

# *Metals and Metallurgy in Early Cultures of the Gangetic Plains : A Case Study*

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The beginning of culture in the Gangetic Plains has its roots in the metal using cultures. The earliest settlers in the alluvial region were the users of copper-Hoards-the massive copper implements hoarded in caches dated to 2000-1100B.C.. The hoards are attributed to Ochre Washed Ware (OCP), a flimsy culture that comes to an abrupt end due to adverse climatic conditions. Who were these people? What was the exact function of the implements they prized? What was their source of copper? What happened to these people afterwards? These are some of the questions that are yet to be answered satisfactorily. What is certain, however that there is a desertion of sites for a considerable time following OCP. The region is later occupied by Neolithic-chaleolithic people perhaps coming down from the bordering hills once they take to sedentary agrarian life style. Small quantity of copper comes to be used by them along with cord impressed red ware Black-and-Red ware, and Black Slipped ware. The settlements are small and scattered. It is in this milieu that iron was first introduced in the Gangetic plains. This is borne out by excavations of almost every site in the plains like, Kausambi Jhusi, Agiabir, Rajghat, Khairadih, Narhan, Manjhi, Senuwar etc. and Koldihwa, Nal Ka Tila and Malhar etc. in the hilly zones in the Vindhyas. The issue of introduction of iron is still controversial in several respects. However, it is not opportune to enter into that controversy here. It is proposed to concentrate on the iron age cultures, especially at stages when metal starts playing important role in the cultural make up. Special attention is paid here to Khairadih a site excavated by the Dept. of AIHC and Arch. BHU under the able directorship of Late Prof. K.K. Sinha and subsequently followed by Dr. B.P. Singh & the present author.

The reason for selecting this site for a detailed discussion is firstly because it has not been reported in detail so far, and secondly because it has yielded very important evidence on pyrotechnology the likes of which are rarely revealed in excavations. A series of furnaces and forges both for copper and iron working have been unearthed here. There are finished and unfinished objects of metal along with ore pieces, slag etc. in large quantity. There is also a complex where copper coins were being minted. Before we take up these things for a detailed study, a brief introduction of the cultural setting of the site is called for.

The village of Khairadih in Dist. Ballia, U.P. is a sleepy little hamlet today. It was excavated for a number of seasons from 1980-81 to 86 and later in 1996-97. The

mound is located on the bank of river Saryu or Ghaghra near Belthara Road railway station. The mound has been washed away substantially by the river. A horizontal excavation was planned for getting real insight into the life pattern of Ganga plains in the early historic - historic times. It yielded worthwhile results. Though the site was first occupied in a small way by the chalcolithic settlers as early as 11th century BC, it flourished during the later half of Northern Black Polished Ware (NBPW) culture and reached its zenith in the Kusana period. We come across a well laid down settlement complete with planned structures with multiple rooms, roads joined by lanes, wells, craftsmen's quarters, underground structures. The cultural sequence is briefly discussed here.

**Period I The chalcolithic period :** A corner of the mound was occupied by the Black - and - Red (BRW) using people. Post-holes, earthen walls indicate wattle and daub structures and huts perhaps with thatched roof. The ceramic art was well developed. Both painted and unpainted variety of BRW and BSW were being manufactured along with red ware. Wheel thrown pottery with burnishing turned out shapes like channelled and lipped bowls, squat dishes, bowls-on-stand, bowls and basins in addition to storage jars. Bone and stone tools were in use in good quantity. Copper was used, though scantily. Only two copper objects were found- an arrowhead with a socket that is almost an exact replica of its bone prototype (Fig. 1). Other objects include steatite micro-beads and semi-precious stone beads.

**Period II A and B Northern Black Polished Ware :** There is a marked improvement in the nature of cultural deposit with emergence of NBP at the site. An expansion in area of occupation, structural activity, craft activity is noted. Within this period there is a consistent and marked growth from period II A to B, i.e. from early NBP to late NBP phase. NBP itself is a denominator of pyrotechnological growth. The site has yielded beautiful sherds of NBP in all its shades in good number. Even painted specimens occur frequently. Other wares include plain BRW, BSW (painted variety is also seen), Grey ware, Red ware. New shapes in Black-Slipped ware and increased number of grey ware in the later levels may suggest new inspirations at this stage. Burnt bricks became a norm at the later phase i.e. II of NBP period. There are instances of renovations in structures. The size of houses is larger. Material remains include a touchstone with gold scratching, carnelian pendant shaped like a monkey' a jasper weight and casket with lids, an iron spindle whorl with a grey arcenut bead attached at the base, silver and copper coins, beads in rich variety and number.

