Kushāṇa coins, made of gold and copper, were quite plentiful and extensively available throughout their dominion. Most of the Kushāṇa kings issued these bi-metallic currency yet some of the early Kushāṇa kings also issued silver coins which were issued up to Vāsudeva-I's reign. These silver coins are mostly found in North Afghanistan and Indus region.¹ The Kushāṇa did not introduce a regular silver coinage for the whole of empire and did not object to the circulation of non-Kushāṇa silver coins in silver coins using areas of their empire.² The gold and copper coins of the Imperial Kushāṇas were struck in a range of distinct denominations which formed a clear and logical monetary system. Though the fully developed Kushāṇa coinage contained many important and novel features introduced by Wima Kadphises, it seems to have been based, in part at least, on earlier patterns and models.

Wima Kadphises had introduced regular gold coins in

India. The coins of Wima were known as dinara based on Roman *denarius aureus*. As the Kushāṇa gold dinara has approximately the same size and weight as the Roman gold *areus*, the introduction of the denomination by Wima Kadphises may well have been suggested by the Roman gold coin. The average weight of dinara is 122.6 grains or about 7.970 grams. On the other hand, weight of a Roman *aureus* is 122.9 grains. As such, these can be related to each other. Other varieties of Kushāṇa gold coins are either double in weight i.e. 246 grains or just one quarter of the weight of such a dinara, i.e. about 30 grains.

Alexandar Cunningham had long back showed that the average weight of the full denomination of gold pieces of Wima Kadphises, Kanishka, Huvishka and Vāsudeva I was about 123 grams. After taking the weight of 179 specimens he concluded that the:

i average weight of Wima Kadphises dinara is 122.21 grains.

ii average weight of Kanishkas' dinara is 122.10 grains.

iii average weight of Huvishkas' dinara is 122.16 "

iv average weight of Vāsudeva-I dinara is 123.03 "

Gold coins of the imperial Kushāṇas may be divided into

three classes according to their average weight:

i. **Double dināra** 246.4 grains

ii. **Dināra** 123.2 "

iii. **Quarter dināra** 30.8 "

Only a few quarter dinara^4 coins of Wima Kadphises have, so far, been discovered. Quarter dinaras of the Kushāṇas in weight range from the lowest limit of 27 grains to the highest limit of 30.8 grains. However, most of the quarter dinaras weigh more than 30 grains.

Only a few double dinaras^5 were issued by Wima Kadphises. Their weight ranges between 237.6 grains to 246.1 grains.

Dināra issued by Wima Kadphises range in weight from 119.0 grams to 123.3 grains. The weight of dinaras issued by Kanishka ranges from 109.2 grains (Boddo type) to 123.4 grains.

In case of Huvishka,^6 these dinaras range in weight from 119.3 grams to 125 grains (Mahāsena type). The weight of dinaras issued by Huvishka range from 122.3 grains to

---


124.7 grains. Therefore, the lowest limit appears to be 109.2 grains and the highest limit is 125 grains. Average may be fixed at 123 grains. Average weight of a Kushāṇa dināra was much below the weight of an Attic standard weighing little over 130 grains. An examination of the weights of Roman aurei and Kushāṇa dinaras shows no precise correspondence between the two coinage. It appears that standard of the Kushāṇa dinaras was determined by relative value of gold and silver during their time.

Kushāṇa and Roman coins seem to have been exchanged principally in large scale commercial transactions of international trade, but perhaps, these were never side by side in circulation in the same or adjacent territories.7

The fully developed denominational system of Wima Kadphises did not survive unchanged. Due to a certain degree of inflation, the real values of the various denominations had decreased and the gold coinage was increasingly debased, and copper denomination progressively reduced in weight to keep pace with the economic changes. Some of these changes in the weight standard of coins can give invaluable evidence for the chronological sequence of distinct issues.8

7 Chattopadhya, B., The Age of the Kushāṇa, p. 201.
8. Infra, p. 196.
The weight of the gold coins of the Kushānas had almost remained constant. However, there was a tendency to reduce slowly, the percentage of pure gold content in Kushāṇa coins. The rate of reduction is so imperceptible that a view put forth by some scholars that gold coins (even copper coins) of Huvishka should be assigned on the basis of their weight about to two different kings of that name,⁹ is not acceptable to some weight of the Kushāṇa gold coins after Vāsudeva-I had remained almost constant very near the imperial monetary standard. But, gradually a decline followed in the standard as the quality of the metal deteriorated more and more.

