ISSN No:-2456-2165

Metallurgy in Ancient India and Jharkhand

Sarbajit Roy, Ravindra Kumar, Romus A., Shailendra Kumar Pandey, Purushotam Kumar, Vishal Kumar, Sudhir Kumar, Neeraj Kumar Sinha, Raman Kumar Mandal, Abhimanyu Kumar, Rajnish Kumar , Deepshikha Mishra

RamGovind Institute of Technology, Koderma, Jharkhand

Abstract:- Metallurgy has emerged as one of the most important inventions of humankind and has contributed enormously to human culture. Metallurgy in India has a distinguished history, beginning from the Indus Valley Civilization and even earlier. The Indian state of Jharkhand, which currently contains about 40% of the nation's mineral resources , has a consistently long history and tradition of metallurgy . Smelting sites of iron, copper and gold have been found in many areas of the state. It is known that primitive tribes of Jharkhand especially one known as Asurs, who are now facing extinction , possessed and implemented the metallurgy of iron, copper and gold. This paper discusses the practice of metallurgy and mining procedures in ancient India and Jharkhand of metals, minerals and alloys including iron, copper , gold , Bronze and brass, tin zinc, mica and coal.

I. A BRIEF HISTORY OF ANCIENT IRON AND STEEL METALLURGY IN INDIA

Iron implements have been found in archaeological excavations at Malhar, Dadupur, Raja Nala ki Tila and Lahuradewa In Uttar Pradesh between 1800 BCE to 1200 BCE.These discoveries indicate that iron technology may have appeared in India as early as the 16th century BCE.

Iron metallurgy in India developed extensively during the first **millennium** BCE. [1]The earliest iron objects found in India are dated at 1400 BCE through radio carbon dating . Several archaeological sites have revealed iron implements such as knives, daggers, spikes, arrow heads, spoons, saucepans, bowls, axes, chisels, tongs and door fittings dating from 600 BCE to 200 BCE.

Iron appeared early in South India near present day Mysore as early as the 12th and 11th century BCE. [2]

Perhaps as early as 300 BCE and certainly by the 3rd century CE high quality steel was produced in southern India, using a method known as the crucible technique, as was called later by Europeans. This system involved a procedure where wrought iron of high quality was mixed with charcoal and glass in a crucible and heated till the iron melted and absorbed the carbon. . The steel produced in this manner is known as Wootz steel and its manufacture originated in India before the beginning of the Common Era. Wootz steel was exported through the centuries mentioned and in the early Medieval Era to Europe , China and the Middle Eastern Arab countries , and became particularly famous in the latter as Damascus Steel. Archeological excavations have revealed that this highly efficient manufacturing process was already in existence in the south of India more than 2000 years ago. and spread to the north.

The excellent quality of steel and cast iron produced in ancient India earned it a high reputation in the then known ancient world. The tempering of steel in ancient India was a craft achieving perfection. King Porus is said to have gifted Alexander the Great with thirty pounds of steel as the Roman historian Quintus Curtus has recorded.[2]

Ancient Romans used armor and cutlery made of Indian steel.Many historians have written about Indian iron in various ages, including Pliny the Elder (1st century CE) a Roman historian and Mohammed al Idrisi an Arab historian (12th century CE), who wrote about the excellent quality of steel made by the Hindus.[3]

The famous Sun Temple at Konark built in the 13th century has wrought iron beams .Iron beams have also been used in the Jagannath Temple, built in the 12th century.

The art of Wootz steel manufactured in India spread to the Arab countries as mentioned earlier where Damascus Steel was used in making sword blades known as Damascus blades , which acquired much popularity in the Medieval period.[3]

Indian and Persian armies prior to Alexander's time used arrows tipped with iron. The Greek historian Herodotus (5th century BCE) has recorded that the Persian armies who invaded Greece under King Xerxes used Indian mercenaries who used iron tipped arrows.

The world's first iron pillar was the iron pillar now at Delhi and was built during the reign of ChandraGupta Vikramaditya(late 4th and early 5th century ACE). The pillar is a column in the Qutb Minar complex which has remained rustless till today, and is seen as a marvelous example of ancient Indian metallurgy. The iron pillar at Dhar in Madhya Pradesh is dated to the 12th century AD, and the one at Mt.Abu was built in 1412.

