but they could well be from eastern Iran or its neighbouring lands, and like the Nīshāpūr pieces 9th-11th century.

An eastern provenance for 4 and 5 is also supported by the form of the body of 3 which was found at Maimāna in northern Afghanistān, and which is of the same rounded, pear-shape though without the elaborate rim. Ultimately, like them, this must have ceramic origins. However, its three legs, each in the form of a booted human leg and foot, may indicate, as Scerrato suggested, that its more immediate origin is to be sought in certain theriomorphic cups. Undoubtedly there is a strong resemblance between the cup with the bull's head handle found in the Nagyszentmiklós treasure (Alföldi 1951 pl.8 no.2) and the Maimāna piece,

even though the latter is highly stylised to the point where the three legs and the height of the handle are virtually all the relevant detail that is left in addition to the general form. Related earlier pieces have been discussed by Alföldi(1951 pp.144-9) and the few later examples noted by others (see Scerrato 1964 p.685). These suggest that this object is part of a very ancient tradition which has continued almost to the present day although so few surviving examples offer all too little certain evidence. The palmette on the handle perhaps suggests a 10th century date, the ring handle shows again the influence of Soghdia, while the boots evidently have Central Asian origins (Scerrato 1964 p.686): hence it is possible that the object was made in Transoxania and only later came to Khurāsān before being buried at Maimāna, though a Khurāsānī provenance is by no means impossible.

A similar dependance on ceramic style is to be seen in bronze lamps of group C. Such a style of lamp in pottery occurs in the classical world in the 4th century B.C., if not earlier, and the Romans occasionally manufactured the form in bronze (Walters 1914 pl.39 no.12-13, pl.8 no.109). In early Islamic times the pottery lamp styles of Syria and Mesopotamia followed Roman traditions. Thus at Islamic Ramla in Syria slipper lamps of standard classical form have been excavated (Rosen-Ayalon and Eitan 1969 middle page left), at Sāmarrā in Iraq such slipper lamps are found alongside the open, round classical type with a slight point and solid handle (Baghdad Department of Antiquities 1940 II pl. 54,60), and at Susa the latter is the predominant from (Rosen-Ayalon forthcoming pp.124-133). Given therefore that the Islamic examples of dish-shaped lamps in bronze with known provenances come from Susa, Sīrāf and Banbhore, it is evident that they are based on the south Mesopotamian and Khuzistānī ceramic style of the early Islamic period, and that in these objects at least lower Iraq ,

the Gulf coast, and the edges of the Indian Ocean were in some sense a cultural unit. Since the Sīrāf piece from its archaeological context cannot be earlier than 1025 A.D., it is evident that such a cultural link continued well into the 11th century if not later.

The three major groups of bronze lamps discussed so far thus indicate some important facts about the bronze industry and general cultural patterns of Iran in early Islamic times. In the first place it may be that, in this type of object at least, metalwork borrowed from ceramic, and that such borrowing occurred in the east and north-east as well as the west. In the west it is in a sense to be expected, since Mesopotamian culture was bound, by nature of the natural resources of the area, to be ceramic-orientated. But it is perhaps surprising in the north-east where all the evidence points to a very strong metal working industry. Secondly, not only did lower Khuzistān, the Gulf, and the edges of the Indian ocean share a tradition, as already noted, but that tradition was in complete contrast to anything known in the north-east of the country, even the bronze copies of ceramic objects in the latter. Since Mesopotamia and Iran were equally open to the influence of classical metal designs, a ceramic-orientated culture in Mesopotamia and a metal-orientated culture in north-east Iran do not fully explain this situation. One might suggest, however, that whereaspottery objects and styles could reach Mesopotamia without difficulty, the Zagros and the subsequent distances to the lands nearer the Oxus meant that only the sturdiest objects arrived intact, in this case the bronze ones. If a classical lamp style was to be adopted in the north-east therefore, and one certainly was, then it had to be the bronze style.

Of the two groups of lamps still to be discussed D is a zoomorphic form, and E a hanging form. The four objects in group D are very

strange, and exactly which animals they are supposed to represent is not at all clear, except perhaps 2 which may be a boar. The only vaguely comparable earlier lamps seem to be the Roman type in the form of human heads, which have the same pointed mouth (Walters 1914 pl.12 no.413). The only comparable objects in Islamic art seem to be the small ceramic lamps in the form of pigs or rats which occur on the rubbish heaps of Fusṭāṭ and may be late medieval. One other point about them may one day turn out to be significant - the likeness of the metal used for 4 and that used for the two pear-shaped lamps in Berlin (B/4-5), a very pale bronze which may have a high proportion of tin in it.

The various hanging lamps and lamp fragments listed in the catalogue have been discussed in some detail by Rice (1955a), and there is little to add to his conclusions. Lamp 1 came to the Art Institute in Chicago together with fragments which have been given the number 2. Their origin is unknown, but Rice suggests, on the basis of the inscriptions, that 1 is late 9th or early 10th century, and that the other fragments are probably contemporary. He adds (p.214):"Elements for a geographical localization are lacking. Persia is not an unlikely place of origin for these lamp fragments, as a comparison with similar pieces found at Rayy will show". His study of the Rayy fragments lead him to conclude that the latter were probably discarded in the early 13th century, and that they variously date from the late 9th or early 10th century up to the late 12th century (Rice 1955a p.223).

The same form appears in pottery in the 11th-13th centuries, in an alkaline-glazed lamp from Nīshāpūr (Wilkinson 1973 pp.264,277 no.4) which is dated by Wilkinson to the late 11th-12th century, and in a Saljūq white ware jug of the same shape but with a short spout in

one side (Lane 1947 pl.38A). Such pieces are obviously derivative, but whether the metal objects are the basis of the tradition or whether they are derived from a glass form, as Wilkinson (1973 p.264) seems to imply, is not clear: the earliest known examples of the form in glass (Rice 1955a pp.225-6) seem to be contemporary with the earliest in metal.

Lampstands

All the surviving stands for oil lamps from early Islamic Iran are basically of the same form and consist of three parts: a base with or without feet, a tall shaft, and a flat tray top. For convenience they have been divided according to the shape of their bases, A convex with feet, B with concave lobes and feet, C convex without feet, and type A has been further subdivided according to the form of the shaft used. All the examples appear to be cast, and the one piece analysed (B/5) suggests that a quaternary alloy of copper, lead, zinc and tin was probably usual. Piercing is common, so too is incising; inlay is rare, the only example being B/3,7 and 11. Great caution is needed in studying these objects since the fact that they are in three pieces means that complete objects can easily be assembled by a dealer, museum official, or private collector, from items which originally belonged to different lampstands. By looking at some of the pieces myself I have been able to weed out a few which do not seem correct as published, but there may be others whose differences are undetectable until one has them in one's hand or looks at them under a magnifying glass. Hence, while it would appear, for example, that lampstands of type B always have shafts made up of small spherical-bodied or baluster units it would be rash to base any

general conclusions on that specific one, and such observations are therefore omitted from the following discussions.

Proof that these objects are lampstands is provided by illustrations in Iraqi manuscripts of the late 12th or early 13th century, where they are depicted standing on the floor inside dwellings, bearing oil lamps of various types. Thus in the 1222 A.D. De Materia Medica is a picture showing a lampstand apparently with a cylindrical shaft with hemispherical-bodied units above and below, while in the 1199 A.D. Kitāb al-diryāq are pictures showing lampstands with shafts totally made up of such units (Kühnel 1922 pl.4; Farès 1953 pl.7-8).

The dates and provenances of the known examples of the various groups have to be deduced for the most part from their decoration. In group A there appears to be a range from the 10th or early 11th to 13th century. A/1/4 should probably be dated to the late 10th or early 11th century on the basis of its strapwork and palmettes (cf. Tashkhodzhaev 1967 fig.15,17), while A/1/8 appears to have decoration of a decadent early 13th century type. In group B a similar range also exists. B/5 represents the earliest style with its 10th or early 11th century palmettes, while B/1-3 all have designs typical of the 12th or early 13th century. The known examples of C should all probably be dated to the latter period, though a stand in Boston (unidentified objects F) has a base which appears to reflect style C as much as style A, and it is therefore possible that C existed already in the 11th century.

Turning to the provenances of the various pieces, a certain number come from known findspots or areas. Thus A/1/5 is from Maimāna, A/1/6 from Dandānqān, A/1/7 from Afrāsīyāb, A/1/9 from Bukhārā; A/2/1 is from Ghazna and A/3/1 from Maimāna; B/1 was acquired in Bukhārā,

B/2 in Tehrān, and B/11 in Egypt; C/2 is from Ghazna. Excluding B/11 which was evidently exported to Egypt, the findspots suggest that the centres of production were somewhere in Transoxania, Khurāsān or Sīstān, and this is further emphasised by the nisba's of the two craftsmen whose names are recorded: Pāydār ibn Marzabān al-Qāyinī (B/3), and Aḥmad ibn Muḥammad ibn Hārūn al-Haravī (lampstand shaft 5). These nisba's do not of course prove that their owners worked in Qāyin, the chief town of ~~Sīstān~~ Kūhistān, or in Herāt, but they do back up the evidence of the various findspots in pointing to an easterly or north-easterly area of production. Whether the Tehrān piece was found there or brought there to be sold from further east there is no way of telling, but it would be rash, in view of the appearance of such objects in Iraqi manuscripts, to deny the possible existence of workshops producing such objects in the west or north of the country.

The origin of these Persian lampstands is to be sought in the classical world, for the Romans commonly used objects of similar style. Like the Islamic examples they were usually made up of three pieces (base, shaft, and tray), but they sometimes had a spike on top rather than a tray. This spike either held a candle, or, more rarely, fitted into lamps with specially designed tubular sockets. The bases were often given three animal feet (Richter 1915 pp.365-6). Variations on this form in bronze or silver continued to be widespread under the Byzantine empire, and baluster stems became very popular (Dalton 1901 p.81 no.376 pl.22, p.100 no.495-6 pl.26). From Byzantine territory they evidently passed to Iran, for one was found in a late Sasanian context at Qaṣr-i Abū Naṣr near Shīrāz (Hauser and Upton 1934 fig.33, 36). This latter object is of the greatest importance in illustrating the development in shape that took place to produce the Islamic group B. For it is based on a typical Byzantine style exemplified in the

Lamsacus silver lampstand (Dalton 1901 no.376) with its expanding hexagonal base of smooth curves and its baluster stem. The development of this body form in Byzantine times can be seen in a style in which the six sides take on a more concave form and a projecting boss appears midway between the legs attached to the edge of the base (Dalton 1901 no.495), while the baluster stem also undergoes transformation, being subdivided into smaller baluster stems one above the other, sometimes retaining a tall central portion, sometimes using smaller balusters all of equal size. These developments of both body and stem are represented by the Qaşr-i Abū Naşr lampstand, in which the body has become deeply lobed and the shaft is made up of four roughly equal balusters. The form of group B is extremely close to this Byzantine or late Sasanian style, and perhaps its most striking aspect is the fact that apart from the variation in the projections and feet, and the emphasis placed on the outer rims of the body lobes, this form continues unchanged from late Sasanian times until the Mongol invasions: a remarkable example of conservatism of taste.

The origin of group B of the Islamic Persian lampstand is thus clear, and so too is the origin of the general form of all three groups, A and C included. But the bases or bodies of A and C also call for some explanation. The A body is an extremely simple one, and looks like a stem bowl with a wide flat rim which has been inverted onto three legs. However, a certain amount of complexity is added by the projections from the edge, consisting usually of a bird's head either side of each leg top and sometimes some sort of vegetal projection midway between each pair of legs. Given the earliest dating of Group B it seems unlikely that a stem bowl should have been the source of the design, since the surviving examples of stem bowls from Iran are all considerably later, and it is thus more likely that the body is

an inverted stemless bowl form, to the top of which has been added a suitable fitting to hold the shaft, such a fitting being readily derived from the traditional classical forms of lampstand. The shape of the bowl is in this case hardly likely to be informative, since in different metalworkers' hands it would easily have been modified, and indeed individual examples within group B do have slightly different profiles. As a result of this it is impossible to deduce from the main part of the body when this fashion in lampstands was inaugurated. The edge of the body is rather more helpful since it has characteristics in common with other metal object groups. For example bronze ewers A/1/a have a wide flat rim with an animal or bird type of head projecting on either side, and A/1/d have a bird head projecting on either side of the handle top at the rear of the mouth. The latter are so close to those on these lampstands that some sort of connection can hardly be denied. It is interesting to observe that both those groups of ewers grew from an Iraqi or west Iranian tradition based on classical prototypes, and this is all the more significant when one realises that the only other vessels with a rather wide lip and projecting trefoils or similar motifs are cosmetic mortars which are also likely to be of more westerly origin (see p.351). The ultimate classical origin of the projections on the lampstand bases is clear from surviving classical objects (e.g. Strong 1966 pl.34), but the evidence of the ewers suggests that the impact of the tradition was first made in Iraq and only after that passed to Iran. It therefore seems possible that this was the situation with regard to lampstands of group A: faced with a complex classical body form some particular group of metalworkers in Iraq or western Iran used the simplest possible design of an inverted bowl instead, adding to it a wide rim and various projections, also of classical inspiration, plus the legs and stem fitting of the original

form. This style, along with the original style (group B), then passed into the repertoire of the metalworkers of north-east Iran, where it was probably first used in the 10th century.

It was undoubtedly upon A that style C was based. In essence the body is of the same shape, but two or three complete steps have been introduced in place of the three legs. The size of C/1 is unknown, and C/3 is of average dimensions, but C/2 is such a large lampstand as to demand the sort of architectural appearance which it has in fact been given. Whether the craftsman was inspired by the Buddhist stupas of the Swat valley which seem to be reflected both in the form and in the arched windows looking like niches, one cannot be certain. It is certainly a tempting thought, however, particularly as this would approximately fit with the Ghaznian origin of the piece. It is interesting too to note that the unidentified object with a comparable base form mentioned above is also of monumental size, suggesting that this very solid style might have come into use for large objects and then become fashionable for those whose weight did not necessarily require such support.

Polycandela

Polycandela were widely used in the 6th and 7th centuries in the Byzantine world (Elbern 1970), and this sole surviving Persian example is obviously based on such a model. The rarity of the form in Iran indicates that this was probably an experimental piece, and the use of projecting birds' heads in profile suggests that it was produced by a workshop manufacturing lampstands, on which the motif is common. The style of inscription points to a 12th or early 13th century date, and the decoration in general to a Khurāsānī workshop. Its primary interest is as a freak, for it adds little or nothing to our knowledge of the Persian metalworking industry as a whole.

(4) Measuring Equipment

Two balance-pans and a variety of bronze weights are the only survivals of an industry which must have been as important in early Islamic Iran as it still is today (Wulff 1966 pp.61-5). Balances (mīzān) and steelyards (qarasṭūn) belong more properly to a scientific study, witness the numerous writings by medieval authorities on the theory of the balance (EI_I al-mīzān; al-ḳarasṭūn) as also al-Muqaddasī's telling statement (p.141) that balances were made in Ḥarrān, Ḥarrān being the earliest Islamic centre for the making of astrolabes, and therefore the centre of the scientific industry. It must have been from such workshops that the extremely accurate instruments demanded by scientists such as al-Khāzinī came (Khanikoff 1860). On the other hand, as today, large numbers of balances and steelyards would have been required for commerce, particularly in the medieval bazaars, and these would have been made locally. The larger ones were probably of steel, the smaller were probably of bronze. Two illustrations of smaller balances are known from the period. One in the Varqa and Gulshāh manuscript shows balance-pans of stem-cup shape (Melikian-Chirvani 1970b fig.1); another in the Kitāb al-diryāq manuscript shows balance-pans of full hemispherical shape (Farès 1953 pl.11). The two surviving examples of such pans are shallow and rounded, and both are probably the products of the same Sīstānī sheet brass workshop in the 12th or early 13th century.

(5) Writing Equipment

Inkwells

In antiquity and the Middle Ages, in Europe and the Islamic world, there were two standard types of ink. The first had a soot base and was known in Arabic as midād, the second consisted of a mixture of gallnuts and vitriol and was called ḥibr (Theophilus pp.42-3; Levey 1962, expecially p.13 n.53; Stapleton et al. 1927 p.349 n.2; Qaz I p.226). Detailed descriptions of large numbers of each type of ink given by the Zīrid prince Ibn Bādīs (1007-1061) in his book on writing (Levey 1962) show that both types were used in Islam. The soot inks were made into cakes and then dissolved in water as required, like Chinese inks, while the tannin inks were generally made direct into liquid form, though Ibn Bādīs also mentions some "dry" recipes which would keep until needed. It was the employment of tannin inks in their permanently liquid state which necessitated the use of inkwells, as the Arabic name for inkwell, miḥbara , indicates, though a simple device called a līq, consisting of a piece of ink-soaked felt or wool inside the inkwell, prevented the liquid slopping around. A līq also had the advantage of cleansing the pen each time it was dipped and holding the ink in a state of suspension, though it could not be used with a brush (Levey 1962 p.13 n.55).

In view of the apparently widespread use of a līq in the early Islamic world, the form of the inkwells under discussion in this chapter is somewhat provocative. The wide inner rim seems to be a splash preventative, suggesting that no līq was used, and if the sheer size of many examples is added to this, one might legitimately surmise that the wells were used by artists working with brushes not pens. However,

the evidence for a scribal use is very strong: the Baghdād Ḥarīrī manuscript of the early 13th century shows such an inkwell in a scribal context (Ettinghausen 1962 p.106), the owner of inkwell B/32 styles himself al-mushrif ie. inspector of the court treasury (Baer 1972 pp.199-200), and the inscription on inkwell A/1 indicates that it was owned by a scholar, not an artist. One can only wonder at the enormous quantities of ink that must have issued from bureaucratic and scholarly pens and the wealth of manuscripts that has disappeared over the intervening centuries.

Surviving Persian inkwells of the early Islamic period fall into three groups, called here A, B and C. All are cast, and the one piece which has been analysed, B/3/13, which is an inkwell lid, has proved to be a quaternary alloy of copper, lead, zinc and tin. Group A, of which only one example is so far known, has a slightly bulging cylindrical body with flaring rim and foot, and a lid with a deeply concave edge. Group B has a very slightly inward sloping cylindrical body and a lid with an almost vertical edge and domical top piece. Group C has a body which bulges slightly above the base. Group B is subdivided according to the shape of the top of the lid, which may be almost spherical, conical, six-lobed, eight-lobed, or zoomorphic. A further group (B/6) consists of bodies of such inkwells whose lids do not survive and which cannot therefore be included in any of the preceeding groups.

Dealing with each group in more detail the one surviving example of group A is striking for the peculiar form of its lid. It fits so exactly that it is obviously part of the original object, and yet it is so entirely different in concept from the body that it can scarcely represent the peak of development of a long tradition: indeed, quite the opposite, it has all the appearance of being an amalgamation of

two disparate objects. The body form is similar to a Roman inkwell shape (London British Museum 1908 fig.196), but the size difference between such Roman inkwells and this Persian object is so great as to make the likelihood of a relationship between the two very unlikely. More relevant is the fact that the body shape is virtually identical to that of a particular type of bronze mortar (C/2), and that if the lid is turned upside down it is then very close to the incense-burner dish form used in Iran in the 12th-13th centuries (bronze incense-burners F). Hence it would appear that this inkwell, whose use is incidentally proven by the inscription, derives its shape from two other object forms. This is not all, however, for the lid once had a central domical top of some sort as is proven by the round sunken area in the centre with its roughened surface. If one reconstructs this in one's mind it is evident that the object originally had a very architectural form: a cylindrical structure with a flat roof and central dome. It may therefore provide evidence of the influence of architectural forms on metalwork as suggested by Aga-Oglu (1943) for a group of ewers. Turning to its date and provenance, both these depend on the attribution of the inscriptions. Those on the body are in a form of kufic quite different from that on the lid, indicating more emphatically than ever the usual problem of placing any particular example of kufic in its correct historical situation. I have been able to find no close parallels to either form found on the inkwell, but an 11th to early 12th century date is probably not far out. There is no way of telling where exactly the object was made, though on the basis of the two conjoined forms probably in east or north-east Iran. A further point about this object should be noted - the way it was carried. For it has three holes in the lid, below which are three cylinders cast in one piece with the body and running down the sides of the body at three equidistant points. Hence the inkwell must have

been carried on three cords knotted underneath, coming up through the body and lid, and then joining again some way above: a very practical system.

Turning to group B, the shape is much simpler, being almost perfectly cylindrical, but there is a wide variety of forms for the top of the lid - conical, lobed, zoomorphic. There is also a wide variety of design layout used, and one can count about seven distinct systems. The most common consists of three bands of decoration on the body, one or two of the bands usually being inscriptions (B/2/2, B/4/1, B/3/3, B/6/6, B/6/8, B/3/4,B/6/2 and B/3/12), while other popular ones are seated figures or floral designs in cartouches with roundels (B/3/2, B/3/5, B/6/2, B/6/4), and zodiacal signs (B/2/1, B/3/10, B/6/1). The script used on group B inkwells, whether kufic or naskhi, and the forms and details of the designs used for their decoration, are typical of the bronze objects generally ascribed to Khurāsān in the 12th or early 13th century, and this provenance is supported by the nisba's of two of the craftsmen who signed their work, Muḥammad al-Harawī (B/3/3) and ʿAbd al-Razzāq al-Nīshāpūrī (B/3/4). In addition, in one particular case (B/6/2) the design is very similar to part of the decoration on the Bobrinski bucket.

There is, however, one important exception: the inkwell from Ghazna (B/3/8). This object has an undecorated bronze body but bears a unique form of "overlay": silver plates with niello designs soldered to particular areas of the surface. The three plates with a kufic inscription which adorn the lid shoulder have never been properly published, but from Scerrato's reproduction (1966 pl.16) it is possible to suggest that they bear an earlier form of kufic than the other objects in the group, dating from about 1100.

This inkwell has one further significant feature, which it shares with one other inkwell in group B, the de Unger lid (B/1/1). For both indicate the same suspension system as the inkwell in group A in that the suspension cords went through the objects, and not, as in the rest of group B, through external loops and loop handles. The de Unger lid has an inscription which fits the more general 12th or early 13th century dating of the rest of the group, but its dome-like top has a motif incised on it which suggests a Transoxanian origin. This may appear to confuse the picture, but certain deductions can be made from the evidence that has now been pieced together. First of all it would appear that group B, being later in date generally speaking than group A, is derived in shape from group A. In other words, in the period from the 11th-13th century there was a development of form in bronze inkwell manufacture. Secondly, during this same period there was a change in the method of suspension, the three holes and hollow cylinders allowing an internal cord system giving way to an external system based on three loop handles. The Ghazna inkwell indicates that round about 1100 the new form had come in but the old suspension was still in use, and the de Unger lid may indicate that beyond the Oxus the old suspension system was sometimes retained beyond the period of current use in Iran itself. The change over in Iran seems to have taken place early in the 12th century.

Having brought together groups A and B into a constructive relationship, two questions now present themselves. The first is why the earliest surviving bronze inkwell should appear to be based on a combination of other metal and architectural forms. The second is how the Nīshāpūr inkwell (group C) fits into the picture. Taking the first question first, it is apposite that we should consider what is known of inkwell forms in other media, if no other early bronze examples survive. Turning to the text of Ibn Bādīs it would appear that in his day in

the Maghrib glass inkwells were standard. Their form, however, probably varied (Levey 1962, especially comments on qārūra zajāj p.22). In Iran a glass well was often set into a body of faience or some other material (Grohmann 1967 I p.124, Smith 1957 no.457) alternatively a small glass phial with wide lip was set into a large surrounding glass holder with inturned rim (Whitehouse 1974 pl.12d). But many other forms may also have existed: after all any ordinary shape of small glass pot will serve as an inkwell. Surviving ceramic inkwells of the 10th and 13th centuries emphasise this diversity (Wilkinson 1973 p.43 no.49; Atil 1973 no.45). In such a situation, a bronze caster, asked to make a bronze inkwell, might well have been at a loss for what form to use, particularly if the object required was to be large, and an object of complex inspiration such as A/1 would have been likely to result. Against this background too the small Nīshāpūr piece (C/1) may perhaps be seen as a rendering in bronze of a small glass inkpot shape, with the addition of rim and ridge for a lid. In addition one must take seriously Eva Baer's suggestion (1972 p.199) that another object from Nīshāpūr, catalogued here as unidentified object D is in fact another early form of inkwell.

Having discussed the origins and general development of the various bronze inkwell forms, certain individual examples call for further comment. Much has already been said about A/1, but a little more remains. For the inscription shows that this inkwell was the prized possession of a female scholar, providing an important reminder of the existence of feminine scholarship in the Islamic world. The text also indicates that in 11th century Iran dawāt could be used to mean an inkwell although it is more commonly thought to have applied to pen-cases or writing sets.

Two other inkwells which call for particular comment are B/4/1 and B/4/2. Although these are superficially similar to the inkwells in B/3, both have significant idiosynchrasies. In B/4/1 the proportions are very strange, the dome having become rather squeezed and concave. In addition the loops on the lid are narrower than normal, the clasps on the body more spade-shaped, and the body has geometrical patterns not found on other pieces, although its triple-band layout is common enough. It would therefore seem to be a product of a particular workshop whose inkwells have not otherwise survived, and a town on the far side of the Oxus may have been the location in view of the knots and geometrical patterns used.

B/4/2 is quite different from both B/4/1 and group B/3. Its gently concave form gives it a personality or character which makes the other inkwells look rigid and,lifeless, and speaks for a craftsman of great artistic ability and imagination, while the different method of joining lid and dome also suggests a separate workshop. Although, as Melikian-Chirvani (1973 p.23) points out, merlon decoration is found in the 11th century as a brick pattern, this is scarcely relevant to the dating or provenancing of this particular object. A more valuable comparison is to be made with the various geometrical patterns used on a group of 13th century north-west Persian cast bronze candlesticks (group E). From these it is clear that experiment was going on with such decoration which could easily and naturally have encompased the design on this inkwell, and it is therefore no surprise to find candle-stick E/1 showing a use of rosettes, albeit eight-petalled, very like that on the inkwell. This inkwell is therefore an important object in its witness to the movement of bronze forms westwards at the time of the Mongol conquests, and even more so in its testimony to the skill of the men working in north-west Iran at the time, whose other successes

include candlesticks, such as those mentioned and a range of superb stem-bowls (group A/2).

Pen-cases

All three types of pen-case (dawāt, qalamdān) catalogued here are divided into two compartments. One being long and narrow was obviously for pens. The other, which is usually approximately square, must have been for other items of equipment. Although Qalqashandī in his discussion of writing materials and implements (II pp.455 ff.) does not give any information on this point, Grohmann (1967 I p.123) suggests that this smaller area was probably for the Tintenkapsel, the inkholder, in Arabic ḥuqq. That this suggestion is correct for some examples is shown by an Egyptian wooden pen-case of type C below which still has the remains of ink and līq in situ (Petrie 1927 p.66 no.52 pl.58). On the other hand the fact that pen-cases and large inkwells appear side by side in the illustrations of the 1199 A.D. Kitāb al-diryāq manuscript (Farès 1953 pl.7-9) shows either that the small compartment was sometimes non-functional, or that it was used for other items of equipment as well, such as sand perhaps (Grohmann 1967 I pp.117-127).

There were two different methods of withdrawing the pens. In most examples (B/1, B/3-5 probably, B/8, C/1-3) they were lifted out through a lid in the upper side of the case, but sometimes (A/1, B/7) they were slid out through an opening in the end of the case. (B/5 has no hole at all for the extraction of the pens, and was probably "restored" before appearing on the art market. Whether the main part of B/2 forms a lid or not is not clear from the published photograph, but one imagines that it does.) Sometimes a hole was made in the end of the smaller compartment as well as in its top (e.g. B/8), and

indeed this may have been common, though the ruined state of a number of the cases makes it impossible to tell. In any case such a hole would have allowed a greater number of different items to be stored in the smaller compartment and would have therefore made the case all the more effective in its scope and utility.

The cases are catalogued here according to shape. Group A has a rectangular form, group B a basically rectangular form which narrows from one end to the other, and group C a rectangular form with rounded ends. All three groups also differ from each other in the method of manufacture used. Group A was made by the lost-wax principle (Gyuzal'yan 1968 p.97); Group B consists of objects made from sheet metal and held together with solder; Group C were cast in separate pieces. Given these variations in functional principle, form, and method of manufacture, it is necessary to try and discover whence these variations came and why. The first step must inevitably be to give an approximate dating and provenance to the objects in each group and hence to each group as a whole.

The only example of group A dates from 1148 A.D. and Gyuzal'yan's detailed study of it suggested that it came from north-eastern Iran. There is no dated example of group B but the decoration on B/1,4 and 5 suggests that they are products of Khurāsān in the 12th or early 13th century, by comparison with known Herātī pieces and comparative objects. B/3 though of indifferent quality is probably of like origin. B/2 on the other hand has an unusual combination of motifs in its design, and while undoubtedly of the same period may come from a different area of Iran. B/6-7 cannot be dated or provenanced owing in the one case to the poor state of the decoration, in the other to the complete lack of it. B/8 is a composite object. The cover for the smaller compartment is much later than the rest of the object, and the

cover for the penbox is also later than the body itself. The latter has horsemen and swastika ornament which suggest that it is 13th century northern Mesopotamian work, perhaps from Mawşil. The body has a plaited kufic inscription which is unique on Persian metalwork, as far as I am aware. Its closest parallels are to be found at Marāgha in the inscriptions on the Gunbād-i Surkh, dated 542/1147-8, and the unnamed tomb tower dated 563/1167-8 (Godard 1936c fig. 91,95), and in Mawşil on the Jāmiʿ al-Nūrī (1122-46) and on the great mosque at Amida (1091-2) (Grohmann 1967 II fig.192,195,255). These parallels suggest that the object may be a north-west Persian product and that it is of 12th century date. Group C includes one object dated 1210 which came from Bukhāra and belonged to a ruler who resided in Marv, and is therefore almost certainly Khurāsānī, while the undated pieces in the group bear naskhi inscriptions which must be 12th-13th century. The shape was also common in Northern Iraq and Syria at a slightly later date (e.g. Pope 1938 pl.1336).

From the above it would seem that all three shapes of pen-case are roughly contemporary i.e. 12th or 13th century, and that although Khurāsān was an important production centre other areas too may have manufactured objects of shapes B and C. The only pen-case shape which appears in paintings of the period is C, which is found in the 595/1199 illustrated manuscript of the Kitāb al-diryāq already cited (Farès 1953 pl.7-9). These illustrations show quite clearly the division of the cases into their two unequal areas, and confirm the dating already suggested. They also suggest, however, that such objects were far more popular than the few remaining examples might seem to indicate.

In the face of the sudden appearance of bronze pen-cases of three different forms in the 12th century Qalqashandī (II p.431) supplies some important information about the previous history of these objects. Before

discussing the metals used in his own day for pen-cases he notes that pen-cases require the finest wood for their manufacture, and enumerates a few of the most suitable. From this it would appear that pen-cases were in earlier Islamic times wooden objects. Evidence that this is indeed true comes from three sources. First, there is the indirect evidence supplied by the variety of the methods used for manufacturing the Persian bronze pen-cases which suggests that the metalworkers were utilising non-metal objects as their models. Secondly, there is the evidence of pen-case C/1 whose heavily decorated clasp and hinge pieces must be based on the metal fittings appropriate to a wooden or ivory case. Thirdly, there survives a wooden pen-case of group C shape of Arab or Coptic Egyptian origin, along with wooden Roman pen-cases of a rectangular form also of Egyptian origin (Petrie 1927 pp.65-66 no.48,49, and 52,pl.58). Not enough of the latter seem to have survived to show how the Roman shape was transformed to its 12th century forms, if indeed a direct line of development can be assumed at all, but the available information suggests that this is indeed the most likely origin. It is interesting, as a footnote, to observe that type B seems to have been designed to be carried tucked into a man's belt, being considerably narrower at one end than the other, a tradition still popular until recent times in Egypt, although in later times a different shape developed (Lane 1908 fig. on p.31).

(6) Furniture

Boxes

Amongst the objects described as boxes or caskets in earlier publications and attributed to pre-Mongol Iran are two circular pieces, one of which is in Ankara and the other in Chicago. These were discussed in detail by Rice (1958 pp.239-252, pl.7-12, 14-15, pp.252-3, pl.16), but he himself was tentative about his conclusions, and further study reveals that they are not in fact boxes at all. Rice confessed to doubts as to the unity of the Ankara piece: material published since his time shows that the lid and body are indeed of different origin. The body is similar to a style of high tin bronze bowl manufactured in the 12th-13th century in pre-Mongol Transoxania (cf. Ivanov 1970 no.6-11), but is probably earlier, perhaps of the same date as two as yet unillustrated bowls (Ivanov 1970 no.14-15) said to be 11th century. The lid on the other hand displays a vegetal scroll which can hardly be earlier than the 12th century. True, the drinking scenes appear archaic due to the plant forms between the figures, but these plant forms are probably developments of the bulbous-leaved plants found on objects in a late Soghdian style (Marshak 1971 T.41), and suggest that the lid, like the bowl, was made in Transoxania. It would therefore appear that the so-called casket in Ankara consists of an 11th century Transoxanian bowl with a 12th century Transoxanian lid, and that its form as a result is fortuitous, and may have been the product of a much later era.

The second circular casket in Chicago also appears to be a composite object. The invertion of the script suggests that the body was once the other way up, and when reversed it is at once seen to be the lower

part of the body of a facetted cylindrical-bodied bronze ewer of a type produced in 12th and early 13th century Khurāsān (ewers C/3/b). The cast accessories have nothing in common with pre-Mongol Persian metal styles, and the piece as a whole must be a later creation.