There are important differences between the Roman and the Kushāṇa gold coinage. The Kushāṇa dinara did not precisely copy the weight standard of the current Roman aureus; the Kushāṇa authorities solved their economic difficulties by slightly debasing their coins, but maintaining the weight standard of the Roman, however progressively reduced the weight standard. There was never any exact parity between the Roman aureus and the Kushāṇa dinara.

---

The analysis of the gold contents in the coins of the late Kushāṇa coins gives us an insight into the fading economy of the period and this can also lead us to fix the relative chronology of the late Kushāṇas and their derivatives. It have been shown by S.K. Maity.¹⁰ That the gold content of the Kushāṇa coins gradually decreased. It is clear from the specific gravity analysis by the scholar that the percentage of pure gold progressively reduced in the times of the successors of Vāsudeva-I. Similar, results were also obtained by the studies conducted by Jaya Bhattacharya and Dr. R. Mukherjee in the appendix to his paper.¹¹

The gold contents of various later Kushāṇa kings and their successors are tabulated here.

**Gold Content of the Coins of the Later Kushāṇa and their successors**

<table>
<thead>
<tr>
<th>Name of the King/Dynasty</th>
<th>Type</th>
<th>Maximum %</th>
<th>Minimum %</th>
<th>Average %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kanishka III</td>
<td>Śiva Nandī</td>
<td>96.64</td>
<td>91.09</td>
<td>94.70</td>
</tr>
<tr>
<td>Kanishka III</td>
<td>Ardoksho</td>
<td>90.29</td>
<td>83.82</td>
<td>86.66</td>
</tr>
<tr>
<td>Vāsudeva III</td>
<td>Śiva Nandī</td>
<td>96.59</td>
<td>86.44</td>
<td>92.36</td>
</tr>
<tr>
<td>Imitation of Vāsudeva III</td>
<td>Śiva Nandī</td>
<td>90.02</td>
<td>79.47</td>
<td>85.52</td>
</tr>
<tr>
<td>Chhu</td>
<td>Enthroned Ardoksho</td>
<td>88.38</td>
<td>75.31</td>
<td>84.72</td>
</tr>
<tr>
<td>Kidāra</td>
<td></td>
<td>57.23</td>
<td>50.31</td>
<td>53.75</td>
</tr>
</tbody>
</table>

¹⁰. JNSI, XV, 1958, pp. 162-64.

The average gold content of the coins of Kanishka III are 94.70% for his king at altar: Śiva Nandi type. Whereas the Ardoksho type coins have average 86.66%. There is every likelihood that this Ardoksho type coin do not belong to this king but to some of his later namesake may be Kanishka IV. King at altar and Śiva with bull type of coins of Vāsudeva III (of our scheme) have average gold contents of 92.35%. On the basis of the reducing gold contents we may place here Ardoksho type coins of the so-called Kanishka III after Vāsudeva III, which may belong to Kanishka IV. The gold contents were further reduced by the king issuing imitation of Vāsudeva III type coins which have 85.52% of gold contents. While the enthroned Ardoksho type coins with Chhu legend have 84.72% average gold. The Kidāra type gold coins have average gold contents as low as 53.75%. Thus, on the basis of the reducing gold contents we can frame a chronological order of various kings and dynasties.

The Kushāṇa gold coins were generally die-struck.12 Through the Kushāṇas were certainly not the first to introduce this minting technique in the Indian subcontinent, the practice of this method of striking coins was

imitated by the Indo-Greeks in India and from them it passed on to the Kushānas through the Scythians and Parthians.

From the appearance of the gold and copper coins under the microscope, it is obvious that they were struck from dies through the hammer anvil process at the time of minting. They properly struck portions of coins are found to have homogeneous small grains of more uniform structure than those of the some pieces which are left unstuck or not properly struck. On the later portions we can notice scratches (looking as a whole almost like a dendrite). It seems that the coins were not always struck with uniform weight or pressure and that proper care was not always taken to cover the upper side of the blank fully with the upper die. ¹³

But die striking technique was not the only technique employed by the Kushānas. From a number of sites are found a good number of coin moulds for minting the Kushānas gold and copper coins. Some of the important yielded moulds are discussed here in this chapter. We presume that side by side the die-striking technique moulding of coins was also going on. But some scholars considered the moulds as the handiwork

---

forgers. It is true to some extent. Forgers forging gold coin of a particular king can make fortune by debasing the gold contents where as a forger forging copper coins can gain very little while the risk of the punishment by the states remains the same. Hence, we can conclude that atleast coin moulds of copper coin are part of genuine mint even if we suspect the authenticity of moulds of gold coins.

