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Signs of Ancient Metal Mining (Old Workings) and Metallurgy in SE Rajasthan

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I. INTRODUCTION

Metal mining is practiced in India since time immemorial. Gold, silver, copper, lead zinc, iron metals and alloys are mentioned in old religious Hindu literature. Finding of metal objects from the archaeological sites of Indus Valley Culture (3500 BCE; Harappan/ Pre-Harappan) e.g. MohenjoDaro, Harappa, Lothal etc., is well known. Kautilya (400 BCE) in his Arthashastra described the metal mining and metallurgical activities on different metallic ores.

In Rajasthan metal mining is being conducted since ancient past, the testimony of which are numerous mine sites, mine waste dumps, slag heaps and remains of furnaces or retorts. The great historian Colonel James Todd (1829) adorned the autonomy of Rajput Kingdoms with a triple figurative of 'Aan-Daan-Khaan' indicating the importance of mining in these states. He mentioned working mines of Silver-Lead-Zinc in Zawar and copper in Dariba. Study of the old metal mines, are popularly known as old workings.

A. The first category mines are open in nature and occur as irregular pits to trenches, and show shallow to moderate depth of half a meter to 15 m or so. Some of these might be trial pits. Generally these are filled-up by rubble, soil or vegetal material. Such old workings are present in almost all metal prospects in Rajasthan (Fig.1 and 2).Near Salumbar the old mines are in the form of trenches or shafts viz. at Anjani, Bedawal, Balicha, Chari, Jambura, Rajpura, Boraj, Kukra, Manpura-Sanjela, Lohagarh, Ambav, Parsola, Hinglaz Mata, Bharkundi etc.In Sirohi belt 15 multi-metal prospects exhibit ancient mines, mostly in the form of shallow pits or trenches e.g. Basantgarh and Deri. Around Agucha there are 20 prospects, of which 15 bear testimony of ancient mining.

B. The Second category of mines occurs as vertical shafts with circular openings, narrow in diameter (0.75 to 1.5 m) but deep (up to 80 m). These are sub-classified as lined with stone mortar and lime, or un-lined. The lined shafts were used for haulage of ore or dewatering the mine when working below the water table. The un-lined shafts were meant for mine ventilation (Fig. 3).Zawar area was active for mining till 1820 AD. There is an old mine known as Pratap Khan because Great Warrior Maharana Pratap had taken refuge in it during war with Moguls. Between Zawar and Dungarpur, ancient Copper mines are present near Parshad, Paduna, Bara, Deval, Metali, Mando Ki Pal, Sarkan etc. Around Udaipur these are seen near Bemla, LalMadri etc. In Salumbar-Ghatol belt about 70 localities have ancient metal mines for iron, manganese, copper, lead, zinc and gold.

C. The third category of mines are inclines or tunnel-like openings meant for entering into underground mine as seen at Bhukia ((Banswara district)), Zawar and Hinglaz Mata (Udaipur district) areas (Fig. 3, 4, 5, 6, 7, 8 & 9) (Chauhan N.K., 2011). In Bhukia-Jagpura area there is a cluster of more than 400 old mines (small, large, underground etc.). The recent surveys, however, revealed that these were mainly for gold associated with copper. Tamba Dungri near Jharka and Phalet near Sakroda are an old copper mine site with many small mining pits From archaeo-metallurgical studies it is confirmed that our ancestors had mined the oxidized part of lead ore for extraction of silver out of it. In Pur-Banera and Rajpura-Dariba belts about 50 metal prospects and impressive old mining sites are located. In Dariba area the ancient prospectors had carried out mining up to a depth of 260 m, which makes it the deepest ancient mine in Rajasthan. Around Udaipur-Zawar-Dungarpur belt about 40 ancient multi-metal mine areas including the world famous Zawar mine for zinc-lead-silver are located. Archaeological studies conducted in different parts of Rajasthan indicated that the initial metal mining activity in the area is of great antiquity. Carbon dating showed a maximum age of 3040 ± 150 years Before Present (BP) for Rajpura-Dariba. Zawar (2360 ± 50) and Agucha (2350 ± 40) mines came later. Presence of metal artifacts and equipments at Chalcolithic site of Ahar (Ayyad) near Udaipur bears its testimony.

