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Project Report

History of High Tin Bronze and Brass of Eastern India*

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1. Introduction

The aim of this project was to reveal first the introduction of Copper and its alloy in geographically known region as Eastern India and its switch over to the states of Assam, Bihar, Odisha, Jharkhand and West Bengal. The history of copper and its alloys in the states including Arunachal Pradesh, Chhattisgarh, Meghalaya, Sikkim and Tripura have also been studied in the process with an objective to unearth the picture of high tin bronze and brass in eastern India. Some remarkable theoretical studies were made by Chakrabarti and Lahiri (1996) and fieldwork of Meera Mukherjee (1978) whose pioneer surveys had made immense help to reconstruct my studies and report in this region.

2. Copper and its Alloys in this Subcontinent

The Copper or Chalcolithic Age of the Indian subcontinent is as old as the Harappan Civilisation possibly having its connection with that of Mehergarh in Baluchistan in late sixth century BCE. Contemporaneous to Harappan civilization, the well-known copper technology of Middle East in Sinai and Far East in China constitute a glorious past of ancient history. With the decline of Harappan Civilisation, copper casting technology opened new frontiers in mainland India in second millennium BCE. Daimabad bronzes owing even a heavy cast piece of 29 kg bore the evidence. That was an achievement over Harappan technology for casting heavy statues.

Other than the casting technology there are a few references of forging technology in excavation in Harappan sites. Other than small tools of boring drills, saws, nails but again some bun shaped ingots were reported by a number of archaeologists from Mohenjodaro and Lothal. In case of Eastern India earliest evidence of copper alloys were reported from Pandu Rajar Dhibi, Mangalkot, Bahiri, Chirand, Golbai Sasan and Senuwar (Period IB and II). Thus from earliest initiation from Neolithic-Chalcolithic transition, a continuation of copper, bronze and brass products were noted in eastern India through early historic period – from medieval and continuation of traditional processes in Pre-industrial period. The present researcher thus studied an overall development of metallurgy in this part of the country. The project was accomplished under the following chapters:

I. Metallurgical traditions related to copper and its two principal alloys – bronze and brass and their introduction in eastern India.

II. Geography and Geological background of Eastern India, representing the source of ore minerals.

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III. Archaeology and historical background including cultural anthropology of Ho and Santhal tribes of Bengal, Jharkhand and Odisha.

IV. Metallurgical practices of people of eastern India.

V. Major products made of bell metal, brass and mixed alloy.

VI. Cannons of eastern India.

VII. Metallurgical analyses of different artefacts to understand the manufacturing technology.

VIII. Chariot and other Museum objects.

IX. Traditional tools and tackles in Bell metal and Brass technology.

X. Traditional Techniques in manufacturing Bell metal and Brass in Eastern India.

XI. Conclusions and Bibliography.

3. Metallurgy in Eastern India

Most of our cultures known through archaeological remains have been equated in one way or another with the cultures of West Asia or Southeast Asia by the diffusionist schools. Only a few scholars have laid stress on the independent or indigenous origins of this culture. On the probable origin of metallurgy, D P Agrawal predicted that early man in the wooded plateau of Singhbhum copper belt might have independently discovered copper metallurgy, for the availability of copper ores, plenty supply of woods, perhaps with presence of *Shal* (Shoria Robusta, etc. (Agrawal 1971: 196-97). The other tree is *ber* in Hindi, or Indian Jujube, its scientific name is (*Ziziphus mauritiana*), Chinee apple, jujube, Indian plum and *masau*. This is a tropical fruit tree species belonging to the family *Rhamnaceae*. This is one of the major trees in the forest of Singhbhum. The charcoal produced from this plant is an excellent reducing agent for smelting copper ore. The actual location, though not identified, it is somewhere in the junction of Odisha, Jharkhand and West Bengal.