**Important Kushāṇa Mints:**

When the ancient dynasties took over the region they manufacture their own coinage and they were obliged to have their own mints. But unfortunately no names of ancient mints of the Kushāṇas have come down to us, therefore we have been forced to rely upon indirect evidences on this subject such as the interpretation of the symbols on the coins, the find spots of the coin moulds and coin legends etc. Just as in regards to the Punch marked coins Walsh have suggested that one of the constant symbols of PMC may represent the place where it was struck, Cunningham have also based his conclusion on the coins legend. He believes that the legend Kapan denotes geographical name where the coins was actually minted. This name not only occur on Kidāra Kushāṇa coins but

also on Gadahara Chiefs as well. As we have seen that the Kushāṇa coins were manufacture by two techniques viz die striking and casting but as far as the actual dies are concerned so far no coins dies pertaining of our period are reported. But we have found coin moulds from a number of sites such as Khokrakot, Kapan, Atranji Khera, Sunet, and Naurangabad. Not all sites yielded the coin-moulds pertaining to the period of our studies but we presume that the method of moulding of coins continued right upto the end of the Kushāṇa period.

Khokrakot (Kushāṇa: Ist C. A.D.):

Khokrakot (Rohtak) (28° 54'° N 75° 35'E) was an important centre of cultural and historical importance and lies about 70 kms. west of Delhi. The excavations conducted here have yielded a continuous sequence of cultures ranging from the painted Grey ware period to the Gupta times.\(^1\) The site was an important mint town and capital of the Yaudheyaśas where Yaudheyamāṃ Bahudhanak type coins of c.2 nd-Ist century B.C. were minted.\(^2\) Apart from this site have also

\(^1\) Indian Archaeology (A-Review) (IAR hereafter), 1986-7 pp. 34-86.

\(^2\) Birbal Sahni, Antiquities from Khokrakot noted in the Jumna Valley, Current Science, 4 No. 11 May, 1936, pp. 796-801.
yield Indo-Greek coin moulds and even Kushāṇa coins moulds.

V.S. Aggrawal published a circular Kushāṇa coin mould of clay of 0.8" diameter discovered from the Khokrakot site in Rohtak town, the collaborated mint-town of the Yaudheyas. The mould has a female figure standing to right, holding in her upraised left hand a cornucopia. The right hand is fixed at elbow and placed near the girdles with a slightly forward motion. She is seen to be wearing a turban on the head, pendants in the ears, a sleeved jacket on the bust and a dhotī dropping front fold (patati) shown as a loop in front of the figure. Besides, we have on the right side the legend Ardakso in Greek script as is usual on Kushāṇa coins.18 Evidently, the purpose of this circular mould seems to cast a gold coin of Huvishka. Prof. Aggrawal is of the opinion that it is difficult to determine the official character of this mould. A.S. Altekar is inclined to take it to be a forgery and suggests that the local rulers of the Punjab might have issued Kushāṇa coins from mould during the 3rd, 4th and 5th century A.D. owing to their great popularity thus, it is difficult to say when and by whom the mould was prepared. If its genuineness is proved, it can be said that Khokrakot also formed one the mint sites of the imperial

18. JNSI, XV, pp. 68-69.
Kushāṇas. 19

Later on some more coin moulds of Huvishka with half length figure of kings and Ardoksho type were found and published. 20 Manmohan Kumar feels that the moulds found from the site seems to be the handiwork of forgers who make fortune by debasing the coins. 21

Kophen (Kushāṇa: 2nd Cent. A.D.):

In 1893, Cunningham published a gold coin (0.85" and weight 118 grains) which bears on the obverse a standing king as on the coins of Kanishka and his successors with a standard in left hand offering oblations on a altar in his front on the left side. The legend in Brāhmī characters is inscribed at three places: Kushāṇa to the right, Kidāra under kings arm and Kapan to the left. The reverse portrays the figure of Ardoksho (Laksmi) seated on a throne with a cornucopia in her left hand. A similar coin was noticed again by Cunningham in the Bastipind stupa to the north of Hadon Abdal. 22

