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BOOK REVIEWS

Bhardwaj, H. C. *Aspects of Ancient Indian Technology*, Motilal Banarsidass, Delhi, 1979; pp. 212+xvi; 46 tables and 35 figures (mostly photographs). Price: Rs. 60.00.

The book has the subtitle 'A Research Based on Scientific Methods'. It may well be assumed that the author's intention is not to state that other researches on this subject by earlier scholars or the contemporary scientists are not the product of scientific methods and analyses. Perhaps what he wants to convey by this subtitle is that it is a book more on chemistry or metallurgy than on pure archaeology. In fact, the author here has tried to present the result of laboratory studies of selected antiquities from various archaeological sites with special reference to excavated material from Rajghat, near Varanasi. His own laboratory studies are, therefore, confined to only a few objects unearthed from the excavation at Rajghat, the number of samples (5 beads, 5 copper objects, 5 copper coins, 6 silver objects, 5 gold coins etc.), according to the reviewer, being too small for coming to any specific conclusions. Yet the author by way of comparing the results of his analyses with those from other sites have drawn several conclusions which may even prove to be hypotheses in course of further research.

The book, divided into seven chapters, has the appearance of several research papers joined together. In the seventh chapter (Emerging Facts and Problems) the author has made an attempt to place before the reader his own conclusions succinctly. Also, there are two appendices—one on "Experimental procedures" and the other on "List of some ancient copper mines of Bihar, Rajasthan and Uttar Pradesh"—besides an exhaustive bibliography. In three chapters (chapters 4, 5 and 6), the author deals with the ancient Indian copper, silver, gold and iron metallurgy while the chapters 2 and 3 are devoted respectively to the "Ancient Indian Glass Technology" and "Some Technical Observations on N.B.P. Ware Slip". The book has a simple introduction (chapter 1) without a coherent history of metallurgical or metallographic researches on ancient Indian ceramics, glass and metal objects which began in the closing years of the eighteenth century.

The chapter on glass technology is the longest, and one of the important conclusions of the author is that the copper red glass from Rajghat appears to be an indigenous innovation; on the other hand, the Taxila copper-red glasses show foreign influence. He is of the view (p. 168) that though the Harappans did not make true glass, they "had the knowledge of glass making as revealed by the glazed pottery" and that they made "experiments with colouring technique or ceramics specially by using iron and copper compounds both in oxidizing and reducing atmosphere". It was Marshall who had pointed out half a century back that the glazing of pottery is an Indian innovation and practised by the Indus valley people for the first time.

According to the author (pp. 73 and 169), the black colour of the slip of the Northern Black Polished Ware is materially on account of carbon and that the slip was probably "obtained by the application of well levigated emulsion of refined clay and organic liquids (say plant juices) over the dried pots". B. B. Lal, former Chief Archaeological Chemist, Archaeological Survey of India, propounded the theory of the use of organic material resulting in the deposition of carbon on charring. "However, in view of the presence of a detachable clayey slip", says the author (pp. 73-74), "post-firing application of organic liquids looks doubtful". The mystery of the lustrous slip, it is felt, can be fully unveiled only when the experiments on the Northern Black Polished Ware of other shades are carried out, as the colour varies from shades of black and grey, while silvery, golden and other hues are not uncommon.

But for the results of chemical, metallographic and spectrographic analyses on a few copper objects from Rajghat, the chapter on copper metallurgy does not reveal any improvement over D. P. Agarwal's work, *The Copper Bronze Age in India* (1971), in which the same problems and results of investigations have been presented more scientifically with greater clarity, depth and in a wider perspective. In his chapter on silver and gold metallurgy he has tried to establish or reestablish the validity of certain facts: silver is not reported to occur in India as a primary mineral; two secondary sources are, silver associated with gold from the Kolar mines (Karnataka) and silver associated with argentiferous galena; the association of lead as impurity in all the samples, except those from Gungeria, shows that silver was probably extracted from argentiferous galena from the Harappan times (c. 2300 B.C.) down to the present day; the copper-hoard people seems to have their own metal technology and their silver might have been obtained from the alloy electrum; and the sources of local galena are not known though the author feels that there are good chances of rich Bawdwin (Burma) argentiferous galena ore having been smelted for extracting silver in ancient India. The author refers to Hegde's spectrometric studies in the Kshatrapa coins and the latter's conclusion that silver for these coins was not obtained from galena of Zewar mines in Rajasthan. It is well known that *The Periplus of the Erythraean Sea*, of the first century A.D., refers to copper, tin, lead, silver coins, vessels of silver, etc. as items of imports, particularly for western India.

