

General Principles and Processes of Isolation of Elements

Objectives

The learner will be able to

- appreciate the contribution of Indian traditions in the metallurgical processes
- explain the terms minerals, ores, concentration etc
- explain different methods of concentration of ores like hydraulic washing, leaching, magnetic separation etc.

History of metallurgy

India has 7000 years of tradition in metallurgical skills. The skill of extraction of metals has brought about several changes in the human society. Metals were used to make weapons, tools, ornaments, utensils, etc., and it enriched the lives of people of different civilisations. The 'Seven metals of antiquity' are gold, copper, silver, lead, tin, iron and mercury.

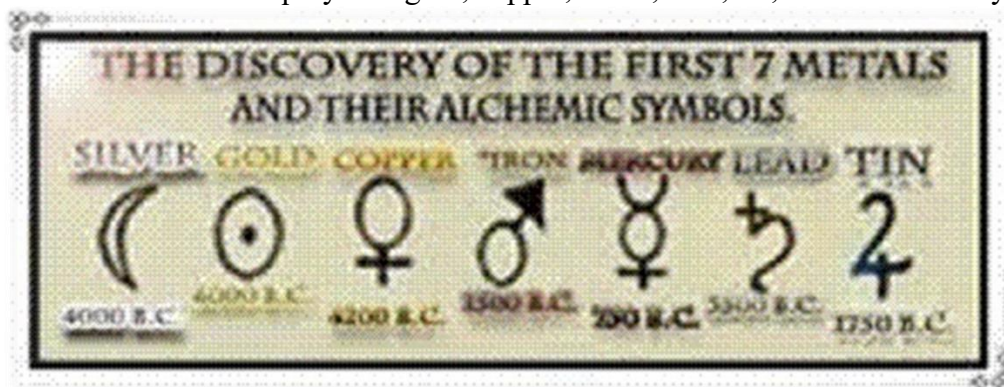


Fig.1 The alchemic symbols of seven metals of antiquity

Chalcolithic Cultures in Indian Subcontinent – Copper Metallurgy

The two important sources for the history of Indian metallurgy are archaeological excavations and literary evidences. The first evidence of metal in Indian subcontinent was a copper bead (6000 B.C.E) found at Mehrgarh in Baluchistan. Spectrometric studies on copper ore samples obtained from the ancient mine pits at Khetri in Rajasthan and on metal samples cut from representative Harappan artefacts recovered from Mitathal in Haryana and eight other sites distributed in Rajasthan, Gujarat, Madhya Pradesh and Maharashtra prove that copper metallurgy in India dates back to the Chalcolithic cultures in the subcontinent.

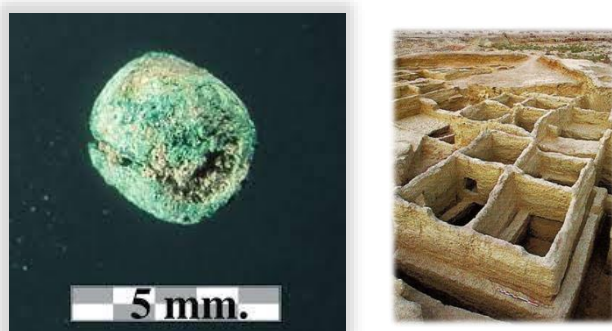


Fig.2 The copper bead found at Mehrgarh, Baluchistan.

In ancient period, many royal records were engraved on copper plates *which is known as tamra-patra*. Oldest copper plate has a Mauryan record which describes famine relief efforts. It has one of the very few pre-Ashoka Brahmi inscriptions in India.



Fig.3 Brahmi inscriptions

Gold metallurgy in ancient times

Harappans also used variety of ornaments such as pendants, bangles, beads and rings have been found in ceramic or bronze pots made up of gold, silver or joint electrum. Early gold and silver ornaments have been found from Indus Valley sites such as Mohenjodaro (3000 BCE). These ornaments are displayed in the National Museum, New Delhi.



Fig.4 Gold ornaments from Harappa civilisation

The river Sindhu was an important source the deepest ancient gold mines in the world, in the Maski region of Karnataka.