4. Literary Evidences of Copper Alloying and Casting

Vedic literatures evince a clear knowledge of metal-smelting respectively by the roots *dhmā* and *sic* which are found mentioned as early as the *Ṛigveda*, V.9.5. There are several references to the root which stands for blowing of fire in order to generate certain amount of heat to smelt the metal. That passage envisions an inflamed fire likens it to one blown by a smelter in course of melting the metal. From a description in the *Aśvamedhika Parva* in *Mahābhārata* has given the hints that liquified iron poured (into a mould) takes the form of the mould. Pāṇini mentions in his *Aṣṭādhyāyī* that tools and implements made of copper and other metals were used by a metalsmith. Patañjali while commenting on Pāṇini *Sūtra* notes in his *Mahābhāsya* that the Mauryas had made images of Gods. This most probably refers to metal images. Kauṭilya's *Arthaśāstra* mentions about the Superintendent of mines and metallurgy under whom a *Lohādhyakṣa* worked, who carried on manufacture of copper, bronze (*kāmṣya*) , lead, tin, sulphurate of Arsenic (*tāla*), *lodhra* and *ārkuta* (?) (Kangle, 1986).

In Islamic literatures one may find the mention of adding zinc oxide (*tutiya*) directly to molten copper. *Āin-i-Akbarī* informs that in 16^{th} century an alloy namely *safidru* or *kasi* was popular which was made of Cu and 20% Sn (4:1) definitely it was Bell Metal (Abu'l-Fazl Allāmi, R.1993).Interesting information is obtained from Chhattisgarh. From undated Kuruspal stone inscription of Nāgavamśī king Someśvara, includes a word *kānsāravādo*. The scholar rightly pointed that the word is connected with the hamlet inhabited by the workers of copper, bell metal or brass. The place was perhaps located near Kuruspal. From the concerned period two names are also known from this region. These are Tamanāladeśa and Kansāravādo denoted the location of metal industry including high tin bronze. Though the casting technology initiated in Harappan civilisation indicating that clay moulded investment casting was well known in India but its information is lacking in ancient literatures. In the classical Indian literature, some information may be found about the image making, which often describes the casting techniques.

5. Copper and its Alloys in Metallurgy

From the middle of first millennium BCE, both copper and wrought iron technology in India moved faster hand in hand. Copper worker learnt many technologies of iron makers. With huge production of zinc in the belt of Zawar mines area, alloy development of copper got a boost. Brass or *Pittal* (copper + zinc alloy) and technical bronzes (copper + tin alloy) improved. Copper casting technology had improved during Mauryan, Kuṣana, Scythian and Gupta periods in the north. During the same period eastern India blessed with import of tin from Malaysia, Myanmar and similar areas continues casting technology of tin bronze side by side with her own production of tin from cassiterite of Bastar in Chhattisgarh.

Throughout the world casting of bells were popularized; so it was named as Bell Metal or percussion metal at alloy is well known as *kānśa* in Eastern part of the subcontinent and particular tribes who traditionally manufacture bell metal is known as *Kānśāri*. All over the world high tin bronze was applied for manufacturing of bells. The ancient objects of this alloy were mostly made by casting. *Bharan* is the alloy of copper, zinc, lead with little tin; it is reddish in colour. This alloy is manufactured through heredity and the artisans strictly maintain trade secrets. Gunmetal is a kind of bronze similar to *Bharan*. Originally the alloy namely gun metal was used chiefly for making guns. German silver is the new alloy being used in eastern India in early twentieth century. This alloy is the combination of nickel, zinc and lead with copper.

(a) The period I of Pandu Rajar Dhibi (23°35′N, 87°37′E) has been identified as the pre-Chalcolithic metal free, period I, level. In period IIA, bronze bangle and beads have been discovered along with Black and Red Ware and microliths (Fig. 1). The important metallurgical activities related to copper metallurgy from West Bengal need to be reviewed.

Fig. 1: The bronze fish of Pandu Rajar Dhibi

6. Copper-bronze Figurines in Mauryan Period

The earliest evidence of bronze figurine has been discovered from the Mauryan level from the recent excavation at Chechar, Bihar (Fig. 2). The specimen is under research at ASI Patna Circle.

Fig. 2: Earliest figurines from Chechar

The early historic site Chandraketugarh (88° 41`N, 22°42` E) is located in Uttar 24 Parganas District of West Bengal. The antiquities of the site are known from the beginning of the last century. The site has revealed thousands of antiquities by surface exploration, unauthorized digging and a limited excavations carried by the University or Archaeological Departments. That was the reason for the lack of scientific evaluation of those objects. The antiquities include various types of pottery, ceramics, punch marked silver and copper; and cast copper coins, seals and sealings, terracotta, figurines, sculptures and other objects of art. The earliest settlement perhaps began in chalcolithic, if not in Pre-Mauryan Period and continues till Pala-Sena Period.