It is at the stage II that kilns for tile making and iron smelting furnaces (three in a row) were found at the northern, side of the mound. In another workshop area glass, copper and iron working remains were discovered. This may be termed as composite or multiple furnace area where glass cane, tiles, copper and iron slag, finished objects and pieces of ore along with stone pestles and querns used for ore crushing have been

found. The floor of this complex was *kuccha* plastered with yellowish clay. A small earthen lamp was also found nearby. This area also yielded charred rice and some powdery stuff (kind of atta flour!) kept in earthen jars. Thus they appear to be habitation - cum-workshop area. In general this period has the features of a flourishing NBP period township.

**Pd. III, the Kushana period** is the culmination of the life at Khauradih. This phase belongs to Kushana period. Located between the two important centres of its time i.e Kashi & Magadh, it must have evolved as a centre of trade and commerce or may be even a political centre of this time.

The structural activity picked up during this period. Two types of bricks measuring approximately 38 x 23 x 6 cms and 41 x 24 x 6 cm were used. A road flanked by residential buildings was constructed in two phases. It was an important discovery. Brick bats, kankar and broken pieces of pottery were rammed to provide the soling of the road. Drainage was also noticed. One of the larger houses had an underground structure of 2.4 - 1.68 m tapering towards the base where it measured 1.40 x 1.8 m. Wells were found. Boundary walls encircled several houses.

A pottery kiln was noted in the section. Terraced discs, balls, skin rubber, dabber, potter's stamp, wheel, cone, stopper rattle, pestle and quern, toys with wheel and animal figurines and typical Kushana style human figurines, were used. Carnelian, ivory, basalt, were favoured stones. Beads of semi-precious stone, and green and red glass were found. Pd III also yielded seals sealing and coins including one belonging to Kanishka with Kharoshti inscription. Sealings have clearly 1<sup>st</sup>-3<sup>rd</sup> AD characters. Gold and silver foiled beads need special mention.

**Metal Objects:** Gold, silver, copper, iron, etc. have been found in excavations. Gold as well as silver are indeed scarce. However, the utilitarian metals like copper and iron come to be used for variety of purposes. A brief description of copper and iron objects is being given here.

### **1.1 Copper Metallurgy :**

Copper appears albeit in a limited number (only two copper objects are present) with Black-and-Red ware in period I. The number of copper objects increases gradually from 6 in Early NBPW level to 17 in late NBPW rising to 114 in Kushana levels. There appears to be a gradual rise in number as well as typology through the cultural stages, (table I). Among the two objects of period I one of the objects is indeterminate, the other one is an arrowhead with a shaft through which two holes are made. Interestingly, it is an exact replica of its bone prototype. Perhaps its a weapon of a privileged one of the society.

With advent of NBPW copper comes to be associated with luxury goods like toiletries and ornaments. Rarely an axe or an arrowhead is fashioned with copper. If

at all, it may be part of the regalia of a noble man of this time. In early NBPW level antimony rods are the only identifiable objects. During the late phase there are wires, handles, nails, ornaments like bracelets and utensils like bowls. We also come across coins in sizeable number. There is a sharp increase' as pointed above in utilization of copper for variety of purposes during period III. Beautiful ornaments like bracelets, pendants *nupurs* and a fairly large number of bowls, handles and spoons alongwith nails, rods etc. have been excavated. Many of the ornaments are exquisite pieces of art representing the fine workmanship of artisans working with copper. A pendant shaped like a bunch of grapes and a violin shaped pendant and several such pieces like rings, bracelet and necklaces are simply superb examples of workmanship. Special mention may be made of a miniature piece of some ornament that depicts a lady holding a branch of a tree the *shala bhanjika* of Indian art. Another such example is a chariot with spoked wheels. Bowls, ladles, spoons, eye needle etc. (many of them coming in the category of bronze) manifest the popularity of copper-bronze in day-to-day life of people by this stage. Thus copper was being freely utilized for ornamental and utilitarian purposes by period III i.e. Kushana period.

It was found that tin alloying was prevalent from NBPW period onwards. At Senuwar, (Dist. Rohtas, Bihar) a needle with an eye pertaining to chalcolithic period was a bronze piece. Some of the bowls of NBPW period were also that of bronze. 3.5 per cent tin was detected in antimony rod of NBPW period. High tin bronze specimen have been reported from Agiabir recently. It may be apt to suggest that the copper smiths knew their job well--alloying casting, forging and carving beautiful pieces of copper-bronze.

