Part - I

Texts
One of the most important technological advances of mankind is the mastery of iron and the introduction of what may be archaeologically described as the Iron Age. This gave man a very useful metal that could at once achieve adequate hardness or sharpness to meet nearly all his requirements in peace and war, and was yet more serviceable than copper or bronze which were discovered and worked earlier. Archaeological discoveries have shown that iron did not appear in human use simultaneously everywhere, nor even over a large part of the world. On the contrary, it is known to have made humble beginnings in one or more centres and to have played a minor or subordinate role alongside copper or bronze, often as a precious metal or with magic properties, for several centuries.

Iron could not for long replace copper or bronze in hardness or sharpness. This was due largely to the fundamental difference in the metallurgy of iron from that of copper or bronze. While the primitive furnaces could produce temperatures high enough to smelt copper ores, they were not capable of achieving the temperature required to smelt ores of iron. Though in the case of copper the molten metal could be poured into moulds, and
objects of desired shapes easily produced, the workable material from iron ores obtained by the application of heat was in the beginning a softened spongy mass. This had to be hammered to be produced into objects of choice. Being unmixed with carbon this new metal did not have the sharpness or hardness which could be achieved with copper or bronze. It was only gradually, through many trials and errors, not always consciously or deliberately made, and not often aided by lucky accidents, that the high temperature of \(1535^\circ\) centigrade required to smelt iron and the use of a catalytic flux to produce a slag and thus separate molten iron from impurities were slowly achieved.

This was, however, not the end of the story. The iron metal so produced was yet soft in comparison with copper or bronze. It was not until the achievement of the characteristic hardness as the result of the admixture of carbon in proper proportion that the special properties of iron in the service of man had been fully realized.

Iron produced by smelting is now known to be of three kinds, namely, (i) wrought iron with little or no carbon, i.e. about 0.08\% or lower, (ii) cast iron with up to 7\% of carbon, which renders it hard but brittle, and (iii) steel, with up to 1.7\% of carbon, which makes it hard but not brittle. It was only after at least the basic principles of the manufacture of some kind of steel through carburization had been discovered that iron could
effectively replace copper or bronze as the main metal in human use. Apart from this 'steeling' of iron, the principles of 'quenching' and 'tempering' had also to be achieved; and possibly these processes had been discovered earlier than full fledged 'steeling', as these steps also served to furnish the objects of iron with a degree of hardness, superior to that of copper or bronze.

'Quenching' consists in immersing the red hot metal into water, which results in hardening of the metal. Similar practice has the reverse effect on copper or bronze. 'Tempering' is tantamount to localized steeling of iron, and consists in repeated heating of the metal and allowing it to cool slowly while it is hammered. In the process some carbon from the furnace gets impregnated into the metal, though not uniformly, imparting to it the properties of steel.

It must be recognized at once that long before ores of iron came to be smelted and worked the limited use of meteoric iron was already known. But the utilization of meteoric iron has to be distinguished from the employment of man-made iron by the deliberate smelting of iron ores which the latter implied. The mere acquaintance with the use of man-made iron was not also enough to usher in the Iron Age. It cannot be said to have commenced its course until it had assumed its dominant role in man's life by the displacement from that position of honour of copper or bronze. But this important transformation began in
different countries at different times, some times independently, but more often depending for its inspiration upon a neighbouring pioneer.

The evidence on the beginnings of the Iron Age in India has not yet been correlated to produce a well-knit and continuous picture of the technological advance accompanying the coming of iron into this land. The problem is of extreme importance in the country’s history of technology, for it is not known for certain as to how and when iron came to be introduced into this subcontinent. It is at the same time beset with many difficulties, which comprise, apart from the disjointed nature of the evidence on the chessboard of India’s geography, the inadequacy of the data on the technological processes and also the uncertainty of the chronological assessments of the different cultural levels where iron has occurred. Nevertheless, some recent discoveries have made the task easier in regard to both the correlation of the earliest iron-bearing deposits in different parts of the country as well to their chronological estimation. In regard to the technological processes, the outstanding problem remains in respect of the composition of the objects as of ores from the neighbouring regions for lack of adequate facilities for spectral analysis, making it difficult, if not impossible, to relate or connect the finished goods to the sources of ores. The method of smelting, however, is indicated to an extent by the evidence at Ujjain and the prevailing practice of smelting of iron ores among the
primitive tribes, which by tradition has a long ancestry. The evidence on 'carburization', 'quenching' and 'tempering' being inadequately represented, no more than broad generalizations are at present possible in regard to these fundamental technological procedures.

The present dissertation concerns itself, in the main, with the beginnings of the Iron Age in India and its coming into its own, both of which took place within the confines of the first millennium B.C.