The chance-find objects represent that from the early historic period bell metal industry were existed here. The artisans were proficient with casting of images, mirrors and others along with of the earliest use of die-struck coins were noted here.

Fig. 3: Earliest human figurine

Fig. 4: Elephant rider, Chandraketugarh

6.1 Two Earliest Images from Chandraketugarh.

Two unique specimens shown in Figs 3 and 4, are preserved in Shri Vinod Krishna Kanoria's collection in Patna. The first one image, is 110 mm in height. That human figure stands on a lotus pedestal, crude in finising. The figure is standing as *'sampadasthānaka'* pose. The figure worns a lower dress. There are three prominent or spirals. Hands of both the arms are broken, left hand is broken near arm pit. Right hand is broken at the wrist. Some things were perhaps caught at the right hand side.

The second figure is elephant riders and it is 65 mm in height. The elephant riders is a unique image. Two human figures are seating on an elephant. One of them seating on the back side is a warrior having a raised sword; the sword's case is attached to the waist. The person seating on the front side is the *mahout* (Fig. 4).

So far as the processes of manufacturing were concerned we may take a look at the method practiced by the metal image artisans: Extreme finesse was required for the modeling and casting processes involved in the making of the intricate pieces of Pala – Sena images. The images were generally cast in lost wax technique, which, apparently continues from the times of the Harappan civilization. Basic casting process is of two types – with the use of wax or without wax. Bronze Images of this phase can be classified into three types:1. Hollow, 2. Solid, and 3. Apparently solid with clay core inside.

The lost wax process of casting was the most dominant method the makers of metal images employed. As we have already noted, so far as casting is concerned, there were two processes: solid casting (*ghana*) and hollow casting (*suśira*) for lighter weight images. The first example is referred in the 11th century CE Calukyan text of *Manasollasa*, which probably describes a standard, all – Indian practice for metal image crafting in early medieval times.

The wax model is first prepared and coated with clay very carefully. The mould with the wax is heated, when the wax drains out through an opening provided for it the molten metal is poured through the same and allowed to cool. In the case of hollow cast a model is made of clay or saw dust or some such ingredient and covered with wax. The thickness of the wax determines the thickness of the actual image. Then the model coated in wax is further coated with clay and dried in sun. Finally the whole piece is heated. The wax melts out through a channel already made in the body of the clay coating. In its place molten metal is poured from a crucible. Molten metal takes the shape of the model inside. The metal casting process involved several techniques relating to basic process, mentioned earlier. In case of images those are half hollow and half solid, controlling of thickness of metal images during poring of molten metal is a highly sophisticated process. During casting process artisans often use metal armature, chaplets, and moulds of clay with wax along with runner and risers. The chaplets are often an iron wire which fixes clay core with investment of outer side.

After casting, the major tasks left to the artisans are giving an overall finishing of the image. The pre-planned holes arise out of casting are closed with soldering. Those holes are often covered by fixing jewels on it. It is also known that often a hollow image was partially filled with molten lead. It is apparently confusing whether the metal is simply solid made of metal or alloy. Use of clay cores helps to improve the soundness of casting. Sometimes pipe, spongy surface etc. are formed due to the formation of entrapped gas bubbles during cooling.

Sometimes visually one can explain the stages of processing, finishing and repairing techniques through examination of surface unaided by the use of instruments. Gilding was practiced on images in some cases we shall discuss later. During casting with molten metal, the early medieval craftsmen of Bengal used their own technique of casting. The direction of casting may be detected from surface studies coupled with X-ray. Images were cast in one single piece or of different pieces made separately (Santra *et al.* 2008).