The excavations have exposed, as stated above several smelting-forging workshops pertaining to both NBPW (Late) and Kushana periods. There are ores, slag, ash, refractory material, crucibles and finished metal objects including coins all in one complex. Interestingly, from trench CC-6 we have come across all these things in addition to glass tile, cane and beads as well as copper and iron slags and finished metal objects. There are also short handled pestle and short legged rectangular quern used for crushing ores. It is worth pointing here that copper slag was crushed for oxides for colouring glass as has been suggested by experts on ancient glass (Singh 1989). It was a good and easily available source of copper oxide. Thus these finds, along with numerous green glass beads found here assume special significance. This appears to be an example of composit technology, i.e. a variety of materials being worked in the same complex. Incidentally, this may also be an example suggesting that perhaps same group of artisans mastered a variety of mediums. In another trench (EE8) we have come across a 25 cm. bowl - shaped pit with plenty of burning activity and slag scattered around it. The copper chariot mentioned above was found near by. This was a copper working area no doubt but the exact shape of the furnace-

forge could not be determined. The amount of slag suggest it to be a smelting area than being a mere forge for shaping objects. It may be added here that the spoke wheeled chariot, perhaps a replica of the true chariot of its time indicates that there was no dearth of copper. A total of 127 copper objects were found in the first excavation of the site -- 2 from period 4, 6 from early NBP and 17 from its later phase. Rest of the 102 objects were found from the Kusana period.

P.K. Chattopadhyay of Alloy Steel Plant, Durgapur, who analysed the copper objects as well as the slag, suggests a remarkable similarity in composition between the specimens at Khairadih and that of specimens from Bihar sites. The impurity pattern, according to Chattopadhyay, closely resembles the Bihar specimens indicating thereby a common source of copper for both the areas. Location of Khairadih on Saryu, that has several important sites both upstream and downstreams, is significant indeed,. Saryu must have linked this region to important deposits of malachite and azurite - the ores used at Khairadih and other Bihar sites in the vicinity. A large area in this region was linked together through a network of rivers that were navigable. Communication and transportation of goods thus could be efficiently managed throughout this region. We have recorded evidence of movement of Kushanas from Mathura to this region. right up to Magadh through Varanasi. Khairadih must have been very much on the route. This explains the similarity in cultural material unearthed during the excavations. There exists a fair possibility of movement of merchantile groups from much earlier times throughout this region.

## **I.2 IRON METALLURGY**

Iron, the was introduced at Khairadih during early NBPW period. Like copper, iron is not very prolific during early NBPW period (Table II). Only a limited number of objects - 9 to be precise, have been found. During the late phase of NBPW the number rises to 27. There is a sharp rise in use of iron during the Kushana period with 115 iron objects. Most of the beautiful, utilitarian and impressive specimens of iron come from this phase. However, we have come across furnaces and forges from Sunga-Kushana levels. The evidence has been described at length by the author elsewhere (Tripathi and Tripathi 1994; Tripathi 1995, Tripathi and Mishra 1997). However, it may be apt to briefly describe it here. Shaft furnaces were used at Khairadih. We have come across three such furnaces in a row alongwith large amount of slag, pieces of ore as well as finished iron objects. Another area that has already been described in connection with copper working (CC-6) has also yielded iron slag and objects though the design of the furnace could not be reconstructed in this area. The objects are of wrought iron of high purity though some of the iron objects fall in the purview of mild steel with pearlite showing in the micrograph.

Lamination is a technique in which thin metal sheets are forge - welded

together. Generally, alternate sheets of steely iron are welded with wrought iron sheets. An X-ray radiograph of a heavy duty shaft hole axe confirms the use of this technique in Kushan levels. In nut shell, it may be deduced that in the Gangetic plains as revealed from the specific example of Khairadih, iron technology developed from simple wrought iron to steel making technique of high order. We have examples of carburization and quenching. For heavier tools and implements that had to be sharp edged and durable cutting edge techniques like lamination were in practice. The source of iron, it may be guessed on the basis of evidence of copper, could have been Bihar.