- *Iron Metallurgy in ancient Jharkhand*

An ancient folklore prevalent in Central India among tribes known as Asurs and Birjiyas states that their ancestors first made iron accidentally in a hollow anthill. These tribes settled in Jharkhand about 4000 years ago. The Asurs are said to be descendants of Mahisasur (a demon king in mythology) residing in Gumla.They inhabited the regions of Lalchar, Lohardanga and Palamau in Jharkhand and Alipurduar in West Bengal. They comprised an

extensive population in the past but now have dwindled to about 7700. They were also among the first people to make quality iron in the world. They were essentially hunter gatherers, who gradually adopted shifting cultivation.[4,7.8]

The modern Asurs are divided into three tribal divisions , namely Bir Asur, Birijiya Asur and Agariya Asur. Archeological excavations have confirmed that iron technology began during the second millennium BCE and probably originated with these ancient tribes. Their methods of iron smelting produced iron of excellent quality and with no corrosion.

There are three main kinds of rocks from which iron is extracted. They are Gatla, Tumba (red colored rock) and Pose (biscuit type of rock) .It is known that, during the Mauryan Era, the Magadhan army had access to iron ores and technology at Rajgir and was able to manufacture iron weapons , which marked them as a dominant civilization. It is consequential that many of the weapons were manufactured with the knowledge and skills of the Asur tribes who in all probability inhabited the region.

The Agariyas populated Jharkhand , Central India, Eastern Uttar Pradesh, Bihar and Orissa. In the 19th century , Vernier Elurin traveled to India and studied and published a book about the Agariyas and their iron manufacturing technology.

The Agariyas worship Lohasur or Kalabhairav as their tribal god and every entire family of theirs , including women, have been involved since ancient times in traditional iron manufacture and trade .It is also a well guarded family secret. For some reason during the early years , these tribes were not allowed to settle near the villages and moved from place to place and produced iron deep in the jungles.

The charcoal used in the process of manufacture is of indigenous nature and choice of the particular tribe. The procedures used even today for iron manufacture are identical to those used in ancient times and the knowledge has been handed down for generations.[4]

For making charcoal , the women first go to the forests to collect dry food and green branches of teak, sal and bamboo and other trees which are 2 to 3 years old .The entire tree is never cut or uprooted, following time old traditions.The preparation of wood charcoal is carried out near a river or other source of water. The wood is either fired in an open heap and then quenched with water at some suitable stage or buried in a pot , and when the wood becomes charcoal, it is quenched, while covering the pot with green leaves to prevent the access of air .The charcoal is collected the next day.

When the fire is extinguished, pieces of charcoal of sizes 30mm to 50 mm are used in the furnace and smaller pieces are used to heat the forge hearth which is used for secondary refining .The bottom of the furnace is prepared by mixing clay with very fine coal dust . The same mixture is used for closing the mouth in front of the furnace.

Most of the furnaces are constructed above ground level and are either circular or rectangular in shape .The furnace wall, which is 100 to 150mm thick, is constructed from aluminum rich clay found locally and sometimes mixed with a small percentage of fine iron ore.[5]

The furnace is tapered and is supported by three or four sticks on the wall. A 300 mm high main hole is made at the bottom of the furnace wall, The furnace is checked for cracks that result from drying and given a final finish. The bottom of the furnace assumes the shape of a bowl . A hole is made on one side for the purpose of tapping out the slag.[6]

In contrast to modern furnaces, the ancient ones have sponge iron in solid form and are above the slag. A slanted platform made from bamboo sticks covered with clay is mixed with charge and slid into the furnace at the mouth. Tuyeres made of the same clay are used for blowing in the air.[4]

Such ancient techniques for manufacture of iron in Jharkhand that still exist are now in danger of dying out, as the tribal population faces the risk of extinction in the future.

- *Copper metallurgy in ancient India*

The first evidence of a copper implement from ancient periods in India is a cylindrical bead from Mehrgarh , which is dated to about 6000 BCE.