Traditionally speaking the image maker leading the group of artistes would be known as *sūtradhāra*, and they are generally not related to the *Kāngasakāra* who manufactured household objects of copper and copper alloy. The common term that described them was *'śilpinah'* so far as the eastern Indian tradition of image crafting is concerned. "Tāranāth's History of Buddhism". The account goes that during the time of the Devapala (9th century CE) a highly skilled duo artistes- father and son Dhiman and Bitpalo respectively lived in the region of Varendra (north Bengal) who "followed the tradition of the Naga artists and practiced various techniques like those of metal – casting, engraving and painting" (Saraswati, 1978, p.27). This evidently points to the existence and proliferation of a separate, highly skilled community of artistes expert in copper, copper – bronze, as well as - judging by the metal content of the images – brass sculpting. They were in no way to be identified with the makers of tools utensils and implements of copper and copper alloys. Meera Mukherjee identified the *bhaskars* as traditional image sculptors (Mukherjee, 2002, p.3).

Bell: This is widely used in the Indian sub-continent since the Megalithic culture (c. 1000-700 BCE). Bells hold an honoured place in various religious ceremonies of the Buddhist pantheon. According to Vajrayāna Buddhist theology bells (both hand bells and singing bells) are cast with a special five-metal alloy in which each of the metals represents one of the five *Thathāgatas*: Amithabha, Amoghasidhhi, Akshobhya, Ratnasambhaba and alloy (although it is often around 75% copper and 20% tin Vairochana. There is no standard proportion to the metals used in this with low proportions of the other metals). In Buddhism bells are used in Asia in religious worship long before the Christian era.

Fig. 5: Bell of Odakbakra

Fig. 6: Bell from Baidyanath with inscriptions

The Bell of Baidyanath Dham: The site (24°29′33″N 86°42′00″E) is located in Deogharh, in Santalpargana District of Jharkhand. This is one of the Śiva Temple of *Jyotirliṅga*. The main temple is lotus shaped,Śiva- Baidyanath faces the east, and is 72 feet tall. There are three parts of this temple; i.e., the main temple, the middle part, and the entrance part of the main temple. The main temple is beyond historical dates. All the temples are having brass bells. Fig. 6 is the bell from the main temple with enlarged inscription in Nāgri script.

Medallion: Typical medallion-like bronze objects of around 17 to 21 cm in diameter, hung on the walls in the houses at Narakasur Hill and Kahilipara in Assam (Fig. 7). The objects dated around CE 10th-11th century are now preserved in the Assam State Museum. Generally, most of those artefacts were obtained from the sites located outside the Brahmaputra Valley.

Fig. 7: Medallion preserved at Assam State Museum

Mirror: It is essential material object of everyday life. It helps us in our daily mundane lives, though we rarely ever really appreciate its usefulness. From the beginning, humans have been fascinated by reflections and based on Archaeological evidence it demonstrates that from the very early period mirror was familiar in human culture. In Ancient India, the mirrors were extensively used, though scanty of specimens are available now. Several stone sculptures and terracotta plaques discovered from this part of the subcontinent, which directly proves the wide use of mirrors by the milieu. For example, the appearance of a woman observing into mirror was seen in a stone sculptures of Bharhut (c. 2nd cent BCE), Sanchi (c. 1st cent BCE) and a few other sites. Indirectly popularity of mirror was also identified in paintings, for example, one may observe in cave 17 of Ajanta, the painting of a princess in toilet, who has a mirror in her hand. In this reporting paper one may be benefited with a specific artifact that was originated in the Harappan sites and continued throughout the ages in the rest part of the subcontinent. One may recall that the burials or cemetery of Harappans are of three types: extended inhumation in rectangular or oval grave; pot-burial in a circular pit; and rectangular or oval grave-pit containing only pottery and other funerary objects. In the first variety the funerary furnishings comprise of pots and such objects of personal jewelry as bronze mirrors, etc., were deposited. The latter two methods were unassociated with any skeletal remains.

From eastern India a few copper or copper bronze mirrors were discovered in excavation. Though Ghosh (1989) has referred the presence of a mirror handle from Vaisali, but with careful search no mirror was detected from the site museum.

Telhara: The recent excavations in Telhara, District Nalanda, in Bihar by the Department of

Archaeology, Govt. of Bihar. The Vihar Telhara or Teladhaka was one of the monastic establishments most extensively described by Heun-Tsang, who visited India in the 7th cent CE. Some times in 2013-14, a mirror was recovered by Dr A.K. Verma, and the mirror is under research. This mirror is an important one in the history of metallurgy of Bihar.