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II. HISTORY OF METALLURGY AND MINING

India has been recognized as a country well-endowed with various natural resources. Metals were mined and utilized in the past in processes from the use of native metals, to those metals which could be easily smelted from ores, and to those metals which was hard to be smelted. The common metals in antiquity are gold, silver, copper, iron, lead, tin and mercury. Indian metallurgist's achievements were indeed significant. Its heritage in metallurgy is matters of pride of India for sure.Mining of various metals and use of various metals in antiquity are very much linked to the history of the Indian civilization. As historical evidences prove, India indeed was a nation which has superior techniques of metallurgy and mining than other countries. Metallurgy in India started during the 2nd millennium BCE. Recent excavation by an archaeologist Rakesh Tiwari in Middle Ganga valley manifest that iron metallurgy began as early as 1800 BCE. Early iron objects such as knives, arrow heads, spoons, bowls etc. ranging from 600 BCE to 200 BCE were found in many sites. Bronze Age swords of copper were found to be created from 2300 BCE. During the Maurya period (322 BCE-185 BCE) which was politically stable, technology of metallurgy was advanced greatly. Many of the modern Indian metallurgic methods came from ancient practices before the Industrial Revolution. Monuments of metallurgy such as iron pillar of New Delhi demonstrate superiority of India's metallurgic technologies. A very interesting fact about the Iron Pillar is that it refused to rust. It is surprising that ancient Indians figured this out long time ago but contemporary technique still deals with rusty iron.

III. ZINC AND BRASS IN ARCHAEOLOGICAL PERSPECTIVE

Brass has a much longer history than zinc. Both literary as well as archaeological records reveal that production of pure zinc had begun in the second half of the first millennium BC, though production on commercial scale begun in the early medieval times. Zinc technology was mastered later than that of copper and iron. For pure zinc production, therefore distillation technology was developed, in which India has the distinction of being the first. In ancient times it was mainly used for brass making.

As far as India is concerned the firm evidence of zinc smelting is known only from Rajasthan. The antiquity of mining various types of ores in Rajasthan goes back to Bronze Age (mid-fourth millennium BCE) as the evidence of Ganeshwar-Jodhpura cultural complex in north Rajasthan and Ahar culture in southern Rajasthan would indicate (Agrawal and Kharakwal, 2003). It appears that large scale production of different metals e.g., copper at Dariba and Banera while lead-silver at Agucha and Dariba, zinc at Zawar and iron at Iswal, Loharia, Parsola, Bigod, belonging to the medieval times (Kharakwal, 2006) was the result of such long experience of metal technology involving pyro-techniques.

IV. ANTIQUITY OF ANCIENT METALLURGICAL SLAGS

Signatures of ancient metallurgical processing of ores are seen in almost all base metal prospects or in close vicinity of metal mining sites in Rajasthan and Gujarat in the form of slag and/ or broken furnaces/ retorts, etc. Based on physical characters and metal association, the slags located in different parts of Mewar, can be classified in following categories.

A. Copper Slag

It is greenish grey to dark grey, fine to medium-grained, somewhat massive and showing large vesicles or bubble-marks and comparatively less flowage-marks (due to higher viscosity during melting. the most common variety found in copper prospects of Agar, Anjani, Jodhawas, Dariba, and Phalet etc.

B. Silver Slag

It is feather-light in weight, extremely spongy and pale greenish yellow in colour identified only from Jodhawas, a well-known copper-silver prospect in Alwar district and Ramgarh-Ras area in Ajmer district. Such slags are also seen in Dariba.