-----------------------

21. Ibid., p. 104.
Basing his conclusion on the coin legend Cunningham suggested that this is a coin of Kushāna king Kidāra of Kapan. Though there can be other interpretation of the legend such as: (i) Kapan, the Kidāra Kushāna King and (ii) the Kidāra Kushāna king of Kapan, there is no doubt about the coin being a Kidāra Kushāna coin. The real problem is the identification of Kapan. Cunningham believed that it was a geographical name, i.e. the name of the place where the coin was actually minted. The name, Kapan is also seen to occur on some coins of the Gandhāra chief. Cunningham himself had some doubt about his identification as he has put Kophene with a query mark after Kapan within brackets and has located it to the district, south of the lower Kabul Valley of which Purusapura (Peshawar) was the capital. Kapan, however, seems to be an Indianised form of the name of a town on the Kophen, Kophes or Koa of the classical writers, Kubha of the Rigveda, Kuhu of the Purāṇas and the modern Kabul river.

Atranji Khera (Kushāna: 2nd Cent. A.D.):

Atranjikhera is an important ancient site in the Etah district of Uttar Pradesh where only one coin-mould, quite

different in design from others, was found from the side of a ravine mound. "The coins represented in this mould are apparently the issues of Huvishka, the Kushāna king, who has the unique elephant rider-type on the obverse. Some of the figures also show a standing deity which, again, is different in different impressions, one of which can be recognized as Moon God."^4

This multiple coin mould of bright red colour and dark grey in the deeper layers is of particular interest, as it betrays a rectangular form and has a peculiar arrangement of the feed-channels. In the middle of the four sides there is a large expended opening from which several canals branch out of supply the coin-sockets. These canals however, only feed the nearest sockets which also communicate with another, through short connecting channels. The sockets further removed from the main opening are supplied indirectly through the nearest coin-socket. The margin is slightly raised in order to ensure a closer coupling with the counterpart. At each of the two corners, which are preserved, there is a tenon.

But as it is, it is difficult to determine whether it

24. Birbal Sahni, The Technique of Casting Coins in Ancient India, pp. 43-44.
is rectangular or square. These is also no indication whether at the time of casting the mould was encased in plaster. Considering this in mind, Upendra Thakur observes, that it is natural to make one suspect a forgery as in the case of Taxila moulds, because the coin cast in it were not at all of one kind.25

**Sunet:**

A large number of coin mounds of Kushāṇas and Later Kushāṇas and Yaudheyas have been discovered during the surface explorations by various scholars and coin collectors for the last many years. They were published by Cunningham, Rodgers, Birbal Sahni and other scholars.

Sunet (Ancient Sunetra) lies about 8 km from Ludhiana Jagraon Road. Presently most of the area of the village has been covered by modern residential complex named Bhai Randhir Singh Nagar. The coin moulds were discovered in the area lying north west of the village. The mint area was separated and excavated by Sh. G.B. Sharma26 during 1983-1984.


The mint site yielded more than 35000 coin moulds along with mint equipment etc. It appears that mint was constantly in use from the 1st century A.D. till 4th-5th century A.D. Earlier coin moulds of Parthian king Gondopharnes followed by those of Kushanas and Late Kushānas. Coin moulds of Vāsudeva II are followed by those of Yaudheyas (Yaudheya Gaṇasya Jayā type possibly the Yaudheyas supplanted the Kushānas. The coins of Kushānas were still in circulation when Yaudheyas came on the scene. Coin moulds of Yaudheyas have been discovered along with the those of Vāsudeva II in the same pile of Śiva Nandi and Ardoksho type coins of Vāsudeva were moulded at Sunet.

Naurangabad:

Naurangabad is situated at a distance of about 35 kms from Rohtak on Bhiwani Road and the village falls in the Bhiwani district of Haryana. This extensive historical mould was also an important mint site from where terracotta coin moulds, crucibles and other mint material is found in abundance. The earliest moulds found from here are of the silver Punch Marked coins followed by the Yaudheya coins (c-2nd - 1st century B.C.). Indo-Greek coin moulds belonged to eight king viz. Menandar, Appolodotus, lysias, Antimachus, Amyntas, Philoxenoes, Antialkidas and Hermaus. The site has also yielded hundreds of coin moulds of the Kushānas. The
earliest king whose copper coins were struck here in Kanishka followed by Huvishka. A complete plaque of coins moulds found from here indicate that the imitation of Kushāṇa coins were also struck here Swamijee did not identified the moulds which clearly shows imitation of Kushāṇa coin devices. Thus, we can conclude that long after Huvishka and Kanishka their coins were imitated in this mint also.