Copper mining in India dates from the 3rd millennium BCE. Harappan sites in Pakistan (Mohenjo Daro, Harappa and Chanhu Daro) and India(Lothal)indicate that at the later phase of the civilization, people were well acquainted with metals and alloys such as copper , bronze, tin, gold, silver, lead and antimony.These sites have revealed swords of copper dating back to 2300 BCE, during the Bronze age .Throughout the Ganges Yamuna Doab , swords have been discovered in various archeological sites , made mostly of copper, some being of bronze. The site at Fatehgarh has yielded varieties of swords dated to periods dated to periods between 1700 to 1400 BCE , but probably used more extensively in the opening centuries of the first millennium BCE.[9]

- *Copper mining in ancient Jharkhand*

From scattered evidence, an outline of the process involved in copper mining and manufacture can be surmised. Pits were dug at sites containing oxide rich ore , which were 7.8 meters in diameter 3.4 meters deep .Fires were probably built within the pits and were rapidly cooled by dumping water on the heated surface , which resulted in the disintegration or shattering of the surrounding rock. This process assisted in the extraction of the copper bearing ore from the mine walls. Simple tools used in quarrying were adequate for the mining process.

As the pits became deeper, air shafts were introduced, later replaced by manual air pumps. All deep galleries were provided with ventilation shafts at regular intervals.

In Jharkhand, ancient shafts, inclines and adits have been found near Rakha mines. An ancient mine located between Siddheswary and Chakri approximately 2 Km away from Rakha mines has three openings , two inclines and one shaft on the same load or vein. One 0f the two inclines has a low gradient and the other a steep gradient (Srivastava, 1995). The technology seems crude , there is no existence of an external (wood) support system. The only support system is of arcs and host rocks in the form of pillars. Smelting was done close to the mining area, as transport would have been difficult.[9]

Extensive smelting of copper ore in ancient times have been reported from Singhbhum, Hazaribagh, Rajasthan and other areas

The process of smelting probably involved introducing air to oxidize the sulfur and iron , while the ore was subject to high heat and in molten form . Ingots were prepared and transported from near the mine areas to places where craftsmen worked to shape them into copper implements.

Evidence of ancient copper mining sites have been discovered in Singhbhum, Kharsawan, Saraikela and Dhalbhum (Houghton, 1854). Twelve old shafts are located at Tama Dungri hill near Narayanpur in Saraikela.

Gold mining in ancient India

Archaeologists have discovered evidence of continued ancient gold mining in India from 3900 BCE to 500/600 CE, after which there seems to be a recession period , during the later phase of which there occurred invasions. Gold mining resumed extensively from 1500 ACE to 1870 CE, after which modern techniques including geological surveys began to be used and old mines were reopened at Kolar, Hutti, Godard and Ramgiri .

The deepest gold mines in ancient India have been found in the Maski region in Karnataka. Ancient silver mines have been located in Northwest India. By the 1st millennium BCE gold and silver were used in utensils, garments and ornaments for the royal families and nobility.The metals were beaten into thin fibers and embroidered into the dresses.

Fire setting techniques to extract gold were used in ancient India to break down rocks in the mine , a process which involved repeated heating and cooling in altering stages. The ore was then crushed by grinding stones to extract gold.

Gold was also mined during ancient times from alluvial placers, which are particles of elemental gold dust found in river sands.The lighter river sands were washed with water , thus concentrating the gold into dense particles. Further concentration was achieved by melting .

- *Ancient gold mining in Jharkhand*

Gold mining and metallurgy in the Chotanagpur plateau region have been well known since antiquity in India..Ancient gold mines in veins of quartz and mine dumps have been found in Singhbhum district at Magasara, Rakhola, Parojara and Kundarkocha , and in Patna district at Sithusura. In West Singhbhum, ancient shafts have been found at Bhitandari and Hakegora, Babuikundi , Jaranha and Paharia areas, where subsurface gold has been confirmed by drilling . In both East and West Singhbhum , recent excavations have indicated ancient deposits at the Tolatanr-Sobhapur area

- *Zinc Metallurgy in ancient India and Jharkhand*

The manufacture of zinc in ancient India has been traced to the 3rd and fourth century BCE. Zinc was produced in large scale industrially in the Northwest of India. At Zawar in Rajasthan , the distillation technique of zinc production was developed around 1200 CE.

Although production of metals appeared in India around the 6th millennium BCE , the ancient societies began producing copper, by the 4th century BCE. They also produced gold , silver and tin during that period. Proper iron production probably began before the 1st millennium BCE. Compared to the mentioned materials , regular production of brass, bronze and zinc by the distillation method appeared later.although brass and bronze had been produced accidentally in the earlier periods.