C. Iron Slag

It is cherry red to brownish black in colour and displays more flowage or melt-flow features (due to less viscous nature or high temperature at the time of melting) as compared to copper slag. Reddish tinge in its colour is due to abundance and oxidation of iron minerals.

D. Lead-Zinc Slag

Owing to special metallurgical processing, which involved smaller retorts, these slags are rarely preserved e.g. at old Zawar area. Some slags somewhat similar to that of copper, however, have been reported from lead-zinc prospects of Rampura-Agucha.

Sometimes more than one type of slag is present at one place, which is indicative of the multiple metallurgical processing of various metal ores.

E. Zawar

The oldest production center of Zinc (Geoheritage Site)

The entire valley of Tiri at Zawar is marked by immense heaps of slag and retorts, which indicate a long tradition of zinc smelting at Zawar (Fig. 10, 11 and 12). Zinc ores are widely distributed in the country, but major deposits are found in the Aravallis. There are extensive remains of old workings in Zawarmala, Mochia Magra, Balaria, and at Hiran Magra in Zawar area in the form of deep trenches, shafts, open stopes, long serpentine galleries and inclines (Fig. 3). These mines are narrow and vary from 10 to 300 m in length. There is extensive evidence of underground mining too (Fig. 1, 2 and 9).

The stopes and branched chambers were supported by finger like inclines further down. Arch shaped pillars (about 4XSm) were left to support the roof while developing such stopes and chambers (Gurjar *et al.*, 2001) (Fig. 9).Extensive use of wood in the form of ladders, roof support, haulage scaffold (^{14}C date: 2350±120 BP) have been found in the mines.

An opencast mine of lead-zinc (300 m long and 100 m wide) developed over east lode at Dariba, (Raghunandan *et al.* 1981:86-87) is a remarkable evidence of ancient mining technology practiced in southern Rajasthan. At Agucha also extensive evidence of mining of rich galena pockets datable to the Mauryan times has been discovered (Tiwari and Kavdia, 1984: 84-85). The smelting debris and mining clearly indicates that it was carried out for lead and silver (Fig. 10).The underground mining of ores at Agucha, Dariba and at Zawar may have been the result of a gradual development of mining technology in Southern Rajasthan going way back to the middle of the fourth millennium BC when Bronze Age cultures had just appeared on the scene in the region. The entire valley of the Tiri in Zawar is emphatically states that the Zawar process is the ancestor of all known zinc smelting dotted by massive dumping of slag and earthen retorts indicating a long tradition and commercial production of zinc (Craddock 1981., Craddock et al., 1989).

To date the oldest evidence of pure zinc comes from Zawar as early as 9th century AD, when distillation process was employed to make pure zinc. The credit of innovating special retorts and furnaces for distillation of zinc surely goes to the Bhil tribe of Southern Rajasthan. It was surely this local knowledge which they could successfully employ for distillation of zinc techniques in the world (Fig. 10, 11 and 12).

Fig.1 Old workings atZawar area

Fig.2 Old workings atZawar area

Fig.3 Old workings atZawar area

Fig.4 Old workings atBhukia Gold Mines

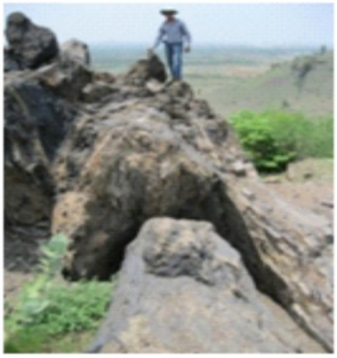

Fig.5 Old workings at Pur-Banera

Fig.6(a) Old workings at Bhukia Gold Mines

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Fig.6(b) Old workings at Phalet Copper Mines