As evident in the case of copper, iron also gains favour with the occupants of Khairadih with time. Both the number and variety of objects increase over the period. Table II here testifies this. Although as at most of the sites of this region weapons occupy the highest position in utilization pattern but at Khairadih the number of hunting and war tools is almost negligible. It could be attributed to two factors - either the community was too peace loving or (the more likely reason) the rate of corrosion being very high as the site is located on a river bank they have corroded beyond recognition. The number of iron objects is only 9 at period II (early) with maximum number of objects being indeterminate. Nails form the highest number. Agricultural implements, hoe and share, sickle, household objects and knife--blades have been used. Typologically, there is a gradual diversification. Iron comes in use for a variety of functions. During the Kushan period (III) there is a significant improvement in number, typology and technology. For the first time, we come across heavy axes and long rods, spears, knives etc.

On the basis of the foregoing detailed discussion on evidence of a site, that is representative of this region, we may conclude that metal working consolidated over the period in the Gangetic plains. The source of ore could be Bihar or the Southern Uttar Pradesh - M.P. region. However, as indicated by Chattopadhyay the trace elements of copper suggests its origin in Bihar region.

For detailed reconstruction of metal technology a need for analytical examination of metal samples cannot be over emphasised, especially for the point of view of ore correlation and also to spell out the metallurgical techniques as they prevailed at diverse cultural levels. To cite an example, earlier it was suggested on the basis of analysis of a few samples of copper hoards that the source of their copper was in Rakha mines. But recent discoveries in the Kumaon hills include a large number of implements of copper hoard family implore us to take a harder look at it. Source of iron is still harder to spell out. Therefore, much work is needed in this area, preferably jointly by archaeologists and metallurgists.

The growth of metal craft is parameter of cultural affluence. Whether the two

could be interlinked directly is a question that is often debated among the archaeologists. The issue need not be reopened at this juncture. However, we cannot deny the fact that technology contributes in economic affluence in a big way. A shift in socio-political paradigm reorients the techno-economic phenomena. Changes become largely perceptible in the material milieu. This is visible in our examination of a representative example of pattern of growth of cultures in the Ganga Plains.

**Table I : Perodwise distribution of Copper objects at Khairadih - 1980 - 86**

Sl.No.	Objects	Chalcolithic Pd. I (1100-7/600 B.C.)	Early N.B.P. Pd. E. (600-400 B.C.)	Late N.B.P. Pd. L. (400-50 B.C.)	Shunga - Kushan Pd. III 50 B.C.-300A.D.
1.	Arrowhead	1	x	x	3
2.	Rod/ handle	x	x	1	2
3.	Antimony rod	x	4	x	25
4.	Loop	x	x	x	2
5.	Nail	x	x	2	3
6.	Bangle / Bracelet	x	x	1	20
7.	Wire	x	x	1	10
8.	Ring	x	x	x	7
9.	Pendant	x	x	x	4
10.	Nupur	x	x	x	6
11.	Ear-ring	x	x	x	2
12.	Amulet	x	x	x	2
13.	Spring / coil	x	x	x	1
14.	Bell	x	x	x	2
15.	Needle	x	x	x	1 (with eye)
16.	Bowl	x	x	2	11
17.	Lid	x	x	x	2
18.	Spoon / Ladle	x	x	x	2
19.	Bead	x	x	x	1
20.	Lady with tree	x	x	x	1
21.	Chariot with spoked wheel	x	x	x	1
22.	Indeterminate	1	2	10	24
<b>Total</b>		<b>2</b>	<b>6</b>	<b>17</b>	<b>132</b>

**Table II: Periodwise distribution of Iron objects discovered at Khairadih - 1980-86**

Sl.No.	Objects	A period wise distribution and their time brackets		
		Pd II Early (600-400 BC)	Pd II Late (400-50 BC)	Pd. III (50 BC - 300 AD)
1.	Nail	1	9	42
2.	Rod	2	3	8
3.	Handle	1	-	6
4.	Arrowhead	-	2	5
5.	Blade	-	5	8
6.	Spear head	-	-	4
7.	Leaf shaped spearhead	-	2	-
8.	Frying showel	-	1	-
9.	Sickle	-	-	1
10.	Chisel	-	-	2
11.	Broken ladle	-	-	1
12.	Clamp	-	-	1
13.	Dagger / Javeline	-	-	6
14.	Spatula and other pots & pans	-	-	4
15.	Ploughshare	-	-	1
16.	Indeterminate	5	2	17
	<b>Total</b>	<b>9</b>	<b>24</b>	<b>106</b>

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