The earliest radiocarbon dating of the Zawar mines is 430-100 BCE. Metallic Zinc is mentioned earliest in Kautilya's Arthashastra (4th century BCE) as being produced regularly. Brass (pital) in India was first produced at Taxila in the 4th century BCE. The text mentions brass (arkuta) and ore in liquid form and being of a rasa (metal) to produce zinc which was also used as an eye salve .[10]

The Arthashastra furthermore describes the production of silver, after refining the ore about 17 times. It mentions the appointment of Mining and Metal Directors who inspected old mines and established new mines and factories for the manufacture of copper , lead, tin, brass and other materials.

The zinc distillation process was an advanced method developed only in India and later spread to China. Brass was formed by the cementation process.

The Zawar mines reveal continuously developing zinc technology from the Middle of the first millennium BCE and finally evolving into an advanced distillation process in the 13th century CE.[10]

Zinc was smelted in early times by an ingenious process of downward distillation of the vapor of zinc which formed after the reduction of the zinc ore. Retorts attached to condensers and furnaces were specially designed for production and the zinc vapor was cooled extensively to a temperature of 500 degrees Celsius to obtain a molten form which solidified into zinc.

ISSN No:-2456-2165

The Zawar furnaces had two chambers, one at the top and the other at the bottom, which were separated by a thick brick plate perforated along its length.Charge was introduced into the top portion and fired.The bottom portion was much cooler, where condensed zinc vapor would accumulate. Retorts were struck vertically through the perforations with the charge on top The vapor condensed in the cooler chamber at the bottom and from there the liquid would drip into the bottommost chamber. Mines containing huge galleries dating to the 1st century CE have been found at Zawar.

If the zinc content was more than 34% to 35 %, it was alloyed with copper, forming brass. An ingot of zinc was found in the Andhra region (Srinivasan, 1998). Ancient zinc deposits have not been recorded in Jharkhand till date . Research however , continues by the Geological Survey of India and may reveal sites in the future.

- *Bronze and Tin metallurgy in ancient India*

The Bronze Age began in India around 3000BCE in the Indus Valley region, a few hundred years before the Mature Period (2600- 1900 BCE). Bronze production was also prevalent in ancient South India.

Bronze is an alloy of copper and tin. The introduction of Bronze resulted in the culmination of the Stone Age. The Indus Valley Civilization societies produced a number of materials including copper, bronze, lead and tin. High tin bronze is also known as bell metal.[11]

The Greek historian Strabo's account mentions Bronze vessels in India which are believed to have been made from high tin Bronze (Rajpitak and Seely, 1979). The Gandhara grave culture , circa 1000 BCE has yielded a quenched high tin bronze vessel with 21% tin (Swinson and Glover, 1995). From the Bhir mound at Taxila eight bronze vessels with mirrors of more than 20% tin have been unearthed. The artifacts have been dated ranging from the 1st century BCE to the 4th century CE.(Marshall, 1951, p. 567).

In southern India , vessels around the Nilgiri cairns, with 20 -30 % Bronze have been reported. (Breeks, 1873, p63) .Bronze vessels have also been found in Kerala, crafted by bronze smiths of a traditional and hereditary community in Payangadi in Kerala (first reported in 1991).

- *Tin Mining In Ancient India*

The earliest mention of Tin in ancient India occurs in the Rig Veda as "trapu". Thus, in the Vedic Era, Tin metallurgy was probably known.The principal ore was cassiterite, referred to in Sanskrit as "kastira".

The region known as Tosham Hill in Haryana, was probably the ancient site during Vedic times for mining of Tin. The ore comprises of potassium rhyolites and deitus, yielding tin upto 180 parts per million.The area is also a potential source of copper and tin (Seetharam, 1986) .Mineral of Indium (Roquesite, CuInS2) has also been reported at the site , as a prospect for silver.

It is projected that further cassiterite deposits may be present in the Himalayan plains and slopes and as such more extensive research is necessary in this field.

- *Ancient Tin metallurgy in Jharkhand*

The Hazaribagh region in Jharkhand has been found to have local deposits of Tin, which was observed by the British geologist Mallet.(Chakravarty, 1979, 1985-86)] The tribals performed smelting of tin in furnaces similar to those used for iron smelting , signifying and ancient art. It is also indicative of the fact that bronze was prepared in ancient Jharkhand, by the tribals themselves , and further research shall supplement this conjecture.[12]

- *Ancient mica mining in India and Jharkhand*

The Indus Valley Civilization people were the first civilization to make mortars and cement from limestone, gypsum and mica.