Mirrors from Lower Ganga Plain: The early historic site Chandraketugarh, (88°41′ N, 22° 42′ 52′ E) situated in the North 24 Parganas District of West Bengal has yielded thousands of antiquities from surface exploration, limited excavation and unauthorized digging by antiquity hunters. The site has yielded lots of metallic objects, potteries, seals and sealing, coins and other antiquities from pre-Mauryan to early medieval period (Chattopadhyay 2002). In 1999 the State Archaeology Museum of West Bengal has recorded one broken mirror (Accession No. 99/103) (Fig. 8) along with other antiquities as a gift from one individual.

Fig. 8: Mirror from Chandraketugarh

That mirror was originally 132 mm in diameter, designed with a flat rim, 11 mm outside thickness. The mirror is attached with a handle of 44 mm in length. Like all of those artifacts, it was supposed to be attached with a perishable objects. The artisans of Chandraketugarh were well versed with ivory and bone craft. So it is quite possible to make the handle with ivory, bone and at least by wood.

Cymbals of Eastern India: Chinese traveler Fa-hsien visited eastern India some times in fifth century CE and mentioned that he has observed many musical instruments and called this country the land of music and dance. A highly developed musical culture was prevailed in Bengal. Through the excavations at Paharpur, Mainamati, Jagjibanpur etc. revealed that music was an integrated part of Bengali culture. Amongst the musical instruments, under metallic category includes *kartāl* (cymbals), *kānsar* and *mandirā* produce sounds through striking the metal body of the instruments. From ancient period the metal craftsmen of Bengal produced this category of instruments from *kānśa* or pital (brass, an alloy of copper and zinc). The name itself of an instrument *kānsār* indicates that it is made of high tin bronze. The instrument jhanjaris made of brass or bronze. In fact *kartāl* is a smaller variety of *jhanjar*. Cymbals of eastern India are most common musical instruments used by folk singers. One of the most important manufacturing center is situated at Nabadwip in Nadia District of West Bengal. In coarse of our field work we had collected a broken cymbal. We had analyzed the specimen for its composition and manufacturing technique. During our field work at Assam, at Sarthabari we have observed cymbel making. Some unique cymbals are preserved in Ahom Tai Museum, Shibsagar.

7. Metallurgical Analyses

Some in-depth analyses of bell metal and brass were made in the Department of Met and Mat. Engineering, Jadavpur University under Prof. Prasanta Kumar Datta. A number of students made their Ph.D. programmes with Archaeometallurgy. The earliest evidence of high tin bronze foundry of eastern India was discovered in Tilpi, in West Bengal (Datta et al 2008).

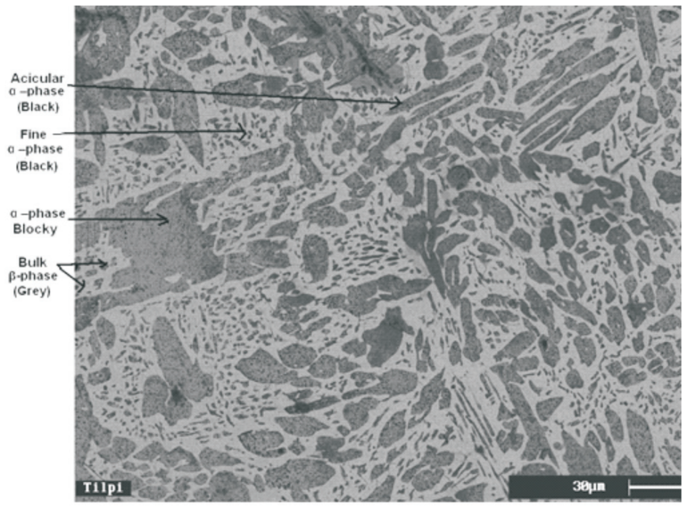

Fig. 9: Microstructure at the central region of cast ingot in Tilpi. Black areas represent solid solution of tin in copper, known as α –phase. Note some dendrites of α –phase look blocky and some are acicular (lens shaped). Between the dendrites a large number of fine α –grains (dendrites) are visible. The bulk phase (matrix) is held by tin-rich, solid solution of tin in copper, β–phase.