Before discussing surviving box forms it should be noted that the only box-shape illustrated in a manuscript of pre-Mongol Persian origin is one which is not known from surviving pieces. It has a circular or oval, rounded body, and a curved lid (Melikian-Chirvani 1970b fig.1). It may of course be an illustration of boxes in a material other than metal, but the shape would be a natural one for raising in sheet metal, and it is therefore suggested that the information to be derived from surviving pieces is far from complete.

Turning now to surviving examples, four basic shapes are found - circular, octagonal, rectangular and semi-circular. Among the circular boxes three different types can again be specified. The first (A/1) has a slightly inward sloping body and outward sloping lid, and the lid probably had a domical top-piece. This form gives every indication of being based on the inkwell shape so common in Iran from 1100 A.D. onwards (inkwells B), and the styles of inscription which decorate the two surviving examples suggest that they are 12th century Khurāsānī products. The second circular type (A/2) has a cylindrical body with a vertical rim to fit inside a lid, but the exact form of this lid is something of a problem. A pure cylinder form is found in boxes made of ivory in 10th century Spain, and these have conical lids, where they survive (Kühnel 1971 pl.12-13). On the other hand cylindrical ivory boxes made in 13th century Sicily have flat lids (Kühnel 1971 pl.110). If, as seems virtually certain, the cylindrical metal box shape is derived from ivory work, in which it is based on the shape of an elephant tusk, then one would expect the lids to have been one of the two above shapes, unless of course Persian ivory boxes, of which no definite examples survive, had some

other sort of lid. Here it is important to note the lid form of boxes associated with Syria and Mawṣil in the 13th century of which two notable examples survive. One in the name of al-Malik al-ʿAdil II (1238-40 A.D.) is in the Victoria and Albert Museum (Lane-Poole 1886 fig.80), the other in the name of Badr al-Dīn Luʾluʾ (1233-59 A.D.) in the British Museum (Barrett 1949 pl.18). Both these have flat lids with bevelled shoulders and vertical edges, and both pieces are of a size very close to the Persian boxes. In view of the generally agreed westward drift of ideas in central Islamic art during the earlier part of the 13th century, it is fair to suggest that this lid form may have come into northern Mesopotamia with the cylindrical metal box form beneath it from Iran, in which case one could hypothesise that the three lidless Persian boxes catalogued all originally had lids with bevelled shoulders. One could further hypothesise that ivory boxes made in Iran may also have been characterised by such lids. The dating and provenancing of the three lidless metal boxes supports the theory of westward drift, since A/2/1 has decoration which is typical of Khurāsān in the late 12th or early 13th century, while A/2/2, with its sharply hatched backgrounds, its large diamond-shaped leaves, and its swastika roundels must be north-west Persian of 13th century date, and A/2/3 with its stylised leaves must be of similar origin. At this point attention naturally focuses on the one lidded box in the group (A/2/4) which indeed has a lid with a bevelled shoulder such as has been hypothesised for the others. Unfortunately, however, although its body is decorated with a crude kufic inscription against a spiral scroll which could easily be 13th century Persian, the motifs used on the lid are so nebulous as to be extremely difficult to date or provenance. Thus while it was felt necessary to include this piece in the catalogue it is no help in proving the point suggested.

The third circular box type (A/3), and the octagonal form (B), pose virtually no problems. The former has a body identical with that used for incense-burner dishes (F/2) and quite clearly taken from the latter. Bearing decoration typical of the north-west in the earlier part of the 13th century it yet again illustrates the way bronze casters of that area utilised old shapes for new types of object. The same origin may be ascribed to B/1, which is evidently an adaptation of the circular form A/1 above. Its main importance historically is that it allows one to trace the way that the almost cylindrical form was gradually modified until it reached the magnificent 14th century inlaid box shape typical of the workshops of Fārs (Paris Orangerie 1971 no.136 for example).

Group C boxes have already been discussed in some detail in connection with the two surviving silver caskets. Here it need only be repeated that forms C/1 and C/2 are evidently based on an ivory box tradition going back to ʿAbbāsid Iraq, while form C/3, although no parallels to its shape survive, is also probably based on a wooden or ivory box style. Box D/1 is another 12th or early 13th century piece. Unrelated in form to any other Persian box it was presumably designed for a particular semi-circular object. Whether it was based on a box in another medium, or made to order without a model, the lack of fittings prevents one deciding.

Braziers

Although later bronze braziers from the Islamic world are known (Pope 1938 pl.1379; Grabar 1959 no.60), this appears to be the only surviving example from pre-Mongol Iran. Its decoration points to an 11th century date and a north-east Persian provenance. Judging by an illustration of a brazier of similar style in the mid-13th century north Iraqi manuscript of the Kitāb al-diryāq in Vienna (Ettinghausen 1962 p.91), it was designed for cooking purposes. The history of bronze braziers is obscure. They were known in the Mediterranean area in Etruscan times (Brown 1960 pl.37b), but to what extent they continued in use in later classical times, when terracotta was the popular material is difficult to discover. It is possible that braziers were bought into Islamic Iran by nomadic peoples, as perhaps were kabābs. However, the burning of incense in a wide variety of metal objects in early Islamic Iran, and the fact that some at least of these were based on pre-Islamic Persian tradition (see incense-burners), makes a continuous history perfectly likely for metal braziers too, although for the moment all evidence is lacking.

Chairs

The history of folding chairs has been discussed in detail by Kurtz (1972). The Islamic form, though decorated with larger bosses than its predecessors, is based on the chair style used for Roman imperial camp stools, which was in its turn based on a New Kingdom Egyptian model. In the Islamic world in the 12th and 13th centuries such chairs were used in everyday situations (Kurtz 1972 fig.4-5 - Dioscorides manuscript illustration of 1224 A.D.), as well as for thrones (Kurtz 1972 fig.6 - early 13th century Kitāb al-aghāni manuscript illustration). Another illustration of the latter usage incidentally occurs in the early 13th century Kalīla wa Dimna manuscript

in Paris (Blochet 1929 pl.15), where it is shown as the throne of the leopard. The one surviving example from Iran is probably 12th century, and judging by its rather mundane decoration was probably destined for a personnage of little importance. A boss from such a chair was found in the Rayy excavations (chair boss 1).

Incense-burners

Six distinct forms of bronze incense-burner survive - round-bodied (A), square-bodied (B), hexagonal (C), ovoid (D), zoomorphic (E) and dish-shaped (F). Square-bodied incense-burners with handles have already been discussed in connection with silver incense-burners, and the origin of the form is to be sought in steatite vessels of early Islamic times. Whereas the silver examples are close to their models, there is considerable variety in the four surviving bronzes, visible particularly in the forms of lid. B/1 has a square lower lid and an upper lid in the form of an almost complete sphere: the corner pilasters on the lower body are all that remains of the traditional stone leg form found in the silver pieces. B/2 has an upper lid in the form of a hemispherical dome with crenellations around its base, and B/4 a pyramidal upper lid with birds at each corner. The lid of B/3 does not survive,but it is different from the other pieces in having its legs in the middle of each side instead of at the corners. The earliest of the four is probably B/2 with its magnificent pierced palmette designs, probably a 9th century Iraqi piece. B/1 seems to be slightly later and could come from anywhere in Iran. B/4 has no decoration of sufficient character to allow it to be dated or provenanced, though its form looks somewhat decadent compared to the two just mentioned and it may therefore be later. B/3 has a kufic inscription and vegetal design which point to the 12th century, and it is

presumably a Sīstānī piece. From these four bronzes it would therefore appear that the style continued in use in Iran, though never in great quantity, up to the Mongol invasions (cf. handle K/1).

One round-bodied incense-burner is known in silver but has not been discussed in any detail. The large number of surviving bronze pieces of related form now allow it to be placed in context. The bronze incense-burners fall into two groups. A/1 is a handled type with a complete hinged cover; A/2 is a handleless type with a fixed half-cover. In the first group there is a general problem of dating and provenance due to the lack of attributable decoration. Thus 1 and 2 have almond-bosses as their main decorative design, 5 has interlacing circles, 6 and 7 have dots in circles. As Aga-Oglu (1945 pp.30-1) has pointed out, however, 6 and 7 cannot be later than the first half of the 11th century for historical reasons, and the scrolling stem on 3 must be 11th century or earlier, while the use of a pomegranate top finial on 3 and of a finial derived from this style on 8 also point to a fairly early dating. The impression from the bronze objects is therefore that the style is early, perhaps 9th-11th century, and the silver example is thus a late piece in terms of the group as a whole. That the style may well have continued, however, is indicated by the appearance of a very similar looking incense-burner in a painting in the 1237 A.D. Baghdād Ḥarīrī manuscript (Ettinghausen 1962 p.121).

A/1/6-7 call for more comment since they emphasise the variety of forms in use. For the handle found on these incense-burners is of the same shape as a type of leg found on some of the silver incense-burners (A/1-2), and moreover of the same shape as some small bronze objects found at Nīshāpūr, Rayy and Susa (support fittings B/2/b). Since the only objects in silver or bronze on which this form appears are incense-burners, the latter pieces are presumably legs of bronze

incense-burners of the same shape as the silver ones mentioned. There is thus evidence of yet another form being used in bronze.

A/2 is apparently a standardised form of A/1. The handle has been abandoned, and instead of a hinged cover which had to be lifted up to allow the incense to be placed inside a permanent half-cover is used. Although the finest examples have character the style in general is dull in its uniformity and rigidity. Most of the pieces have decoration typical of Khurāsān in the 12th or early 13th century, but there are occasional exceptions. Fourteen for example has a double-bow pattern in a roundel which suggests a Transoxanian rather than a Khurāsānī origin; 15 has a palmette design and a form of kufic which seem to indicate an 11th century date; the findspots of 8 and 10, and the general decadence of 8, suggest that the form was being produced in Sīstān as well as further north.

A curious ambiguity is apparent in some examples which illustrates the derivative nature of the form in general. For one would imagine that the pierced cover was supposed to hide the burning coals and incense from view and to present an elegant and decorative aspect to the assembled company. In certain cases the object supports this supposition: in 9 the inscription is placed on the body below the cover. And yet, where finials have survived they face in the same direction as the opening of the cover, and that opening is often emphasised by elaborate ornament around it. In these latter situations the cover has become superfluous, the eye of the onlooker being drawn in beneath it to the burning coals it was intended to hide. Immovable for want of a handle, illogical in the combination of form and decoration, probably mass-produced, and in many cases designed without any real concern for proportions, these objects point to a real decline in taste and artistry in the 12th century in the north-east and east of Iran.

The origin of the round incense-burner was discussed at some length by Aga-Oglu (1945 pp.29-32), who asserted that they and certain Coptic incense-burners have a common origin, and implied that the former were probably based upon the latter. As evidence of this he cited the settlement of Coptic families in Baghdād after the Egyptian Coptic revolt of 829 A.D., suggesting that they would have taken such crafts and traditions with them. Up to a point his exposition is convincing but there is one particular feature which does not bear close scrutiny: the dating of the surviving Coptic and Byzantine examples of the form. Aga-Oglu offers no proof that any are pre-Islamic, and that proof must be produced if the theory is to be watertight. The problem here is the lack of art historical study of Coptic metalwork, a lack which regrettably cannot be righted within the confines of this thesis. A second point which also requires investigation is the origin of a small ceramic incense-burner from Taxila (Marshall 1951 III pl.65f). With a round body, three elephant feet and a domical pierced cover with a splayed finial, this gives every appearance of being related to the Islamic objects. But its 5th century date can only make it an ancestor of the Islamic pieces, and it therefore contradicts a Coptic origin for the form. Here again, however, the lack of art historical study makes it impossible to draw any conclusions.

In group C, hexagonal-bodied incense-burners, there is only one object. This one piece is closely related to the earliest surviving bronze inkwell (A/1), and differs from the latter only in being hexagonal rather than round, in having retained its domical lid top, and in having pierced decoration. Otherwise it has the same proportions, the same style of rim and foot on both body and lid, and even three holes running through lid and body so that it can be carried about. In this particular characteristic it is unique among Persian incense-burners,

for although they often have handles no other example has a holding mechanism which so strongly stresses the idea of movement. This general lack emphasises in its turn the very sedentary nature of incense ritual in Islam as opposed to the Christian use of swinging censers. C/1 is probably to be dated to the same period as the ink-well, the 11th or early 12th century.

Group D/1 is related to the standard, though by no means common, vase form of early Islamic Iran (p.321). Not only are the shapes of D/1/2-3 the same as the latter but they also retain the neck ring with its classical associations. Their identification as incense-burners is based on their pierced designs. The decoration on these three objects points to an early dating. Thus the palmettes and curious double-bow interlace patterns on 1 and the palmettes on 2 are related to those on 10th century north-eastern ceramics (Tashkhodzhaev 1967 fig.15), and the inscription on the rim of three is related to those found on Ghaznavid high tin bronze bowls, suggesting the early 11th century. The high feet on 1 and 2 also strengthen the evidence for a north-eastern if not Transoxanian provenance (cf. support fitting B/3/1). D/2/1 differs from these three ovoid-bodied incense-burners in having a high shoulder. In this it is related to ewers A/1/d, though of course it has no neck or handle. Its decoration, with its kufic inscription and birds or animals in roundels can hardly be later than the 11th century, and it may therefore provide a link between the use of the form for ewers in 9th century Iraq and its appearance in the 12th century in the north-east.

In group E are a variety of objects of zoomorphic form which make a very different visual impact from those mentioned so far. Five quite different zoomorphic styles are apparent: a lion-bull (1), a lion (2), a partridge (3), an incense-burner with ornithomorphic cover (4), and

another with a central body and three zoomorphic supports (5). Functionally these same objects could be divided up rather differently. E/1 and 3 both have a square opening in the chest through which the incense was placed in the body; E/2 and 4 both have a single piece neck and head unit which could be removed to allow incense to be introduced from above; in E/5 the zoomorphic features of the design have nothing to do with the incense and are merely supports for the incense holder. Having understood this situation it is most convenient to treat the groups one by one in terms of provenance and date.

The one example of E/1 is probably a north-eastern 10th or early 11th century object, bearing designs which should be compared to those on ceramic products of the period (Tashkhodzhaev 1967 fig.21). So too are almost all examples of E/2, with their palmettes or trefoils in interlacing ogival or geometric framing (cf. Tashkhodzhaev 1967 fig.15, 17), and with kufic inscriptions which have every appearance of being pre-1100. E/2/1 is the only dated piece, and at first sight indicates that such objects were being made right up to the Mongol invasions. However, the kufic lettering and the general design have an archaic air about them which suggests that this object was made to be an "antique", and that the style had probably gone out of fashion long before. In size, form and decoration, bearing the name of the owner and the date where all could admire it, this incense-burner has all the pretentiousness of the nouveau-riche philosophy of the rose-water seller who ordered it. Nearly three feet high and two feet six inches long the cost of filling it with incense must have been enormous, and Muḥammad's ~~Ja'far's~~ less well-off neighbours must have been envious indeed of a man who could not only afford to fill the beast but then afford to burn the contents. Surely this is the object which most strikingly

reflects the attitude to wealth and personal possessions described in such literary pearls as al-Hamadhānī's maqāma, al-mudīra.

Less impressive perhaps, but of cultural importance, is the Cleveland incense-burner (E/2/3). This bears Koranic quotations enjoining the faithful to attend the Friday services at the mosque (Shepherd 1957 p.116). Aga-Oglu (1945 p.28) discovered literary evidence that incense was burnt in mosques and religious shrines and this beast was presumably designed for that very purpose. How its animal form was reconciled with Muslim tradition is an interesting point.

Before leaving these incense-burners two structural points should be noted. All complete examples have the head and neck unit attached to the body by a bayonet lock - a T-shaped key which fits into a slot in the base of the neck when the neck is at right angles to its correct position. Among the loose head and neck units known are some, however, which have hinges. They have all been catalogued together for convenience, but it should be emphasised that some may have come from objects more akin to group E/5. Secondly, it is interesting to observe that the incense compartment in 2 is cut off from the rest of the body by a metal barrier which would have prevented the incense fumes coming out of any part of the animal except the head and neck. In some cases at least therefore the piercing of the body and tail of such an animal was purely ornamental.

The partridge incense-burners (E/3), as noted above, have a hole in the chest which connects them with the lion-bull object, and decoratively they have much in common with both of the above animal styles. The trefoils, interlaced six-pointed star, and knot patterns all associate them with Samarqand in the 10th-11th century (Tashkhodzhaev 1967 fig.12, 13,15,17) and the use of hatching or a water-like motif, recalling the

water style found on Sasanian silver bowls, since it is not found on Khurāsānī objects probably indicates that they are in fact products of Transoxania rather than Khurāsān. V.1 is of a slightly different form, and not recognisably a partridge, but its decoration points to the same origin. The history of partridges in Islamic art is outside the scope of this thesis but their association with royalty in early Islam is evident from their appearance in the decoration of Syrian and Iraqi palaces (Herzfeld 1927 pl.48; Hamilton 1959 pl.42). It is therefore no surprise to find them in use in metalwork alongside lions or bulls with all their traditional astrological and political overtones. These partridge incense-burners are incidentally the only metal objects which have survived which seem to have been made as part of a set of objects of the same form. For the same partridge shape was used for incense-holders (see below), and there is little doubt that they were made in the same workshops and sold in pairs.

Compared to these fully ornithomorphic objects incense-burners of group E/4 are clumsy and crude, though 1 is rather morehandsome than 2. The palmettes on 1 again point to a 10th-11th century north-eastern source, as too the punched backgrounds, and although the decoration on 2 is too crude to be attributable with certainty the rosette finial to the handle may well indicate a similar date. In form they appear to be an amalgamation of the round-bodied, handled style of incense-burner (A/1) with the type of zoomorphic interpretation of an object illustrated by the lion form (E/2).

Finally in group E are the incense-burners with three zoomorphic legs. How these came into being is uncertain though E/5/V.1 suggests that they may be related to the dish incense-burners (F). From the form of E/5/3 it is evident that some of the incense-burners may have had a shaft of considerable height and been very impressive objects, and

the existence of a pierced bronze cover (cover 1) which may have come from such a piece, as well as the number of finials (group A) and support fittings (A/2/a), indicates that they were more popular than the number of complete surviving examples would otherwise suggest. Again they are probably 10th-11th century north-eastern products.

The origin of the three-dimensional bird form has already been discussed in the section on aquamaniles. There it is pointed out that the Persian forms are based on a north Mesopotamian style current round about 800 A.D., and that a link between the latter objects and the 10th-11th century partridges is provided by a bronze cock dating from the 9th century. No such early lions are known, but they occur as fountain-heads in Fāṭimid Egypt, and elsewhere in western Islam, and there is little doubt that the Persian form is the eastern branch of the tradition inherited from the classical world. A similar explanation may be offered for the incense-burners with lion supports. Animal forms were frequently used in such a way in classical art and the Persian pieces illustrate the continuation of that tradition with modifications in form and decoration in accordance with the art of the times. Whether the lion form and the lion supports reached Islamic Iran via Islamic Syria and Iraq, or whether they continue a classically-orientated Sasanian tradition, there is too little surviving pre-Islamic evidence to be sure.

The last group of incense-burners, and also one of the largest, is the dish form (F). Four main styles survive: one with vertical sides and flat rim (1), a second with inward sloping sides and flat rim (2), a third with inward sloping sides and thickened rim (3) and a fourth with concave rounded sides (4). None of these have handles of any sort. Some have no legs while others have, or probably once had, three small

ones. The four examples of such dishes analysed (F/2/1,8, F/3/1 and F/4/1) indicate that a quaternary alloy was usual, though in the case of F/3/1 the amount of tin or lead is very small. There seems little doubt that the origin of this form is the Hellenistic incense-burner style of which a large number of examples survive from pre-Islamic Iran or its neighbouring lands. In the west at Dura-Europos was found a bronze incense-burner with brazier-like square tray and long handle (Rostovtseff et al. 1936 pl.26); in Iran have been found a bronze dish incense-burner with lion handle and silver dish incense-burner with animal-tipped handle (Bahrami 1948; Washington Smithsonian Institution 1964 no.502); at Taxila were found a three-legged copper or bronze dish with long ring handle dating from the Greek period, another such dish with lion handle of Parthian date, a bronze lion handle and another such dish in iron (Marshall 1951 II pp.595-6 no.320-2, p.543 no.36, III pl.176, 184, 163). Proof that the form was still known in early Islamic times comes from Ghazna where a complete lion handle has been brought to light, and from Susa, where part of a handle of the same form appeared in Islamic levels (handles H/1-2). The Islamic form F/1 is nearest to the pre-Islamic dish style and were it not for its lack of handle would be in essence identical. F/2-4 are variations on F/1 in which the rigidity and angularity of the form has been happily reduced.

Among the four examples of F/1, 1 and 2 should be noted for their similarity of design, and since F/1 was purchased in Nīshāpūr it is highly likely that both were made there. They are probably 10th-11th century on decorative grounds, whereas 3 is 12th or early 13th. F/1/4 has inlays of copper discs which are similar to those found on some Transoxanian ewers, and it may therefore come from beyond the Oxus.

In F/2 there are also pieces very similar to one another e.g. 1,5 and 8, and various individual styles suggest either individual craftsmen or particular workshops e.g. the use of hares in the central roundel. F/2/7 is said to have been found in Hamadān, but its elephant feet suggest that it is more eastern, and the findspots and decoration of the other examples points to the east and north-east as the centres of production. As noted in connection with some other metal objects Sīstān sometimes produced what can only be described as provincial pieces, and among the dish incense-burners 3 is such a one. F/2/1 and F/3/1, however, which are also from Sīstān, are of a quality more akin to that of the rest of the group. Whereas the pieces in F/2 are almost without exception to be dated to the 12th or early 13th century, F/3/1 has an inscription which points to a slightly earlier period, perhaps the 11th century. In F/4 the most easily datable piece is 1, which has an inscription comparable to those on objects associated with 12th century Herāt. F/4/2-3 have decoration which seems to span the Mongol invasions, and this style of dish incense-burner was in fact very popular in the 13th-14th century, witness a piece dated 725/1325 (Pope 1938 pl.1283C).

Although most of the extant dish incense-burners are footless, that should not be taken as proving that they never had feet. Quite a number of feet in a style akin to those on F/2/4 are known (support fittings A/2/b-c), and their form would have enabled them to be lightly soldered in position in such a way that their subsequent disappearance would leave very little trace. Moreover it is unlikely that hot coals would have been placed in a footless and handleless object, and since there is strong evidence in the form of decoration to show that they never had handles some sort of feet are logically to be expected.

Finally brief mention must be made of F/5/1 and F/6/1. The former appears to be a cheap Sīstānī beaten bronze incense-burner, its form based on the dishes under discussion, but simplified for ease of manufacture. Its decoration points to a 12th or early 13th century date, while the use of simple repoussé work links it with another Sīstānī object, stem bowl B/4/1. It is interesting to note the fitting designed to take a handle on one side. F/6/1 on the other hand is a cast object complete with handle from Rayy. It appears to be based on the same tradition though its lack of decoration makes constructive comment difficult.

The above survey of surviving incense-burners brings to light one important general point in connection with the use of form and decoration. In 10th and 11th century incense-burners traditional forms are modified and developed, vase, aquamanile and ewer forms are borrowed and adapted, and the potentials of animal and bird forms are constructively realised. In the 12th century stylisation takes over and one form of dish and one illogical and often characterless form of round-bodied object become typical. Moreover, whereas in other objects like ewers the 12th and early 13th centuries are characterised by magnificence of decoration the surviving incense-burners are for the most part as second-rate in decoration as in shape. In other words in these objects at least a very different concept and quality of art is visible in these two periods in Iran.

Incense-holders

The objects catalogued under this title have never previously been identified as anything in particular. With their hinged upper beaks and holes in their bellies they are obviously containers for something, and the fact that the filling hole is in the base and that the mouth cannot be sealed makes it highly unlikely that they were for liquid. If they were for some sort of solid it must have been a powder. The most obvious substances are salt, spices or incense, and since there is a group of objects of identical form which are clearly for the burning of incense (E/3 above) there can be little doubt that these are incense containers and that pairs of partridges would have adorned the houses of the wealthy, enabling small amounts of incense to be conveniently burned for appropriate guests on appropriate occasions. The decoration on these partridges is virtually the same as that on the incense-burners and there is every likelihood of their having been produced in pairs in the same workshops.

Stands

Two types of bronze stand survive from early Islamic Iran. Both have wide flaring bases and rims, but the one (A) is cylindrical, the other (B) octagonal. All the examples appear to be cast and all were probably produced in east or north-east Iran in the 12th or early 13th century. The combination in A/1 of rather archaic features of decoration, such as the kufic inscription on the rim and the rather curious knot pattern, with obviously 12th century features, such as the naskhi inscription on the outside, suggest that the Qandahār object was made in one of the remoter parts of the area, whereas the running animal

style of A/2 could indicate a more centrally placed workshop. B/1-5 all appear to be products of the same workshop, though where it was located it would be hazardous to suggest.

The origin of these two styles is probably to be sought in ceramics, for potters had been supplying stands for objects since earliest times. For example square unglazed stands are found in the earliest Islamic levels at Susa, and in the 8th-9th century stratas are found waisted cylindrical types with slip painting (Rosen-Ayalon forthcoming pp.86-90, 100-105). In the 11th-12th century north-east at Nishāpūr and Marv are found pottery stands with truncated conical body, splayed or upturned foot, and flaring mouth (Wilkinson 1973 p.312 no.65; Lunina 1962 p.357 fig.80 bottom left). These are probably derived from the south-west Persian style, and are evidently the basis of the bronze group A, or at least that is what their shape suggests. Bearing in mind, however, that the bronze pieces were designed to hold rounded-bottomed vessels, and that in Sīstān hemispherical bowls were used for ablutions under the Ghaznavids (see p.188), it may well be that the 12th century metal pieces are all that remain of a metal-working tradition which goes back a good deal further in history. In this case its relationship with the ceramics industry is by no means so certain as the ceramic evidence might seem to suggest.

An interesting additional indication that there is more to the history of bronze stands than is apparent from the surviving objects is the fact that the type of stand which is found combined with hemispherical bowls to make the north-west Persian high tin bronze stem bowl group (stem bowls A/2) is not known from any extant piece. As noted previously the existence of a Mamlūk stand of this shape makes it certain that it existed, and from what is known of the north-west Persian

industry in the 13th century it is highly likely that it was a form brought from further east and reutilised, although tangible evidence has yet to be found. It should therefore be emphasised that the study of these particular bronze objects is at a very elementary stage.

Table-tops

The objects discussed in this section have been variously described as appliques, architectural plaques or trays, and it is worth reconsidering these ascriptions on the basis of various features of the examples known. If one considers these objects as trays various features immediately stand out. First of all they are very thin metal and could not have taken any weight comfortably. Second, all, whether with sides or without, would have been extremely uncomfortable to hold. Thirdly the base or underneath of these objects is very crude and would hardly have been left like that if the objects were to be used in this way on social occasions. Hence it would appear that the objects were not trays, for they were neither designed to take weight nor to be carried or held, nor were they made to be seen from any direction except from above. The idea that they are architectural plaques has certain merits: it recognises that the form of the objects and their edges is designed to be fitted into or onto plaster or cement of some sort in such a way that the back could not be seen, and this is borne out by the plaster-like substance still adhering to the back of B/2/1; it also recognises a resemblance between the star-and-cross tile design, so common in the Islamic world, and the relationship between the sunken and upper areas on the square metal examples. However, two facts militate against this theory. Firstly, at least one example has decorated sides (A/1/3) and could not therefore have been fitted completely into a plaster backing - the sides must still have been

visible. Secondly one object of rectangular form has on its sunken area two roundels, one with a duck the right way up, one with a duck upside down. In other words the latter object was made to be looked at from two sides; if it had been set in a wall one duck would have been permanently upside down.

The most likely solution seems to be that they are the ornamented tops of small tables. Such tables would have had to be the exact width of those tops with decorated sides, but where the tops have no sides or undecorated ones the actual dimensions of the tables may have been larger. Exactly how such tables were constructed one cannot tell. They would presumably have had a plaster top into which the metal top could then have been set and four short legs, but whether the latter were wood or some other material one does not know. In this form the metal objects would have been convenient for sweet-meats, nuts or the like, and a low table with these choice foods on it would have fitted well into typically oriental floor-orientated social gatherings, standing about the same height as the tabourettes known in Persian 12th-13th century pottery styles (e.g. Pope 1938 pl.702A), but fulfilling a function more akin to the small tables which appear in 13th century Iraqi manuscripts (e.g. Ettinghausen 1962 pp.69,106).

All the table-tops catalogued appear to be sheet metal, and the three analysed (A/1/2, B/1/1, B/2/1) proved to be brass. All can be attributed on stylistic grounds to the 12th or early 13th century. Those in group A/1 plus B/1/1 and B/3/1 are of immeasurably finer quality than the rest, both in the strength of the body metal used, the character of the decoration, and the sumptuousness of the inlay, and the decorative style suggests that an attribution to the workshops of Khurāsān is probably correct, as is also indicated by the existence

of a table-top from Samarqand in the Samarqand Museum (Pugachenkova and Rempel 1965 fig.225). (This has not been catalogued with the rest as its exact form is not clear.) In view of the material used and the method of manufacture they are to be associated with the sheet brass industry in Khurāsān, which also produced cylindrical-bodied ewers and candlesticks of superb quality (discussed above).

In technique the rest of the table-tops divide themselves into two groups. The one, consisting of groups A/2 and B/2, gives the impression of being second-rate work based on the above inlaid pieces. B/1/2-3, on the other hand, have repoussé work as well as incising, and the effect is totally different. The use of this technique in conjunction with certain decorative motifs suggests that they were produced in the same workshop as three objects resembling cymbals or shield-bosses (unidentified objects C) and others mentioned by Melikian-Chirvani (1973 p.41). Since one of each of these two groups was found in Ghazna it is conceivable that both were produced there; if not they are at any rate probably Sīstānī in origin. The latter group have the merit of pointing to a school of craftsmen somewhere in that province with considerably more skill and originality than many of their provincial contemporaries.

(7) Ornamental Objects

Miniature vessels

The large numbers of miniature vessels from Rayy and Nīshāpūr excavations testify to the popularity of this type of object. Exactly what such bowls and other miniature pieces were used for is not, however, known: most were probably ornamental, but some may have been for putting small pieces of jewellery in, just as today the female dressing table usually carries one or two small ash-tray like objects, and some may have been for cosmetics. There were probably other uses too.

The scaling down of a shape in order to produce it in miniature, unless accompanied by a proportional scaling down of the thickness of the material, leads to a blurring of the true form, and this is generally the case with these miniature bronzes. Thus bowls 1,2,4-6,12 and 15 are too clumsy to be convincingly compared with any other full-sized bowls. On the other hand, one or two do retain enough character for their origin to be recognised. Bowl 14, for example, must be based on the traditional Sasanian wine bowl shape, dish 1 is based on the dish style used for certain bronze incense-burners (group F), while bowl 13 is probably a miniature copy of a stem bowl. Bowl 16 with its three lion-legs is also probably related to the incense-burner tradition, and the miniature bucket is just that. Two other forms should be noted. One is a flat-bottomed bowl with concave flaring sides (7-8), for which the only parallels seem to be some lids from Nīshāpūr (Wilkinson 1973 p.306 no.47); the other is the covered bowl 1 with its curious open-centred lid, a piece with no known parallels. The dating of the excavated pieces listed is, as usual, uncertain. The only objects with enough decoration to allow tentative datings are

bowl 14, which is probably 10th-11th century, and bowl 15, which is probably slightly later.

Vases

The identification of these two objects as vases is based on the existence of a ceramic piece of similar form but with small mouths around the lower neck which was clearly designed as a flower vase (Wilkinson 1963 pl.60). This object is in minai ware, and therefore presumably north Persian, 12th or early 13th century. Other examples in pottery, but without these side mouths, occur in Kāshān style lustre-on-blue and in Raqqa blue and black ware (London Victoria and Albert Museum 1969 no.124,146). Both these latter are of similar date to the minai piece, and of similar date too to bronze vase 1 which has decoration like that found on a bronze dish (B/1/4). Bronze vase 1 is probably Khurāsānī work, whereas 2 has a knot pattern which is more typical of Transoxania.

In origin this form goes back to a particular classical flask and jug style (Strong 1966 pl.52,55A) which has a neck ridge which must be the origin of the shallow neck ring on the Islamic pieces. The continued use of the form in earlier Islamic times is indicated by a glass bottle of 10th century date found at Fusṭāṭ (Scanlon 1967 pl.9a) in which the splayed mouth is more obvious than in the classical pieces, and the use of this shape of vase for flowers is proved by its occurrence in a Fāṭimid drawing of a dancing lute-player (Jones 1975 p.2). The two Persian bronzes represent a considerable development on the style, not only because of their exaggeratedly splayed mouths but also because of their large feet - originally vase 1 almost certainly had such a foot as well. Such a foot may be characteristic of Transoxania (see support fittings B/3). The use of the vase form was not confined to these objects: it also occurs as a style of incense-burner (type D/1).