Technique of Manufacturing of Coins:

There were at least two methods of manufacturing coins prevalent in Kushāṇa period. In modern terminology they are respectively called (I) Die-striking, (II) casting and III Droplet technique.

(I) Die-Striking:

About the technique of striking coins from dies nothing can be learnt from the dies themselves because not a single die of ancient India coins has come to light so far; only die struck coins themselves and some literary references throw light on it. In the Christian era this method became very popular. It was used in ancient Greece also. Dr.


28. Ibid., No. 440.
Charles Seltman describes it thus:29 "An artist or craftsman would carve an intaglio design on a thick disk of bronze; this was the obverse die which fitted into a pit sunk in the top face of an anvil. On the lower end of a square faced bronze punch the man next carved another intaglio design this was the reverse die".

In the little furnace, near by, blank disks of silver, carefully adjusted to the correct weight, were heated to make them adequately malleable, and one by one these silver disks were placed with the aid of a pair of tongs upon the anvil over the sunk obverse die. Down upon each disk came the reverse die on the end of the square faced punch held in a man's left hand. The hammer in his right hand remote several blows upon the upper end of the punch. The tongs pulled the silver disk away, for it was now a finished coin which required only to be refrigerated."

As regards the origin of the various techniques of manufacturing coins, it is obvious that the question of the origin of the techniques of die-striking and casting, which were used to manufacture the oldest Indian coins now available is intimately connected with the problem of the

origin of the Indian coinage itself for, if the oldest coins of Indians were the result of foreign influence then the techniques for producing them were most likely also of foreign origin. As regards the credit for the invention of the system of striking coins from dies is concerned, scholars widely differ. James Prinsep advocated foreign origin for this system. Smith differentiated between single die and double die systems and maintained that final adoption of the double die system was undoubtedly due to Greek and Roman influence. But Bhandarkar rightly asks if Indians could develop this technique themselves gradually why should it at all be presumed that they depended on foreign influence for taking the final step. Thomas also believed that all the advances in this technique were effected before the advent of the Greeks. However, many Indian scholars including S.K. Chakraborty have supported the theory of foreign influence.

Our literary sources also throw some light on the methods of manufacturing coins in ancient India. The

31. Ibid., p. 152.
33. Ibid.
Paninian sutra rupadahata prasamsayoryap gives the word 'āhata' for striking or punching. Therefore, following V.S. Agrawala, scholars generally take the word 'āhata' to indicate punch-marked coins. The Kasika, commenting on the Sutra of Pāṇini, even includes die-struck coins in the category of 'āhata'. But as pointed out by V.S. Pathak34 it was a legitimate mistake for when the Kasika was composed the PMC had gone out of vogue and the author of the Kasika could have gone astray by calling a die struck coin such as dinārā an 'āhatamudrā'. For punch and die the terms used in literature is 'tanka'. Thakkur Pheru in his Dravya Parikshā uses it as a verb to den die striking. Inscriptions refer to 'ṭanka sālā' (mint house) and ṭankaśāla (the Department of Minting Coins).35

Kauṭilya uses the term 'ṭanka' in the sense of an implement for punching coins. He lays down that a watchful eye should be kept on those who frequently purchase bimba 'ṭanka' which obviously means 'ṭanka' for punching or stamping bimba or designs. The Kasika indicates a later process when 'ṭanka', the punch, had transformed itself into a die. According to it, the design which is embossed on

34. Ibid., pp. 11-12.
'dināraś' and other coins by striking them on the anvil (nighatika, nihāni of Hindi) is termed ahata. The use of the term nighatā or anvil proves that here the die-striking method is being referred to.

The process of manufacturing coins has been described in the Arthasastra. In this work Kautilya gives a list of things, that were used in a counterfeiter's (Kuṭarūpakarakas) atelier. Obviously the same things must have been in use in the state mints. They are: various kinds of metals (lohā), alkalis (kshāra), charcoal (angārā), bellow (bhastra), clapper (saṇḍāsa), hammer (mushtikā), anvil (adhikarṇi), crucibles (musha) and dies with designs (bimba 'tanka').