From the results obtained from those analyses we understood the technology part of it. The evidence of a high tin bronze or bell metal guild at Tilpi was established around 2nd century BCE in excavation (Fig.9). The conical crucible confirms the technological competence of metal workers in conserving the scarce energy during melting. The investigation on the Bell Metal ingot confirmed the production of Bell Metal in Ancient Bengal in regular fashion. The relics of guild at the excavation site become the replica of the melting sections of a modern foundry. That also indicate the lower melting point of around 820°C. The composition of 22 to 25% Sn, balance Cu probably standardised as Bell Metal composition in Ancient Bengal with the level of Sn kept at higher end. The composition of Bell Metal puts it in a single β phase.

The second effect of high super-cooling introduces long solidification time and facilitates grain growth of some dendrites. The microstructure of as cast Bell Metal consists of fine grains of α-phase associated with large dendrites in the matrix of β- phase. The ingot investigated distinctly produces three clear zones for any cast structure. Bell Metal incidentally has short freezing range but due to incomplete peritectic reaction becomes a case of delayed freezing and produces some long freezing range characteristics of deep super-cooling. The addition of Fe in ancient Bell Metal probably is un-intentional but the presence of Fe definitely improves the grain fineness of the metal ingot.

7.1 Analysis of high tin bronze forged product obtained from Gajol of Maldah: A Bell Metal Bowl

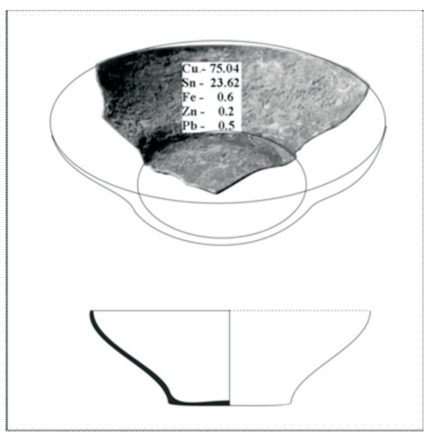

Fig. 10: The fragment of High- tin Bronze or Bell Metal bowl recovered from Gajole. The composition showing Sn 23.09, Fe 0.71, Zn 0.28, Pb .061, alloy has been displayed inset.

7.2 Thermo Mechanical Treatment (TMT) and SEM analysis of Bowl Sub-grain formation leading to recrystallization has taken place

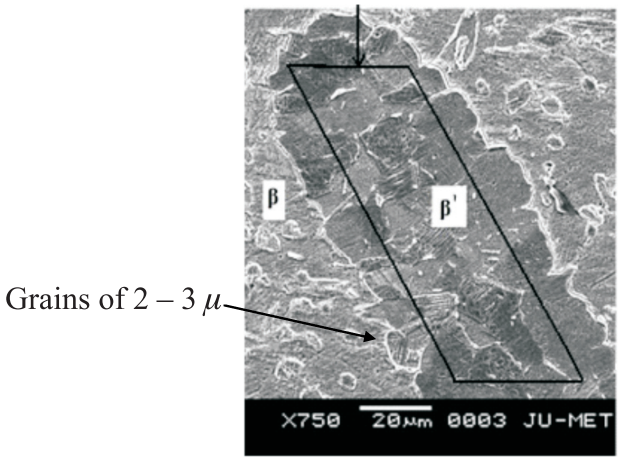

Fig. 11: One large or blocky grain has developed sub-grain formation with the impression of deformation slip bands faintly visible. The sub grains have converted into new crystallized strain free grains producing dynamic recrystallization of parent α-Cu-Sn phase of the casting ingot. This metallurgical transformation along with mechanical deformation has been called Thermo Mechanical Treatment or TMT.

Incoherent twins are visible due to the simultaneous operations of deep drawing as well as banding.

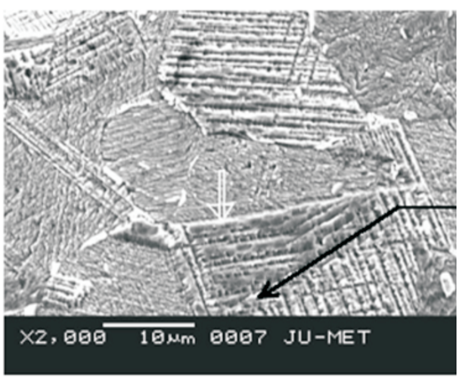

Fig. 12: SEM of forged high-tin bronze or Bell metal forged specimen shows deformation bands (marked by arrow). The β' Cu-Sn phase a 'lath' type transformation of the matrix was observed. The laths might be of the martensitic β Cu-Sn phase of the matrix. Some twin bands with micro twins can be observed.