II Personal and Cosmetic Articles

(1) Personal Articles

Personal articles although catalogued alphabetically may be conveniently divided into three groups, belt fittings, jewellery, and other items. Bronze belt fittings have been discussed in detail alongside the silver and gold examples (p. 90), and will not be considered any further here. Among the jewellery objects amulet cases have also been discussed in detail above (p.88), so too finger-rings (p.106), and these therefore require no further comments. The one gilt bronze bead from Sīrāf is of typical spherical Persian form and adds nothing to the overall picture established by the numerous silver examples known. The commonest bronze jewellery objects are in fact the pendants. These take a variety of forms, the most numerous being crescent-shaped and pear-shaped, and the relatively large numbers of pendants from Rayy and Nīshāpūr indicate that such objects were much used. The dating of any one item is at present unknown. Curiously, no pendants were found at Sīrāf. The bronze pendants which do not come from controlled excavations and have been included in the catalogue are attributed to early Islamic Iran on the basis of comparative pieces, D/3 for example on the basis of D/2 which is almost identical, and D/4 on the basis of a gold amulet case F/1.

The other personal items consist of appliqués, bells, buttons, needles, pins and seals. Four of the seven appliqués catalogued are rectangular and one is square, and these five are all of the same general type, the outer form enclosing a bird or animals in an openwork surround. They have flat backs and rounded fronts and were probably, like the horse-harness ornaments discussed elsewhere (p.361), designed to be pinned or riveted to leather. Their large size makes them too big

to fit on belts or horse-leathers, and their designs suggest a quite different cultural environment from the nomadic horse ornaments, the heraldic-looking eagles in particular being more associated with the art of the Saljūq ruling class in the Near East rather than grass-roots Turkish tribal art. Hence they were probably ornaments designed to be attached to some item of a man's clothing or personal equipment. Appliqué 6 with its central boss and radiating arms is of a quite different form. It was evidently a well-known variety of ornament in the medieval period since other examples have been found at Sāmarrā and Corinth (Baghdad Department of Antiquities 1940 II pl.140 no.12; Davidson 1952 no.2645-8), and since it has no rivet holes it was probably a type of ornamental button designed to be sewn onto a material backing. Appliqué 7 is also circular in form, but is solid apart from a small hole in the centre. It is of a rosette style known from the Parthian period at Taxila (Marshall 1951 II pp.582-3, III pl.179) and from Islamic Sāmarrā and Ḥamā (Baghdad Department of Antiquities 1940 II pl.141; Riis 1969 fig.6 no.5,8), and an openwork rosette of rather similar form was found at Corinth (Davidson 1952 no.2643). The Ḥamā pieces appear to be 12th-14th century, and these various finds suggest that in everyday bronze ornaments there may have been a variety of forms in use throughout the Islamic world which were a continuation of pre-Islamic traditions.

Surviving bronze bells may be divided into two groups, those with a rounded body and those with a conical body. These two groups differ not only in shape but also in structure, for the first (A) have a split opening or pierced hole in the lower body, whereas the latter (B) have a completely open base. Within A there are a variety of shapes varying from pear-shaped to flattened spherical, and while most of the bells in the group are similar in design, 10 stands out by the

form of its lower body, made by bending inwards triangular pieces of metal. In this it is similar to an iron bell also from Sīrāf (see p.452). The lack of Sasanian excavated bronze bells makes it difficult to comment constructively on the Islamic forms, though the existence of a number of bells with an open base and one bell with a slit opening at Taxila (Marshall 1951 II pp.598-9 and III pl.176) indicates that both forms were known in the East in pre-Islamic times. On the other hand the pure conical shape is not found at Taxila among the former variety, though it occurs in a 13th century A.D. context at Ḥamā (Riis 1969 fig.31 no.23). The only datable bell is Sīrāfī A/10 which is 12-13th century.

Of the one button catalogued there is little to say, except to note the method of attachment. All the Corinth buttons have a central hole like appliqué 7 above, whereas that from Rayy has a bar fitted across the inside of its hollow back.

Five bronze needles from Sīrāf, not yet dated, and another from Banbhore, were all probably designed for making nets - an important feature of life in such coastal towns. A smaller needle with a "turned" body from Nīshāpūr is of unknown use, and may conceivably be something other than a needle, despite its eye in the top.

Pins with ornamented tops have been found at Rayy, Nīshāpūr and Sīrāf, and like related objects from Ḥamā (Riis 1969 fig.28 no.3-7) were probably used for pinning clothing and hair. Such objects have a long history in Iran, simple garment pins appearing among the earliest bronze artefacts known, and wide varieties of decorated forms being produced as early as the late second and early first millenia B.C. These include conical-headed pins like C/5 as well as examples with

bird tops like group A (Moorey 1971 p.174 pl.43-5, 50). Conical-headed pins also appear in Parthian contexts at Taxila (Marshall 1951 II p.586 no.230, III pl.173), and in view of the existence of early Sasanian spatulas with ornamented tops as noted elsewhere (p.343), a continuing tradition in the production of such items seems highly likely. The large numbers of examples with bird finials (A) should be noted, though it is possible that some may have come from small objects other than pins.

Two groups of seals survive, a group of three from Nīshāpūr, and another group of three from Qazvīn. The former are squat and are difficult to parallel at present among other published seals from the Near East. Two of the latter, however, are of a type which occurs at Ḥamā and Corinth in medieval contexts (Riis 1969 fig.28 no.18; Davidson 1952 no.2678-2683), though unlike the more westerly examples the Qazvīn pieces are cast in two vertical sections hinged together at the top. The Qazvīn seals may be 13th century, the Nīshāpūr ones somewhat earlier. None of them have sealings which are meaningful, though they were presumably designed for personal use and the identification of personal belongings.

(2) Cosmetic Articles

Although all the objects in this section are catalogued in alphabetical order, they will be discussed in two groups - mirrors and other objects. Since mirrors are by far the most outstanding among the surviving cosmetic articles this is a rational division at a superficial level. That it is a rational division at a much deeper level will become apparent when the origins of the various objects have been pinpointed.

Mirrors

Islamic medieval mirrors (Arabic mirāt; Persian āyana) have often in the past been assigned to Iran without any attempt to justify such an attribution, and it is therefore necessary, before discussing more important aspects of the mirror industry of early Islamic Iran, to identify those mirrors or mirror types which are definitely Persian. Hence it is desirable first of all to point out those mirrors which have actually been found in Iran.

To start with there are three objects from excavations in Iran, which, though undecorated, are most probably mirrors (A/1-3). They are discs of bronze, sometimes in two or three layers, and their method of manufacture is discussed below. None of the three are of certain date, though the Sīrāf piece may well be datable once the stratigraphy of site K has been fully worked out.

Next there are two decorated mirrors which were found in the excavations at Nīshāpūr (B/1/1 and B/2/1). Both are bronze and both have a central boss or eye on the reverse through which a hanging or holding cord could be passed. One has an all over pattern of 6-petalled rosettes

the second has two zones of decoration, the inner one - the only one visible due to corrosion - having four running animals. Certain other mirrors in public or private collections also came from Iran. A bronze mirror bought in Iṣfahān and now in Leipzig (B/3/1) has a central boss, a main decorative zone of two addorsed sphinxes, and a kufic inscription of good wishes around, another mirror of the same design came from Ardabīl (B/3/2), and a third probably came from somewhere in Iran (B/3/3). Another example of this type found in Tirmid on the Soviet bank of the Oxus is also relevant (B/3/4). On the basis of the inscriptions which adorn these sphinx mirrors a 12th or early 13th century date would appear to be in order (Bräunlich 1931; Rice 1961 p.289), while the animal mirror from Nīshāpūr came from a part of the site which Wilkinson reckons was abandoned in 1221 A.D. if not in 1153, and is therefore likely to be 12th century at the latest (Wilkinson 1973 p.xxxvi). The mirror from Nīshāpūr decorated with the rosette pattern is more problematic. It was found at an unknown location on the site and cannot therefore be dated from its findspot, but its decorative design is found as the background ornament on a group of mirrors bearing faces surmounted by tricorn hats (e.g. Pope 1938 pl.1302D). This hat being characteristic of royal dress in the Il-Khānid period in Iran (compare for example illustrations from the Demotte Shāh-nāma in Pope 1938 pl.836-840), the mirrors in question are probably to be dated to the late 13th or 14th centuries. However, the pattern itself goes back to earlier times, occurring in a four-petalled form for example on unglazed pottery from Lashkarī Bāzār (Gardin 1963 pl.7 no.55) dating from the 11th or 12th century. The design on this mirror may therefore be an intermediate stage in the development and usage of the pattern, and datable to the 12th-13th century.

On the basis of the above one can therefore say that in 12th-13th century Iran, in addition to plain disc mirrors, bronze mirrors with central bosses were used, and that at least three different styles of decoration were in vogue. One can further add that in view of the known existence of a mirror industry in Iran in the 10th century (IF pp.205 , 253-4) and the wide range and enormous scale of bronze industry in the 12th-13th century, witness this thesis, it is highly likely that the mirrors found in Iran were produced there.

One proviso however should be noted at this point. While it is highly likely that mirrors decorated with addorsed sphinxes and a band of inscription around the edge were produced in Iran, it is likely too that metal-workers in other parts of the Islamic world were also producing them. There are, for example, mirrors of this group which were acquired in Anatolia - Istanbul, Tokat, and Urfa, others in North Mesopotamia or Syria - Khābūr, Aleppo or Damascus, others in lower Mesopotamia - Ṭāq-i Kisrā, and still others in Cairo. While trade might explain an odd find to the west of Iran so many examples turning up suggest that other metalworkers in other Islamic countries adopted the style and produced their own variations. Close examination of the mirrors does indeed show that such variations exist, both in tiny details of the designs and, more obviously, in the dimensions of the objects, and it is therefore unwise to claim all known sphinx mirrors as being Persian products. Hence, those with no known provenance, or with a provenance west of Iran, have been listed separately from those of Persian or more easterly origin, partly to provide a check list of all the examples so far located, but at the same time to stress the possibility of a separate origin.

Returning to those mirrors actually found in Iran, one could hardly suppose that those few objects would give a complete typology, and it is perfectly plausible to suggest that other mirrors of no known origin were also made in Iran. In order to identify these it is next necessary to take a more negative approach and exclude from future argument a number of Islamic mirror types, sometimes assumed to be Persian, which are probably not so. For example, those with zodiacal signs (two formerly in the Harari collection, Pope 1938 pl.1301A and B; one from the Öttingen-Wallerstein collection, Sarre and Martin 1912 pl.140; one in the Victoria and Albert Museum M.91-1952) are most likely to be north Syrian or Anatolian on the basis of the Urtuqid example. So too are mirrors with animals, birds or human figures within roundels formed by an interlaced stem, a style very like that on the Urtuqid zodiacal piece (Victoria and Albert Museum 1535-1903; British Museum 91.4-18.41; and 1922.8-12.122; Louvre unnumbered), two mirrors with a double-bodied, single-headed harpie (Detroit Institute of Arts, Aga-Oglu 1931 fig.3; Dahlem I 5135), a mirror with a heraldic-looking eagle (Victoria and Albert Museum 1536-1903), and a mirror with mounted falconer, and dragons in the border (Rice 1961 fig.5-6 in Topkapi Sarayi 2/1792). It also seems possible that two mirrors decorated with four running sphinxes have been wrongly attributed to Iran (British Museum 1963.7-18.1, which is unpublished; Dahlem I 2220, which came from Egypt according to Sarre 1912 fig.41 but is attributed to Iran by Zick-Nissen, Berlin-Dahlem 1971 no.357). Although little is known of Fāṭimid and Ayyūbid bronze work, the deeply cut details on the bodies and limbs of the sphinxes, and the turban-like head-dresses they wear, are difficult to parallel in Persian iconography, and an Egyptian origin seems probable. Other mirrors, previously ascribed to pre-Mongol Iran are more probably of Il-Khānid date, for

example that with huntsman and phoenixes in the Louvre (Pope 1938 pl.1302B; Louvre 6020), and the mirror published by Rogers (1970 pl.6) as "?Iran 11th-12th century", which is further from the Chinese type than he indicates, and the fishes and other sea creatures of which suggest, by comparison for example with the fish-pond ornament on the Modena bowl (Baer 1968 fig.7), that this might be a post-Mongol object.

Having identified those mirrors found in Iran, and excluded a number of groups which were almost certainly made elsewhere in the Islamic world or which are post-Mongol, a further line of approach can now be made through mirrors of Islamic character found in countries or areas to the east or north-east of Iran which are thus most likely to be objects of trade of Iranian origin. Into this category fall four mirrors decorated with addorsed sphinxes and kufic inscriptions (B/3/5-8), two of which come from Minusinsk, the third from Narym, and the fourth from Semirech'e, a mirror with a central lobed boss decorated with six animals of the hunt within a kufic inscription from Samarova (B/4/1), and two mirrors with handles (C/1/1 and C/1/2), one from Staryе Knyšī and one from Kazakhstān, bearing different forms of hunting scene within borders of kufic inscriptions. The sphinx mirrors are presumably of the same date as those mentioned above. The other three mirrors are all to be dated to round about 1100 A.D. or perhaps the early 12th century (compare silver wine bowl C/6, silver table-top, the inscription on the minaret at Sangbast, Grohmann 1967 II fig.128). The sphinx mirrors merely emphasise the probability that Iran was producing mirrors of this design, and that with animals of the hunt is almost certainly of the same general style as the example from Bāzār Tapa in Nīshāpūr, though it is interesting to observe the large lobed boss. The other two mirrors, however,

add an important dimension to the discussion, for they are decorated with hunting scenes and they have, or probably had, handles, both being features not previously mentioned. The hunting scenes are firmly in the Persian tradition, the Kazakhstān mirror's lion hunt being somewhat more ancient in origin than the depiction of a hawker with cheetah on the other piece, and there is little reason to doubt that the latter piece is indeed Persian. The former is probably Transoxanian rather than Persian proper, as Balashova noted, what with the details of the picture itself, the unusual content to the inscription and the holes through the middle of the crescents which in the Transoxanian style probably originally held inlay, but its Persian inspiration is incontestable. Thus these two mirrors strongly suggest the possibility that designs of a central hunting scene with an inscription around were used to decorate Persian mirrors of the pre-Mongol period. Although one of these two mirrors is badly damaged, it seems likely that both originally had handles attached to the edge of the rim and for this reason the Starye Knyši example also indicates that handled mirrors were produced in Iran prior to the Mongol invasion.

Further mirrors can now be attributed to Iran on the basis of the similarity of their decoration to that on Iranian mirrors already discussed. For example, the form and general style of decoration on the Samarova mirror (B/4/1) and another one like it in New York (B/4/2) have much in common with two other groups of mirrors (B/5 and B/6), both of which have lobed bosses and tall rims, and both of which bear two decorative zones, the major inner one consisting of animals of the hunt, the lesser outer one of an inscription. The first of these latter groups is distinguished by having two pairs of animals moving left against a scrolling stem, whereas the second has four different

animals moving in the same direction. It would appear that group B/5 with the animal pairs is the earlier, for group B/6 has, among the animals, an ibex, which seems to be a mistake for the hare in the other groups, the horns replacing the hare's head and ears. There are also a number of other mirrors with animals decorating them which are listed as variants of B/5. They are mainly characterised by differences in the inscriptions they bear or in their size, showing that different casts would be used to produce what were essentially the same styles of mirror.

It cannot for the present be proved that all these mirrors are Persian. However, in view of the existence of the Samarova mirror, and its probable Iranian or Transoxanian origin and in view of the fact that there is no element in any of the decoration in these groups which cannot be fitted quite happily into the artistic traditions of Iran in the pre-Mongol period, a 12th century date and Iranian provenance seem likely. The variation in detail would suggest that the mirrors were widespread in the country and manufactured in a variety of centres.

Finally there is a group of mirrors which do not fall happily into any of the categories delineated (B/7). The form of rim, single design field, and type of boss all put them apart. The latter point is particularly strange, for two out of the three now have no boss. The objects certainly have every appearance of being mirrors, so that one can only presume that the bosses were soldered on and have since disappeared. But this is an odd way of adding a boss, for it would have been much simpler to cast the object in one piece, boss included. The design suggests that, like the other mirrors with animal decoration, these are 12th or 13th century Persian products. V.1 may either be an Il-Khānid corruption of the form or a poor contemporary copy by an

inept caster. In either case it is surely derived from this group and not from the Egyptian sphinx group mentioned above, as Basil Gray suggests (Beirut 1974 p.137).

As an appendix, another mirror which can also be ascribed to Iran on stylistic grounds is that depicting a falconer in the Victoria and Albert Museum (D/1/1). Here again the nature of the kufic inscription and scrolling stems suggest a 12th century date. More will be said about the particulars of this object later on, but the presence of both a central boss and a space in the inscription for a handle should be noted.

Having, hopefully, identified the surviving examples of Persian mirrors of the early Islamic period, it is now necessary to comment briefly on the methods of manufacture involved in their production. The two undecorated broken mirrors excavated in Susa and Sīrāf show different methods of manufacture from one another as well as from the later decorated mirrors. The Susa mirror has a central core with a sheet of a different alloy of about the same thickness on either side of it, producing a sandwich effect. The Sīrāf piece on the other hand consists of two sheets of metal placed flat against each other and then soldered together round the rim. The analysis of this mirror made in Oxford (Table 21 no.46) shows that the two sheets are of quite different alloy. One sheet, presumably the reflecting side, is made of high tin bronze, the other is copper with a small amount of zinc. The method of manufacture used on the later decorated mirrors is uncertain since no scientific investigations have ever been made. They appear, however, to have been cast in one piece, relief decoration included. Such relief casting is sufficiently unusual in Islamic Iran to demand particular attention. True it is found on three groups of ewers (A/1/a-b and A/2/a), but since those ewers originated in Mesopotamia the method

of manufacture is not particularly Persian, and indeed the examples of these ewer forms actually made in Iran are generally without such decoration. Relief casting is also found on mortars bearing almond or other shapes of boss, but here it is so simple that it is hardly worthy of comparison with the mirrors, the decoration of the best of which has an articulation and definition which stresses the high quality of workmanship involved.

The information pieced together so far brings to light a number of strange facts. In the first place a glance at the decorated mirrors shows that none can be dated much before 1100 A.D., that they are all relief cast, a technique otherwise very rare, and that although handled mirrors seem to have existed post-1100 only one has actually survived. Second, and more strange still, there seem to be virtually no surviving examples of Persian mirrors pre-1100 A.D., whether undecorated or decorated, whether with a central boss or with a handle.

To sort out these problems it is most advantageous to start with the question of the handles. It has already been suggested that a handled type of mirror was known in 12th and 13th century Iran, and yet there appears to be only one surviving example to back up the evidence of the Kazakhstān find. This is a mirror in Berlin (B/1 V.1) with a design very like that of the Nīshāpūr mirror with rosettes. It has a small handle which appears to have been cast in one piece with the mirror, but it also has the remains of a small central boss or eye in the centre. Only one other mirror even hints at such a style, the mirror bearing a mounted falconer in the Victoria and Albert Museum (D/1/1). This has a central conical boss and a tall complete rim all the way round the edge, but at the bottom of the back, inside the rim, and dividing the band of inscription, is a triangular area left plain and clearly designed for a handle. That it can never have been used

for that purpose is certain from the lack of any sign of a fixture and from the fact that the rim prevents such a use. But there it is, pointing to a tradition of handled mirrors somewhere. The design on this mirror shows that it is 12th or early 13th century.

The only other certain evidence of handled mirrors being used before the Mongol invasions comes from Mawṣil. On the Blacas ewer which is inscribed with the information that it was made in Mawṣil in the year 629/1232 (Pope 1938 pl.1329-1330) is a picture showing a handled mirror being held by a court lady. It is unlikely that a Mongol fashion could have become assimilated into Mawṣil life so completely as to appear in 1232 on this object, and one must assume that it reflects pre-Mongol practice. Yet, where are the mirrors?

Two alternatives present themselves. Either they were a rare commodity for some reason and never existed in large quantities, or they existed in larger quantities and have disappeared for a particular reason. The first alternative is intrinsically quite likely. They may have been considered clumsy and unfashionable, and the bronze casters may have been forced to produce the handleless variety to meet public demand. That however would not explain the use of a handled mirror on the Blacas ewer. Mawṣil fashion may have been different of course, but handled mirrors have survived in no greater numbers from northern Mesopotamia than they have from Iran.

The second alternative is at first sight less likely that the first, for it is difficult to imagine what circumstances could have led to the disappearance of a whole group of mirrors without destroying evidence of all mirrors. At this point it is important to recall the textual evidence of the mirror-industry in Iran in pre-Mongol times. This evidence is based on Ibn al-Faqīh who ascribes mirrors to Hamadān

and Fārs (IF pp.205, 253-4). But, and this is surely very significant, he does not say they are bronze. On the contrary, in both cases he strongly implies that they are of iron. Now iron of course rusts very fast in the ground, and very few iron objects have been recovered from Iran. Hence, it is quite conceivable that large numbers of iron mirrors were produced in pre-Mongol Iran of which no traces remain or could even be expected to remain today.

If one then conjectures that large numbers of iron, or presumably steel, mirrors were produced in pre-Mongol Iran can one say anything about their form or designs? The only evidence inevitably comes from later objects, but evidence there certainly is. The handled mirrors decorated with tricorn-hatted faces and a rosette pattern ground, attributable to the Il-Khānid period, have already been mentioned, and so too the origin of that ground pattern. These mirrors are striking in their uniformity and strongly suggest that they are based on a prototype. No such prototype has come to light in Minusinsk or in the nearer parts of Central Asia and Transoxania, and since the ground pattern is found in Nīshāpūr and Lashkarī Bāzār, it is perfectly legitimate to suggest that the form itself comes from eastern Iran. This cannot be proved but is supported by the fact that no bronze mirrors have to my knowledge come to light at the main Ghaznavid sites, which would suggest that they used iron, and that the Il-Khānid mirrors in question have a strikingly black quality which appears to be due to the alloy itself rather than corrosion products, suggesting that it was manufactured in imitation of steel. A second thread of evidence is to be found in a contemporary or slightly later product of Anatolia. A superb Saljūq Anatolian mirror decorated with a falconer on horseback and a band of animals (Rice 1961 fig.5-6) has a handle which fits on to a plain triangular

area near the edge of the mirror, and is made of steel. Even if the details of some of the animals, mythical and naturalistic, are clearly Saljūq Anatolian, the concepts of the mounted falconer and a band of animals around are very much part of the Persian artistic heritage, and one is surely right to connect the triangular space into which this handle fits with the useless space on the bronze Persian mirror discussed above. In other words this steel Anatolian object suggests itself as a continuation of a steel handled-mirror tradition already established in Iran. This this tradition would appear on stylistic grounds to have been rather different from that which we have suggested for eastern Iran, does not in any way weaken the theory, for if steel mirrors were widespread more than one style is to be expected. Hence one may suggest that at least from the 10th century there was a substantial Iranian steel mirror industry, that some time in the pre-Mongol period these mirrors were given handles, that occasional bronze parallels are found, but that the impact of this style in terms of surviving objects is only to be seen in Anatolian and later Iranian mirror types.

It is interesting to note in passing the existence of a Chinese handled mirror found in Afghanistān (Trousdale 1961) which may, like its handleless compatriot, have arrived early in the 12th century (see below). However, Loubo-Lesnitchenko (1973 p.57) considers this mirror to be Mongol. Chinese mirrors had, of course, been manufactured with handles in earlier periods, but there is, as yet, no evidence that this was the source of the Persian fashion.

For all the above evidence, however, one must not assume that there was no bronze mirror industry prior to the 11th century. Bronze mirrors had after all served the needs of Greeks and Romans quite adequately, and it would be surprising if not one bronze mirror was made in Iran

prior to this time. One small object of gilt bronze which appeared in the excavations at Nīshāpūr is at this point of the utmost significance, for it is the only surviving Islamic example of a type of mirror handle known in Iran in pre-Islamic times (handle J/1). In Lūristān and Scythian south Russia in much earlier times mirrors were given handles in the form of a rather square loop which developed animal forms (Portratz 1955 pl.3_{3-4}; Minns 1913 pp.65-6). Such mirrors appear with rather more elaborate handles, which have been lengthened and given animal forms at each corner, in the Parthio-Sasanian period (Malleret 1967 pl.1; Ghirshman 1964 fig.100 which Dr. Moorey suggests is much later than the date given by Ghirshman), and it is a rather dull stylised form of such a handle which occurs in the Nīshāpūr finds. The piece itself is dated by the excavators to the 9th-10th century, and gives extremely valuable testimony to the continuation of an ancient mirror form in Islamic Iran. What is more, widespread use of this form of mirror, which would presumably have had very little decoration on it owing to the position of the handle, would also explain the lack of surviving examples. The mirror itself could have been of relatively thin bronze, and with a handle soldered to the back which would have easily come off with hard treatment or corrosion it would become in the ground an unrecognisable disc of corroded bronze which no dealer would consider trying to sell. The handle too would be relatively easily broken or become badly corroded, like the mirror itself, leaving too little trace to attract any but the archaeologist.

It has become clear from the discussion so far that although almost all the surviving mirrors from early Islamic Iran are cast bronze with relief decoration and central bosses datable to the 12th-13th century, other mirror types were produced at the same time as the latter and in the preceeding period. These were either of iron, in which case such

a mirror probably had a long handle attached to its rim, or of bronze, in which case such a mirror had an angular three-sided handle soldered to the reverse side. There is no way of telling when the iron style was introduced, but it is probable that the bronze style, continuing pre-Islamic tradition, was in vogue throughout early Islamic times.

Turning now to the other problem point mentioned earlier, the question of decoration and the use of relief casting for the 12th-13th century decorated mirrors, it will be observed that that method of decoration had no precursor in the earlier mirrors of the country. It is clearly of some importance therefore to discover whence it came. A glance at Chinese mirrors of the same or a slightly earlier period shows that it is in fact to the Far East that Iran owed this style.

This is clear from the nature of T'ang and Sung Chinese mirrors and the way their decoration is laid out. For they are relief cast, and their designs like the Persian ones are usually based on concentric bands. In the Table 22 are shown the different forms of layout in the relief cast mirrors of 12th-13th century Iran. Most of these can be paralleled without difficulty in Chinese products. For example, a 7th-8th century three-zoned Chinese mirror from the Minusinsk basin with geometrical patterns, a band of animals and a band of inscription (Loubo-Lesnitchenko fig.7), suggests the origin of the layout of groups B/4-6 and D/1, while the common T'ang mirror form with a central zone of "lion and grape" design, and an outer zone of birds and grapes, or running animals and grapes (Loubo-Lesnitchenko 1973 fig.9; Cammann 1955 fig.10), offers strong parallels to the Persian style with only two zones. The connection between the Persian and Chinese products seems all the more likely when one considers that from the vocabulary of early Islamic designs and style it would have been quite easy for artists and craftsmen to have created a set of designs for a flat circular

disc which would in no way have resembled those used on any foreign products. The only design which appears to be purely Persian in the mirrors under discussion is the all-over six-petalled rosette pattern on the Nīshāpūr mirror (B/1/1), which has no Chinese parallels; that of B/7 seems to be a single-zone derivative of one of the other mirror types with animals.

Given then that the Persian relief cast mirrors are based almost exclusively on Chinese models, one also has to account for the fact that such copying did not begin until about 1100 A.D. although such styles as the "lion and grape" design had been part of the scene since early T'ang. The clue to this problem appears to lie in Central Asia, for at Minusinsk have been found alongside the two Persian or Trans-oxanian mirrors mentioned large numbers of Chinese mirrors. According to Mary Tregear these are for the most part northern Chinese products, and the accumulation of 12th-13th century mirrors in Minusinsk is probably to be explained, as Trousdale (1961) pointed out, by the uniting of Mongolia and north China under the Tatars in this period, and the consequent removal of large quantities of booty and objects from the conquered Chinese provinces in a westerly direction. These would have been filtered along the trade routes still further westwards or been carried by tribal movements thus reaching the Islamic world, while the odd Persian product would then have crept back by the same means to Mongolia. That this could scarcely have happened on such a scale before about 1100 A.D. is explained by the strong control of northern China by the central government and the constant efforts toprevent incursions from the north-west, thus hindering movements of peoples and objects. It is interesting to note here the Cernuschi mirror published by van Berchem (van Berchem and Strzygowski 1910 p.126 fig.56) and further discussed by Rogers (1970 p.71 n.11). This must be of virtually the

same origin as a mirror of the 11-13th century in the Seoul Museum (Kim and Kim 1966 cat.146), despite the evidently fake Arabic inscription dating it to the year 111H./729-30 A.D. Being of northern Chinese origin it too probably reached the Islamic world via Mongolia and Central Asia.

The most serious objection to the theories offered above would seem to be that Chinese mirrors were known in the Islamic world long before 1100 A.D. This is shown first of all by the various references to khār şīnī in the literature (see p.159), and secondly by the discovery of two Chinese mirrors at excavation sites in Iran. One was found at Sīrāf (unpublished), the other at Susa (Ghirshman 1956). Both are probably of T'ang date, and are therefore likely to have been imported into Iran in earliest Islamic times. Some explanation is thus required of why Chinese mirror forms were not copied and developed long before 1100 A.D. It may be that only a few actually arrived in Iran; it may be that those that were imported all came by sea and thus arrived at cities where the metal-industry was not so highly developed due to lack of local metal resources; it may have been due to changes in taste. The most likely reasons for the sudden interest in developing the Chinese mirror form from about 1100 A.D., however, are probably first of all the numbers of examples that began to arrive overland, and secondly the fact that they were imported into the very area of Iran in which the bronze industry was centred - Khurāsān (see also pp.383-4).

Other cosmetic articles

Apart from mirrors cosmetic articles include cosmetic mortars, kohl-sticks, spatulas, spatula blades, toilet flasks, toilet dishes, and tweezers. It is most convenient to begin with the simplest - kohl-sticks and spatulas. Kohl-sticks have been found in some numbers both at Rayy and Sīrāf, and take two main forms, the one undecorated, the other having a decorated centre, usually combining square, oval and angular shapes. Kohl-sticks have been known in Iran since the 3rd or 4th century B.C., when they were probably introduced by the Greeks (Marshall 1951 II p.585), and a wide variety of forms, often combining kohl-stick with tooth-pick or ear-cleaner, were found in the Parthian levels of the Taxila excavations. The neck of one example is decorated in a style very like the centres of the decorated Islamic sticks (Marshall 1951 III pl.173 no.221) but otherwise none bear a particularly close resemblance to the Islamic ones. Of Sasanian kohl-sticks virtually nothing is known, and it is therefore hazardous to propose theories about the origin of the Islamic form. It is noticeable, however, that both the decorated and undecorated types catalogued in this thesis were common throughout the Islamic world in the early Islamic period. They occur, for example, at Fusṭāṭ (Ashmolean Museum 1974.53 from the 1972 excavations at Fusṭāṭ), at Ḥamā (Riis 1969 fig.24), and at Sāmarrā (Baghdad Department of Antiquities 1940 II pl.142), and if Petrie is right in ascribing examples of these forms to the Roman period (Petrie 1927 p.28 no.45-50 pl.23), it may be that they are in fact based on Mediterranean and not pre-Islamic Persian forms.

Turning to spatulas, a fairly wide variety of both spatulas and spatula blades has been found at Rayy, Sīrāf and Susa. Some have a flat blade (A) while others have a shallow bowl-shaped blade (B). Spatulas, like

kohl-sticks, were in use in Iran and neighbouring lands centuries before the Islamic conquests. For example, they occur in the Parthian period at Taxila (Marshall 1951 III pl.177 no.361, 364-5), and have been found in early Sasanian graves in Dailam (Egami et al. 1965 III pl.43.11, 46.3, 47.4). It is noticeable that all these spatulas have ornamental tops, a situation which contrasts strongly with the Islamic examples only one of which is of this form (spoon-shaped spatula B/1). (One must of course take into account the fact that many of the Islamic examples are broken and have therefore lost the upper part of their handles). Spatulas with plain handles seem to have been characteristic of Roman Egypt (Petrie 1927 pl.23), and there are also important links in bowl or blade shape between the Persian Islamic pieces and those of the latter country. For example, the blade of spatula A/10, and the free spatula blade 1, are both examples of a shape found in Egypt in pre-Islamic times (Petrie 1927 pl.23 no.36-40, 51-3) and the ornamental neck style also occurs there. It could therefore be argued that the spatulas of early Islamic Iran, like the kohl-sticks, were of Mediterranean, not traditional Persian, inspiration.

It is interesting to note that spatula forms seem to have been standardised to some extent in Iran. For example, an oval bowl with an ornamental neck is found in varying sizes both at Rayy and Susa, and a spade-shaped bowl with an angular neck joint occurs both at Rayy and Sīrāf. There was evidently a freer movement of ideas in these small objects between the Iraqi plain and the Gulf on the one hand and the Persian plateau on the other than seems to have existed for other types of vessel such as oil lamps.

The situation with regard to the next group of cosmetic objects, tweezers, is somewhat obscured by the small amount of evidence. Tweezers were widely used in the ancient Near East and in the Roman world, and

were traditionally made by bending a single piece of copper or bronze into a suitable shape (Comstock and Vermeule 1971 no.626-8; Babelon and Blanchet 1895 no.1630). Iron tweezers of straight-forward design occur at Taxila in 1st and 5th century contexts (Marshall 1951 III pl.167 no.133-4), and the Nīshāpūr pair (A/1) shows the continued use of the simple bronze style in Islamic Iran. A more ornate and carefully manufactured form (B) also occurs, however, and in view of the fact that an example was found at Nīshāpūr and Sīrāf it too must have been widely used. Its particular characteristic is an adjustable sliding piece enabling the opening distance of the tweezers to be preset, suggesting the use of a very springy metal, though the analysis of the Sīrāf pair indicates, surprisingly, that the alloy in this instance has a large amount of lead in it. The Sīrāf pair is incidentally datable to the early 9th century. There appears to be no precedent for this form in Iran, but adjustable tweezers were known in the classical world (Babelon and Blanchet 1895 no.1627). Such tweezers have a sliding piece which fits around both arms, rather than working within them, but the purpose and principle is much the same, and it is therefore interesting to learn from Dr. Scanlon that a pair of tweezers of the same form as the Persian pieces have been found in the excavations at Fusṭāṭ (no.72.11.59). This suggests once again that these objects represent a continuation of Mediterranean tradition and point to a movement of forms eastwards in early Islamic times.