Mica deposits in India exist extensively in Jharkhand from Koderma to Giridih and in the Nellore district of Madras.[14] No records exist at present of ancient mica mining practices in Jharkhand, but it is speculated that tribals have extracted mica from ancient times .

- *Ancient coal mining in ancient India and Jharkhand*

Modern coal mining began in India in 1774 by the East India Company, who began commercial mining in the Raniganj coal field. The coal capital of India is Dhanbad located at Jharkhand .Bengal and Orissa are two other states where coal is mined .[13]

In ancient periods there is mention of charcoal in iron extraction performed by the Asurs and Angarias. There are no existing records of ancient coal mining in India and Jharkhand and further research is necessary

II. CONCLUSION

Metallurgy and mining of metals and alloys have been associated in India from ancient times , beginning from rudimentary practices at Mehrgarh, through sophisticated extraction procedures in the Indus Valley culture, especially in its Mature Phase, and later , as more .metals and alloys were extensively associated with Ayurvedic practices.

The Indus Valley Civilization was probably the first to use cement and mortar, and one of their methods for making cement included the ingredients of mica,limestone and gypsum. Ancient Indian and Jharkhand metallurgy produced iron, copper and gold, with bronze and brass as the main alloys of copper. Zinc, tin, mica and coal were also produced , although further research is required to establish complete proof in areas such as coal , mica tin and zinc.

REFERENCES

[1]. Ancient Metal Technology and Archaeology of South Asia (A Pan-Asian Perspective): D.P. Agarwal,, Aryan Books International, New Delhi, 2000.
[2]. Marvels of Indian iron through the Ages : R. Balasubramaniyam, Rupa and Infinity Foundation, New Delhi, 2008.
[3]. India's legendary Wootz Steel ; and advanced Material of the Ancient World, NIAS & IISC, Bangalore, 2004.
[4]. Asur - An Ancient Iron Smelter can get Global Recognition: Ashis Kumar Sinha , Research Scholar , SNU, Jharkhand, India., The Researcher's , Volume 1,Issue 1, November, 2025, International Journal of Research.
[5]. Metallurgical Heritage of India : Sharda Stinivasan and S. Ranganathan, Department t of Technology , Indian Institute of Science, Bangalore.
[6]. Metallurgy of Ancient Indian Iron and Steel: R.Balasubramaniam,
[7]. Encyclopedia of the History of Science, Technology and Medicine in Non Western Cultures, 2008 Edition, Editor: Haines Selim , Springer link
[8]. The Early Use of Iron in India : D. K.Chakravarti, Delhi. Oxford University Press, 1992
[9]. The Origins of Iron Working in India; New Evidence from the Central Ganga Plain and Eastern Vindhyas: R.Tiwari, Antiquity 77 (2003) , 563- 45.
[10]. Nonferrous Materials , Heritage of Mankind :S.Srinivasan and S.Ragunathan, Trans Indian Inst. Mat., Vol 59 No. 6, , December, 2006.
[11]. School of Humanities , National Institute of Advanced Studies, Bangalore.
[12]. Department of Metallurgy, Indian Institute of Science Bangalore
[13]. The Primacy of India in Ancient Brass and Zinc Metallurgy : Ashis Kumar Biswas, Indian Institute of Technology, Kanpur, 208016.Indian Journal of History of Science , 28(4), 1993
[14]. Zinc and Brass Production in Ancient India : K.J.M. Hegde, Interdisciplinary Science Review , Volume. 14, 1984- Issue 1.
[15]. Metallurgy of Zinc, High -Tin Bronze and Gold in Indian Antiquity, Methodological Prospects : Sharada Srinivasan, Indian Journal of History of Science, 51.1 (2016) , 23- 32
[16]. History of Coal Mining in India : E.R. Gee, M.A. (Cantab) , F.G.S. , Geological Survey of India, Aug. 10th, 1940, Volume VI No. 3
[17]. Global Mica Mining and the Impact on Children's Rights, Executive Summary: Irene Schiffer and Roberts Cowan (SOMO)