SYNOPSIS

THE METAL TECHNOLOGY OF THE HARAPPANS AND THE COPPER HOARD CULTURE - A COMPARATIVE STUDY

The cultural significance and artefact typology of the Copper Hoards, distributed in the Indo Gangetic plains, has been one of the less attempted areas of research in South Asian Archaeology. In direct contrast to this we have the Harappan Culture where extensive research has been done in all aspects, may it be pottery, art, architecture or metallurgy. The similarity in the cultural assemblages of these two Cultures excluding the typology of copper artefacts forms the basis of this study. Generally archaeological studies on metal artefacts especially of the Copper Hoards, are much restricted to typology. A few scientific studies on the Harappan and Copper Hoard artefacts, carried out by Mohammad Sanaullah Khan, B.B.Lal, D.P.Agrawal and K.T.M.Hege have used the traditional wet chemical analysis and spectroscopy for the quantitative analysis. However it needs to be mentioned that the earlier studies had restrictions with regard to metallurgical processes and ore artefact correlation on account of lack of appropriate analytical techniques. This thesis in an attempt to determine the chemical composition and technique of manufacture of a few representative copper samples using modern analytical techniques. Using this information a comparative study on the metal
The aim of this study is to reinvestigate the metal technology of the Harappan and Copper Hoard Culture along with a detailed typological study which may help to draw significant information like the alloying pattern, metallurgical processes and smithery techniques used by the two Cultures.

The major objectives of this study are:

1. To analyse the representative samples of both the cultures using modern analytical techniques in order to understand the purity of the metal, alloying patterns and smelting technology.

2. To carry out metallographic studies of the samples using microscopy to reveal the microstructure for understanding the smithery techniques.

3. To make an attempt to trace the sources of raw material for the manufacture of the artefacts.

4. To compare the knowledge of copper metallurgy possessed by these two Cultures.
CHAPTER I INTRODUCTION

This chapter contains general discussions on the status of research in archaeometallurgy in India, a review of the previous work, the aims and objectives of the present study and outline of results.

CHAPTER II ARCHAEOLOGY OF THE HARAPPANS AND THE COPPER HOARD CULTURE

A brief survey of the archaeological background of the two cultures highlighting the cultural assemblages, geographical distribution and copper repertoire is reported here. This chapter also discusses in detail the differences and similarities in the typology of the artefacts.

CHAPTER III METHODOLOGY

This chapter deals with the description of the various scientific techniques, their principles of working, uses in archaeology and their advantages over earlier techniques. The principles of metallography, description of various methods like
grinding, polishing, etching and definition of scientific terms used in the interpretation of the results are also outlined in this chapter.

CHAPTER IV: RESULTS

This chapter is divided into two units: The first reports the sample wise results of the chemical analysis, while the second unit concentrates on the metallography.

CHAPTER V DISCUSSION

The composition and microstructure of each sample has been discussed in this chapter. Based on this, the alloy pattern, smelting technology and metal forging techniques of the two Cultures has been compared.

CHAPTER VI CONCLUSION

The concluding chapter enumerates the inferences drawn from this study and brings out the vast scope for further research in this area.
Statement I

(Statement showing the particulars on which the work is based, the discovery of new facts and of new relationships between facts observed by others and how the work tends to help the general advancement of knowledge.)

The scientific study consisting of quantitative analysis and metallography of samples from Chalcolithic sites has been carried out by earlier workers like Mohammad Sanaullah Khan, D.P. Agrawal, B.B. Lal and K.T.M. Hegde. These studies have used the traditional wet chemical analysis and spectroscopy for the analysis. The use of non-destructive Energy Dispersive X-ray Fluorescence without an external standard for the quantitative analysis metallographic examination is a new approach adopted in this thesis.