Artistically a most important group of toilet items are the toilet flasks, of which three distinct forms exist. The first (A) has a tall square body with three short angular legs, a flat shoulder and octagonal neck. This shape is based on a classic form of Islamic glass flask, of which numerous examples have survived (Lamm 1929 I pp.163-4, II pl.59,61-2). The centre of this particular glass industry was Egypt, from which most

of the pieces have come, and although occasional examples have been found in Iraq or Iran, Lamm suggests that they are imports, and were not made locally. The glass flasks are usually dated to the 9th-10th centuries. The fact that one of the bronze flasks (A/1) previously belonged to Murdoch-Smith makes it likely that it came from Iran and not Egypt, and the decoration on that same flask and A/2 would appear to be Persian, of 12th or early 13th century date. Hence, it would seem that bronze flasks of type A were manufactured by Persian bronze casters at this period in imitation of an Egyptian glass form imported in earlier Islamic times.

Flasks of type B have bodies based on an inverted pear or cone shape, and the fact that all three examples known are quite different in detail from one another suggests that a wide variety of such objects were in use. B/1 appears to have been cast in one piece, but B/3 shows that two halves were sometimes cast separately and then soldered together. B/2 may also have been made in this way. The source of the form is once again glass (cf. Lamm 1929 II pl.2-3), and as in the case of flasks A, although this is a much more straight-forward form, Egypt seems to have been the main producer of the glass products. While firm dating is impossible for the Nīshāpūr pieces, the decoration on the Cairo flask suggests that the bronze workers were utilising this particular glass form by the 11th century.

Three types of zoomorphic flask (type C) have survived, bird, animal and fish. All are based on what is essentially the same shape - a reclining body, wider at the front than the back, with a protruding neck at the wider end. The most realistic and the finest of the three types is undoubtedly the bird group. Like the rest they are cast bronze, but their form is strong and well-balanced, and they are all decorated with inlay patterns of the finest quality. The inlay allows them to be

dated to the 12th or early 13th century and to be associated with Khurāsān, in particular Herāt, and also indicates that they were destined for those same purchasers who were demanding inlaid ewers, inkwells, buckets and other items.

The animal flask is the least successful of the three zoomorphic types, its body having a fish-like tail and fins, and being otherwise without much character. Its decoration also suggests a provincial school of craftsmen, and so too the rather less sophisticated method of casting the body in two parts, a technique also found in other objects, including unidentified objects group A. The fish is more convincing than the animal form, and appears to have been used standing on its tail, since it has neither a flat base to its body nor an angled neck. This perhaps accounts for its tail having been broken at some time.

Both the bird and the fish flasks originally probably had tops in the form of the appropriate head with some sort of spatula or bronze stick attached. (The Victoria and Albert bird flask still has such a top and spatula intact though it may not be original). The animal flask has its head cast in two with the body halves, and the published description and photograph do not unfortunately indicate how big the hole in the head is, and whether therefore this piece was used for pouring liquid, as Dr. Zick-Nissen (Stuttgart Linden Museum 1972 no.144) suggests, or whether a spatula could have been used to extract by hand what was inside. Both animal and fish flask are to be attributed on decorative grounds to 12th or early 13th century Iran.

The shape of these flasks is typical of the way the Persian bronze workers and other craftsmen treated animal forms. The creature is reproduced naturalistically and in three-dimensional form, and its hollowness is then utilised for practical purposes. This same concept is found in the manufacture of partridge and lion incense-burners,

partridge incense-holders, bird and animal aquamaniles and so on. It is therefore unnecessary to look outside Iran for the source of such objects. Rather one should see them as spontaneous developments based on the traditional use of animal forms in the culture of the country.

Such a point certainly does not hold, however, for the two toilet dishes catalogued here. Datable on decorative grounds to the 11th-13th century, they show what is in Persian terms an extremely unusual concept of the use of animal or bird forms for objects. Far from using the hollow possibilities of a naturalistic three-dimensional animal or bird form, the manufacturer has visualised the bird as two dimensional, and has then hollowed out that flat body to provide a central receptacle area. Not only is such a concept of form foreign to Islamic Iran, it is also foreign to pre-Islamic Persian culture, in which rhytons, animal handles and figurines all point to a tradition of animals in the round, and in which, moreover, toilet dishes were traditionally decorated with figures standing out from the background in high relief (Marshall 1951 III pl.144-6). To find a source for this very un-Persian concept of form one must look westwards once more to the products of pre-Islamic and Islamic Egypt. For under the 18th dynasty toilet-dishes in the form of gazelles with the body hollowed out were used (Petrie 1927 pl.34 no.18,20), and although classical forms were introduced in the Roman period this concept of a hollowed-out animal form continued, witness two fishes of this design (Petrie 1927 pl.34 no.33-4), one having an Arabic inscription indicating its use if not manufacture in the Islamic period. An 18th dynasty ivory dish in the form of a hollowed-out duck also has later parallels, for example in an ivory dish in the form of a hollowed-out bird holding a worm in its beak which was excavated at Fusṭāṭ and is of pre-Tulūnid but Islamic date (Scanlon 1966 p.104 fig.14). It is this continuing Egyptian tradition that must have been the inspiration for the two Persian bronze dishes under discussion. Compared to the objects cited they are somewhat

crude; whether they are the end of what had become a Persian tradition through adoption in a medium such as ivory or stone or whether they are based directly on Egyptian imports there is at present no way of telling.

The most numerous group of cosmetic items of any size to have survived are objects with a hemi-spherical body, flat everted rim, horizontal handle and side flanges, and long horizontal spout. In the past these have received a variety of names. Sometimes they have been called lamps, but the spout is the wrong length and shape to hold a wick, and this use can be discounted. Sometimes they have been called baby-feeders, e.g. by Dr. Whitehouse, who found them being sold in the Bushire bazaar under that name. While they might occasionally have been used for this purpose in early Islamic times, it seems highly unlikely that that should have been their primary function. Until this century babies have always been breast-fed, either by their own mother or a wet-nurse, and everyday objects such as spoons would have been much more handy than such elaborate bronze objects for feeding special medicines to children. Furthermore, if the long spout was designed for insertion into a baby's mouth then the tail-piece on V.1 would have prevented such a use and that example at any rate cannot have been designed for the purpose. Finally, they have come to light in relatively large numbers, and it is difficult to conceive of there having been such a widespread need for baby-feeders. Another possible use for them is indicated by two illustrations in manuscripts of Abū'l-Qāsim al-Zahrāwī's book on surgery and instruments, dated 670/1271-2 and 870/1465-6 (al-Zahrāwī pp.261-2, fig.64), from which it appears that objects of approximately this form were used as nose-droppers. Here again, however, the need for such objects would have been small, and one would certainly not expect large numbers to come to light on sites all over Iran. Yet

another name given to them is cosmetic mortars. True no evidence has yet been put forward to prove this, but compared to the others it does seem reasonably logical - the cosmetic bottles mentioned above all have narrow necks, and the long spout would therefore act well as the filling agent; the hemispherical body would be an excellent receptacle for mixing small quantities of material for eye make-up and other purposes; the flanges and handle would help steady the object as the substance was poured from object to bottle; the large number of surviving objects would be easily explained since make-up has always been widespread in the Islamic world, as much among the poor as among the rich. Furthermore, surface testing of object 2 showed that the corrosion products were antimony-rich. This could best be explained by continual use of the object for kuḥl prior to its being buried, even though antimony-based compounds were not usual (see above p.168); it would certainly be unlikely if the object had been used all its life for any other purpose.

The surviving cosmetic mortars were all cast, and the one example analysed (1) proved to be lead bronze. They are almost all the same shape, and usually have a low foot ring, though three small feet also occur. Sometimes the flanges and handle are joined at the extremities (6); in one case the object has been given zoomorphic characteristics (V.1). (For other examples of cosmetic mortar handles see handles G). Despite the relatively large number of surviving examples it does not seem to be possible to establish regional variations in form. Susa and Sīrāf, as might be expected, produced objects of very similar design e.g. those with dot and circle motifs (1 and 4), but Susa also produced objects with a quite different style of ornament e.g. object 3 with its bosses. Likewise, the dot and circle style was not confined to the south-west, for it appears on two Nīshāpūr examples (10 and 11). The

feet used on various examples do not appear to be regional either, the low foot ring occurring at Susa, Sīrāf, Tal-i Ẓuḥāk, Rayy and Nīshāpūr, and three small boss feet at Sīrāf, Tal-i Ẓuḥāk and Nīshāpūr. Two pieces can be approximately dated from their archaeological contexts - 1: perhaps 9th century; 4:8th-9th century. Others can be attributed on the basis of their decoration - 23:11th century; 6:12th century; 18:12th-13th century. Such dates indicate that the objects were in use throughout the early Islamic period but do not betray the nature of any development or variation in form.

Turning to the origin of the shape, there are certain parallels which call for comment. Small, often hemispherical, spouted bowls in alabaster were used in ancient Egypt at dates varying from the late 3rd millenium to the 4th century B.C. (von Bissing 1904 no.18516, 18620, 18624,18760 pl.7), and a Hellenistic silver object with hemispherical body, flat base, loop handle, two side flanges and very short spout, evidently based on another short-spouted Egyptian stone type, has also survived (Schreiber 1894 p.333, fig.69-70; von Bissing 1904 no.18754 pl.B). In the Islamic world objects of the same form as the Persian type occur frequently in Egypt. Thus a lidded example was found in probably 11th-12th century levels at Fusṭāṭ (Scanlon 1966 p.97 fig.11), other probably Islamic examples are in the Coptic collection in Cairo (Strzygowski 1904 no.9150-2), another from Madīna Habū, near Luxor, is in the British Museum (Dalton 1901 p.104 no.527, pl.27), and yet others from Egypt are in Berlin (Wulff 1909 I pl.53 no.1057-8, 1060-1). Given the existence of similar if not identical forms in pre-Islamic times in Egypt and the Hellenistic world, and the enormous numbers of examples associated with Islamic Egypt, it is tempting to suggest that there was a continuous chain of development in classical and early Islamic Egypt which led to the establishment of the form, and provided the source of the Iranian style.

There are not enough surviving objects to prove this suggestion conclusively but there are two important indicators that it may well be correct. The first is the small triangular flange which occurs on either side of the spout on virtually every example. Such a style, which is also found on cauldrons, is based on stone carving techniques, indicating that stone objects are to be expected somewhere in the ancestry of the mortars. The second is the form of cosmetic mortar V.1. For this zoomorphic rendering of a mortar is quite un-Persian, and should be compared to that of the toilet dishes discussed above, whose origin is Egyptian. V.1 therefore indicates a definite link with Egypt, and as a result further reinforces the suggestion that the mortars in general are of Egyptian origin and that the form was imported into Iran in early Islamic times.

On the basis of the above discussion the bronze toilet articles of early Islamic Iran throw important light on the culture of that country in the period up to the Mongol invasions. It is generally agreed that the bronze industry of Iran exerted a very strong influence on that of north Mesopotamia and then those of Syria and Egypt in the 13th century owing to the arrival of the Mongols in Iran and the need for craftsmen if not to flee at least to seek more profitable employment in the more stable conditions of the Islamic countries to the west. But here there appears to be a movement at an earlier period in the opposite direction, from Egypt to Iran. In this case it was probably not a movement of people, nor even of particular bronze objects, but rather a movement of cultural traditions and the various objects in various media associated with them. That movement was undoubtedly due to the political unity of the Near and Middle East in early Islamic times; it was also probably due to the luxury and luxurious customs which established themselves round the ʿAbbāsids in Iraq from 750

onwards. However, it must also have been due to the traditional superiority and sophistication of Egyptian and Roman toilet and cosmetic customs, customs which the rulers of Islam and their families were evidently delighted to adopt and propogate.

III Scientific Instruments

The classical basis of Islamic science in general has frequently been discussed, and Islamic astrolabes and globes, and the theories on which they are based, are part of this heritage (EI_2 asṭurlāb). Thus Hipparchus (active c.161-126 B.C.) was probably the first man to construct a celestial globe, while Ptolemy's Planisphaerium was the authorative text on the astrolabe prior to the writings of the Muslim scientists. According to Ibn al-Nadīm (II pp.670-2) the early centre of the astrolabe industry in Islam was Ḥarrān, presumably because of its Sabaean astronomical traditions, and al-Ḥarrānī is a nisba frequently encountered in Ibn al-Nadīm's lists of early Islamic astrolabists. The evidence for the manufacture of globes, astrolabes and other scientific instruments in early Islamic Iran comes first of all from literary sources, in particular from what we know of the life and work of al-Ṣūfī, from his own writings and the writings of others. Al-Ṣūfī was born at Rayy in 903 A.D., and spent most of his life in central and southern Iran. The leading observational astronomer of his day he was patronised by his pupil, ʿAdud al-Dawla, to whom his book of constellations was dedicated in Shīrāz in 946 A.D., and is known to have directed an extensive series of solar observations at Shīrāz between 969 and 972 A.D., for which special instruments were made. These would mostly have been enormous quadrants made of wood or masonry, but probably included metal armillary spheres. al-Ṣūfī is recorded as the manufacturer of a silver globe seen in 1043 A.D. in the royal library in Cairo, and may therefore have made some of the latter instruments. On the other hand one would guess that, as chief astronomer to a patron as wealthy as ʿAdud al-Dawla, he would have had skilled assistants to do much of the basic

construction work prior to observation. Be that as it may, al-Ṣūfī's work in Iran in the 10th century probably attracted other interested parties, and it could be logically suggested that an industry for the manufacture of scientific instruments probably grew up there.

Certain archaeological evidence backs up this theory: in the first place a 10th century astrolabe by a known Persian maker. This is the piece by al-Khujandī dated 374/984. al-Khujandī, as his name implies, was a native of Khujanda in Transoxania. He lived much of his life in Rayy, and was famed for an enormous sextant he constructed for determining the obliquity of the ecliptic, a feat which he achieved in 994, some six years before his death (Brieux 1973 pp.10-13). It is highly likely that the surviving astrolabe was made by him in Rayy, and the heavy palmette forms on the kursī and the animal heads are not at all out of keeping with Persian Islamic art, even though the latter have their most obvious parallels rather later in Khurāsān.

The obvious features which distinguish this astrolabe from its predecessors are the high and elaborate kursī, and the use of the word al-ḥūt for Pisces instead of al-samaka, and Maddison (1957 p.17) suggests that such features may be the "hallmarks" of the Persian astrolabe tradition. Reviewing the surviving astrolabes prior to the date of the Mongol invasions of Iran, it is possible to compile a list of some nine, in addition to that of al-Khujandī, which appear to be part of this tradition (see catalogue). Reading through this list one is immediately struck by the occurrence of the nisba al-Iṣfahānī: seven of the astrolabes are by men using that nisba, representing six different individuals, two of whom were responsible for one particular example (1). Those not evidently by Iṣfahānī's are 2, which is by al-Khujandī and has already been discussed, and 4-5. The latter two

are signed by a certain Hibbat Allāh. On the Munich astrolabe he calls himself al-Baghdādī and since the Chicago example was made for the Saljūq ruler of Iraq Mughīs al-Dīn Abū'l-Qāsim (1117-1131 A.D.), one might assume that it was made in Baghdād. However, here again there is a connection with Iṣfahān, for his son Abū'l-Qāsim ibn Hibbat Allāh, who is known from a quadrant in the Louvre, is called by one of his biographers al-Iṣfahānī (Destombes 1958 p.310). Since Abū'l-Qāsim seems to have worked most of his life in Baghdād, and his father called himself al-Baghdādī, one wonders why this was so. One is forced to conclude that if Iṣfahān was not actually the centre of the Persian astrolabe industry from al-Ṣūfī's day up to the Mongol conquests, then it must have had an extremely fine reputation as such, a reputation which gave names bearing the nisba al-Iṣfahānī a "magic" ring, and made the products of the men involved, in the purchasers' eyes at least, objects of the highest quality. In fact, however, the only really satisfactory explanation of the widespread usage of the nisba al-Iṣfahānī is that Iṣfahān was indeed the centre of the industry. After all, in the 10th century the geographers testify to its great wealth and its importance as a trading city - second only to Rayy between Iraq and Khurāsān according to Ibn Ḥawqal (pp.362-3) while between 1106 and 1118 it was the capital city of the Great Saljūqs, and regularly during the 11th and early 12th centuries it played a vital role in the political affairs of western Iran and Iraq.

But if Iṣfahān was such an important place at this period, and was so famed for the manufacture of astrolabes, it might be argued that it must have been a metalworking centre in general. Here it is necessary briefly to consider the metal of which astrolabes are made. Although none have ever been analysed, they have all the appearance of being

cast brass, and the colour of the alloy suggests moreover that they are fairly pure copper and zinc with very little if any lead in them. The analyses made of other Persian bronze objects indicates that such pure brass was only common for sheet metal, and historically fine objects made of sheet brass seem to have only become fashionable in the latter part of the early Islamic period. On this basis, therefore, and taking into account the scientific orientation of the skills of astrolabists, it is clear that this particular business was quite separate from the rest of the metalworking industry of Iran, and it is thus quite conceivable that Iṣfahān produced no other bronze objects of note.

Returning now to the instruments themselves, the latest of them, that signed by Muḥammad ibn Abī Bakr al-Rashidī al-ibarī al-Iṣfahānī, deserves particular attention. Not only does it contain the only known early Islamic geared calendar, giving it particular mechanical interest, but it is also decorated around the edge with inlaid figural designs, unparalleled on other pre-Mongol instruments. These have definite Persian characteristics, for example the zodiacal signs in roundels, and the scrolling stem pattern background ornament, and if the figures raising one arm and brandishing a weapon in the other are unusual in their posture that is easily explained by the unusual space they fill. Assuming the instrument to have been made in Iṣfahān it would therefore appear that just prior to the Mongol conquests the industry had suddenly become more integrated, and that the astrolabists were cooperating with artists skilled in traditional Persian metalworking of the type exemplified by the Khurāsān schools. The most logical reason for such cooperation would be that migrating Khurāsānī craftsmen (through whom incidentally the north-west Persian 13th century industry also developed) were suddenly available, and this astrolabe can therefore be interpreted as emphasising the lack of such skills in Iṣfahān prior to this period,

and the consequent isolation of the industry in general metalworking terms.

So much for astrolabes. Only two other instruments survive, one a globe, the other a quadrant. The globe is dated 539/1144 and signed by Yūnus ibn al-Ḥusain. Islamic celestial globes, like astrolabes, seem to have been made initially in Ḥarrān, for al-Ṣūfī found fault with a large sphere made by ʿAlī ibn ʿIsa al-Ḥarrānī and mentioned several others made by Ḥarrānī craftsmen (Wellesz 1959 p.4). Such spheres were probably of wood covered with metal, the method of manufacture proposed by Qusṭā ibn Lūqā in his 9th century treatise on the construction of globes and spherical astrolabes, and this would explain their rare survival (Destombes 1958 p.308). The large silver globe of al-Ṣūfī has already been mentioned, and it is interesting in this connection to note the story which al-Birūnī relates from the geometer Abū Saʿīd Aḥmad al-Sijzī (c.951-c1024 A.D.) that al-Ṣūfī traced single stars and constellations for his written work from a globe. For al-Birūnī himself divides globes into large and small - the large ones being rare, costly and difficult to use (Wellesz 1959 p.19). Hence there seems to have been a tradition of larger more spectacular globes, made of silver perhaps, suitable for tracing from, and no doubt very impressive objects (compare the inlaid terrestrial globe in the vaults of the Bank Mallī in Tehrān), alongside a tradition of small, accurate objects, used for scientific calculation. The globe of Yūnus is one of the latter, and indeed a notable object, since his correction of stellar longitude was 8' more accurate than al-Ṣūfī's. On the basis of the calligraphy Destombes suggests that Yūnus was working either in Baghdād or Iṣfahān. Full publication of the figural designs on the globe might help in confirming this attribution.

The quadrant was found in the excavations at Nīshāpūr and is signed by Muḥammad ibn Maḥmūd. It has been ascribed by Mayer (1956 p.71) to the 10th century, but since the style of kufic used by 12th century astrolabists has a tendency to be archaic, it could be somewhat later. Its scientific accuracy has not yet been tested, and it remains something of a mysterious object. It should be pointed out, however, that it is highly likely that such dynasties as the Samānids and Ghaznavids had trained astrolabists and makers of scientific instruments at their disposal. The complete lack of such surviving pieces, with this one possible exception, should not be taken therefore as indicating that such objects were never manufactured in those regions of Iran; there may have been no centre to rival Iṣfahān but numbers of instruments must have been produced.

IV Tools, Weapons, and Musical Instruments

Only two proper tools or implements seem to have survived: a saw in the Brooklyn Museum, and a chisel from Rayy. As with weapons, iron and steel would usually have been used, and the lack of implements is therefore no surprise. The chisel being undecorated is undatable. The form of the lion head of the saw is akin to those on the bronze incense-burners of lion form (E/2) which date from the 10th-12th century. The incised decoration on the animal's neck is also found on the wings of the bronze partridges used as incense-burners (E/3) and incense-holders, which are datable to the 10th-11th century, and it is therefore to this period that the saw is to be attributed. It may have been a surgeon's saw or it may have belonged to a craftsman working in soft-wood. Also catalogued are certain bronze nails but a detailed study of the hundreds of Sīrāf nail fragments is necessary before any constructive comments can be made.

Weapons or weapon accessories include a dagger handle, maces, shield bosses and various sword fittings. The dagger handle is datable on decorative grounds to the 12th or early 13th century. The sword fittings have been discussed in full in connection with the Nīshāpūr sword (see p.438). The dating of maces 1-2 and 4, judging from their decoration, is also 12th or early 13th century. Mace 3 is undecorated, but the form of lions is not unlike those found on the repoussé ewers from Khurāsān during the latter part of the early Islamic period, and a 12th-13th century date is probably not far out. The use of mace-heads of form 1-2 and 4 is depicted on the Freer minai dish (Atil 1973 no.50) which is of the same date. A rather different style of Transoxanian mace-head should also be noted (Sarre 1906 no.11 fig.3).

Shields are briefly discussed elsewhere (p.450). It should be noted that the identity of the Nīshāpūr bronze object catalogued as a shield boss is by no means proven; for various reasons it has seemed more appropriate to catalogue certain other pieces of similar form as unidentified objects (group C). Particularly confusing is the problem of distinguishing shield bosses from cymbals, the two having been virtually identical in shape since the 1st millenium B.C. (Moorey 1971 no.467-473, 478, 483). The continued production of cymbals since that time is suggested by a pair found in a late Achaemenid or Parthian grave in Dailamān (Egami et al. 1965 II p.10, pl.18.2, 43.8-9, 44.1-2, III pl.45.6-7) and the three Islamic pairs catalogued here. The fact that the latter are all pairs and that one of the Sīstānī pieces is of high tin bronze - the best alloy for the resonance required, makes their identity at least virtually certain. The second Sīstānī piece, made of a quaternary alloy, appears to be a poor quality replacement, perhaps after one of the original pair had cracked.

V Horse-harness

Two types of bronze object associated with horses survive. The first is a group of objects which are probably ornaments from leather horse-harness, the second is a style of stirrup. Of the first, let it be said immediately that there is no absolute proof that these objects are horse-harness ornaments. On the other hand it is clear that they cannot be belt fittings. For previous discussion (p. 92) has shown that there was a limited range of shapes used for such ornaments, and that there was also a measure of standardisation which generally led to the production of a metal plaque with lugs protruding from the back and low sides giving the impression of hollowness. Only in the rarest instances was a cut-out technique used. Compared to this the ornaments under discussion in this chapter are quite different. They are solid cast objects with a flat back and rounded front; almost all utilise cut-out techniques as the predominant mode of decoration; all bear small holes through which rivets were passed to fix them to the chosen ground.

The cut-out technique and the designs used call for particular comment. One of the most striking objects in the group, and also the simplest in conception, is 2, a gilt bronze plaque in the form of a pair of horns. The design occurs on saddle pendants from Pazyryk, and is of Altaic origin. But so too is the style and conception, which is paralleled in numerous wood-carvings from the same sites (Rudenko 1960 pl.82-92; 1970 pl.95 F-I), not only in the idea of a form with space all round it, but also in the idea of the form being flat-backed, and solid, with a rounded front. The same is true of 1,3 and 4. Against this Pazyryk background 6-8 and 11-13 also become comprehensible, either as areas of one material with applied pieces of another, symbolised by the empty spaces, or as cut-out appliqués for a prepared ground, in both cases

the decorative idea being based on characteristic Altaic techniques and traditions. The same sort of explanation can be given of virtually all the items catalogued. The only exceptions are 5 and 10, the latter being decorated in a style more characteristic of migration period belt buckles (cf. Arne 1914 fig.215-6) although it has rivet holes like the rest of the ornaments. Since therefore the objects are not belt ornaments, and since they bear a very close relationship to Altaic culture, it seems logical to suggest that they are ornaments for horse-harness, for Altaic culture was horse-orientated, and it would have been through the use of these animals that descendants of the culture would have reached the Islamic world. What is more, because of the way fashion works, horse-harness is more likely than personal ornament to retain traditional types of decoration and this is exactly what is seen in these ornaments.

However, there is a problem here which must be faced. Cut-out bronze ornaments of a variety of designs existed in the Near East long before they appear at Nīshāpūr and have been found in particular at Dura-Europos. Other pieces are incidentally illustrated by Strzygowski (1930 pl.621). The published study of the Dura-Europos finds makes very inadequate use of Central Asian material, and the comments about the origin of the forms as they occur in the Roman period are therefore unreliable. Some of the bronzes certainly show a connection with Altaic designs (Frisch and Toll 1949 no.46,54,56) but others are of uncertain origin. Among these are circular plaques akin to our 16, and possibly to our 14 (Frisch and Toll 1949 no.4-6,8 etc.). The question therefore arises as to whether there were not two different sources for the Persian horse-harness designs, the one second-hand Altaic, the other very much third-hand nomadic, having reached Islamic Iran as a legacy of classical culture. Unfortunately this question can only be posed:

any attempt to answer it must await the discovery of far greater quantities of material both pre-Islamic and Islamic.

Turning to stirrups, only three examples are well known. Two (A/1-2) are from Ghazna, and a third of the same type from the same site is mentioned by Scerrato (1959 p.107). If his dating of 11th-12th century is correct - and the decoration on the two published stirrups is nebulous enough to make the dating hazardous - then this style was evidently a Ghaznavid or Ghūrid one. Assuming that the Susa piece (B/1) is a stirrup it appears to represent a quite different tradition, though its significance remains elusive. In view of the fact that Samarqand is singled out as an important stirrup-manufacturing centre by al-Muqaddasī (p.325), it may be right to assume that there were a variety of stirrup forms in use in Iran, produced in a variety of centres.

The date of the introduction of the stirrup into the Middle East or into Europe is still debated. The best discussion of the evidence is that of White (1962 pp.18-26). He notes that the Persians used the Arabic word rikāb for stirrup, suggesting that it was introduced into Iran with the Arab conquests, but he also points out al-Jāḥiẓ's (Jāḥ Bayān III pp.19-20) attribution of iron stirrups to the Azraqites, which seems to fit the evidence of al-Mubarrad who claimed that stirrups were first made of wood but that iron ones were introduced by al-Muhallab, who in fact campaigned against the Azraqites in Central Persia. Against this he places the traditional view that stirrups were known to the Byzantine armies in the sixth century or at least in the eighth, depending on the dating of the Strategikon, and that they would have therefore been introduced into Iran before the Arab conquests through Byzantine-Sasanian contacts, or after the Arab conquests

through the Arab attacks on the Byzantine lands (see also Bivar 1955 and 1972 p.290). What is absolutely certain is that stirrups are shown in the hunting scene at Qaşr al-Ḥair al-Gharbī, probably datable to 724-7 A.D. Since this particular painting is definitely of Persian, not Syrian, inspiration, the Persians must already have been aware of the use of the stirrup by the beginning of the 8th century. Until more information comes to light, historical, or art historical, the exact date of its introduction and its immediate source must remain a mystery.

VI Architectural, Furniture and Object Fittings

A variety of box fittings survive, the most impressive being a group of gilt bronze appliqués in the form of human figures (A/1-5). Their origin is clear from the Boston bronze box dated 1197 A.D. (box C/1/1), which is adorned with three very similar appliqués, and from the silver caskets found in the Harari hoard, one of which bears a gilt appliqué very like 5. The origin of A/6 on the other hand remains something of a mystery. If it really is a box fitting, it must have come from an otherwise unknown style of box. Its form and decoration suggest that it is a 10th-11th century Persian product.

The other box fittings catalogued are small and for the most part unremarkable, and none of them seem to have exact parallels on known objects. Those with rivet holes (the majority) would have fitted onto non-metal boxes, but those without (e.g.1,5) must have been soldered to metal objects. Two pieces are particularly noteworthy. Ten is datable from its context to the 9th century or earlier which is important evidence that objects suitable for such fittings were already in use at that date. Twelve is a finely-cast gilt bronze clamp which is similar in general form to those on the silver boxes from the Harari hoard. Its decoration suggests, however, that it is somewhat earlier than the latter, perhaps 10th-11th century. No dating is possible for the other Nīshāpūr and Rayy pieces. Of the other Sīrāf finds 6 is from the surface, 9 is pre-Mongol, 11 is 11th century or later, and 8 is undatable. The smallness of most of these items makes it extremely difficult to tell whether they are cast or cut from thick sheet metal: the analyses done indicate that they were usually made of a quaternary alloy.

A variety of chains have survived. The most elaborate is the openwork chain from Rayy (1). Other decorative ones from Susa are catalogued under the hooks they bear (B/2-3). Other chains which should be noted are those holding a cauldron from Susa (cauldron B/1). These have S-shaped links, like the chain from Rayy (2) and also double, double-angled links. The few surviving lengths of chain can scarcely be representative of the vast quantities which must have been used throughout the cities of Iran for suspending vessels and other objects.

A cast bronze sphere with an opening at each end and pierced decoration is probably a fitting for a chair. Chairs with such bosses are known to have been relatively common in 12th and 13th century Iran, and one has survived (Chairs 1). This boss bears decoration of 11th-13th century date.

An octagonal pierced cover surmounted by two spheres and a bird is almost certainly the upper part of an incense-burner. With decoration typical of north-east Iran in the 10th-11th century it shows again the variety of forms utilised at this period for such objects. Originally it probably covered a base with zoomorphic supports (incense-burners E/5), though no octagonal examples of this style have otherwise survived.

A set of bronze door fittings in the British Museum has a type of bird-head profile projection which is also found on ewer rims and lampstand bases, and it is therefore likely that the fittings are early Islamic. The only other early Islamic fittings published are those on the doors taken from Maḥmūd of Ghazna's tomb and now in the Red Fort at Agra. Their style is very similar to the British Museum group, and though it is impossible to be certain that they are original their spacing on the doors and their obvious purpose in holding the three planks in each door together suggests that, like the doors, they are probably datable to about 1030 A.D., the year of Maḥmūd's death. It would therefore appear

that in early Islamic Iran bronze was not only used for hinged door fittings (6 and 7), but also for brackets to hold the door planks in position. As regards the hinged fittings, it will be observed that while fitting 7 has two rivet holes and was therefore nailed to the door, 6 has no rivet holes and must therefore have been unattached at the back. Hence, it would appear that these two pieces, when hinged together, are designed as a locking bracket, 6 swinging on 7, the square hole in its head fitting over some sort of loop, through which a door pin would then be passed. Two door pins have survived, though neither regrettably is of known origin. Virtually identical, they were probably held by a chain attached to a ring through the head. The heads are in the form of lion-heads, and while they fit into a 12th or 13th century Persian context it could be argued that they are Anatolian. There seems to be no way at present of establishing their true provenance since apart from the head they are both virtually undecorated.

Although a wide variety of finials have survived intact with their parent objects, many others have become separated from them. Among these latter one particular group of bird-finials may be distinguished (A). Such decoration as they bear, plus the forms of palmettes on A/1 and A/5, point to a date in the 10th-11th century. That date combined with their general form suggests that they are the finials of a particular type of incense-burner (E/5), for a similar bird is used as the finial on the only complete example (E/5/3), and another like it occurs on an incense-burner cover which probably comes from a similar object (cover 1 above). The other bird finials are of unknown origin, the only particularly impressive one being B/2 with its silver inlay and striking form. In group C the most impressive object is the ibex (C/7). This is large enough to be an ornamental free-standing animal, but the survival of two ibex handles on bottle E/1 suggests that such objects

may have been used on other objects as handles or finials, hence its inclusion here. C/4 is virtually identical to the bulls' heads which embellish a bronze lampstand base from Ghazna (lampstand C/2), and is presumably from a similar object.