8. Traditional users of *Kāṅśa* in Eastern India: Ho tribes

In course of our investigations we have noticed a long tradition of this alloy in Jharkhand by the Ho tribes (Chattopadhyay and Purty 2014). In the early part of this chapter, we mentioned the presence of bronze objects in Megalithic burial. That belonged to one of the 32 tribes including Jharkhandi, Santhal, Munda and Ho are supposed to be related to Proto-australoid group and belonged to patriarchal family. This District was earlier known as Kol-Sthana (land of Kols) or Kolhan area. For administrative reason the erstwhile Singhbhum is divided into three Districts East Singhbhum, West Singhbhum and Saraikela-Kharswan. In West Singhbhum District where we had concentrated our studies, the total population is 17, 87, 955 according to the census of 1991. Ho means man and any human being can be designated as Ho. The Ho tribes have their own language known as Ho. That District is considered a core place of the Hos from where they are migrated to different parts of this state and neighbouring areas. Approximately 15% of Hos have left their initial Svarna religion and accepted Christianity.

Hos strictly follow their own traditions. The ceremonies in Ho language are called Dustur. All the ceremonies are connected with the application of high tin bronze or bell Metal (*kāṅśa*). In the naming ceremony given to a child, is called mantijome. Here a *kāṅśatādi* (dish) is filled with water, sun dried paddy, a variety of husked pigeon pea and durba grass and with proposed names. The selected name which floats with paddy, pea and grass is normally taken up. Hos prefer the names of their predecessors. When a guest visit a Ho family first time, he is offered warm water in a *kāṅśaguṭṭi* and his feet is washed in *kāṅśatādi* filled with water. Utensils used reflect the status, like rice in *kāṅśatādi*, vegetable in *kāṅśagina* and *pakalbhāta* (fermented rice) served in large *kāṅśabelā*. In the engagement ceremony (*junaskandiang*) Hos's bride and groom, exchange with each other three times, *kānsatādi*, placed on a *kānśaguṭṭi* filled with water and mango leaves kept on it.

8.1 Santhals in connection with *Kānśa*

Santhals are the largest tribes in Santhal Pargana region of Jharkhand; Odisha; and Maldah, North Dinajpur, Purulia, Medinipur and Birbhum of West Bengal and allied areas of eastern India. Discussing with Dr. Santosh Besra lot of information has been gathered about Santhals of eastern India. Till mid seventy of twentieth century utensils other than *kānśa* was unknown to Santhals. They used aluminium for cooking rice only and iron for frying and cooking vegetables and meat. For the purpose of eating the standard crockery used to *kānśa*, the use of *pittal* was handful of elites among Santhals. The usual utensils of *kānśa* are plate (*thālī* or *thārī* in *Santhali*), *gilas* (for tumbler), bowl (*bātī*) for *dal* or meat or vegetables even. The most important domestic utensil is *lota* for water. The tradition of *Lota-dak,* or *Lota-pānī* an offering to the guests on arrival has to mandatorily in *kānslota* as it carries auspicious element with it. It is similar to *Lota-pānī* among Oraon community. That is exactly similar to Hos of Singhbhum. In fact, this tradition is well practiced by the tribals migrated to tea gardens in Assam, Dooars and Darjeeling. This is also maintained by Santhals of Nepal, Bhutan and Bangladesh. After salutation (*Pranām* or *Namaskār*) the guest spills out water from the lotaan offering to the God the Great Marang Buru, ancestors of other Gods *More Ku, Turui Ku,* means 'fives & sixes', symbolic to the traditional system of self-governance by village council consisting of five persons headed by *Manjhi*.The *lota* has to invariably made of *kānśa*. The water in the offering to the guest is not meant, contrary to popular assumptions for drinking. However for drinking *gilas* is used.

The Santhals are well aware, but without any explanation to them the contact of sour delicacy with the *kānśa* cause staining and so, they clean up early after eating sour preparations in *kāns* plates. The cleaning of plates is done by scrubbing ash by a tuft of dried paddy stem stored for roofing and for consumption of cows and buffalos. Whereas, the *lota* and *gilas* are first rubbed clean with mustard oil by dried *Sarjom* (Shorearobusta), then washed to keep its shine.