A thorough scientific study of the samples from the Copper Hoard Culture has not been attempted so far excepting for a few isolated analysis by Agrawal and Smith before a decade or two. This is for the first time that a comparative study of the metal technology of the Harappan and Copper Hoard Culture has been carried out.
The material used in this study has been obtained from the excavated sites of Harappan and post Harappan affiliation, viz Nagwada, Kuntasi, Pithad and Somnath in Gujarat and Mitathal in Harayana. The Copper Hoard samples are mainly from the Patna Museum collection and are unstratified, chance finds from Bhagrapir in Orissa, Saguna and Hami in Bihar and Madnapur in Uttar Pradesh.

The thesis adds useful information to our existing knowledge of the metal technology of these cultures in the following aspects:

**ALLOY PATTERNS**

1. The quantitative chemical analysis have revealed that only two types of alloys were prevalent during the mature Harappan and late Harappan phases viz tin bronzes and arsenical bronzes.

2. Of these a detailed statistical study has revealed that only tin bronzes were a result of conscious choice while arsenical alloys were still in the experimental stages and the few examples were merely incidental.

3. In the case of the Copper Hoard artefacts all the samples are pure copper and no alloys are noticed.
4. The ornamental pieces from Kuntasi show a high percentage of lead which is significant; as, high content of lead is disadvantages for weapons and tools but helps in objects of art and ornamentation by enhancing the appearance.

SMELTING TECHNOLOGY

1. The iron contents in all the Copper Hoard samples are quite high; while the iron content in the Harappan samples is negligible. This indicates that the smelting technology of the Harappans was superior to that of the authors of the Copper Hoard Culture.

SMITHERY TECHNIQUES

1. The objects from the mature Harappan phase were made in smooth well ventilated moulds as seen in the axe from Nagwada. The inference has been drawn on the basis of the microstructure which does not show any gasholes.

2. The working edges were bevelled in order to attain a sharp cutting edge.

3. Many Harappan objects were cold worked as revealed from the sliplines and cross slip lines on the cutting edge.
4. The Copper Hoard objects show evidence of annealing, but do not indicate any type of cold work.

5. The complete absence of any evidence of cold work suggests that the objects were not put to use.

TRACE ELEMENT PATTERN

1. The study has brought to light that the impurity pattern of the artefacts from Nagwada, Pithad Somnath and Kuntasi, all in Gujarat, are in relative agreement. Such an agreement is usually derived from the similar sources of raw material for the extraction of the metal.

2. Only the samples from Gujarat i.e of Nagwada, Somnath and Kuntasi show the presence of zirconium in traces. This is absent in all other samples. Again, it may be an indication of common source of raw material.

3. The Copper Hoard samples also show a very similar trace element pattern though the samples are from different sites.
Statement II

(Statement indicating the sources of information and the extent to which the thesis is based on the works of others and the portion of the thesis claimed as original.)

The chief sources of information for this study are the published reports of excavations of sites viz. Nagwada, Somnath and Mitathal. The reports of the other sites are not published so far and information pertaining to these is based on personal communication with the excavators. Published data on the chemical analysis of various sites has also been cited in the thesis. For the general information on the research in Archaeology and analytical studies the following reference books were consulted.

3. The Archaeology of India by D.P. Agrawal.
4. The Copper Bronze age in India by D.P. Agrawal.
5. Copper, by F.F. Poland.
7. The principles of Metallographic Laboratory practice, by G.L. Khel.
In addition to this, articles published by various scholars like K.T.M. Hegde, S.P. Gupta and J.P. Northover, excavation reports and monographs were also referred to during the compilation of this thesis.

The portion of the thesis as claimed original are the use of Energy Dispersive X-ray Fluorosence for the analyses and the interpretation of the results. The detailed metallurgical study of the 11 samples from the various Harappan sites and 8 samples of Copper Hoard affiliation is the original contribution of this thesis. In addition to this, the comparative study on the alloy patterns, smithery techniques and trace element pattern of the two Cultures has been carried out for the first time in this study.