II Casting

Cast coins were manufactured by passing molten metal into moulds of clay or metal. Archaeological evidence suggests that in India the use of both punching and casting seems to indicate that the cast technique was in use even earlier than the punching technique. However, gradually the casting method replaced the punching method because the

36. JNSI, XXIII, p. 178.
37. Sahni, B., The Technique of Casting Coins in Ancient India, pp. 18f, 35f, 38, 42 and 45.
introduction of much alloy in the metal used for coins made it difficult for the metal to stand the blows of hammer. The cast coins were all of copper including its various alloys.

The moulds for casting of coins were made of burnt clay or of hard metal. Only one metal mould of bronze has been discovered from Eran though clay moulds have been found in a fairly large number from several sites. Instead of punching several symbols by separate dies, a single model was prepared where all the symbols were put together. From the model, moulds were then made and molten metal was poured into them to cast coins. In his investigation of the technique of casting coins in ancient India Birbal Sahani has examined the moulds found from Eran, Rohtak, Taxila, Mathura, Attranjikhera Sanchi, Kondapur, Sunet, Kasi, Naland, and Kadakal, other sites from where clay moulds were found later on include Sisupalagarh and Khokhrakot.

**Techniques of Casting Coins**

According to Upendra Thakur\(^3\) who has also studied the methods of manufacturing coins in ancient India in detail, the moulds show that several techniques of casting coins

\(^3\) Thakur, Upendra, Mints and Minting in India, JNSI, XXIII, pp. 175-197. Further observations on Mints in Ancient India (INC III, pp. 68-69) is revised version of his earlier paper.
were employed in this century. The technique, known from the coin moulds of the Yaudheyas found from Rohtak, was the most complex one. It consisted in making a series of discs placed in a vertical column. The coupled faces of the contiguous discs bore the negative impressions of the obverse and reverse of the coin. The whole pile of discs was plastered with clay; only a funnel crater was left at the top of receive the molten metal. From the crater the molten metal went into a central shaft like canal and from there into the separate coin sockets by separate channels radiating into them from the shaft. After the metal was poured and then, cooled, the mould was broken and coin separated. 39

Another technique of casting coins is revealed by the complex multiple coin moulds found from Mathura, Sisupalgarh and Kondapur. Most of these bear the impressions of the PMC. The important peculiarity of these moulds is that while the Rothak moulds were meant to cast coins only once, these moulds could be used for repeated castings.

A third technique of casting coins is revealed by the moulds found at Sunet, Kāšī, Nalanda, Sāñchi, and Khokhrakot. The moulds were found containing single discs of

the coins of the Yaudheyas, Kushānas, Guptas etc.

(III) Droplet Technique

Droplet technique was in vogue right from the time when punch marked coins were made. A.N. Lahiri has discussed this technique in his paper.\(^{40}\) In the Later Kushāna period also this technique was employed and in this metal of specified weight in semi molten state was dropped and then the die was struck.\(^{41}\)

Technology of the Kushāna Coins:

The technological investigation on Kushāna copper coins was done by Nadoosan\(^{42}\) and investigations found out specific gravity (density) and consisted of measurement and chemical analysis. We have interpreted his data in order to show the technological advancement of the Kushānas.

First the coins were thoroughly washed with water and dried and weighed. These coins are dipped in a solution of 10 grains each of tartaric acid, and sodium hydroxide in 100 cc. distilled water. After three days the solution along with the coins was heated to boiling temperature for few

---

40. *JNSI*.


42. *Ibid*.
minutes. Then the coins were taken out thoroughly brushed with copper wire brush. This procedure was repeated several times till after the scales were completely removed.

The coins were dipped in 10% sulfuric acid for a few minutes and then they were rinsed with distilled water, dried and weighed.

For conserving the clean coins were heated at a temperature 105°C for one hour and then dipped into the solution of polyvinyl acetate and alcohol for two three minutes. Then they were dried and preserved for further investigation.

The specific gravity measurement along with chemical analysis is a simple tool to find out the purity and soundness of the coins.

Two different methods were used for this purpose. In one of them the coin was suspended by a thin copper wire from one arm of the chemical balance and its weight was measured, first in air and then in water. From the weight loss the specific gravity was calculated. In the other method a simple apparatus described by Kushellevsky\textsuperscript{43} was modified by Nadoosan and used for accurate determination of

\textsuperscript{43} A simple instrument for measuring the density of solid objects, \textit{Archaeometry}, 17, i (1975), pp. 99-138.
volume of the coin. By the knowledge of mass and volume of the coin, the density could be easily calculated. The specific gravity obtained by these two methods are given. In both these methods care should be taken to see that coins are free from any greasy substance. Otherwise air bubbles would stick to the coins and would give erroneous result.