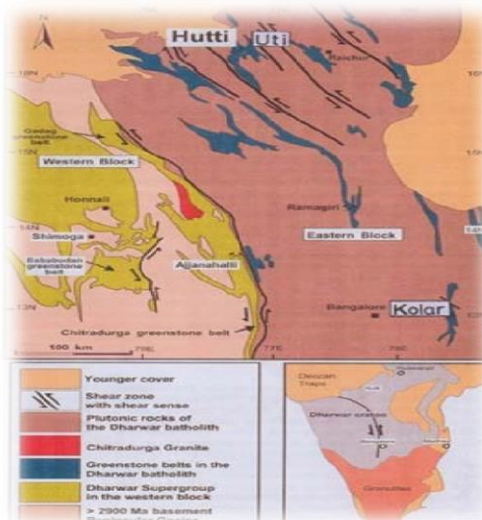


Fig.5 Maski region

Carbon dating places them in mid-1st millennium BCE. Alluvial placer gold has been reported in the river Sindhu in modern times too. Also, gold mines are being reported in the region of Mansarovar and in Thokjalyug today also. In *Anguttara Nikaya*, the process of the recovery of gold particles from alluvial placer gold deposits has been narrated. In Arthashastra, Kautilya describes naturally occurring gold solution called *rasviddha*.

Iron metallurgy in Ancient time

Iron artefacts from East Vindhyas and Gangetic plains and a highly corroded arrow from Lucknow by archaeological department proves the development of iron metallurgy was strong in India. Radiocarbon dating places the artefacts and slag obtained in recent excavations in Uttar Pradesh between BCE 1800 and 1000. Indians in those areas were aware of iron refining from the early 2nd millennium BCE.

India produced an advanced quality steel called ukku (wootz steel) which was called 'the Wonder Material of the Orient'. A Roman historian, Quintus Curtius, records that one of the gifts Porus of Taxila (326 BCE) gave to Alexander the Great was some two-and-a-half tons of Wootz steel. Wootz steel is primarily iron containing a high proportion of carbon (1.0 – 1.9%). In the Middle East where it was named as Damascus Steel. Even Michael Faraday had failed to duplicate this steel by alloying iron with a variety of metals, including noble metals, but failed.

Another exciting example of iron metallurgy in ancient India is the world-famous Iron Pillar which was made out of wrought iron. It was placed in Delhi in 5th century CE. The most important fact about this pillar is that there is no sign of corrosion though being exposed to the atmosphere for about 1,600 years.

Radio carbon dating proved the presence of iron metallurgy in Khasi hills of Meghalaya too.



Fig.6 Khasi hills of Meghalaya

Zinc and mercury metallurgy in India

There is archaeological evidence of zinc production in Rajasthan mines at Zawar from the 6th or 5th BCE. India was the first country to master zinc distillation. Due to low boiling point, zinc tends to vapourise while its ore is smelted. Pure zinc could be produced after a sophisticated 'downward' distillation technique in which the vapour was condensed in a lower container. This technique was also applied to mercury. Indian metallurgists were masters in this technique. This has been described in Sanskrit texts of 14th century. Indians had

knowledge about mercury. They used it for medicinal purpose. Development of mining and metallurgy declined during the British colonial era. By the 19th century, once flourished mines of Rajasthan were mostly abandoned and became almost extinct. In 1947 when India got independence, European literature on science had already found its way slowly into the country. Thus, in post-independence era, the Government of India initiated the process of nation building through the establishment of various institutes of science and technology. In the following sections, we will learn about the modern methods of extraction of elements. The figure below shows the retorts in Zawar, Rajasthan.

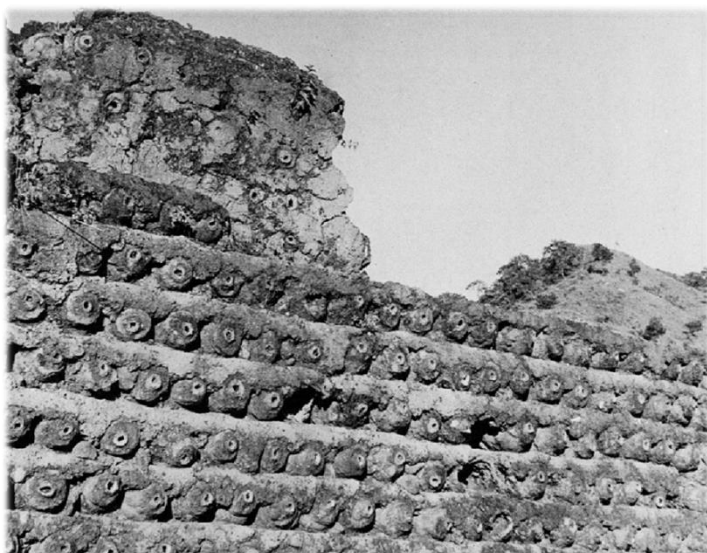


Fig.7 Retorts in Zawar, Rajasthan

[Video: The history of metallurgy in India](#)

[Quiz](#)

References

1. Journal of Archaeological Science (2002) 29, 1393–1401
2. NCERT chemistry textbook, plus two
3. P.T. Craddock, The early history of zinc, Endeavour,
4. Volume11, Issue 4, 1987, Pages 183-191, ISSN 0160-9327
5. indiaenvironmentportal.org.in