Like the cover and some of the finials, some of the surviving handles add a certain amount to what is known of early Islamic Persian object types. Thus group A handles, unknown from complete objects, have parallels on two Mesopotamian pieces - the Innsbruck enamelled dish, and an inlaid bronze basin (Sarre and Martin 1912 pl.159,156). This does not of course prove that either of the latter forms existed in Iran but it certainly emphasises the fact that object types still remain to be discovered. Type B, being hinged, is probably a style designed for furniture, but here again the nature of the furniture remains unknown. Type C (ring handles) on the other hand are known in silver on drinking bowls, and in bronze on certain styles of oil lamp (A/1-3, B,D), suggesting that they were fashionable until about 1100 A.D. Type D are found on the standard bronze 12th and early 13th century lamp style (A/7), while type E is a typical ewer or jug form, and occurs particularly on 11th century zoomorphic-spouted ewers (A/2/c). Type F is a primitive style of bucket handle. F/1 is probably 10th century, and F/2 is pre-Mongol. Type G handles are evidently the remains of cosmetic mortars. The lion-handles (H) represent the continuation of the Parthian incense-burner tradition into Islamic times (see p.312), while J/1 is the only known mirror handle of its type from the Islamic period. Its significance is discussed elsewhere (p.338). K/1 and 2 are from another type of incense-burner (A/1, B or possibly E/4), and K/1 is important not only as a signed object but as illustrating the continuation of one at least of those incense-burner styles into the 12th century. K/2 is probably 10th or 11th century. The original styles of the handle fragments in group L are not known.

The use of wall hooks or pegs (A) in early Islamic Iran is attested by an illustration in the 595/1199 manuscript of the Kitāb al-diryāq, in which small bags are depicted hanging from double pegs attached to some sort of strip backing placed on the wall (Paris Bibliothèque Nationale 1973 no.191). All the surviving pegs from Susa and Nīshāpūr are single rather than double but since none of them have rivet holes they would have had to have been soldered to a metal strip and then fixed to a wall, and they therefore closely correspond to the illustrated examples.

Hooks (B) were also used for suspending objects for cooking and other purposes. Excavations at Susa and Rayy have brought three such hooks to light, all of them about the same size, and all of cast bronze. The Susan pieces are still attached to lengths of chain consisting of flat openwork plates with eyes at each end joined by small circular links. These plates are also cast.

Two keys and three locks were found in contexts or bear decorative designs which allow them to be attributed to early Islamic Iran. The locks are all spring locks, and the two keys are both designed for this type of device (cf. two found at Sāmarrā, Baghdad Department of Antiquities 1940 pl.140-1). Spring locks were widely distributed in the medieval world. An example with an Arabic inscription dated to 541/1146-7 is in the Kazan Museum, and an argument for a more central Islamic, perhaps even Persian, origin could be made out in spite of the assertions of Malov (1927) that it is a Bilyarsk product. Similar plain spring locks occur in the migration period in Europe, for example in Hungary (Hampel 1905 III pl.283) and Gotland (Arne 1914 p.199 fig.334), and even more popular were those in the form of animals (Hampel 1905 III pl.283). Horse locks are still made today in Iran (Wulff 1966 pp.70-1), and numerous examples are to be found in Museum collections. Since most of them are undecorated

there is a considerable dating problem, and the pieces catalogued here are those which bear decoration which points to the pre-Mongol period: it is quite possible that other undecorated pieces are also from early Islamic times.

Lids are divided for convenience into two types - domical, and sunken. The domical variety (A) is the more numerous and has a variety of forms. The simplest (1 and 2) are shallow domes with a broad flat rim and could have been used for small jars of some sort. Slightly more sophisticated are 3 and 4, the points of the latter recalling the points of a group of circular oil lamps (lamps C). A/5 with its inset hinge may be compared to A/9-11 and is apparently an elaboration of a lid found on another type of bronze lamp (A/3 V.1). A/6 and 7 have no hinges and are probably lids for jugs (cf. that on silver jug B/2/3). A/9-11 may be compared to the lid on a bronze lamp from Shahristān (lamp A/3/1). A/12 seems to be unique.

Only one of the sunken lids is of known provenance, the very small example found by Stein in Sīstān (B/4), but the decoration on the other three indicates that they are all 12th-early 13th century north-eastern products. Their provenance is confirmed by the discovery of numerous pottery lids of this form at Nīshāpūr. Wilkinson (1973 p.306 no.47) suggested that these were covers for wide-mouthed pottery pitchers, and the metal examples may well have been covers for bronze jugs with an appropriate mouth diameter, such as jug B/1/2. Whether the finials on the three more elaborate bronze lids are original is not certain. Both the pottery examples and the piece from Sīstān have small knobs, and the elaborate example on B/1 and the fact that all B/1-3 have visible repairs to the finials may indicate that the original ones were rather plainer.

Two types of ring have been found on excavations, one with a round section, the other with a triangular section. Their uses were no doubt many and various. The only decorated one is B/3 from Nīshāpūr.

An 11th-12th century cauldron spout from Sīrāf points to an otherwise unknown form of cooking vessel.

Under the clumsy but convenient term support fittings are grouped all items which functioned as feet, legs or any other form of support for a larger object. They have been divided into two groups, zoomorphic (A) and non-representational (B), and then subdivided according to the details of their form and the nature of their fixing mechanism. Only two supports in the form of complete animals survive (A/1/1-2). The first, a lion on its backlegs with a bayonet fixture in its front paws, is related to the lion handles occasionally found on incense-burners (handles H). The angle of the bayonet fixture, however, suggests that it was part of a much taller object, perhaps the foot of a tripod lampstand of a type known in the classical world though as yet unknown in an Islamic context (Ridder 1913 II pl.111 no.3144). A/1/2 is a splendid horse with a bayonet fixture on the top of its tail. What it actually supported there is no way of telling. The saddle-cloth and other trappings should in theory help to establish the date and provenance of the animal, but unfortunately there are all too few early Islamic dated representations of such features for purposes of comparison. Late Sasanian saddle-cloths were square, although large ones were used on elephants (Fukai and Horiuchi 1969 I pl.82,90,99), and 12th-13th century Islamic ones were rectangular with a long point behind the rider's leg (Pope 1938 pl.667), but for the intervening period there seems to be no information. The pattern on the bronze horse's saddle-cloth occurs also on unglazed 11th-12th century pottery from Lashkarī Bāzār (Gardin 1963 pl.7 no.55), and the blossoms alongside point to a

10th-11th century date. The emphasis on lute-players, favourite ʿAbbāsid court symbols, suggest that the object may be west rather than east Persian.

A/2/a are a group of fittings in the form of animal forequarters with bayonet fixtures at the rear. Two are in the form of gazelles, the third is more like a horse, and they vary in height between about 16.0-18.0 cms. No extant objects have identical supports, but a fairly close parallel is provided by the lion supports on group E/5 bronze incense-burners. The decoration on the gazelles and horse indicates an 11th century date which would certainly fit with the incense-burners, and these three may thus indicate the use of removable as well as permanent legs for such objects. A/2/b-c are two groups of supports which are very similar to one another but have different projecting ledges at the rear. They were presumably designed to fit onto the lower angle of some object, though the concave design of the ledge in the second group is somewhat mysterious in this connection. A probable use for many of the examples is as legs for bronze dish incense-burners, such a dish with legs still attached being in the Widmaier collection (incense-burner F/2/4). In group A/2/e are four supports with other fixing devices. The first and fourth have long projecting bars, the second has an angled slot, and the third has been broken from its parent object. The pieces in A/2/f have been catalogued separately since the nature of their fixing devices is unknown.

The use of animal forms for object supports or feet was well-known in classical times, and they were particularly employed on lampstands and cistae (e.g. Ridder 1913 II pl.111-113). Forequarters of animals or birds continued to be used, and indeed played an important role, under the Sasanians, when they are found as throne legs (London Burlington House 1931 pl.8 left; Ettinghausen 1966 fig. 1; Melikian-Chirvani 1969a), and the transition from that style to the smaller animal supports

catalogued here must have been easy enough. The animal forms utilised in the Islamic period are typical of their day - lions, often with heavy facial features like those of the lion incense-burners; harpies, with their mythological overtones; amalgams of animal forms taken from tradition and the craftsman's imagination rather than any observations of the original beasts.

The non-representational supports have two main forms. The first is a ball foot which occurs with a variety of attached areas for fitting to appropriate objects. Ball feet, like animal legs, are part of the classical heritage in Iran, ball and claw, for example, being a common foot style in classical bronzes (Richter 1915 pp.290-3), and ball-like feet occur on ceramic dishes in the early levels of Islamic Susa (Rosen-Ayalon forthcoming p.196 fig.468). The origin of baluster legs (B/2) is rather different. These occur in two distinct forms. The one surviving example of B/2/a, which is over 50 cms. high, was described when published as a stand, but must in fact be a throne leg. This is clear from surviving manuscript illustrations of the 13th and 14th centuries. For example, a wide low throne with four such legs appears in an illustration of the Kitāb al-diryāq of the mid 13th century from northern Iraq now in Vienna (Ettinghausen 1962 p.91), and a century later in the Egyptian Ḥarīrī manuscript of 1334 A.D. also in Vienna (Ettinghausen 1962 p.148). At this later period it was also a style of leg for a low table (Martin 1912 pl.16a), and judging by other depictions of table legs, for example in the 1229 Dioscorides manuscript (Ettinghausen 1962 p.69), the form is based on turned wooden legs. It is thus related to the shafts of the standard Persian lampstand form which are of like origin. The lack of pre-12th century pictorial evidence makes it impossible to trace the precise development of this particular throne leg style, or indeed the style of the throne itself. The surviving leg

has a kufic script and a form of leaf of 12th rather than 13th century form, providing evidence of its use prior to the manuscript illustrations. The existence of throne legs in the form of eagles or griffins from Sasanian times suggests that it is not a Sasanian legacy. When it first came into use in bronze between those limits, however, it is at present impossible to say.

Examples of group B/2/b are much smaller than B/2/a/1 and far too small to be throne legs. It is possible that some of them are handles, since this form is found as a handle on bronze incense-burner A/1/7, but their frequence occurrence on silver incense-burners (A/1-2 and B/1/1) as legs makes the latter a more likely identification. Despite the fact that they have a flattened central section they must, like the throne leg, be based on turned wooden leg forms.

In group B/3 are two bases, rather than legs or feet. Large domical forms of base are found on pear-shaped bronze incense-burners (group D/1) and a pear-shaped ewer (A/2/d/V.1) where they are associated with north-eastern Iran in the 10th-11th century. The same dating is appropriate for the second of the separate bases; the Nīshāpūr piece is undecorated but its find-spot confirms the likely provenance of the style. The nearest parallels to these bases, apart from those mentioned, are the splayed bases found on a group of Transoxanian ewers (Ivanov 1970 no.20-27), and it may well be that the larger domical style developed in Transoxania at this period.

It is unfortunate that none of the taps catalogued have a known provenance, for the stylisation of the animal forms which are used for the spouts and handles is such as to make an attribution extremely difficult. Indeed it is by no means certain that these are Persian objects, and an argument for an Anatolian provenance could be made on the grounds that

springs are a common type of water supply in Anatolia, whereas wells and qanāt's are more common in Iran. Such taps clearly go with the former. However, since the form of animal heads, birds and complete beasts on the taps are at home in an Iranian environment during the period between the 11th and 13th centuries, and since it would have been from there that they reached Anatolia, the taps have been included here.

VII Unidentified Objects

In this section are included six types of object whose function is uncertain. Three have in the past been given specific names. Objects in group A have been called pumice-holders, D/1 has been called an inkwell, and F/1 is generally considered to be a stand. The other objects, when referred to, have been given descriptive rather than functional titles: C/1 for example has been called "pièce d'applique circulaire".

All the objects in group A appear to be cast, and although they are all basically the same form there are some interesting differences of detail. A/1-4 are all apparently cast in one piece, whereas 5 is cast in two pieces, and this structural difference coincides with the facts that 5 is a lion looking right not left, and that its rear side is very sparsely ornamented, as though it was only meant to be seen from the front. Moreover 5, when the two parts are joined together, is a complete object, with no holes to the interior. Its flat base indicate that it had a function as a sitting or reposing object, while the holes in its ears suggest that it was either suspended itself, or that other items were suspended from it. A/4 on the other hand has an oval hole in its back and a long cartouche-shaped hole in its base, plus holes in its ears, eyes, nostrils and mouth. It was evidently designed to function in a quite different way from 5, and, since neither 1, 2 nor 3 have a hole in the back, in a different way from them too. The holes in the head area suggest that it may have been an incense-burner, but in that case a hole in the chest for the introduction of incense and coals would have been more expected in view of the form of other animal incense-burners. Unfortunately the details of construction and form of 1-3 are not given in the relevant publications, and it is difficult therefore to know whether Harari's title of pumice-holder is

apposite for the two pieces previously in his collection or not. It is, however, noteworthy that in the 1931 exhibition one of them was called simply a cover (Wilson 1931 no.229H), and that 3, like 4, is too big to be held comfortably in the hand.

It is also worth comparing these objects with two other unidentified pieces, B/1-2. B/1 has a rectangular base with sloping sides on which reposes a lion of similar form, facing left, and it is quite conceivable that lions 1-3 came from this type of more complex object. Unfortunately this does not allow us to gauge their function any more accurately since the purpose of these two objects is also a mystery. B/2 is composite. Its base is the remains of a large sheet of bronze which originally had a complete circle of inscription on it, and the inscription appears to indicate a somewhat earlier date for that piece than the rest of the object. The presence of such a base plate unfortunately makes it impossible to tell whether the fish is hollow or not. Two features of B/2 are intriguing - the four holes in the corners of the base, and the eye protruding from the fish's back. The former suggests that the object was the base for something more than the reposing fish, but how in that case the eye functioned is a mystery.

The decoration on all the objects so far discussed, with the exception of the base plate of B/2, indicates a 12th-13th century date and a north-eastern source. The latter is emphasised by Zick-Nissen (Stuttgart Linden Museum 1972 no.133) who appears to know of other examples of lions in this style from northern Iran and Afghanistān.

While the form of the objects in group C resembles both cymbals and shield bosses neither category seems appropriate for them. The relatively soft and flexible sheet brass or bronze of which they are made would be totally unsuitable for cymbals, unless they were intended to

make rather flat, thin soundsinstead of the resonant clash usually associated with the instruments. They are also unsuitable as shield bosses or for that matter as breastplates for although elaborate shield bosses of a similar type seem to be represented in the Varqa and Gulshāh manuscript illustrations (Melikian-Chirvani 1970b fig.12,19), the repoussé form of decoration would hold rather than deflect the point of an opponent's weapon,and rim straps or fixings would be required rather than a single central hole. It is possible that they were ceremonial shield bosses designed for show and not the battlefield, and polished repoussé bosses would certainly look very fine, but that is not a totally satisfactory solution either. The three surviving examples seem to be east Persian. C/1 comes from Ghazna, C/3 is in the Kābul Museum, and C/2 judging by the decoration, is probably from the same workshop as C/1. In date they appear to be 12th-13th century.

Object D/1, with its flat splayed base and cylindrical body, was obviously designed to hold something, but the question is what? Baer (1972 p.199) suggested that it was a Samānid inkwell, but does not give reasons for her identification. While this is certainly a possibility there are various problems:for example , did it have a glass ink-holder within it like the faience blocks of early times (e.g. Smith 1957 no.457), if so how was that held in position, if not why is there no rim for a lid? Until other evidence is forthcoming it is safer to place this object alongside other unidentified pieces. Coming from Nīshāpūr it may be assumed that the object is of north-eastern origin. An ʿAbdallāh Parsī was in fact khaṭīb of Bukhārā in 1036 A.D., and is recorded as taking part in an embassy to the Ghaznavid court (Barthold 1958 p.299). This may well be the same individual, for the style of the inscription and the palmettes and stems which ornament the background would fit a dating c.1000 A.D. very well.

E/1 is a much later object, the style of script suggesting a late 12th or 13th century date. The inscription appears to be in Persian, and has yet to be deciphered. The object appears to be the top of something, a sceptre or staff perhaps, for such a rod would fit into its hollow body and could be pinned in position using the small pin-hole above the lower rim. The purpose of the solid downward curving projection on the side with its "v"-shaped end is not clear, however.

F/1 is evidently a stand of some sort, but its exact function is elusive. In shape it is closely connected with the standard Persian lampstand form, a connection emphasised by the use of projecting bird-head profiles to ornament the double-crescent finial. Its decoration and the style of kufic inscription point to a 10th-11th century date and a north-east provenance. According to Mr. Simon Digby ropes attached to wall fixtures were used to separate off areas of the Red Fort in Delhi in the 17th century, and it is conceivable that this could have been a free-standing object designed to fulfill a similar function. Alternatively it could have had an ornamental or in some way ceremonial function.

Lead Objects

Surviving lead objects from early Islamic Iran include utility objects (A) such as dishes, bowls, a cosmetic mortar and a spatula; ornaments (B) such as pendants, a belt appliqué, and a finial and a clasp fragment; and weights (C). The bowl (A/1) with flaring rounded sides and flaring mouth is of a shape not otherwise known in metalwork, though it is paralleled in unglazed wares from Nīshāpūr (Wilkinson 1973 p.316-7 no.83). The most interesting of the utility objects is A/6 which is of a shape closely akin to the Parthian dish incense-burners, and may indeed provide a link between the latter and the smaller rimmed dish incense-burners of the Islamic period. A/3 is closely allied to some of the miniature bronze dishes discussed elsewhere.

Among the ornaments, the pendants are relatively plain, except for 2 which has a piece of blue glass set in it. B/3 is closely paralleled by a bronze pendant from Nīshāpūr (bronze pendant B/2). B/5 is a cheap variety of belt ornament, and may be compared with the wide variety of types known in gilt bronze or silver. B/6 reflects Islamic Iran's widespread interest in the crescent as an ornamental form. B/7 is the only piece to have been analysed and indicates that pewter, an approximately 60% tin 30% lead alloy, was known, though its use was obviously restricted. It is quite possible that others of the objects catalogued here are of the same alloy. The weights are all about the same size, and may be spindle whorls. In Iran today spindle whorls are generally made of wood or iron, and often have arms (Wulff 1966 p.185), but spindle whorls throughout large areas of the world are traditionally simple discs e.g. a spindle from Naxos published by Wilson (1938 pl. 3 fig.2), and it is difficult to suggest a more likely function for these lead objects. They were probably cast in a stone mould such as was found in medieval layers at Corinth (Davidson 1952 no.2832).

Techniques

Certain techniques used in the manufacture of objects discussed above have already been considered, for example the forging and casting of high tin bronze (p.156) and the construction of complex sheet metal objects like ewers C/3/b-d (p.227). Two other technical aspects of the objects need further investigation however - the methods used for casting other types of bronze, and the techniques used for decorating cast and beaten pieces of all sorts.

The survey of bronze objects reveals that there were at least three distinct methods of casting in use in early Islamic Iran. The first and simplest involved the use of an open mould, or perhaps a mould with a flat cover. This was employed for the most straight forward objects like the gilt bronze horse ornaments from Nīshāpūr which are solid with a rounded front and flat back. The second involved the use of piece-moulds. These enabled the caster to produce more interesting and intricate shapes in larger numbers. At the simpler end of the scale two-piece moulds would have been used for the manufacture of straightforward vessel handles; at the more complex end multi-piece moulds would have been used for the casting of complete objects such as bottles or ewers. In some cases the core could have been reused; in other cases it would have been destroyed in the course of its removal. Most of the objects made in this way were cast in one or perhaps two pieces, but certain metalworkers evidently preferred to manufacture an object by casting it in pieces in smaller moulds and then assembling it from these separately cast units (e.g. ewers A/2/d/1-2). Evidence of the use of piece-moulds for the manufacture of a particular object is sometimes seen in the plugs of metal inserted into holes through the body: these holes were designed to allow short rods to anchor the core to the outside of the mould

(e.g. ewers A/1/a/1, A/1/c/1, A/1/d/7). Contrary to what is sometimes believed they have nothing to do with repairs. The third method of casting was the lost-wax or cire perdue technique. Here the model was made of wax, the mould was then built around the model, and the wax was melted out before the molten metal was run in. Gyuzal'yan (1968 p.97) has used an allusion to the use of wax in the manufacture of metal objects in Niẓāmī to suggest that it was a technique widely used in Islamic Iran, and it may well be that it was employed for such individual objects as the aquamanile in the form of a zebu with calf (bronze aquamanile 3) as well as some of the other aquamaniles and perhaps also the bronze pen-case A/1. On the other hand two points in this connection should be noted. Firstly it is often extremely difficult to tell objects made by this process from objects made in piece-moulds as historians of Chinese art have found (Pope et al. 1967 II pp.21-31). Secondly mention of wax in a text does not necessarily refer to this process since wax would also have been used in the casting of objects in piece-moulds: strictly speaking the technique used is not cire perdue unless the outer mould is in one piece from which the wax can only be removed by melting (Maryon 1971 p.219).

One aspect of casting which has been noted but not fully discussed elsewhere demands particular attention at this point - the general lack of relief decoration on cast objects. Casting gives unrivalled opportunity for varying the height and thickness of an object's surface, as craftsmen of many diverse bronze cultures have discovered e.g. those of Bronze Age China and those of Nigerian Benin in more recent times. Yet the number of relief-cast objects from Islamic Iran is very small. With the exception of those ewers, bottles and mortars which bear almond bosses, there are only two major groups of such objects: certain ewers (A/1/a-b, A/2/a, B/1/1) and the decorated mirrors (B-D). Apart from

B/1/1 all the ewer groups are connected with Iraq, and it is interesting to observe that as the forms concerned spread to Iran relief casting was dropped in favour of a smooth surface which could later be incised. Why that should be so is not clear.

The decorated mirrors have already been discussed at length above, and the Chinese origin of the tradition and the approximate date of its arrival in Iran (c. 1100 A.D.) have there been noted. It was suggested in conclusion that their sudden adoption and mass production in Iran may have been due, amongst other things, to the fact that they were first imported into Khurāsān, the most important bronze producing area of Iran. It may be, however, that there is another, technical explanation. In his translation and discussion of the text of al-Jazarī's book on mechanical devices written in the middle of the 12th century Hill (al-Jazarī trans. pp.190-5, 274) draws attention to the description of the casting of the lattice work ornaments for a palace door at Amida. From that description it would appear that the casting was done in green sand moulds. This is important historically since the first use of such moulds in Europe seems to have been in the late 15th century, and the invention of this technique was presumed to have taken place about the same time. Hill has also drawn attention to an allusion to the technique in a Chinese work of a slightly earlier date which describes how a sand found on the shore in Hangchow was used for making moulds. The implication is that the technique came from China to the Islamic world about this period. Returning to the mirrors certain unusual facts about them were noted in the main discussion: they appear suddenly; they appear in large numbers; they are relief cast; the style spreads quickly to large areas of the Islamic world. If green sand moulds were introduced into Iran from China about 1100 A.D. then many of the problems apparent in these points disappear. The casting of objects in quantity had been possible by using piece-moulds but it is tedious. Green sand moulding is a far

superior method of casting objects in large numbers, particularly objects of an essentially flat form like mirrors. Moreover it provides a very simple method of casting from a previously made object, which would explain the sudden appearance of almost identical mirrors throughout the Near East in the 12th century. It would also explain a curious feature found on mirror B/6/5: an inscription which at one point has clearly "slipped", presumably due to the mirror used as a model having been clumsily handled as the mould was being prepared. And the introduction of both objects and technique would also explain why such an extraordinary type of object (in Islamic terms) became suddenly so widely used in Islam.

It is all the more apparent therefore that the relief cast bronze mirrors are objects of exceptional interest. Not only did Muslim craftsmen adopt the form and the decorative style of these foreign intruders wholesale, but they also learned through them of a technique of casting which was nothing less than a technological breakthrough. If its effects on the rest of the Muslim world in the pre- and post-Mongol periods have yet to be analysed, its eventual importance in Europe and indeed in the whole modern world is in little doubt (Smith 1972 pp.114-5).

The second technical aspect of the bronze objects which needs further exploration and if possible illumination is the means used to decorate flat surfaces. It was pointed out in the introduction that all too little work has been done to distinguish traced from engraved designs on Islamic bronze objects, and such detailed object studies have regrettably been beyond the facilities available to me. The same obstacles have hampered the study of inlay techniques but here I am fortunate in being able to use the results of the brief research project carried out by Dr. Michael Hughes of the British Museum Research Laboratory into the techniques used in the manufacture and decoration of four Persian bronze

objects (ewer C/3/c/2, table-top B/1/1, stem bowl A/2/3 and bucket B/3/4). In his report Hughes distinguished three types of linear inlay. In type 1 (pl. 1a and fig.100a) a pointed punch was used to produce a series of two parallel lines of overlapping circular depressions into which a silver wire was then hammered. This type of inlay was found in the table-top and the footed bowl. In type 2 (pl.1b and fig.100b) a chisel-pointed scraper was used to gouge a channel, several parallel strokes very close together giving a depression with sharp ridges at the bottom. Copper was inlaid into the bucket in this way. The third type of inlay (fig.100c) consists of two parallel lines of rectangular depressions into which the silver inlay was hammered. This is found on the ewer. Hughes also distinguishes three types of spatial inlay. In the first (pl.1c and fig.100d) a pointed punch was used to produce a groove or channel around the edge of the area to be inlaid, and the silver was then driven into this groove and merely overlaid the central, untouched, part of the area. Such a technique was used on the stem bowl and the table-top. In the second (pl.1d and fig.100e) a chisel-shaped punch or scraper was used instead of a pointed punch to produce a similar type of channel around the edge, and the central part of the area was then scraped down to a lower level leaving parallel lines which helped to hold the silver inlay in place. This technique was used on the table-top. The third type of spatial inlay (fig.100f) is essentially the same as the second except that the edge of the central area was bevelled off before inlaying commenced. This is found on the ewer. Microscopic examination of three inlaid Ashmolean objects (stem bowl B/3/1, bucket B/4/6 and mortar C/2/b/1/1) suggests that the third type of linear inlay was common, since it is found in all three, and the type 2 spatial inlays on these three objects show the use of the same chisel-shaped tool.

Of themselves these observations are inconclusive. If further studies of this type are undertaken in the future, however, it seems likely that a regrouping of objects on purely technical grounds will be possible. Such a regrouping will bring to light important new information on the craftsmen and their skills.

In conclusion comment is desirable on the history of inlay even if the techniques used for it are still largely uncharted. The dating and provenancing offered above for various ewers bearing copper or copper and silver inlay (bronze ewers A/1/a/2-4, A/1/b/1, A/2/a/3), plus the existence of circular areas designed for inlay on the Marwān ewer, shows that inlay was already an established technique in Mesoptoamia in about 800 A.D. Since ewer forms associated with the former groups soon became established in Iran it may be assumed that within a short time the inlay techniques too became known to Persian craftsmen. The earliest use of inlay on an object made in Iran seems to be late 9th-mid 10th century (ewer A/2/b/1), where, however, it is only used for a brief inscription. As a widely used mode of decoration it does not in fact appear until the 12th century. These facts pose certain important questions. Was there a continuous tradition of inlaying bronze objects? If so what has happened to the objects? If not how did the technique come into being again and why was it used in such profusion from about 1100 onwards?

The answers to these questions depend upon certain more fundamental observations about the nature of the 12th century bronzeworking industry in Iran, and its relationship with other metalworking industries. Since these go beyond the realm of pure technique into the wider fields of art and culture they are examined in the Conclusion following, to which reference should be made.

CONCLUSION

In the preceding pages the surveys made of particular object groups have brought to light specific points relating to those objects, to the culture to which they belonged, and occasionally to wider aspects of their relationships with other objects or object groups. Now that the time has come to try and draw the threads of those surveys together it will be apparent that in certain areas there is little more to be said than has already been expounded by other scholars. For example, the few signature-bearing objects which have come to light since Mayer's roll of metalworkers was published add virtually nothing to his short but pointed discussions of those men, the way they signed themselves and their social status (Mayer 1959 pp.11-18). In so far therefore as it was hoped that this thesis would shed light on the organisation of the industry and of the craftsmen working in it we have drawn a blank. However, in many other areas of the study it is now possible to see larger patterns emerging as rays of light from one source illuminate pools of darkness elsewhere.

In the first place it is now possible to paint a balanced picture of the sources from which Islamic Iran drew inspiration in its bronze-working traditions, and hence of the influences exerted by other earlier or contemporary cultures. These may be summarised as follows. From the Graeco-Roman inheritance in general came the forms used for dishes, buckets, lamps (A/1-6), polycandela, chairs and jewellery, together with the scientific or technological knowledge necessary for the production of scientific instruments and stirrups. More specific regional influences from the classical world can be seen in objects associated with cosmetics which, apart from mirrors, are almost all based on Mediterranean,

particularly Egyptian, fashions. In the same way the origin of the bucket style is particularly associated with the classical culture of the Egyptio-Syrian lands, while other object types may be traced to the classical legacy as it was worked out in Mesopotamia - aquamaniles, ewers (A/1/a-e), lampstands, and possibly zoomorphic types of incense-burner and incense-holder. Pre-Islamic Sasanian influence is visible in bottles A/1 - B/4, bowls B/1 and 4, ewers A/2/a, in forks and in spoons, dish incense-burners reflect Parthio-Sasanian fashions, while pre-Islamic Soghdian influence is to be seen in ewers A/2/b and the handles used for lamps A/1-6. Since all these latter objects ultimately go back to classical forms Islamic craftsmen were being influenced by Graeco-Roman traditions here as well.

The impact of China is visible in the mirror industry which has been discussed at length. The impact of the Central Asian steppes and their nomadic peoples is visible in thehandles used for the hemispherical cauldrons, in certain aspects of lamp B/3, in some of the surviving appliqués, and above all in the horse ornaments. It is tempting to see the influence of Buddhism in the form of lampstands group C. In addition the influence of other crafts and industries may also be recognised. Boxes were largely based on ivory or wooden prototypes, pen-cases often copied wooden styles, cauldrons and incense-burners group B were copied from stone objects, and mortars sprang from a stone tradition. From glass came certain bottle forms (C/1-2, D), ewers (B/1) and perhaps also hanging lamps (E). The extent of the influence of ceramics is a more thorny problem. Intrinsically rather unlikely it nevertheless seems to have occurred, and is probably to be seen, for example, in lamps A/7, B, C, in bottle E/1, in stem bowls A/4-6, and perhaps also in certain stands.

These influences, once expounded, are obvious enough, but never before has a complete picture been assembled. The striking aspect is the extent

to which Islamic metalwork in Iran was the child of classical culture. From this conclusion another conclusion of importance for pre-Islamic studies emerges. The lack of surviving Sasanian metal objects, apart from the well-known silver pieces, has made it difficult to be sure to what extent Sasanian culture was classically orientated. The classical orientation of the succeeding culture is so pronounced that many of the forms used in Islamic times may be assumed with confidence to have been the norm in the Sasanian era. Our study therefore emphasises indirectly the classical heritage of Sasanian Iran.

Another aspect of the complete picture which is worth emphasising is the very limited interplay between crafts. The influence of glass, stone, wood and ivory forms have been noted, and are certainly there. Essentially, however, the industry was a metalworking industry and the majority of the objects manufactured were part of a tradition which owed nothing to objects in other media. The ceramic copies of metal objects noted throughout the survey show that ceramics and metal are in this way of fundamentally different significance in early Islamic Persian culture: the former are very often derivative, the latter usually remain true to their own tradition.

As well as emphasising the limited interplay between different crafts the study of the various object types highlights significant divisions within the industry itself. Thus it is evident that high tin bronze objects were considered to be of far greater worth than those of low tin alloys, at least until the 12th century. The relationship of the different alloys is most clearly visible in the stem bowl groups in which the types of stem bowl made of a low tin alloy give every appearance of being designed for a less wealthy market than the high tin pieces, a situation incidentally confirmed by contemporary texts. Bearing in mind

the existence of a sheet metal industry which until about 1100 was producing objects of no particular artistic merit for an even less well-off market, and then in the 12th century the sudden rise to prominence of a sheet metal industry of the highest quality, it becomes apparent that there are at least four stratas to the bronze production industry in early Islamic Iran which have to be clearly differentiated and separately assessed.

The survey has also significantly illuminated the relationships between different metalworking areas within Iran and to a lesser extent within the bordering areas of the Islamic world. Recent scholars like Melikian-Chirvani have been at pains to emphasise the role of Khurāsān as the metalworking centre par excellence of Islamic Iran, if not of the whole of eastern Islam. This view can now be tempered and a more realistic picture unfolded. In the first place it seems clear that in the early ʿAbbāsid period the centre of the bronze industry was located further west, in Mesopotamia (see for example ewers A/1/a-d, A/2/a). Secondly, it would appear that in the 10th-11th centuries not only Khurāsān but Sīstān too had a strong metalworking industry. Given the political and cultural divisions of eastern Iran in this period this is to be expected, and the most striking artifactual evidence is to be seen in the metal objects associated with ablutions - buckets in Khurāsān and Transoxania, following the classical Islamic tradition; large bowls in the Ghaznavid lands to the south. Limited but continued separate development is to be seen in these two regions in the 12th-13th centuries. In this period of course the northern school became the dominant one, witness the copies of Khurāsānī objects found at Ghazna (e.g. ewers in the C/3 groups, table-tops etc). The existence of a workshop somewhere in Sīstān producing repoussé objects of individual style(stem bowl B/4/1, unidentified objects C) suggest that there was still some life in small areas of the industry, but it was for the most part probably in decline.

The survey also clarifies the relationship of Khurāsān and its industry to Transoxania. Thus it becomes apparent that it was beyond the Oxus in the old Soghdian lands with their great silversmithing traditions that high tin bronze first became an important medium for bronze objects and that Transoxania remained dominant in this field at least until the middle of the 12th century. At that point the one specifically Khurāsānī high tin bronze object type came into being - stem bowl type A/1. Otherwise the Khurāsānī and Sīstānī high tin bronze industries were very limited and were certainly the poor relations of the Transoxanian one, witness the forms of dishes and bowls produced. Since this thesis has not dealt with the specifically Transoxanian objects made of ordinary bronze there are other areas of relationship between Transoxania and Khurāsān still to be explored. It would be no surprise if such exploration led to a still greater emphasis on the role of Transoxania as a metalworking region.