Fig.7 Old workings atPur-Banera

Fig.8 Old workings atPur-Banera

Fig.9 Underground Pratap Khan, Zawar

Fig.10Heaps of slags &retorts at Zawar area

Fig.11Walls made by used retorts, Zawar

Fig.12 Retorts used in smelting, Zawar

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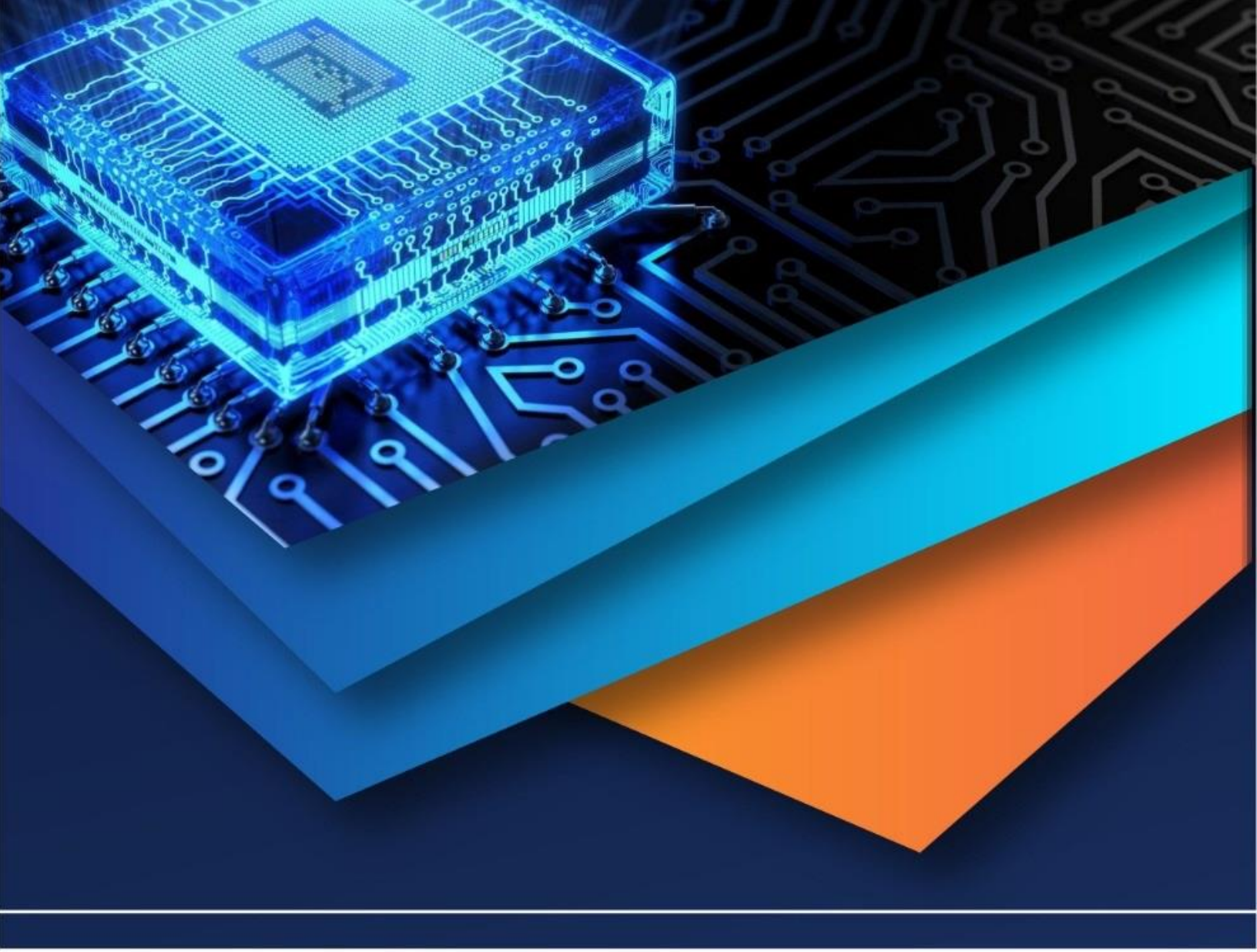

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