Visual wet chemical analysis method described by B.C. Aggarwal and S.P. Jain\textsuperscript{44} was adopted for finding out the constituents present in the coin. Apart from copper, iron also was found in it. The other impurities were in minor quantities and were not estimated.

The chemical analysis of Kushāna copper coins reveal that they were of almost pure copper having a purity of more than 97 % copper. Only a few coins of Huvishka period are of less purity and show the presence of considerable amount of iron in them. The rest of coins have less than one percent iron. Two coins of the later Kushāna period also show a sizable presence of elements other than iron. They may probably be prone coins. As these coins were not analyzed for other elements nothing can said conclusively.

The presence of large percentage of Iron in a few Huvishka coins is not due to deliberate addition but due to

\textsuperscript{44}. A Text Book of Metallurgical Analysis, (Delhi, 1987).
improper technique used for extraction of copper from its ore, where iron present in large percentage as an integral part of the ore or as a gauge mineral. Deliberate addition of iron to copper coins to debase them is ruled out, because copper is and was a relatively cheap metal. Large addition of iron to copper only reduced its mechanical, as well as, corrosion resistance properties.

Specific gravity measurements of the coins of Kushāna period show lower specific gravity than that for pure copper coins (8.94). This shows that the coins contains other elements or materials such as slag, of lower specific gravity, or they have blow holes. To confirm this and to find out if other phases are present four selected coins, one belonging to the Kanishka period, one of Huvishka and two of later Kushāna period, were subjected to X-ray diffraction analysis. All the four coins show that they are essentially pure copper coins. There are no peaks showing the presence of other phases. Thus, the presence of other height metals in large proportion in the coins is ruled out.

In a recent studies on the so-called Kota coins found in the Northwest India the researchers used the non-destructive X Rays Fluorescence method and have tabulated their results according to which it was reported that these coins have even upto 98.118 per cent of copper contents. It was revealed that the late Kushāṇas continued to mint the coins of the same metal contents. The later imitation of the so called Kota coins started mixing copper with cheap metals such as iron and led either due to poor extracting or by design. From the purity of 97 or 98.118 per cent we can conclude that their technology of extracting pure metal from the ore was quite advance which can be compared to the technology of modern period even.46

In the coins of Kanishka and Huvishka they are of irregular shape, but in coins of later Kushāṇa period they show elongated structure along a certain direction. Visual observation of the coins shows the chisel marks on the edges suggesting that they were made by sheet cutting technique. The coins of Kanishka and Huvishka are fairly thick and of uneven thickness. They suggest that fairly large sheets were

made by hammering the copper ingot, that is why thickness is uneven. During later Kushāṇa period the sheet seemed to have been made by first forging the ingot into a large rod and then flattening into a sheet by hammering. These sheets were then cut into coins of required weight by chisels. This proposition shows from the presence of elongated particles of slag inclusion in a certain direction. The dark phase can not be due to blow hole because the ingots were heavily worked while making sheets and the blow hole present would be closed by heavy working. The dark phase can also be due to oxidation of copper melting and the inclusion of assessed particles in the mixture.

After sheet cutting the blanks were die struck to impress devices on the coins after heating the fairly high temperature. That is why the effect of working is not visible in the micrographs. The grins have recrystallized.

Some of the coins of the later Kushāṇa period were made by dropping technique and not by sheet cutting. In this technique molton drop of metal of required weight was die struck when it was in semi-solid state. These coins do not show chisel marks on them and they have rounded eyes.47

47. Nadoosan, F.E. op.cit., p. 313.
From the above discussion we can conclude that the later Kushāna copper coins were mostly of high purity copper, with traces of other impurities. This high purity percentage suggest that proper care was taken to eliminate the iron and other metals from the chalcopyrite or during extraction of copper.

The coins were prepared by various methods by die striking, casting and droplet technique and also by moulding. In the case of die striking technique coin blanks were first prepared and subsequently dies were punched, whereas in moulding technique terracotta moulds were used. These moulds were used only once and hence they are found in thousands from the ancient mint sites.