It has also been possible from the survey of extant objects to distinguish a large number of north-west Persian 13th century products, and this too helps to pinpoint more accurately the role of the north-eastern industry. The spread of the decorative style and of certain shapes westwards prior to the Mongol conquests leaves no doubt that the craftsmen were moving westwards. But in the north-western school one particular characteristic occurs which is not found in the 12th-13th century in the north-east. This consists of an outstanding sense and bold use of form, in particular a willingness to combine existing shapes to create new styles of object of great strength and quality. A creativity to rival this is occasionally visible in eastern products of the 10th-11th century, for example in the wide variety of incense-burner forms developed, but it seems to have been stifled by the introduction of ever richer decoration from the late 11th century onwards, witness for example the decline in lamp designs at this

period. The sense of form for which the north-western school is to be noted is visible most clearly in the stem bowls of group A/2 and the candlestick groups C-E, in both of which may be recognised a perfection of form far surpassing anything previously achieved in Islamic Iran. If such boldness and inventiveness occasionally overstepped the mark (e.g. jug C/1) it was probably also the creative influence which brought such sensitivity of shape into already existing styles (e.g. inkwell B/4/2).

This is not of course to deny Khurāsān a role. There is no doubt that it had the longest continuous tradition of good quality bronze production of any province in Islamic Iran or indeed in its neighbouring territories. Moreover in the 12th and early 13th century its highly decorated products overshadowed both its own earlier products and the products of rival regions. Nevertheless it was not the only metalworking province, nor was it in everything superior.

While Mesopotamia, Sīstān, Khurāsān, Transoxania, and the north-west can all be placed in some sort of relationship with one another in terms of their metal products, mystery still hangs over the central areas of the country, especially Jibāl. Iṣfahān was the centre of astrolabe manufacture, but there is still nothing to say about the bronze industry in general in the province. Was there no industry, and were all the bronze objects imported from further east? The same question hangs over Mesopotamia from the 10th century until the rise of the north Mesopotamian industry evidently centred in Mawṣil in the 13th. One scrap of information thrown up by the survey may be significant: the fact that bronze lamps on the Gulf coast show a cultural link between lower Mesopotamia, southern Iran and Sind. Given that each of these areas possessed what was essentially a ceramic culture, a small scale metalworking industry is evidently not ruled out. Since Jibāl had a ceramic culture too,

witness the Rayy and Kāshān pottery products of the 12th century, it is logical to suggest that in that area also there was probably a small-scale metalworking industry. As noted in the introduction to this thesis an excavation of an Islamic site in Jibāl province is badly needed to throw light on the nature and extent of those metal products.

If the metal products of Jibāl are an unknown quantity, its ceramic ones are certainly not, and it could be argued that these objects had a profound effect on the metalworking industry not in terms of shape, but in terms of decoration. This thesis has not primarily been concerned with decoration, and the influences and currents indicated by individual motifs are beyond its scope. Nevertheless the use and distribution, or lack of decoration on certain objects should not be passed over. For it is striking that whereas most of the ordinary bronze products of Khurāsān and Sīstān in the 10th-11th centuries are either virtually undecorated, or bear a standard grouping of vegetal or geometric patterns, those produced in the 12th-13th centuries are highly decorated with a wide variety of motifs and designs. Moreover it will also be observed that the decoration in this later period has little in common with the highly decorated ceramic products of the 10th and 11th centuries in the north-east but a reasonable amount in common with the highly decorated contemporary wares of central Iran, the Jibāl. Since these latter objects represent the peak of a tradition in decorated ceramics which goes back to 9th century Iraq the influence can hardly be from metal to ceramics at this period, despite the fact that many pottery shapes are based on bronze objects. It might therefore be argued that in the late 11th century or round about 1100 the taste which found fulfilment in the lavishly ornamented pottery of the Jibāl extended further into the north-east where satisfaction was offered by an aware and responsive metalworking industry.

There may, however, be an alternative source of this fashion. To discover it, it is necessary to turn to the beaten bronze and brass products of the north-east. Four distinct groups of objects among these products may be distinguished. First there are those which were cheap to produce and were designed for the lower stratas of society. Examples are bowls D, pans, buckets C, ewers C/2, incense-burner F/5/1. A second group consists of objects of little general importance but of specific interest, pen-cases B, hanging lamps E, and dishes A/1. A third group consists of the products of the Sīstānī workshop mentioned above which specialised in repoussé work, stem bowls B/4 and unidentified objects C. The fourth and most important consists of well-made, heavily-inlaid objects clearly designed for the luxury market. These are bottles B/5, ewers C/3/b-d, candlesticks A, jugs A/4 and lids B. It will be noted that although beaten objects do occur in earlier periods in the north-east no surviving example has any particular merit: they certainly do not prepare the way for the sudden appearance of these superb creations. It will also be noted that the bronze casters who had been producing objects of all sorts during the preceding centuries began to inlay their products, or rather have them inlaid by other craftsmen, at the same time as the beaten objects began to appear. In other words, in the late 11th century there was a sudden flowering of the industry in terms of technique, in terms of richness and of colour. The traditional explanation offered for this phenomenon is that the rise of the merchant class at the expense of the aristocracy led to an enormous growth in industries which could satisfy the new class's needs for self expression (Grabar 1968 p.648, cf. Ettinghausen 1970). This might be sufficient to account for a growth in the cast bronze industry, but it does nothing to explain the sudden rise from obscurity to eminence of the beaten bronze industry. The explanation therefore fails to account for what is undoubtedly one of the most striking changes in the industry during the early Islamic period.

In the detailed discussions of the various groups of luxury beaten objects it has been noted that bottle B/5 has numerous parallels in silver (silver bottle B/1 and rosewater sprinklers), that a silver ewer of bronze type C is known (silver ewer C/1), as is also a silver table-top of the same form as bronze B/1 group, and that the bronze jug forms like ceramic ones are based on silver prototypes. Moreover it has been postulated that the elaborate beaten candlesticks produced in 12th century Khurāsān are probably based on an earlier silversmithing tradition. In other words all the forms found in the luxury beaten bronze industry of Khurāsān, with the unimportant exception of the lids, can be paralleled in earlier or contemporary silverwork, or the existence of such parallels can be logically surmised. To this may be added the following points: the bulk of surviving silver objects predate the rise of this industry i.e. the silver industry appears to have been in decline as the beaten bronze industry began to blossom; the silver objects are virtually all of sheet metal as are the bronze or brass ones in question; many of those associated with the north-east display extremely fine repoussé work commonly with gilding or niello, repoussé work and colour again being characteristic of the sheet bronze industry. There is only one explanation which adequately accounts for such striking parallels between the different metal products: round about 1100 many silversmiths must have given up working in precious metal and begun working in sheet bronze or brass instead.

Such an explanation seriously challenges the relevance of the rise of a merchant class at this time in Iran, for such a merchant class would have wished to emulate its upper class predecessors by adorning its houses with silver and gold. But this it quite clearly did not do. The true reason for this changeover from precious metal to bronze and brass is in fact to be found in the supply of metals available to 11th

century Iran as exposed by recent numismatic studies. For Watson (1967) and others have shown that from the 11th century onwards the Near and Middle East were in the grip of a savage silver famine. The effects of the famine are first visible in the Levant and Asia Minor in 1027-8 A.D. when silver coins ceased to be issued. From that date the famine spread eastwards, and although silver coins continued to be struck for about fifty years more in Central Asia they were of notably decreasing fineness, and their minting too had ceased by the end of the third quarter of the 11th century. Only in Ghaznavid India did silver continue as currency. Not for two hundred years did silver return to the rest of the Islamic East: it was first minted again in Bukhārā in 1281 A.D. Such a crisis in the availability of the precious metal would inevitably have hit the silversmithing industry too. The effects would have been seen more gradually, but large-scale production would have ceased before very long. Small-scale production on the other hand would probably have continued since small amounts of metal would have been available at a price even in times of great scarcity, and the use of silver as inlay would have been a very economic way of using what silver was still in circulation.

Seen in this light it is clear that the large numbers of surviving bronze objects of all sorts from about 1100 A.D. onwards do not particularly reflect the demands of a certain portion of the population. Rather they show that objects of value had to be made of bronze because silver was not available. In this case it becomes evident that the Saljūq period was not, as is sometimes claimed, a period of expansion or of general flowering in the metalworking industry. Rather it was a time of transfer. There had always been an industry but whereas prior to the late 11th century attention had been focused on silver, now the lack of silver forced craftsmen and patrons to turn to less glamorous metals and alloys. Quite incidentally other changes were taking place

at the same time - the Saljūqs were establishing their suzerainty over Iran, the merchant class was beginning to play an increasingly important role in society - but these were not decisive factors in the changes taking place in the metalworking industry itself. Nor should the fact that the diversity and richness of the products of the industry first become so obvious in the Saljūq period be ascribed to the changing roles of the aristocracy and the middle class in society: it is due simply to the fact that the alloys of which by necessity the objects had to be made have withstood the ravages of time and man better than their silver predecessors.

Turning now to the question of the origin of the highly decorated and highly colourful styles used on 12th and early 13th century objects in the north-east, it becomes apparent that there is an alternative source to ceramics, and in fact a more likely one - silverwork. This can be observed at two levels. At a deeper level, physically, the silversmiths' common use of inlay to produce variety of colour convincingly explains the sudden reappearance of inlay in the bronze industry after centuries of neglect. At a more superficial level silver designs offer a likely source for the new styles found on bronze objects. This latter point deserves closer examination.

In the discussion of silver and gold objects it was pointed out that there were two distinctive styles in vogue in the pre-Saljūq period in Iran. In the west there was a feeling for space, a liking for bands of inscription and roundels, a tendency to fill small areas of ground with very tightly wound scrollwork. In the north-east there was a sense of horror vacui, a desire for overall covering of surfaces with blossoms and other vegetal designs, a greater feeling for colour and surface texture. Something approaching an amalgamation of the two decorative styles was observed in silver rosewater sprinkler 7 (p.111), and it was

suggested that the object represented the merging of the two styles described, plus the addition of a significant Central Asian overlay probably due to the effect of the imposition of Saljūq rule in the late 11th century. Against this background the styles of decoration found on the bronzes and brasses of Khurāsān are not only strikingly different from those found on earlier east and north-east Persian bronze objects but also show an important dependance on characteristics of both west and east Persian silver designs. The proportion of characteristics derived from either area varies from object to object and design to design. The beaten brass industry clearly grew up on the basis of the north-eastern rather than the western silversmithing tradition, witness the emphasis on repoussé work, on colour, and on all-over decoration. On the other hand the decoration of many cast objects points to a predominance of western influence, particularly in the more sensitive utilisation of space, e.g. buckets B/4/1 and B/3/3 and other pieces such as dish B/1/1 (Pope 1938 pl.1292B, 1307, 1288A).

It would thus appear that in the late 11th century the influence of the silversmithing industry not only brought about the rise of the bronze or brass beating industry in the north-east but was also the source of the new decorative style found on both beaten and cast bronze products. While these two factors may both have been due to the economic (i.e. precious metal) situation, the fact that the new bronze style consisted of an amalgamation of the two previous silver styles requires some other interpretation. And it is surely here that the influence of the new rulers should be recognised. For the uniting of the whole of Iran and Iraq at least temporarily under one ruler could well have provided a climate in which different traditions could come together to produce a new and composite main stream style. In this

case the effect of the dynastic change on the industry may well have been profound, but in a rather different way to that traditionally suggested.

It is now apparent that through a long and detailed survey some points of fundamental importance have been established. Among these two are outstanding: the dependence of the high tin bronze industry on the silversmithing tradition in early times (p.186 and 201), and the vital role that silversmiths once again played in the development of the bronze industry at another critical stage in its history, in the late 11th century. The frequent dependency of ceramics upon metal has already been noted. Seeing now the dependency of less precious upon more precious within the metal industry itself it becomes clear that in early Islamic Iran the greatest influence was generally held by workers in the most precious materials. If this is a situation which might have been foreseen and expected, it is also a situation which was hitherto undocumented. Although its wider implications probably lie in the realm of sociology, in the structure of early Islamic society, its importance for the history of the arts and the metalworking industry in particular can scarcely be doubted.

PART 3 - IRON AND STEEL

Chapter 1 - THE METALS

Modern surveys indicate that there are three main groups of deposits of iron ores in Iran. The most important are those between Bafq and Sāghand in central Iran, which are mainly magnetite; secondly there are those occurring in the Alburz range, around Zanjān, and still further north-west in Azarbāījān, which are ores of various types and values; last there are the small deposits of red ochre which occur in the salt domes of southern Iran, especially on the island of Hormuz (Curzon 1892 II pp.514-21; Ladame 1945 pp.248-267; Harrison 1968 pp.496-500). There are also many smaller deposits, worked on a local scale until very recently, which may have had significance in earlier periods of history out of all proportion to their size. Wertime, for example, mentions magnetic ores as occurring at isolated points around the rim of the central Iranian desert, not only along its southern fringe but also at places such as Samnān and Kāshān, and the latter area is indicated by other authorities who record iron deposits in a triangle between Iṣfahān, Kāshān and Nā'īn (Curzon 1892 II p.519; Schindler 1896 p.114; Stahl 1893 p.1910; Fateh 1926 p.31). Other iron deposits occur at Hanaskh, north-east of Pasargadae (Caldwell 1967 pp.321, 338, 388), further south near Nīrīz (Curzon 1892 II p.518), and in Balūchistān (Hughes 1877 p.22), while the Tal-i Iblis expedition recorded the remains of extensive workings in the area of Baft, south of Kirmān (Caldwell 1967 p.339).

Against this background certain conclusions may be drawn from the locations of iron sources as given by the early Islamic geographers and others (Table 13), particularly when viewed in conjunction with

recorded manufacturing centres (Table 14). In the first place the general spread of ore sources in early Islamic times indicates that iron production was very much a local industry, utilising local ore bodies. On the other hand it is also clear that as with virtually every other metal the richest part of the country was Transoxania, expecially Farghāna, which is singled out by al-Iṣṭakhrī, Ibn Ḥawqal and al-Muqaddasī. Indeed Ibn Ḥawqal says that the iron extracted in Farghāna was so malleable that it could be plied into any desired form, the artisans racking their brains to invent strange objects in order to utilise it (IḤ p.506). This may not be and probably is not an accurate description of the iron produced there but it does emphasise the exceptional role of Farghāna as an iron producing area. Mink and Marsmanda were evidently the two main manufacturing towns, exporting iron objects not only throughout Khurāsān but even as far as Iraq (IḤ p.506). Farghāna itself was the centre of sword and arms manufacturing, and it was presumably on the basis of Farghānan iron that other centres of this industry occurred in Ashījāh and Khwārazm.

The second most important province for iron and steel production seems to have been Khurāsān, which produced its own iron though it might also have imported some from across the Oxus and manufactured arms and armour of many different varieties. Two points stand out here. The first is al-Birūnī's stress on Herāt as a steel making centre, from which the cakes were exported to other areas for manufacture into swords - Sind and Multān for example (Bir pp.254, 256). The second is the role of Ghūr in the manufacture of arms and armour.

Other provinces in which iron production and manufacture are noted include Fārs and Kirmān, but it is interesting to observe that two of the most important modern areas of iron production - north-west Iran

and the south-east (Hurmuz) scarcely receive a mention before the 13th century. Then al-Qazvīnī's comments imply that the iron resources of the north-west were becoming better known, probably due to the location of the Mongol capitals, though even so Abū'l-Qāsim's lack of acquaintance with the nicities of sword manufacture suggests that the industry was still in a very elementary stage in 1300 A.D. al-Dimashqī's comment on iron coming from the Persian Gulf is vague but it may be that by about 1300 A.D. the iron resources of Hurmuz having hitherto been neglected, were also being exploited in a fairly substantial way.

The general picture of iron and steel working in early Islamic Iran therefore seems to pinpoint Transoxania, particularly Farghāna, as the most important area of production, followed by Khurāsān, and to a lesser extent Kirmān and Fārs, with the north-west and south-east beginning to play a part in the 13th century. However, it is important to note that not only were there other scattered sources of iron in many parts of the country, but there were towns throughout Iran dealing in specialities: Damāvand producing arrow-heads, Qūmis axes, Rayy scissors, and Hamadān mirrors and incense-burners. This is significant when one tries to put together a picture of the structure of the industry and the various trades involved. Of these features the texts say virtually nothing. There is however limited evidence from the Sasanian period, and the analogy of the industry as it exists in Iran today. Four different words for iron craftsmen occur in Sasanian times (Tafazzoli 1974 pp.193-5): <u>āhengar</u>, a man who evidently made spades and adzes, <u>āhen-paykar</u>, literally a man who cast or moulded iron, <u>čēlāngar</u>, a worker in small iron artifacts, and <u>pālāwad-paykar</u>, a "steel-smith". In contemporary Iran Wulff (1966 pp.48-73) has identified the following ironworking professions: blacksmith

(āhangar), nailsmith (mīkh-sāz), farrier (na'lband), cutler (kārd-sāz), swordsmith (shamshīr-sāz), scissor-maker (qaichī-sāz), cutlery grinder (qaichī-tīzkun), file-cutter (suhān-sāz), balance-maker (mīzān-sāz), locksmith (qaffāl) and steel fretworker (shabaka-kār). With regard to the interplay of these professions and their distribution he noted as follows (Wulff 1966 p.48):"The general blacksmith is the most important representative of this group and can be found in many communities, from large cities to medium-sized villages. Wherever specialization is possible a farrier will be found in rural areas, ... In some communities the work of these ... may overlap. The other ironworking crafts, from cutler to locksmith, are usually specialized trades in larger towns and their work is rarely done by the general blacksmith." Wulff (1966 pp.35, 48-9) also notes the existence of ethnic groups specialising in iron-working, such as the Sibbī of Khuzistān and of itinerant smith-tribes such as the Kulī. The latter roam the plateau in small groups doing the odd blacksmith jobs in villages and small communities, and their ancestors probably did the same work centuries if not millenia before them.

The early Islamic situation may be surmised to have been somewhere between the Sasanian and contemporary ones, but was in fact probably nearer the latter. For the comments of geographers about particular places producing particular types of objects indicate that already in the 10th century there were many highly specialised craftsmen: arrow-head manufacturers in Damāvand, axe-makers in Qūmis, scissor-makers in Rayy, general smiths in Hamadān, armourers (zara-sāz), sword-smiths and breast-plate manufacturers (jawshan-pūsh) in the north-east and east. And, at the same time, as today, the general blacksmith must have been the most important worker in ferrous metals for the community at large, whether he was settled or itinerant, Muslim or non-Muslim, seeing to the everyday needs of the bulk of the country's population.

Turning from crafts to the movement of objects and materials, Iran was involved in the iron trade in three different ways. First and formost it exported both the substance and the objects. Salmānī iron or steel (see p.427) was exported from Transoxania to the Yemen where it was manufactured into swords, while salmānī swords themselves were evidently known in the Yemen, in Iraq, and in Mawṣil (Kin pp.21,23). Iraq also imported a wide range of other iron or steel goods from Iran: breastplates from Ghūr, arrow-heads from Damāvand, axes from Qūmis (Jāḥ pp.344-5), and a variety of implements from Farghāna (IḤ p.506). In the east Herātī steel cakes were exported to Multān (Bir p.256).

In the second place, there was widespread trading in iron within Iran. Farghānan implements not only reached Iraq; many were undoubtedly purchased in towns situated on the main trade routes before they had arrived at the border, while salmānī swords were known in Khurāsān and Jibāl as well as further afield (Kin p.23). If Herātī steel cakes were being exported eastwards they were probably also travelling around Iran, and Ghūrid arms and armour, if they were part of Ghūrid tribute to Ghaznavid or Saljūq sultans, were also almost certainly items of internal Iranian trade.

Thirdly Iran imported a certain amount of iron and also iron goods. al-Kindī records that Fārs sarandībī swords were with some exceptions made of sarandībī iron ie. iron from Ceylon, or at least iron from the east brought by ship up the Gulf. But the import of iron was probably much less significant than the import of certain iron and steel goods, particularly Indian swords, which seem to have been known at all periods. Hindī is the only adjective of nationality given to swords in the Shāh-nāma, and in view of al-Birūnī's enthusiasm for

them and his descriptions of their damasks, and in view too of the emphasis placed on them by Fakhr-i Mudabbir, it is evident that from Ghaznavid times at least they were considered the finest weapons available. Since, however, al-Kindī, although recognising Indian swords, does not give them pride of place, it may well be that their impact had not yet been felt in the middle of the 9th century. Only a careful sifting of virtually every mention of Indian swords in the early Islamic literature would confirm or disprove this suggestion, however.

It is also possible that arms and armour were imported into western Iran from the north-west. According to al-Mas'ūdī the Caucasus was an important manufacturing centre (Mas para.477), and al-Jāḥiẓ (p.342) notes that Khazar armour was imported into Iraq, presumably through the Caucasus. In view of the strong textual emphasis on north-east Persian areas as the Iranian centres of the arms and armour industry it would clearly have been as convenient to import objects into western Iran from the north-west as from the north-east, and this possibility should therefore be noted.

Literary sources give virtually no information about mining techniques and processes of extraction and purification in early Islamic Iran. However, the Tal-i Iblis expedition survey of iron mining sites in southern Iran brought to light 11th century pottery sherds in association with old workings at Hanashk, north-east of Pasargadae. In the mines themselves the expedition noted that the workings followed the soft parts of the ore, and ceased where hard haematite was encountered. On the surface the expedition recorded refractory furnace stones, broken tuyère pipes, bloomery slag and hammer slag, showing that the ores had been processed on the spot. The furnace used was evidently similar to the standard lead furnace of southern Iran (see p.130), standing some two metres in height with an interior diameter of up to one metre. Two distinct forms of tuyère pipe, one tubular, the

other y-shaped, might indicate that two operations were involved in the smelting and concentration of the metal (Caldwell 1967 pp.321-3, 379-89, 401).

This brief survey of the Hanashk mining area leaves many questions unanswered. Oxide ores such as limonite, magnetite, and haematite would have undoubtedly been the ones used in the medieval period, and it is difficult to believe that haematite was too hard to be mined; it is only half a point harder than limonite on Mohs' scale. Pleiner suggests that operations at Hanashk might have been seasonal, though he does not give reasons for this view. This opens up a whole new vista in any discussion of the medieval industry - a vista which it is impossible to explore further due to a total lack of information. The expedition sampled and analysed pieces of iron-working slag but the results do not allow one to determine what fluxes, if any, were used in the bloomery process at this period. A myriad of other questions are not even touched upon in the report, and a great many detailed surveys will have to be undertaken before any adequate picture of the early Islamic industry can be built up.

If information about iron is scanty, two early Islamic texts do supply valuable facts about the making of steel. The first text is a letter of al-Kindī entitled al-suyūf wa'ajnāsuhā, which was probably addressed to the ʿAbbāsid caliph al-Muʿtasim (833-841 A.D.) (Kin; Zaki; 1955 pp.366-371). The second is the chapter on iron in al-Birūnī's Kitāb al-jamāhir (pp.247-257). In addition there are the works of other lesser writers such as al-Ṭarsūsī, who wrote a treatise on arms and armour for Salāḥ al-Dīn (Cahen 1947 pp.106-8), of Pseudo-Aristotle (para.62), al-Qazvīnī (I pp.207, 222), and al-Dimashqī (pp.54-5), all of whom give short paragraphs on the subject, of Ṭūsī and Abū'l-Qāsim (NṬ pp.220-2; AQ pp.236-o) neither of whom are very

informative on this particular subject, and of Fakhr i Mudabbir, whose book Adāb al-ḥarb wa'l-shujā'a contains an important chapter on weapons (FM pp.240-273). The value of most of these authors for metallurgical studies has already been discussed, but not al-Kindī, al-Ṭarsūsī and Fakhr-i Mudabbir, who now merit some comment.

al-Kindī, though primarily an outstanding philosopher, was interested in much besides. His letter on swords is a model of thoroughness. The swords are divided into general and specific categories, and their manufacture and characteristics are discussed. Unfortunately every detail is not included, and this is often frustrating to the reader. Of the author's close study of the subject, however, there can be no doubt, and the letter remains the most important single text on the subject. al-Ṭarsūsī's chapter on swords is small compared to al-Kindī's letter but his familiarity with the subject is clear from the detailed recipes he gives for steel, including valuable information on the use of manganese. Fakhr-i Mudabbir's information, written down in the 13th century under the Delhi sultanate, does not in general coincide with that of other authors, and his terminology is obscure, but there are sufficient points of contact to suggest that he is reliable.

The uninformative nature of Ṭūsī's text and that of Abū'l-Qāsim has been mentioned. It should be added here that the lack of information is particularly striking in the case of Abū'l-Qāsim. His chapter on iron and steel is almost totally derivative, and one has the strong impression that in his own time he had little opportunity of studying iron or steel working in north or north-west Iran.

The sources differentiate between three types of metal when discussing iron and steel: shāburqān, narm-āhan, and fūlādh. (For technical vocabulary see Table 15). Fūlādh is easily identified as steel,

and is discussed below. The difference between the first two is by no means so clear, and any conclusions must be based on the individual descriptions of these two substances given by the various literary authorities. al-Kindī groups both under the heading of mined iron, as opposed to unmined steel, and describes the first as "the strong masculine type which can be quenched in the making (of swords)", and the second as "the soft feminine type which cannot be quenched" (Kin p.5). Elsewhere he says (Kin pp.11-12): "one may manufacture swords from male (iron), but they will be dry swords which break quickly when war is joined and quickly have to be soldered. Further, they do not quench evenly because male iron has veins of soft narm-āhan, which often occurs in its blades, and these veins will not accept quenching, and are severed at a blow of the sword. As for the bits which do accept quenching, their edges are severed when war is joined or they are broken off. Only the ignorant make such (swords). Otherwise one needs a source which only has male iron. These swords have no damask whether an etching compound is thrown on them or not, and their iron is all of one colour. They are hard, not feminine, not supple; their iron has no purity or dampness; they are strong edged, varying in their blades, some places being rough, some soft. Swords may be made of narm-āhan, and the Byzantines and foreigners use these. Those composed of a mixture of shāburqān and narm-āhan are of two types, the Faranji and the salmānī " al-Birūnī (p.248) treats of the two in the following terms:"The mined form of iron is divided into two types. One of them is soft and is called narm-āhan, and is said to be feminine. The other is hard and is called shāburqān, and is said to be male on account of its strength. This one accepts quenching with disdain because of the small amount of feminity (in it). Narm-āhan, like iron, is divided into two types, one of them being the substance itself, the other being the water which flows from it when

it melts and is purified of the stone (which is in it). This is called dūṣ, and in Farsī asta, and in the borders of Zābulistān rū, because of the speed with which it comes out of the iron and precedes the iron in reaching a fluid state. It is hard and whitish silver. From shāburqān are made Byzantine, Russian and Slav swords."
Al-Birūnī then equates shāburqān with qalaʿ and says that swords made of the latter have a peculiar quality of whiteness, and later in the same chapter he writes (Bir p.250):"I have heard on the subject of shāburqān from a number of sources that the Russians and Slavs cut it in small pieces, knead the pieces in flour and put them in leather bottles. They then wash them from their impurities, and repeat this action many times. Then they solder them together after putting them in the fire, and fashion swords from them." al-Birūnī (p.252) also comments that shāburqān is the same as one type of fūlādh and that it has been tempered by natural means. Of the other authorities neither Pseudo-Aristotle nor al-Dimashqī make useful distinctions in iron types, whereas al-Qazvīnī (I p.207, II p,222) notes three: shāburqān, which is mined, and anīth and dhukūr which are evidently not. He also mentions a substance called ḫūsāī, which may be the same as al-Birūnī's dūṣ, commenting that it was what Aristotle described as coming off the iron when the latter was purified by fire, i.e. iron dross. Ṭūsī does not mention either shāburqān or narm-āhan. Abū'l-Qāsim (p.236) briefly mentions that narm-āhan is a type of iron with the same basis as pūlād but obtained by a different system of melting, and also notes that the best iron is white iron - āhan-i safīd, which was used for making instruments and tools and could not be quenched. It was different from pūlād. Fakhr-i Mudabbir only mentions narm-āhan in passing. Finally al-Ṭarsūsī notes that that narm-āhan is derived from iron, that it is best when it is made

of the heads of old nails, and that either it or shāburqān or both, can be used as the basis of fūlād (Cahen 1947 pp 106-7).

To offer a definition of shāburqān or narm-āhan which accords with all the above texts is impossible, even though it is necessary and desirable to make the attempt. The impossibility presumably stems from the fact that the medieval scholars worked by observation, not through exact chemical analyses and equations, and that as a result different authorities may be found calling the same substance by different names or different substances by the same name, recognition of a given substance or compound being inevitably hampered by a host of impurities accidentally intermixed with it. However, some general points may certainly be made. For example, it is likely that the terms "mined" and "unmined" as used in the texts do not mean exactly what they say, as Hammer-Purgstall noted (1854 p.68). Steel is termed "unmined" iron presumably because it is the result of processing in a fairly elaborate manner the iron produced from iron bearing ore. Hence "mined" need not, and generally probably does not, mean naturally occurring iron. Iron does not after all occur native, like some other metals, and even if it occurs in a fairly pure form in meteorites the number of meteorites still available for use in medieval times must have been very limited, though in one specific instance al-Bīrūnī does use shāburqān to mean this (Bir p.250). What"mined" seems to mean is that the iron is recognisable as iron, in other words that it has been extracted from its ore but that it has not been changed to steel.

Given then that shāburqān and narm-āhan are types of iron which have been produced by man-devised means from the iron ores available, there are two well known types which are tempting equivalents to the modern mind - wrought iron and cast iron. Wrought iron is the basic form of iron produced by the bloomery process, the smelting of

iron ore with charcoal in order to rob the iron oxide of its oxygen and leave free metal. The bloom is a pasty, semi-fluid, fairly porous mass of iron, and it can be worked and forged to give wrought iron. Wrought iron contains very little carbon, less than about 0.3%, and while it is very malleable it does not harden greatly when cooled suddenly. Cast iron, on the other hand, contains so much carbon, c. 2.2-5.0%, that it is not usefully malleable at any temperature. Its great advantage is that it can be cast easily, due to its good pouring quality. Within cast iron there are in fact many different groups, varying in colour of fracture and hardness according to the way the carbon exists in the metallic structure. In white iron the carbon is present in the form of cementite, and since that latter is extremely hard, white cast iron is very hard but brittle. Grey cast iron contains graphite flakes and perlite which make it softer and less brittle (Coghlan 1956 pp.71-2).

On the basis of these brief definitions, narm-āhan seems to correspond to wrought iron, and shāburqān to cast iron. The former is described as soft, the latter as hard, and Abū'l-Qāsim's āhan-i safīd (he does not mention shāburqān) is probably another name for the latter. But while this may generally be true, there are clearly specific points when the correspondance is not correct: e.g. al-Kindī's comment that shāburqān can be quenched and narm-āhan cannot, for cast iron cannot be quenched, whereas quenching does have a mild effect on wrought iron. And because of such specific instances it is undesirable, and indeed inaccurate, to translate shāburqān as cast iron and narm-āhan as wrought iron. It is more correct to say that shāburqān appears to be used in specific instances to mean meteorite iron, and in other instances to mean cast iron, but that very often it can only be described as a hard variety of iron, and that narm-āhan, although it may sometimes be translated as wrought iron, may often simply mean a soft type of iron.

It is important to try and identify one other term which has already been encountered in al-Bīrūnī's text: dūṣ. If, as the form of the word might suggest, it corresponds to al-Qazvīnī's ḫūsāī, which is described as coming off the iron when the latter is smelted, then it must mean iron dross, and this could also be implied by al-Bīrūnī's comment that it is "water" of iron and reaches a fluid state before iron (Bir p.248). However, the rest of al-Bīrūnī's description suggests that dūṣ may in fact mean cast iron, a point noted by Validi (1936 pp.20-1), though he thought it could also be translated as Spiegeleisen - specular iron or iron ore. For in the smelting process of iron ore, if the iron is kept in close contact with the fuel for a long period it will become more highly carburized, its melting point will drop, and it will pour from the furnace as cast iron, and remain distinct from the wrought iron, the production of which is the aim of the process. The idea of dūṣ flowing, of its whiteness (presumably of fracture), and its hardness (Bir p.248), all suggest such a meaning, and if this is the correct interpretation of dūṣ it has important results for our study of steel (below).