The older utensils are changed in any yearly "*mela*" in the locality where *kānśa* are sold by *Diku* traders or from nearby township. Surprisingly, to *Khagra* in Murshidabad is not known to Santhals for its reputation attached with *Kānśa*. The community of Singhbhum areas gets those made at Binka region of Odisha.

The Santhals buys less of *kānśa* utensils, because in the most of social ceremonies usual gift is *kānśa* utensils. Like in *Neemdak'mandi* (the naming ceremony) of newborn children, the childs requirements of utensils are gifted by their maternal uncle's family. At marriage the newlywed couples are gifted by sets of utensils made mostly of *kānśa*. At death a set, at least a plate is sent to burning *ghāt* with the body for his/ her use in post-life.

When brother divides, the married sisters come to visit them, bring a complete set household and kitchen accessories with complete set of utensils, all of which are necessarily are made of *kānśa* for each divided kitchen.

In all ceremonies related to agriculture the rituals are performed in *kānśa* plate, from sowing ceremony called *erok*, then mid period for good harvest called *Janthad* and during post-harvest festival of *Sohrai*. The *kānśa* occupies an auspicious along with snob element in Santhal life.

9. Conclusion

The present project highlights the history of high tin bronze and brass in the eastern part of the subcontinent, the continuation of the same has been identified with the survived traditional practices. In the beginning, background of this project highlighted the origin of copper, bronze and brass were discussed. Later it includes the negligence of this alloys by the so called elite society but the love of this alloy by tribal, but as a case study only the groups Ho of Singhbhum and Santhals of West Bengal and Jharkhand were discussed. This two tribes traditionally maintained brass. So long as institutions like the *satra* will continue to flourish in Assam, craftsmen will be meaningfully engaged in traditional Assamese society.

To observe the traditional bronze making practice an ethno-archaeo-metallurgical studies were conducted at Khagra, District Murshidabad where detail thermo-mechanical processing was recorded. Besides, in-depth studies were conducted at several places of in this part of subcontinent. For example, Muragachha of Nadia District, where batch forging of high tin bronze and brass were studied, in Bishnupur, crucible-cum-mouldpractice were observed. Thus the technology of high tin bronze making and shaping have been experimented at Khagra and thus experimentally established (Chattopadhyay and Datta 2014).

Cireperdue or lost wax casting process is the earliest casting process initiated at Harappan sites in this part of sub-continent. The unique process of combined forging and lost wax practice are traditionally continued at Binka in Odisha.

The in-depth studies with archaeo-materials were initiated for this research. First pure copper specimens were analyzed that comprised with copper hoard objects – both cast and forged specimens were analysed. High tin bronze cast ingot, excavated furnace remains and crucibles of Tilpi were studied. High tin bronze forged product – a vessel from Gazole were studied in-depth by Chattopadhyay (2013). The identification of phase and transformation of high tin bronze after quenching is characterised – that would reveal whether it is similar to martensitic transformation in iron and steel; or new phases of identified as β and β' phases. The special geometry of Chunky shape or lump shape provided the thermal help to keep enough time for mechanical deformation of forging. The available time was the cause of concern for metal smiths. So, East Indian artisans, particularly in Bengal highly appreciated the working geometry of Chunky shape. A master stroke of those metal-smiths was seven-part Cu and two-part Sn ratio for developing the alloy composition known as *kānśa* in Bengal. Those metal workers not only developed thermo-mechanical controlled processing (TMCP) for hot forging of high-tin bronze but also used accelerated cooling or quenching the metal in water. Thus they could successfully manufacture deep drawn bowls or glasses in ancient Bengal.

The remarkable adaptation of cyclic quenching and tempering (Q & T) techniques like steels enabled the metal workers to heat treat high-tin bronzes for the case and the core of the material. Thus ancient Bengal and Odisha accomplished strong and tough forgings of Cu-23Sn alloy free from brittleness. The production of Bell Metal in Ancient Bengal and Odisha is unique and regular fashion. The composition of 22% to 25% Sn, balance Cu probably standardised as Bell Metal composition in Ancient Bengal and Odisha with the level of Sn kept at higher end.

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