Turning to the third type offerrous metal frequently mentioned in medieval texts, fūlādh, the problem of identification is much easier. al-Kindī (p.6) speaks of it as follows:"As for the iron which is not mined, it is fūlādh, which means purified. It is made from mined iron by throwing onto it during the melting something which purifies it, and makes its softness strength, so that it becomes very pliable, accepts quenching and its damask appears in it." He then goes on to describe the many and various swords made from fūlādh. Fūlādh obviously means steel, and the descriptions al-Ṭarsūsī (Cahen 1947 pp.106-7) gives of the different recipes for the fūlādh used for swords shows how it was generally made in his part of the Islamic

world: iron was mixed with a small amount of manganese and various bits of plant or vegetable matter, heated in a sealed crucible, allowed to cool, and the resulting cake (baiḍa) used as the basis of a sword. A similar method is described in al-Birūnī's chapter on iron, but the author gives al-Kindī as his authority (Bir p.256). In fact al-Birūnī's own description of fūlādh (Bir p.252) suggests that a rather different process was used in his experience. "The mixture of narm-āhan and its water, which is the substance which flows when the narm-āhan is purified, is fūlādh. The area of Herāt is especially noted for it and it is called baiḍāt ("eggs") on account of its shape. The eggs are long and round-bottomed, following the shape of the crucibles, and from them Indian swords and others are fashioned. The condition of the fūlādh in terms of its composition is of two types. Either the narm-āhan and its water melt equally in the crucible and unite so that one cannot distinguish the one from the other, in which case it is good for files and the like ... Or alternatively, the melting qualities of what is in the crucible vary, so that the two do not mix completely but on the contrary are separate in their parts from one another, and each part of their two colours is seen individually. This is called damask (firind)". By the "water" of narm-āhan al-Birūnī must mean dūṣ which he has elsewhere described as the water of iron (Bir p.248), and if our interpretation above, that dūṣ means cast iron, is correct al-Birūnī's description of the making of fūlādh suggests that it was a compound or iron with a very low carbon content (narm-āhan) and iron with a high carbon content (cast iron) to produce a steel with a carbon content between the two. This is an otherwise unrecorded method of making steel at this period, and is therefore, as Validi (1936 p.21) noted, of some technological importance. For it indicates not only a different process of manufacture but also a recognition of some at least of the properties of cast iron, a form of metal not fully utilised

in Europe until the fifteenth century, although known and used in China considerably earlier (Coghlan 1956 pp.71-85).

Chapter 2 - THE SMITHS' REPERTOIRE

Damascening

Oriental swords have for centuries been noted for their damascening, that is the watered pattern which occurs on their blades, and considerable effort was expended in Russia, and other European countries, in the 18th and 19th centuries to discover how the effect was produced and to imitate it. The history of how the techniques were discovered has no place here, but a brief description of damask and damascening, based on modern research, is necessary before any useful discussion of the medieval texts can take place. (For the vocabulary associated with Islamic damasks see Table 16).

First of all, however, one important point should be noted. In medieval Europe patterns were produced on swords by welding together strips of different quality steels and irons. This technique, in the past called damascening but now generally known as pattern-welding, has nothing to do with damascening in the oriental sense, and it is in this latter sense that the word will be used hereafter.

Oriental damascening depends on the crystalline structure of the cakes of steel from which a sword blade is forged. The technique is to place the desired quantities of iron and carboniferous materials in a sealed crucible, heat the mixture up, hold it at the temperature of incipient infusion, and then allow it to cool very slowly. As it cools two processes take place. First of all, dendritic crystals of austenite are formed, the slowness of the cooling allowing the full development of these crystals. Then, as the temperature continues to fall, a secondary crystallisation takes place in the solid state, the austenite breaking up to form cementite and ferrite Again the slowness of the cooling allows these crystals to develop fully, and,

due to the chemical composition of the austenite crystals, the secondary crystallisation follows the axes already established by the first. Since most damascene steels are hypereutectoid the crystalline structure in practice consists of pearlite - a balanced combination of cementite and ferrite, plus free or excess cementite. (The best discussion of these processes is found in Belaiew 1918 and 1921).

Numerous forgings and prolonged heatings of the resulting steel cake at or below red heat bring about two important developments. First is the spheroidisation of the cementite crystals and their more general distribution throughout the steel. This produces throughout the sword a greater ductility and ultimately a greater flexibility in the finished product, and since it seems that the greater the spheroidisation and the more even the distribution the better the quality of the steel, so the cutting edge of a damascened sword, being inevitably subjected to more forging in order to make it thinner, will equally inevitably develop a finer structure and therefore be the best quality part of the blade. Second is the realignment of the crystalline structure according to the mechanical treatment the cake receives i.e. if the cake is forged longitudinally parallel rows of crystals will result, whereas if the cake is forged in different directions the crystals will form wavy lines or motley patterns. (This is of course a simplified picture, for as Zschokke (1924) pointed out, how exactly the cementite crystals retain their groupings is by no means fully understood.) Then, when an acidic substance is later put on the surface of the blade, the pearlite reacts differently to the areas of free cementite owing to the higher carbon content in the latter, and a visible bichrome effect is produced, the pearlite giving black colouring, the free cementite white. This visible pattern is the damask on a blade called in the Islamic world <u>jawhar</u> or <u>firind</u>.

The quality of a damascened sword is quite extraordinary. Anosoff's experiments with his own brand showed that one could not break such asword however far one bent it, that if it was bent beyond a certain point all that happened was that it lost its elasticity, but that if it was bent to about a right angle it sprang straight back into shape. The spring in the blade and the high quality cutting edge which could be fashioned from the steel allowed him to cut a gauze handkerchief in half in mid-air with the weapon (Belaiew 1918 p.424). Given these qualities it is no surprise that damascened swords achieved the fame they did in early times and that they are still legendary today, but it is important to note that it is only in this century or perhaps in the latter part of the last century that it has been realised how much the quality of the weapon is tied up with the pattern on the blade, the damask, and that the latter is not just surface decoration; for it is only in the last hundred or so years that the crystallographic structure of the steel has been identified. The sword-smiths of al-Kindī's day could not have explained a sword's quality metallurgically, but they almost certainly knew by experience that the damask was more than just a surface pattern, witness al-Kindī's comment on Fārs swords (Kin p.30). For the steel in a blade subjected to very little forging would inevitably have been of poorer quality and would have shown wide bands of damask, while the steel of a much forged sword would have been of correspondingly good quality and would have had a finely banded damask. Similarly the damask with very intricate and wavy patterns would have been recognised as indicating a more thoroughly and conscientiously forged blade with those qualities which one would therefore expect. Even the inherent weakness of a damascened blade, only recently brought to light by modern research, may have been realised by observation and experience by the sword-smiths. This weakness consists in the fact that the more a carbon steel is

subjected to a heat of between 730-1000°C. the more the cementite in it tends to decompose into graphite, and graphite brings with it fragility. Hence, over-heating and forging of a sword blade will result in the decline of its qualities (Panseri 1965 pp.27-9).

While early Islamic damascened swords were undoubtedly of fine quality for their time, it is important to note that such swords probably would not compare with their modern European equivalents. Zschokke's experiments showed that, due mainly to their high carbon, high phosphorus and low manganese content, 17th century Persian weapons at least were neither as strong, nor as flexible, as modern pieces (Zschokke 1924 pp.654-6).

Unfortunately, at the present time, there is no way of assessing the ability of the early Islamic sword-smith. Only two early Persian sword blades have survived, those found at Nīshāpūr, and although others from Iraq and Syria are known, for example those in Topkapi Museum with the names of Muʿāwiya, ʿUmar b. ʿAbd al-ʿAzīz, Hishām, and Saʿd b. ʿUbāda, plus the sword bearing the names of Muʿāwiya, ʿUmar II and Hārūn al-Rashīd, and that of the last ʿAbbāsid caliph al-Muʿtasim (Zaki 1965 p.271), the apparent lack of damask on their blades and the general lack of information about them, makes it quite impossible to talk about early Islamic sword blades from first hand information. We therefore have to rely on textual evidence.

According to the early Islamic writers, the identification of any particular damask, and hence of any particular damascened sword, depended on two qualities, pattern and colour. The first of these qualities, pattern, was only used in the most general sense, for while it is true that there is an infinite variety of patterns which can be produced by damascening it is equally true that the differences between them all depend generally on a minuteness of design which is

virtually impossible to describe or define in any meaningful way. Hence we find al-Birūnī and al-Kindī using only the most general terms in this context - broad, narrow, thickly decorated, webbed, like the track of ants (Bir pp.252,254) etc. In two or three instances, however, a general description of a style of damask hides an important variation in the method of producing the damask, and these instances demand some further comments. The first concerns al Birūnī's makhūs damask. He writes as follows (Bir p.255): "...Makhūs is similar to al-saqlātūn al-makhūs. The method used for these is that the cake is not beaten over its whole length but is beaten on its head until it spreads like a dish. Then they cut it like a pipe and flatten its circular form until it is level. They then cut out the sword from it. The damask of the sword is then makhūs." The significance of the name given to this damask eludes me but the effect seems to have depended on the way the cakes of steel were used as well as on the effect the forging would have had on the crystalline structure. This method is mentioned by al-Birūnī in connection with the Indian sword industry. A second instance of an important variation of method of damask production is ascribed a Sindī origin by al-Birūnī (p.256). He writes: "A person who was in Sind told me that he sat and watched a blacksmith making swords. He looked at the swords closely and their iron was narm-āhan, and the blacksmith used to sprinkle on the iron a highly refined medicament of reddish colour, then throw the sword (into water) and consolidate it by immersion. Then he used to take it out and lengthen it with a hammer, and repeat the sprinkling and working many times ... I discovered that it was dūṣ which he mixed with narm-āhan for edging and ornamenting (the sword)." Here we have an example of the introduction of specks of iron into the steel blade for ornamental and other purposes, which would result in a very different effect from simple

damascening. There is no proof that this technique or the previous technique described above were used in Iran, but it is important to note their existence and the possibility that straight forward damascening was not the only decorative art in use for early Islamic Iranian sword blades. It is also particularly important to note these two instances because modern scholars like Smith (1960 pp.18-20) have observed that there are certain patterns which appear on so-called damascened blades which must be due to separate or additional processes of a quite different nature.

A third instance which should be considered is a case of a "knotted" damask, described in some detail by al-Kindī (pp.33-4):"The muḥarrar (a type of Persian sword - see below) ... is covered with small knots side by side from top to bottom, made with a chisel, then polished with a polishing stone until it is smooth, and you can see the lines following each other as in the qal'ī sword. Its damask is black." The term "knotted" is rather misleading. Elsewhere al-Kindī (p.15) describes Yemeni swords as having a damask consisting of a ladder made up of equal "knots", or better "rungs". Since no chiselling is mentioned in this Yemeni variety the laddering may simply have been due to the way the cake of steel was used e.g. by making a radial cut in it, opening it out, and hammering it flat, thus utilising the naturally occurring radial crystallisation pattern (see Zschokke 1924 pp.642-3). But in the case of the muḥarrar sword, al-Kindī is almost certainly referring to a type of damask which has been the subject of particular study and debate in recent years and is generally called "Muhammed's ladder". Following on comments by Maryon, Smith and others, Panseri (1965 pp.60-4) authoritatively identified the form of this damask and through his own experiments showed how it was produced. The characteristics of "Muhammed's ladder" damask,

or Kirk Narduban, to give one of its more modern Middle Eastern names, are that it contains some forty or so transverse "bands", almost equidistant from one another, crossing the blade over its entire length. These bands are formed by more minute or dense damask patterning than the rest of the blade, a feature which clearly differentiates them from bands which appear on Malayan kris blades, which are of a more spacious damask than the surrounding areas. A glance at a later Persian blade with "Muhammed's ladder" damask (Panseri 1965 fig.9) indicates why al-Kindī uses the term "knotted", for the bands, due to the closeness of the weave of the damask at those points, do indeed look as though they are created by damask lines being knotted together, and pulled tightly towards one another. The fine weave of the bands is of great importance in identifying the method of manufacture. Smith (1960 p.20) thought, on the basis of work done by Massalski and De Luynes, that the transverse markings probably resulted from cutting shallow surface grooves in a nearly finished blade and then forging the surface flat, but Panseri showed that such grooves, if cut, would lead to transverse marks with a broader damask structure than the surrounding areas, as in the Malayan blades. Through deduction and experiment he showed that the transverse marks with a finer damask structure were produced by making a series of impressions with a chisel with a well-rounded end, grinding or filing down the areas between, and then hammering the blade flat, the effect being to condense and compress the structure of the damask at those points (Panseri 1965 pp.22, 63). This is indeed what al-Kindī describes.

The second quality of damask, used by early Islamic scholars for the classification of both damask and swords, was colour. Some colour will naturally be present in a damascened sword blade due to the

varying carbon content in the steel, but the colours mentioned by medieval authors were in the main probably due to etching. This brings out the contrast between steel qualities due to the difference in speed and form of reaction which takes place depending on the acid or compounds used. Some of the different colours produced by the action of sulphuric acid on different quality irons and steels were described by the 18th century Swedish chemist Sven Rinman (Smith 1960 Appendix A). al-Kindī describes the etching process in outline, giving important details of terminology, though he never reveals the exact substances employed.

He writes (Kin pp.14-15):"As for the ʾarḍ (of a sword) they call it ʾarḍ (lit. "ground") according to its state. I mean the area of iron with no damask. So they say "red of ground", "green of ground", and"dark of ground". But when you find me saying in my book "white or iron", "yellow of iron" or other descriptions of the iron, I am referring to the sword, and I mean the damask. And if I say "before throwing" (ṭarah) or "after throwing" I am referring to the medicament (dawāʾ) which is thrown onto the sword, that is the medicament that is thrown onto the iron to make the damask appear." al-Bīrūnī actually specifies the substance used as the dawāʾ in India. He writes (Bir p.253):"When the Indian wants to make the damask appear he coats it with yellow Bamyānī or white Multānī zāj ... In the process of quenching (the sword) they coat the flat of the blade (matn) of the sword with hot clay, cow dung, and salt, like an ointment, and clean the two edges with two fingers. They then heat it up by blowing so that the ointment boils, and they then quench it. They then remove the coating from the surface of the blade and the damask appears. Zāj may be mixed with the salt.

Analyses of samples of zāj collected in the east showed that this substance, as then marketed, was impure ferric sulphate (Jacquin 1818; Zschokke 1924 p.660), and this would also fit the descriptions of zāj given by medieval authors such as al-Khwārizmī (Wiedemann 1911 pp.92,97), al-Dimashqī (p.80), and al-Qazvīnī (I pp.225-6, 233). Zāj also seems to have been the name given to that very obvious, colourful and plentiful iron sulphide mineral, pyrites, from which the sulphate is formed by decomposition. Either the sulphide or sulphate would in fact have aided the etching process, producing by strong heating and then immersion in water, sulphuric acid. In al-Birūnī's Indian recipe the cow dung, containing amongst other things urea, would also have contributed to the desired process, and it is highly likely that such recipes as devised by different individual sword-smiths contained a wide range of other substances, some active, others totally inert. This is borne out by the fact that al-Kindī uses the term dawā' with its strong implications of a compound substance to indicate what was used for etching, rather than the particular term zāj which one would have expected if that had been recognised as the only essential ingredient.

Two particular types of damask are associated in the texts with Persian swords, though undoubtedly other varieties occurred, and it is only the vagueness of writers such as al-Kindī that prevents their identification. One, that later called by the name "Muhammed's ladder", has already been discussed in detail. The second is known by al-Birūnī and Fakhr-i Mudabbir as bakhrā. al-Birūnī describes it in his discussion of Indian sword manufacture (Bir p.255) but Fakhr-i Mudabbir (p.259) says that most swords in Khurāsān and Iraq were bākhrā. What exactly either author means by the word is difficult to determine.

al-Birūnī first associates it with three colours or a third colour, unspecified, and then says that the name applies to any sword which has no damask. Fakhr-i Mudabbir on the other hand seems to equate it with poor quality damask and perhapstoo poor quality swords:"In Khurāsān and Iraq most swords are bākhrā, not having a good damask, but they are thick and break less in giving injuries and wounds." It may be that Fakhr-i Mudabbir is biased and looking at the Persian industry from an Indian point of view, but his comment certainly seems to suggest that by his time sword-craft had suffered a decline in Iran, at least in terms of damascening.

Swords

The primary early Islamic authority on swords, al-Kindī, divides them into two primary categories: maʿdanī (lit. "mined"), and ghairi maʿdanī (lit."not mined") or fūlādhī (steel). (For the full typology see Table 18). He then divides fūlādhī swords into three main types: ʿatīq (lit."ancient"), lā ʿatīq wa lā muḥaddath ("not ancient and not modern"), and muḥaddath ("modern"), but he explains (Kin p.7) that this does not mean that they are old as opposed to new, but rather that they have ancient as opposed to modern qualities or a mixture of the two. It is interesting here to observe that ʿatīq is used by al-Hamdānī to denote gold which is of high quality (Ham fol.37a, 70b) as opposed to dhahab dūn, poor quality gold (Ham fol.53b, 70b). Within al-Kindī's second type there is a further sub-division - muwallad ("created") and ghairi muwallad ("uncreated"). The reason for this terminology and its significance is never fully explained, though Hammer-Purgstall (1854p.71) suggested that since muwallad in Arabic is used to indicate expressions unknown to Arabs before the time of Muḥammad and therefore of foreign origin, its usage here would seem to indicate non-Arab swords i.e. Persian, Syrian and Indian ones, as opposed to those of Arabia and the Yemen. Persian swords occur in the muwallad division of type 2, and also in the muḥaddath type. The former are Khurāsānī swords made from Khurāsānī iron (Kin pp.11, 33-4) and their manufacture and form is described as follows (part of this passage has already been quoted above p.420):"A type of muwallad sword is called muḥarrar, and it is made in Khurāsān in qalʿī size. It is covered with small knots side by side from top to bottom, made with a chisel, then polished with a polishing stone until it is smooth, and you can see the lines following each other as in the qalʿī

sword. Its damask is black. The widest of such swords is two fingers and a half, and the damask does not appear until the etching compound has been thrown onto the blade. In cases where some of the damask does appear before the etching compound has been thrown onto the blade you see a soft dark damask appearing in rows. The mark of such a sword is that its hilt has fine holes in it, that it is made like a qal'ī sword, and that it fetches 30 dirhams in price". (According to al-Kindī p.23 qal'ī swords are usually less than 3 fingers in width and 4-5 spans in length.)

The muḥaddath swords are divided into salmānī, sarandībī, and baiḍ ("white"), and the first of these, the salmānī, constitutes an extremely important group in Persian terms. Validi (1936) suggested that the salmānī swords mentioned by al-Kindī were the same as the sulaymānī swords mentioned by Ibn Rusta (p.146) in connection with the Rūs peoples living somewhere north of the Black Sea, and then proceeded to elaborate on the evident qualities of the latter using al-Kindī's information about the salmānī sword. A study of al-Kindī's risāla makes it quite clear that these are in fact two different types of sword. The one is the sulaymānī sword, referred to by Ibn Rusta, which comes under al-Kindī's "mined" (ma'danī) heading, and the "compound" (murakkab) sub-division, and is described alongside the faranjī sword (Kin p.33). Like the latter it does not have a typical oriental damask, and the author specifically says that the iron is like faranjī iron. Hammer-Purgstall (1854 pp.70-2), who also realised the identity of this sword type, suggested that the highly evocative name was used because these objects were very much honoured by the Muslims, presumably because of their scarcity value and different qualities from their own. The other type is the salmānī which as just noted, is ghairi ma'danī or fūlādhī, and muḥaddath, and therefore in al-Kindī's mind quite a different category of sword.

According to al-Kindī these swords took their name from Salmān, where the iron was produced, though the swords were actually manufactured in the Transoxanian provinces. Unfortunately, however, Salmān appears in no geographical book I have been able to locate (Cahen 1947 p.150 n.6, was unable to find it either), and the only clue to its whereabouts is al-Kindī's own comment that the iron came "min ʾarḍ salmān ʾilā warāʾ al-nahr min khurāsān" (Kin p.26). Zaki (1955 p.370) interprets this to mean that the iron was brought "from Silman, in the Oxus", but the literal interpretation should be that it was brought to Transoxania from an area beyond Transoxania, presumably somewhere in Central Asia. But this interpretation, and indeed al-Kindī's own information, is hardly satisfactory, for the geographical texts make clear that iron was extremely plentiful in the Transoxanian provinces, especially Farghāna, and that numerous different objects were manufactured from it on the spot, many of them being exported to other areas of the Muslim world (Iṣṭ p.288; IḤ p.506; Muq p.325), in which case it would have been pointless to import large quantities of iron from elsewhere. The only way of reconciling al-Kindī's word with the geographers' comments seems to be to suggest that the name Salmān, and the name given by al Kindī to the wide salmānī swords, bahank, are corruptions of the names of the two towns Marsmanda and Mink, noted by the geographers as the main iron manufacturing centres of Transoxania. Such a solution has problems of its own, not least that bahank is equally likely to be derived from the Farsī pahan meaning "wide", and that salmān is very far from its suggested source word. However, such a solution would at least bring into alignment the positively worded statements of the geographers and the technical knowledge of al-Kindī. It would also indicate why the latter makes no mention in any other terms of the swords which al-Muqaddasī ascribes to Farghāna and Asbījāb,

and why on the other hand he talks of the way Khurāsānī, Mawṣilī, Yemeni and Jibālī sword polishers could be taken in by salmānī swords whereas Iraqi ones could not (Kin p.28), clearly illustrating Ibn Ḥawqal's assertion that Transoxanian iron objects were exported "even to Iraq".

In view of the distinction noted above between salmānī and sulaymānī, it is surely to the salmānī sword, not the sulaymānī, that al-Ṭarsūsī is referring in one of his recipes for steel (Cahen 1947 p.107). Furthermore there is surely some confusion in Fakhr-i Mudabbir's mind when he records among sword types rūsī, khazarī, rūmī, farangī and sulaymānī, and then later talks of two Afghān types sūrmān and tūrmān. It seems to me to be quite likely that the latter three are all the same, and that the text therefore indicates the continued production of salmānī swords in eastern Iran, if not Transoxania, into the early 13th century.

According to al-Kindī (pp.25-8), the most important salmānī swords were al-salmānīyāt al-ṣughār (the "small" salmānī's), which were long and slim, and had a damask which was curly and visible without the use of any etching compound. The hilt end and top end of these swords were of the same width, the tip being a flat point as opposed to the Yemeni characteristic conical point, and the hilt being like the Yemeni hilt and therefore presumably square. The small salmānī swords often seem to have been manufactured to look like either Yemeni or qal'ī swords, and their exact lengths and types of damask were adapted to this end. Wide salmānī swords were known as bahank or bahānaj. These were 4 spans long, and weighed 3-3½ raṭl but al-Kindī is confused over their width, which he once gives as 3-4 fingers and once as 4 (Kin pp.27,10). The latter must be the correct figure since ruthūth swords were 4 or just under. Ruthūth was another type of salmānī sword, which was characterised by having a stamp on the

hilt giving the name of the manufacturer. These swords were four fingers or slightly less in width, four spans long, and had excellent backs, beautiful tips and wide hilts (al-Kindī's other comments p.28 line 1 are obscure.) Their weight was normally 4-4½ raṭl but occasionally 3½. The removal of the maker's stamp and the addition of an etching compound to the surface enable these swords to pass as qal'ī pieces among the polishers of Khurāsān, Mawṣil, Yemen and Jibāl, such was their quality, though the Iraqi sword polishers could evidently tell the difference.

A description of how salmānī steel was made is given by al-Ṭarsūsī (Cahen 1947 p.107): "Description of salmānī steel from which salmānī swords are manufactured. Cultivated myrobalon 20 dirham; manganese 7 dirham; scammony 5 dirham. Make them all very warm, and throw this compound onto 3 raṭl of shāburqān. Blow on it until it melts, (and do this) in a crucible with a lid with a hole in it, so that one can see in and examine the iron until it is molten. Then remove it from the furnace, leave it to cool in the crucible, and then make from it what you want. Then hit a shaft of iron of 20 raṭl with it and it will break it if God wills". As Cahen (1947 p.150 n.6) points out the composition of the steel is little different from that of the other steels described by al-Ṭarsūsī, but it does at least indicate the distinctive qualities which were attributed to salmānī swords at the time.

Persian swords also appear in al-Kindī's second and third muḥaddath groups, sarandībī and baiḍ ("white"). Among the sarandībī occur a Khurāsānī and a Fārsī type, and among the baiḍ a Fārsī. Sarandībī swords appear to have been of two main groups, one made in Ceylon, the other made in Khurāsān (Kin pp.10, 28-30) on a Ceylon model (if this is the real meaning of wa huwa mā ḥumila min sarandīb wa 'umila

ḥadīdhu bi khurāsān). al-Kindī does not unfortunately give either the size or the essential characteristics of sarandībī swords, though it would appear that the Khurāsānī variety was distinguished by the use made of oak or tamarisk charcoal for producing the steel. The damask on all sarandībī swords was brought out by throwing onto them a suitable etching compound, and the resulting effect seems to have had yellow predominating. The Fārsī variety was made in Fārs from Ceylon cakes, as was also the case with another sarandībī type, the manṣūrī, made at al-Manṣūriyya, capital of Sind. al Kindī also records that some people in Fārs used to take to the sword-smith local pieces of ore (al-arkāzmāt- ?perhaps pieces of iron), called shabīīt, from which sarandībī type swords were then made, and adds that due to being locally manufactured some Fārs swords had a wider damask (i.e. were of poorer quality) than good sarandībī swords (Kin p.30).

The "white" swords (Kin pp.31-2) were of two types, one made in Fārs, the other in Kūfa. The Fārsī variety was 3 fingers wide, and while the length of both Fārsī and Kūfan averaged about 3 spans and 4 open fingers, the Fārsī type was 3 fingers longer than the Kūfan. The Fārsī type also had a longer, thicker, and wider hilt, and was usually about a third less in price for the same weight and length of sword. Its damask was wider but not so pure as the Kūfan. The characteristic of the type as a whole seems to be that it had a slim hilt narrowing towards the top, and a blade with a sharp point which was in fact thicker than the end of the sword attached to the hilt. The term "white" presumably refers to the colour of the steel used for such swords, though al-Kindī never makes this clear.

al-Kindī's descriptions of Persian and other swords applies to the mid 9th century, and it is therefore hardly valid for the early Islamic period as a whole. Unfortunately, he is the only writer to deal with

swords in detail, and all other information has to be derived from less comprehensive sources. Even he, it will be noted, does not give all the details, and on one important point he remains silent - the question of whether there were any curved swords in his day. There is one possible allusion to curved swords (Kin p. 17) where, in talking about Yemenì swords, he refers to a type rendered by the editor Zakī as qaljūrī. al-Kindī describes it, again in Zakī's reading of the passage, as ḥaqāf - long and curved. The shape of a qaljūrī sword, as will be mentioned below, may be long and curved, but the editor has taken wide liberties in his rendering of the text here. The manuscripts use the following terms at this point - ʿūrī, quyūrī, ʿunūrī, and qubūzī, and for the word ḥaqāf read khafāf. The latter reading, meaning light in weight, is supported by al-Kindī's remark embedded in this part of the text that these swords weighed 2 raṭl or less, and whatever the exact name of the sword, Zakī's long, curved qaljūrī seems far from what was originally intended. Excluding therefore this possible allusion al-Kindī makes no reference to curved blades, and it seems fair to assume that his silence means that all swords known to him were straight.

It remains to gather together and assess any other information, pictorial or literary, for the history of sword types in early Islamic Iran. As an introduction to this it is first necessary to identify the sword types known in Iran and the areas closely associated with it just before the Arab invasions. Sasanian rock reliefs and objects show that there were three types of sword used by the Sasanians. The first was the long, straight double-edged sword with a quillon which occurs on most of the rock reliefs and which is interestingly contrasted with a Roman quillonless sword at Bīshāpūr (Ghirshman 1962 fig.197). A small version of this sword in the investiture scene

attributed to Narsa at Naqsh-i Rustam may have a quillon in the shape of a shallow "s" (Ghirshman 1962 fig.218). This type of sword was worn on the left of the body and was supported by a single carrying strap and a bridge mount or by two straps buttoned onto opposite edges of the scabbard. The second Sasanian sword type was a short straight sword worn on the right of the body and supported in a similar way (Orbeli and Trever 1935 pl.7). The third type is only depicted in the hunting scene at Ṭāq-i Bustān, and was a straight sword slung on the left side of the body and suspended from the belt by two separate straps each leading to its own mount on the upper edge of the scabbard. A number of richly decorated swords of this last type have been found in northern Iran, including one short one with a very slight curve, and Ghirshman (1963) and Nickel (1973) have shown that these swords are of a design typical of the Avar and Hunnish peoples of the Central Asian steppes. The rock reliefs suggest that this sword type was introduced into Iran late in the Sasanian period, a fact born out by the appearance of a sword slung in traditional Sasanian fashion, and another slung in the latter fashion, in a wall-painting in the 7th century monastery at Funduqistān in Afghanistān (Hackin et al. 1959 fig.199).

A straight sword was also typical of the Soghdians, though it was by no means identical to any of the Sasanian varieties. Two main types are shown in the Panjikent murals - a very long slender variety hung on the left side of the body, and a short type attached to the front or front left of the belt in an almost horizontal position. The long slender sword was slung from the belt by a variety of means. In one mural a cord is shown running from the belt through an eye on the upper edge of the scabbard, then through another eye on the side of the scabbard slightly lower down, and ending at a third eye opposite

the first (Yakubovski et al. 1954 pl.36). In these cases it is not clear whether the rosette shown is the top of the scabbard or part of the hilt. In another mural the sword scabbards appear to have twin mounts, and one assumes that the cords were used to attach these to the belt as in the mural from Mug (Yakubovski et al. 1954 pl.5,10,12). In other cases, where the swords are depicted with neither twin mounts nor eyes, and only a rosette where hilt and scabbard join (Belenitski and Piotrovski 1959 pl.7), the form of suspension remains a mystery. A Soghdian silver dish (Orbeli and Trever 1935 pl.21) shows a scabbard with twin suspension mounts, and twin suspension mounts seem to have been the rule for the short sword carried at the waist. Neither long nor short swords seem to have been equipped with quillons; on the other hand fairly elaborate hilts were often employed, some straight with a pommel, others plain but curved, still others curved and ending in an animal head.

Since the first detailed account of Arab swords is that of al-Kindī it is virtually impossible, with the lack of pictorial evidence, to be sure what the pre-Islamic sword or the swords used by Muḥammad's followers would have looked like. A detailed study of the terminology of swords in early Arabic literature does not seem to have brought to light any evidence that curved swords were known, nor unfortunately much information about hilts, quillons or mounts (Schwarzlose 1886 pp.124-209). But this negative evidence, plus the survival of a small number of early Islamic swords in the Topkapi Museum (Stöcklein 1934 fig.16), all of which are straight, suggests that straight swords were the order of the day.

The first pictorial evidence of swords which seems to have survived from the Islamic world is the manuscript of al-Ṣūfī's treatise on the fixed stars dated 1009-10 A.D. now in the Bodleian Library. Here the two swords shown are both straight, Perseus' being fairly long and narrow with a pommel and curl-ended quillon, and Orion's being short and stout with a similar hilt (Wellesz 1959 fig.7.16). What is

particularly interesting in the light of pre-Islamic Persian and Soghdian sword types is that Orion's sword has twin mounts, and that these were clearly essential in the artist's eyes, despite the fact that the positioning of the stars in the constellation makes it impossible for the sword to hang correctly for this type of suspension system. And it is this system of suspension that from now on seems to have been general in the Islamic world, appearing on a Fāṭimid dish (Atil 1973 no.57), on the Freer minai dish (Atil 1973 no.50 - one of the captured swords lying on the ground), and in the illustrations of the late 12th - early 13th century manuscript of Varqa and Gulshāh (Melikian-Chirvani 1970b fig.2,18,19). From these pieces of pictorial evidence it would therefore seem probable that through their conquest of Iran and their contact first with Sasanian practice and then with Soghdian practice, the Arab armies adopted the suspension system of the swords of the conquered races, which hence-forth became standard for both infantry and cavalry throughout the Islamic world, including Iran. Such an adoption is all the more to be expected in view of the greater ease with which a sword held by double mounts can be drawn.

To what extent the Arab sword blade itself was influenced by the weapons of the conquered or vice versa for the moment remains a mystery, and the next major change which is discernable in relation to Persian swords is the arrival of a curved blade. The first pictorial indications of this come in the late 12th-early 13th century. A lustre dish in the Hermitage (Pope 1938 pl.643A) shows a warrior with round shield and short curved sword with a plain quillon, while in the illustrated manuscript of Varqa and Gulshāh, cavalry are depicted using both curved and straight long swords, though the latter type predominates numerically (Melikian-Chirvani 1970b fig.38). The evidence provided by the dish has to be treated with caution. Pottery

objects from Iran are almost always made up from fragments of which a certain number may have been specially made at the time the object was found, and a close examination of the object is always necessary before its design can be used as definitive art historical evidence; in this case it is noteworthy that the warrior is left handed. The manuscript illustrations would seem more reliable evidence, despite the rather crude drawing in certain parts, and in the instance mentioned the curved sword with plain hilt and a quillon with cone-shaped terminals can hardly be a mistake for a straight sword. Thus it would appear that by about 1200 A.D. a long curved cavalry sword was known and used in the north and west of Iran, and it may be that a short curved infantry sword was also available.

Pictorially there is no evidence to suggest when, prior to this, the curved style of sword came into fashion, but valuable clues as to its origin are embedded in certain Persian texts, and these must now be discussed. In the Shāh nāma, completed in 1010 A.D., and written in Ṭūs in Khurāsān, Firdawsī uses two particular words for a sword: shamshīr and tīgh. True, he never actually seems to describe the shape of such a weapon, but one might assume that a hundred years after al-Kindī the standard sword shape was the same i.e. straight. The same words are used by historians of the Ghaznavid period such as al-Baihaqī and al-ʿUtbī, but al-ʿUtbī also mentions a weapon by the name of qarājūliyya, and states that the qarājūliyyāt of the Qarakhānids captured during the Ghaznavid invasion of Khurāsān were beaten into fetters for the prisoners (ʿUtbī (b) IIp.81, quoted by Bosworth 1963 p.120). Fakhr-i Mudabbir, writing some two hundred years later, but describing the Ghaznavids and their times, also mentions this weapon, which he calls qalāchūrī. Fakhr-i Mudabbir claims that it was Turkish in origin, which is presumably correct since the word must be related to the Turkish kilij meaning a sword. From his description it is clear

that it was a long, curved cavalry sword, deadly in the cutting ability of its curved blade, and long enough to fulfil the role of a lance if the latter got broken in battle. He also tells of its popularity among the Ghaznavid Sultans (FM pp.267, 269): the amīr Sabuktakīn fought with spear, arrows and qalāchūrī with great skill, Sultan Maḥmūd fought with sword (shamshīr) and qalāchūrī, and Sultan Mas'ūd fought with bilgātakīnī (see below p.443) and qalāchūrī. On the basis of the above evidence it would thus appear that a long, curved cavalry sword, used by the Turks in Transoxania, and thus known to the Qarakhānids, was introduced into the Ghaznavid domains in the late 10th century. This so-called qalāchūrī was evidently popular among the Ghaznavids, and with Ghaznavid expansion westwards as far as Iṣfahān and Rayy the qalāchūrī must have been seen or heard of in large areas of Iran by the death of Maḥmūd in 1030 A.D., even though it may not have been widely used or manufactured. Whether it was used by the Saljūqs during their advance across Iran there is at present no way of telling, but its depiction in the Varqa and Gulshāh manuscript already cited suggests that it retained a limited popularity in Iran until the arrival of the Mongols, when miniature painting illustrations suggest that the weapon or its Mongol equivalent became the standard sword type throughout Iran.

The short curved infantry sword on the lustre dish remains an enigma. The decoration on the dish, apart from the warrior, is sufficiently timeless to make a Mongol dating for the piece a possibility, and I am tempted to suggest that it is indeed a Mongol object, and that by then the curved sword had become widely enough known to be carried by footsoldiers as well as horsemen, though perhaps in a modified form. This is supported by a manuscript illustration dating from the Il-Khānid period showing three seated figures with such swords (Pope 1938 pl.816B).

That infantry in all periods carried rather shorter swords than cavalry is highly likely, for practical reasons. Bosworth (1963 p.119) mentions that the Ghaznavid infantry had a short sword, though he gives no references, and a 12th century relief now in the Çinili Kösk in Istanbul shows a Turkish Saljūq soldier wearing lamellar armour and helmet, and carrying a short sword of suitable type (Russell Robinson 1967 fig.33). Unfortunately Fakhr-i Mudabbir does not mention a short infantry sword specifically, and detailed information on this point is therefore yet to come to light.

Having established this general outline of the development of sword types in Islamic Iran, on the basis of literary and pictorial evidence, it is now necessary to discuss the one almost complete sword which has actually survived, that found in Tapa Madrasa in Nīshāpūr in 1939 (sword 1). This sword is a straight-bladed iron sword, of slightly tapering form, and in my own estimation it is double-edged, like the broken blade found in the same mound (sword 2). Wilkinson, however, in his unpublished drawings, suggests that it is single-edged. The hilt is missing but the quillon survives, and though most of the scabbard has perished the large bronze mount at the top, a small piece of bronze half way down, and the bronze tip, are still in a reasonable state. Until it is examined scientifically we shall not be able to discuss the nature of the steel used in its manufacture, or whether it has a damask, but the remaining scabbard fittings are very important in establishing its typology and dating.

The striking feature of the sword scabbard is its similarity to the Soghdian designs shown in the Panjikent murals, not perhaps in its length, but very definitely in the effect the large almost circular mount gives in its position at the very top of the scabbard. The possible suspension systems are indicated by both this mount, and

the small bronze attachment rather less than half way down the blade. Either twin suspension straps were used, the upper one being held by some sort of metal bracket riveted to the large mount (cf. Nickel 1973 fig.19), the lower one being held by this small bronze attachment lower down, or alternatively a suspension system similar to that on certain of the Soghdian swords described above must have been employed, with one cord attached at three different points. In either case, the main influence appears to be Soghdian, not the twin-mounted late Sasanian style. Analysis of form and decoration suggest that one can trace this influence even beyond Soghdia. For the form of mount on the upper end of the scabbard, and the form of quillon, link the sword with one found at Srostki and now in the museum at Biysk (Fettich 1937 pl.31, no.1-3). This has two half mounts which can be compared with two simple sword-mount brackets found in excavations at Puszta-Toti, which probably date from sometime after the late 7th century (Hampel 1905 I p.24, III pl.268 no.12-13), though the mounts of the Srostki sword beard decoration which probably indicate a 9th or 10th century date. Hence, the mount on the Nīshāpūr sword may give a more exact clue to the form of Soghdian sword mounts before the Islamic conquests than the Panjikent murals can offer, and it may further suggest the possibility of the Soghdian swords being related to the swords of nomadic tribes in Central Asia, through whom the style spread into Europe and into the Altai. A detailed study of this phenomenon is out of place in this thesis but would certainly repay further exploration.

The mount on the Nīshāpūr sword also gives a valuable clue to its dating. The comparisons already made with the Srostki sword and the Puszta-Toti brackets indicate that an 8th-10th century dating is likely, and although no attempt was made at Nīshāpūr to stratify objects and

establish an exact chronolgy on archaeological grounds, Wilkinson, in his publication of the pottery from the site, suggests that the main occupation of Tapa Madrasa was 8th-10th century too (Wilkinson 1973 p.xxxii). Confirmation of this period as the likely date of the sword is to be found in the gold jug bearing the name of the amīr Bakhtīyār, and therefore datable to before 974 A.D. (see p. This bears trefoils closely related to those on the sword even if more elaborately conceived, and strongly points to the 10th century for the Nīshāpūr object.

The Nīshāpūr sword thus adds a further important detail to our general study of the development of sword types in early Islamic Iran. For whereas it seems likely that the double mount of late Sasanian form was the suspension system which came to dominate Persian Islamic swords in general it would also appear that the Soghdian style continued to influence the market in the north-east for at least two centuries after the conquest of the area, certainly in scabbard forms, and perhaps even in the single cord suspension method.

Other arms and armour

Other arms relevant to any discussion of iron and steel include the following: spears, arrows, maces, battle-axes and daggers. Spears and arrows, for the sake of lightness, generally had wooden shafts, but both had iron or steel heads. There seem to have been two main types of spear in use in early Islamic Iran, the long cavalry lance, depicted for example in the Varqa and Gulshāh manuscript illustrations (Melikian-Chirvani 1970b fig.23), and the short infantry spear or javelin, such as is depicted on the Freer minai dish (Atil 1973 no.50). The cavalry lance is usually termed nīza in Persian sources (FM pp.260-1), and rumḥ in the Arabic ones, while the Arabic miṭrād or ṭirād was generally used in both languages for the infantry spear (Bosworth 1963 p.104). However, it should be noted that the terminology is not always clear, for in early Arabic literature naizak, derived from the Persian nīza, is used for a javelin (Schwarzlose 1886 pp.212-3), and in any case there were probably a number of spear types in use in different parts of Iran at different periods which fitted neither category exactly. Variety is certainly indicated by Fakhr-i Mudabbir's use of the terms zhūpīn, bīlkush, nīmnīza, and khisht (FM p.260) for short spears or javelins, and representations of lances in the Varqa and Gulshāh manuscript indicate a variety of spear-head forms which could easily have led to a variation in both terminology and use e.g. a long head with two side points at the base, a medium sized pear-shaped head, and a small head (Melikian-Chirvani 1970b fig.35-6). References in early Arabic texts (Schwarzlose 1886 pp.229-233) and later depictions of lances in Persian miniature paintings suggest that the base of the lance also bore an iron or steel tip. The few surviving spear-heads, from Rayy, Sīrāf, and Shamshīr Ghar, do not add any important information. However, in betraying differences in detail between heads

which look superficially alike - the parallel sides to the body of 1, the slight swelling at the neck of 2, the flat tang at right angles to theflat blade of 3, they do serve to remind one of the numerous metalsmiths whose products would have been recognisable not only by their functional shape but also by the individual taste of their makers.

Just as there were a variety of forms of heads for spears in early Islamic Iran, so too there were probably many forms of heads for arrows (Arabic sahm, Persian tīr). None of the early Persian texts give much information about these, though occasional references do occur. Thus al-Jūzjānī (Jūz trans. p.367 and n., but cf. Jūz p.66) appears to refer to a broad-headed arrow, and Fakhr-i Mudabbir (p.268) mentions mawdūdī arrow-heads, invented by Mawdūd and made of gold, so that anyone killed by one could have his funeral paid for by the arrow-head! Quite a number of facts can be deduced, however, from two other sources, early Arab literature, and later Mamlūk texts.

In his study of the nomenclature of weapons in early Arabic literature Schwarzlose (1886 pp.305-19) has pointed out the existence in early Islam of a wide variety of arrow-heads: two-sided, round, leaf-shaped, centrally-ridged, wide-centred, double-headed, triple-headed, and spine-shaped. There is little reason to doubt that such forms would have been known in early Islamic Iran too, particularly in view of the warlike interests and hunting activities of the Sasanians. Furthermore the Mamlūks, who inherited not only Arab but Turkish practice in archery - the latter would also inevitably have influenced Iranian methodology - also had a variety of arrow-heads. Ṭaibughā al-Ashrafī al-Dakhlamishī al-Yūnānī, author of a manual on archery, specifies them as follows: triangular, square-sectioned, broad-headed (for hunting known as ?anwarī), round-headed (for target-shooting, known as nuṣūl al-ahdāf), olive-shaped, and chisel-shaped (Latham and Paterson 1970 pp.24-5, 31). In a militarily organised state such as that of

the Mamlūks there must have been considerable pressure for a certain standardisation of equipment, and it is therefore significant that at least six forms were used. Six to eight main forms of arrow-head are therefore likely to have been known in early Islamic Iran, and different tribal traditions, and the whims of different individual smiths would doubtless have produced some additional forms as well as a large number of variations on the forms noted. Among the surviving pieces there are two forked examples from Shamshīr Ghar (5 and 6) as well as ones of more normal shape from the same site and from Sīrāf. Where these were made there is no way of telling, though Sīrāf was certainly a large enough city to have its own arms-smiths. The only town mentioned in early texts as being especially famous for its arrow-heads is Damāvand, whence they were traded to Iraq (Jāḥ p.344).

It is important here to stress how very specialised the making of arrow-heads must have been as a craft. With the Islamic world, especially Iran and the Turkish lands, so dedicated to archery, there would have been great competition among the smiths of the main production centres to produce the finest quality arrow-heads. The professionalism of their culture in terms of archery is seen in the terminology - the Arabs had special words for all the parts of an arrow-head (Schwarzlose 1886 p.310), and in Ṭaibughā's stress on the weight of an arrow-head and its relationship to the balance of the arrow as a whole. And if form, weight and size were not difficult enough to produce with absolute accuracy, the armourers also had to be skilled in tempering, and adapting their arrow-heads to enable them to penetrate a wide variety of archers' quarries, from a small bird to a soldier's armour.

Another widely used cavalry weapon in Iran was the mace (Persian gurz; Arabic dabbūs, ʿamūd). References in the Shāh-nāma suggest that maces were commonly of steel (pūlādh) (Wolff 1935 p.699), and

they were almost certainly solid in both shaft and head to give maximum weight and therefore breaking power. Indeed weight was in some ways synonymous with prestige, for Mas'ūd's mace was so heavy (80 man) that only he could lift it (Bosworth 1963 p.120; Jūz p.13); Maḥmūd too was known for the fact that his mace weighed 60 man (Bosworth 1963 p.120). The forms of mace head varied considerably, from a simple sphere to an animal head with horns. A Soghdian mural shows a mace with a four-faced head (Belenitski and D'yakonov 1959 pl.7), a Saljūq silver dish shows at least three different styles, one apparently spherical, the other two more complex and asymmetrical (Orbeli and Trever 1935 pl.20), and the minai dish in the Freer Gallery of Art shows on its reverse a mace with an oblong segmented head and another with a lion head (Atil 1973 no.50). Later Persian miniatures contain many and various examples, and the different Mamlūk maces now in Topkapi Museum may well represent types inherited from Turkish or Persian tradition (Stöcklein 1934 fig.2, 14). In addition ox-headed maces are frequently specified in the Shāh-nāma and elsewhere in Persian literature, and the terminology used by other authors confirms that a wide variety of forms existed and that in some cases such forms had special names. Thus Shābānkāra'ī calls Mas'ūd's mace a chumāq (Bosworth 1963 p.120), while Fakhr-i Mudabbir (p.263) mentions a khūdshukan, literally a helmet-breaker, a bilkātigīnī, which must have been some sort of hitting weapon invented by the Ghaznavid Bilkātigīn, and a dūrbāsh, presumably a mace of Turkish origin with a round head.

Another hitting weapon was the battle-axe (ṭabarzīn or tabarzīn). Some indication of the possible forms of battle-axe used in early Islamic Iran is to be found in Soghdian wall-paintings which show a weapon with a curious almost half-moon shaped head (Belenitski and Piotrovski 1959 pl.7) and a simpler double-bladed axe (Yakubovski et al. 1954 pl.36), while a third type of head with a blade on one side

and a pointed piece on the other is depicted on a Soghdian silver dish (Orbeli and Trever 1935 pl.21). Any or all of these could have been in use in pre-Islamic Iran or could have been introduced following the conquest of Soghdia by the Arabs, and a variety of forms in Islamic times is indicated again by the terminology used. In addition to tabarzīn, which he says was a Daylamite weapon, Fakhr-i Mudabbir mentions a nāchakh, the favourite weapon of Sultan Farrukhzād, which may or not be the same as chakh, and a chāk (one manuscript reads chābak), which may also have been a battle-axe or cleaver of some sort (FM pp.262-3, 268,272). Battle-axes depicted in later Persian miniatures, and surviving Mamlūk weapons (Stöcklein 1934 fig.1; Nickel 1972), may reflect forms used in earlier times in Iran, but regrettably no early Islamic battle-axes have survived to prove or disprove the point. As with arrows, however, an odd comment in a text serves to indicate the quality of weapon which was demanded, for Fakhr-i Mudabbir (p.272) notes that the nāchakh was effective in splitting infidels down the middle. Such a battle-axe would require weight, strength and an extremely fine cutting edge, and its qualities leave little room for doubting the ability of the steel-makers and armourers of the Ghaznavid period.

One other steel weapon should be mentioned at this point - the dagger. Daggers of various sorts must have been common throughout the Middle East in the pre-Islamic period, and it is no surprise to find quite a variety mentioned in the Shāh-nāma. The normal type, known by its Arabic name khanjar, occurs with three different specifications - one described as ābgūn i.e. damascened, another of Kābulī, and another of Indian, origin. Another dagger type, called dasna, also occurs, but the shape and details of both this and the khanjar remain elusive (Wolff 1935 pp.327, 337). The latter variety is also

singled out by Ṭūsī and Fakhr-i Mudabbir, the latter describing it as the weapon of brigands and thieves (NṬ p.222; FM p.260). However, that it was also a weapon of battle is indicated by al-Jūzjānī who records how in the battle between Bahrām-Shāh and ʿAlā al-dīn Ḥusain in 1149 A.D., before the sack of Ghazna, two champions engaged in single combat and began by dismounting from their elephants and then plunging their daggers (dashna) into the undefended belly of their opponent's beast (Jūz p.55). Kārd is the normal Persian word for a knife, but it too is sometimes used for a weapon carried in battle: al-Jūzjānī records how such knives were used for stripping the bodies of the slain during an engagement (Jūz p.67). One other variety of dagger should be mentioned, the dahra. According to the dictionaries it is a curved variety: Fakhr-i Mudabbir calls it the weapon of executioners and palace guards, but does not specify its shape (FM p.260).

In an archaeological context, and indeed in a cultural one, it is extremely difficult to differentiate a dagger from a knife, for there are so many uses common to both. Both dagger and knife blades from archaeological excavations have therefore been catalogued together. It should be noted that the list can hardly be complete owing to the large number of unidentified fragments of iron from Sīrāf and other sites, which might, when cleaned and studied in detail, turn out to be blades of such objects.

The study of early Islamic Persian armour, like that of many of the weapons, is hampered by a lack of illustrative and descriptive material. Useful background information can be derived, however, from an examination of the armour used in pre-Islamic Soghdia and Iran, and among the Arab conquerors. The armour used in Soghdia, for example, can be reconstructed on the basis of the Panjikent wall paintings. The

Soghdian soldier dressed in a long armour coat, sometimes totally of chain mail, but more usually lamellar, with chain upper arm, upper chest and neck pieces, the latter being attached to the helmet. He also wore chain-mail leggings, and sheet metal vambraces, and the close fitting helmet was topped by a long spike, sometimes with an ornament at its point. His shield was circular (Belenitski and Piotrovski 1959 pl.7,8,16; Yakubovski et al. 1954 pl.25). Comparison of the Panjikent murals with a silver dish in the Hermitage Museum (Orbeli and Trever 1935 pl.21) makes it clear that the two armed warriors on the latter are Soghdian. For although their helmets have three peaks instead of one, they wear chain vambraces instead of plate ones, their lamellar coats are only knee length, and they also wear protection of the back of their hands, their outfit is otherwise virtually identical with that of the Panjikent soldiers.

The Sasanian style of armour was not very different. The Fīrūzābād relief shows Ardashīr and Shāpūr wearing coats of mail with long mail arms, Ardashīr being further protected by a small circular plate in the centre of his chest, and held in place by cross straps. Their leggings on the other hand are lamellar. Shāpūr wears a simple round helmet; neither figure carries a shield. At Ṭāq-i Bustān the famous equestrian figure, variously identified as Khusraw II or Peroz, wears a coat of chain mail, and a large, veil-like chain mail aventail, which hangs from the round helmet to the upper part of the coat of mail leaving only the eyes visible. The horse wears lamellar armour on its head, chest and neck, and the king carries a circular shield (Russell Robinson 1967 fig.9 and 11).

Sasanian helmets now in the British Museum, Iraq Museum and Metropolitan Museum of Art have a rather different form to that depicted at Ṭāq-i Bustān (Grancsay 1963 fig.1,5-8). In shape they are more

conical, and they are constructed by riveting triangular iron segments to a cross-shaped framework of metal bands. Whether the method of manufacture used for the Ṭāq-i Bustān helmet type was the same it is unfortunately impossible to say, since the king's head is somewhat damaged. Some iron and bronze lamellae excavated at the 5th-8th century site of Qasr-i Abū Naṣr near Shīrāz, and now in the Metropolitan Museum (Grancsay 1963 fig.13), indicate that the lamellar style continued in use for some parts of armour at least into the later Sasanian period.

The Arabs at the time of the conquests probably wore a rather simpler form of armour, either of leather or chain mail (Schwarzlose 1886 pp.322-348). Many of the details are not clear but it seems that a full length coat of mail gave way to a shorter style early in the Islamic period, and it also appears that two coats of mail were sometimes used for extra protection. Helmets were either of metal plates or chain mail (Schwarzlose 1886 pp.349-351) and the rings in the chain armour were riveted with pins. Early Arab authors mention both Persian armour and armour from Soghd (Schwarzlose 1886 p.334) and it may be, therefore, that the armour current in early Islamic Iran following the conquest of Transoxania was an amalgamation of Sasanian and Soghdian styles with Arab-type armour. Horse-armour (Persian bargustuvān; Arabic tajāfīf) does not seem to have been used by the Arabs, presumably for reasons of mobility, and the emphasis on speed and mobility in the Islamic period probably led this item of equipment to fall into disuse in Iran: there are certainly very few references to horse-armour in Iran after the conquests (though see Fakhr-i Mudabbir pp.216, 260-1).

Against this background the meagre information on armour provided by Persian texts and objets d'art becomes considerably more meaningful For instance it becomes quite plausible to interpret the costumes

worn by horsemen on Iraqi 9th-10th century lustre pottery (Pope 1938 pl.577, 579) as coats of chain mail or lamellar armour and pointed helmets. In Iran there is one reasonably good surviving depiction of armour, on the minai dish in the Freer Gallery of Art (Atil 1973 no.50), where the picture of the battle scene includes four sets of armour lying on the ground, evidently stripped from fallen warriors as loot. All are in one piece, with a skirt-like lower half, and long sleeves, and the drawing of them suggests that whereas three are of chain mail one is almost certainly lamellar. The helmets (Persian khūd; Arabic maghfar) depicted on this dish are fairly flat with a slight central point, similar to those on a minai and lustre tile of the same period (Pope 1938 pl.706).

This traditional form of armour coat is also mentioned by implication in a passage in al-Jūzjānī, who relates that during a battle between the Ghūrids and the Ghaznavids, probably in 544 H/1149 A.D., the two champions dismounted from their elephants and fastened up the skirts of their armour coats before starting to fight (dāminhā-yi zara bāz zadand) (Jūz p.55). From this it is clear that the normal armour coat had a fairly long skirt which hampered the warrior when he had dismounted.

These two pieces of evidence are virtually all that seem to have survived from early Islamic Iran. It is perhaps surprising that there are no other illustrations of armour in view of the enormous number of horsemen which appear on minai dishes of the pre-Mongol period, and those which decorate the illustrated manuscript of Varqa and Gulshāh (Melikian-Chirvani 1970b). The reason seems to be that by the end of the 12th century it had become customary to wear a coloured surcoat of some material over one's armour, hence hiding the armour from the onlooker. When this came into fashion is not

known for certain, though there is an interesting reference in al-Jūzjānī to the Ghūrid ruler ʿAlā al-Dīn Ḥusain who astonished his courtiers by putting on a crimson surcoat, though the author does not explain whether their astonishment was due to the colour or the idea of a surcoat. If the latter then the start of the fashion may be datable to the year 544/ 1149 A.D. (Jūz pp.55-6).

It is also noteworthy that there seem to be no descriptions or depictions of breast-plates, such as had been worn by the Sasanians. Nevertheless the word for breastplate (jawshan) occurs regularly in the literature, often alongside zara or dirʿ, which indicates that it continued to be an item of armour, and that its appearance under the Safavids under the name of chār āīna (Russell Robinson 1967 p.38) denotes a later phase of a continuing tradition rather than a reintroduction. Perhaps the same is true of armour leggings called by Ṭabarī sāqayn and by Balʿamī sāʿidayn (Bivar 1972 p.291, though the latter really means a pair of vambraces), which are scarcely ever referred to, let alone depicted, in pre-Mongol times, but which were used extensively in later periods. So too with vambraces proper (sāʿidayn: Jāh Bayān III p.15).

It has already been pointed out that horse-armour was probably not very popular in early Islamic times in Iran. It should perhaps be mentioned that in eastern Iran under the Ghaznavids and Ghūrids armour was widely used for elephants (bargustuvān-i pīl) (Bosworth 1963 pp.116-119; Jūz p.55). The animals were covered by armour except under their bellies and bore metal head-pieces known as the āīna-i pīl, which not only served as protection in battle but could also be hit or clanged to alarm the enemy (and the elephant too!).

In the pre-Mongol period three areas of greater Iran are singled out in the texts as having been centres of armour production- Transoxania, where Farghāna and Asbījāb are mentioned, Khurāsān, where Ṭūs is specified, and the district of Ghūr (Table 14). In view of the iron resources known to exist in Transoxania, and the production of swords there which has already been discussed, it is no surprise to learn that it was also an armour-manufacturing province. The same is true of Khurāsān. But the situation as regards Ghūr is rather different.

Even today relatively unknown, and only briefly surveyed by the medieval geographers, the towns in which this industry was centred remain unidentified, and it is something of a surprise to learn that the where-with-all for such an industry actually existed. But al-Jāḥiẓ and the author of Ḥudūd al-ʿālam are not the only authorities to offer evidence of this fact. For example al-Jūzjānī (p.47) says that al-Malik ʿIzz al-Dīn Ḥusain of Ghūr despatched every year to Sultan Sanjar "such things as had been customary and established, such as breast-plates (jawshan), coats-of-mail (zara), helmets (khūd), and other war materials" and elsewhere (Jūz p.40) notes that such tribute had previously been sent to the Ghaznavids, and (Jūz p.59) that a later ruler ʿAlā al-Dīn Ḥusain in about 1149 A.D. withheld the tribute by then sent to the Saljūqs. Clearly Ghūr played a very important part in arms production in the battles for power in the 11th and 12th centuries in north-eastern and eastern Iran (Bosworth 1963 p.121).

All the armour referred to above was made of iron or steel. What exactly shields (Persian sipar; Arabic turs) were made of is not clear, but in view of the need for mobility on horseback as well as on the ground they were probably designed to be light, and may well have

been of cane or hide. An example of such a light-weight shield is the kārva used by Ghūrid infantry, which was hide stuffed with cotton (Jūz p.56). Most shields, however, probably bore one or more bosses, following pre-Islamic practice (Belenitski and Piotrovski 1959 pl.23), and these would have been made of either steel or bronze. Of the former there are no surviving examples; an example of the latter is discussed on p.360. Most shields were probably circular, but their sizes would have varied depending on whether they were for mounted or foot soldiers. Kite-shaped shields were also known (Melikian-Chirvani 1970b fig.12; Atil 1973 no.50). Bosses would therefore have varied both in size and shape, and presumably too in decoration.

Other iron and steel objects

Due to the nature of the material used surviving iron objects are relatively few in number, and generally highly corroded. The most important group consists of implements - adze and shovel blades, knife blades (already mentioned under daggers), scissors, and a range of smaller items. There is also one surviving dish, however, indicating that a wider range of objects was in fact known and used. (The object types are catalogued in alphabetical order).

The one surviving shovel blade was excavated at Nīshāpūr. Its form is not recorded by Wulff (1966) as existing in Iran today, but since he makes no claim to be exhaustive this is probably unimportant. The only depictions of shovels or spades in the pre-Mongol period occur in the Kitāb al-diryāq manuscript of the north Iraqi school dating from 1199 A.D., where the implements have a pointed blade and cross-bar similar to the modern Shīrāzī style (Ettinghausen 1962 pp.84-5;

Wulff 1966 pp.260-1, fig.346). Surviving adze blades come from Shāh Tapa and Nīshāpūr, blade 1 being easy to parallel in modern times (Wulff 1966 pp.79,83). The sickle from Shāh Tapa has unfortunately never been reproduced, and its relationship with modern Persian sickle types (Wulff 1966 p.272, fig.375) is therefore unknown. The three surviving pairs of scissors from Shamshīr Ghar and Shāh Tapa are all of the same type, which therefore suggests itself as a normal early Islamic Persian form.

Among the smaller implements are numerous nails, especially from Sīrāf. A full catalogue of these fragmentary and badly corroded objects must await the full publication of the excavation. Here it is interesting to note that among the styles represented are large nails with heavy domed heads, a type used in recent times for door construction and fittings (Wulff 1966 p.53 fig.75). Various iron nails were also found at Shāh Tapa and Shamshīr Ghar (Arne 1945 p.333; Dupree 1958 pp.260, 263). Like nails numerous iron rings of various sizes have been found at Sīrāf. Hooks too are common at Sīrāf and one was found at Shāh Tapa (Arne 1945 p.333).

The fragment of a horse-shoe found at Sīrāf appears to be of "oriental" form, i.e. a circular disc with an off-centre hole, while those from Shamshīr Ghar give the impression of having come from horse-shoes of open form. The one surviving iron bell, from Sīrāf, is relatively large and heavy, and would have been suitable for some beast of burden like an ox or camel. It was made in the same way as one of the bronze bells found at Sīrāf (bronze bell A/9), the lower body having been cut into triangular protrusions which were then hammered towards one another after the clapper ball had been inserted. The object catalogued as a key is something of a mystery, and it may well be something entirely different, particularly as objects of this type

are reported to have been found in considerable numbers at Sīrāf. The reason for calling it a key is its head from, which is an irregular "H", and could have been devised to fit into a lock.

That the above objects by no means give a cross-section of the uses of iron in early Islamic times is shown by textual references. A list of iron objects mentioned in a limited number of Arabic and Persian texts is given in Table 19. Among these stirrups are discussed elsewhere (p.363) but balances and steelyards call for further comment at this point. The essential tools of all trading, they must have been used throughout Iran in early Islamic times, just as they are today. Steelyards (qarasṭūn), as Wulff (1966 pp.64-5) points out, have not changed in principle since Roman times, and it is safe to assume that those used in the early Islamic period were virtually identical with modern Iranian ones. With regard to balances Wulff (1966 pp.62-4) distinguishes two modern types: those suspended from a fixed point (mīzān), and those held in the hand (tarāzū). The only early descriptions of balances from Iran seem to be those included by al-Khāzinī in his Kitāb mīzān al-ḥikma, written in 515/1121 A.D. Al-Khāzinī distinguishes between four different balances, firstly the Archemedian balance, secondly the balance invented by al-Rāzī, thirdly that invented by Abū Ḥafṣ ʿUmar ibn Ibrāhīm al-Khayāmī, and fourthly the so-called "balance of wisdom" of Abū Hātim al-Muẓaffar ibn Ismaʿīl al-Isfarzārī (Khanikoff 1860 pp.86-98). All these are more complex than those mentioned by Wulff, for they were designed for scientific experiments, in particular the measurement of specific gavities of substances. Hence, for example, whereas an ordinary balance has a central tongue which indicates when the substance in one pan balances with the weight in the other, these in addition have an adjustable weight on one arm of the balance, and in the case of the "balance of wisdom" a variety of immovable or adjustable scale pans for different

purposes. Given the existence of these complex forms, there is no reason to question the existence of the simple balance, designed to weigh out specified amounts of a substance, as well as the steelyard, designed to give the exact weight of an arbitrary quantity of a substance so that it could be priced accordingly.

Bazaar steelyards, due to their size would normally have been made of steel, but smaller balances like those described by al-Khāzinī could have been made of steel, bronze or brass. Wulff (1966 p.62) notes the existence in modern Iranian cities of two different craftsmen, the mīzān-sāz and the tarāzū-sāz, in the balance-making industry. The former is evidently a steel-working craftsman, the latter a worker in copper alloys, and it is logical to surmise that in early Islamic times large towns would have had similarly trained craftsmen working in the industry. (For further discussion of bronze or brass balances see p.286.)

Another use of iron which should be mentioned here was in buildings, where in the first place it formed an important part of gates and doors. It is not always clear in the texts whether the gates themselves were sometimes made of iron or whether the iron was usually in the form of studs, locks, hinges, bars etc. fitted onto or into a gate made of wood. But the large number of references to iron gates (Table 20) indicates the importance of the metal for the defences of towns and individual buildings. A second use of iron in buildings was for cramps to hold stones together, a use which ties up with, and raises the same problems as, the use of lead in buildings, discussed on p.134. Certainly the Muslims must have recognised the possibilities of such cramps, for Ibn al-Faqīh observed their use in the pre-Islamic stone platform at Qirmāsīn near Kirmānshāh (IF p.217), and Yāqūt records the same system in the Sasanian aquaduct at Tustar in Khuzistān (Yqt I p.848). References to the deliberate use

of cramps in Islamic times are, however, rare. One occurs in Abū Dulaf's description of the Qanṭāra Khurra Zād between Idhaj and Iṣfahān, which has been discussed above (p.134). Another occurs in the Fārs-nama (p.133), where it is recorded that Abū Ghānim sacked ʿAdud al-Dawla's palace at Shīrāz and carried off the woodwork and ironwork to his new castle. The woodwork was presumably ornamental or functional - doors, screens, window frames, furniture etc., but it is difficult to imagine what the iron can have consisted of unless it was the iron cramps holding the stones together, which would presumably have been valuable enough to dig out of their lead surrounds - not a difficult job, and carry off for the new project, a stone castle. One final architectural use of iron may be noted - for an inscribed plaque on one of the palaces of Bukhārā, naming the renovator of the building (Nar p.23).

CONCLUSION

As is by now obvious there are too few excavated iron objects to allow an accurate assessment of the extent and quality of the iron-working industry of early Islamic Iran. As a result most of the information has had to be put together from texts and contemporary pictures, both of which are in a sense only second hand. Nevertheless certain conclusions may be drawn.

First of all, the early Islamic Persians show few signs of having been metallurgically inventive except perhaps in the possible use of cast iron as discussed on p.413. Otherwise the industry depended on the technology inherited from pre-Islamic times. On the other hand, in the field of both quantity and quality the Persian industry was impressive. The country had extensive resources, and while local ores probably met most local needs in most areas, there was particular iron wealth in the north-east. The texts indicate that these were exploited to the full in the manufacture of tools and implements and especially in the manufacture of arms. For Transoxania and Ghūr were the major arms manufacturing centres of eastern Islam prior to the Mongol invasions, and the quantities of swords, arms and armour produced there between the 7th and 13th centuries must have been enormous. Not only that, they were evidently of very high quality, especially the swords. True, by the 11th century Indian swords had become the most prized of all, but al-Kindī leaves little doubt that in the 9th century the products of Transoxania matched those of any of its rivals. The introduction of the qalāchūrī in the 11th century may well have given the industry a new lease of life, for there certainly seems to have been no let up in production. This continuous production of swords is significant, for of all the objects known to the medieval smith, damascened swords were those which demanded the greatest skill and technical

know-how. That Iran was a centre of sword production throughout the early Islamic period therefore indicates that it had an abundance of skilled craftsmen, and that fact probably left its mark on the simplest objects made by an itinerant blacksmith as much as on the most complex and demanding, manufactured in the arms quarter of a Transoxanian or Ghūrid city bazaar.

Finally this survey of the iron and steel industry of early Islamic Iran indicates the limited nature of the relationship between that industry and the workshops producing non-ferrous objects. In the manufacture of swords bronze workers were evidently employed to produce quillons and other accessories, but of a close relationship and in particular of the interchange of ideas between the industries there seems to be little evidence. If this is no surprise in view of the nature of the metals concerned, and if it is a negative note on which to bring this survey to an end, it should be pointed out that it is a conclusion which could not have been reached without the far-ranging study undertaken above.