In his chapter on iron metallurgy the author could have fruitfully made use of D. K. Chakrabarti's excellent summary of the history of research on iron metallurgy though Bhardwaj does refer to this article published in the *Antiquity* (1976). The author's conclusion (p. 172) is that "there are more chances of iron metallurgy having been introduced by foreign elements rather being an indigenous development". But he has not put forth any effective arguments to counter Chakrabarti's view that "We do not find any particular reason for disbelieving that this knowledge could be picked up simply by experience" and that "There is also nothing sacred about the notion of the single centre of origin of iron, first dominated by the Hittites". The author accepts the old but quite valid conclusion that there is an apparent continuity between the early and the contemporary pre-industrial traditions of iron metallurgy in India

but fails to refer to A. McWilliam's (1920) article in the *Journal of the Iron and Steel Institute* comparing Hadfield's (1912) analysis of the Delhi pillar with his analysis of the slag of the primitive Mirjati furnaces of Chotonagpur. The author has made use of the Mirjati percentage composition in his Table 45 but evidently he must have got it from M. K. Ghosh's article (1963) on the Delhi iron pillar located in the Qutb complex. All these points do not, however, seriously detract from the value of this study, which is sure to serve as a reference book for any future work in the area of ancient Indian technology or metallurgy.

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Goldstine, Herman H. *Rev/62 A History of Numerical Analysis: from the 16th through the 19th century*; pp. 348, Springer-Verlag, 1977.

The book is the second in the series "Studies in the History of Mathematics and Physical Sciences", brought out by the publisher. The book consisting of five chapters traces the development of numerical analysis during the period in which the foundations of the modern theory were being laid. As the author says in his Preface "To do this I have had to exercise a certain amount of selectivity in choosing and rejecting both authors and papers. I have arbitrarily chosen, in the main, the most famous mathematicians of the period in question and have concentrated on their major works in numerical analysis at the expense, perhaps, of other lesser known but capable analysts". Excepting the first and the last chapter, the other three chapters are titled with the names of the prominent mathematicians connected with the development of numerical analysis. The first chapter begins with the development of numerical approximations carried out by the early Greek mathematicians, Egyptians and Al-Kashi (1400 A.D.), a Samarkhand astronomer and later gives the development of logarithms (by Napier, Briggs) and interpolation methods needed to construct the tables. Tables constructed by Kepler and others are discussed in detail. The other four chapters deal with the developments made by Newton, Euler, Lagrange, Laplace, Legendre, Gauss, Jacobi, Cauchy, Hermite and others. A glance over the book through these chapters gives a good idea of the various results of numerical analysis used in the solution of algebraic equations, difference equations, integration, ordinary and partial differential equations, Fourier series, method of least squares, characteristic value, Laplace transformations. While dealing with a particular topic the author has taken special care to quote from the original work (translated into English) of the mathematician concerned. While discussing a particular topic from two different periods the author has explained the difference in methods or approaches in tackling a particular problem and discussed advantage of one method over the other. Wherever necessary, the author gives details of how the methods were developed while investigating problems in Astronomy, Mechanics and Physics. To make the book more lively

and interesting the author has quoted extracts from the original correspondence of mathematicians. While dealing with Leibniz the author has carefully avoided mentioning about Leibniz—Royal Society controversy (as it is not relevant to the topics discussed) but points out that Leibniz, inspite of his versatality, could not tackle problems of numerical analysis!! He has also noted (mentioned) contributions of a few early 20th century mathematicians like Moulton, Runge, Kutta and others involved in the development of numerical analysis. The book is a very good contribution to the subject of "History of mathematics and physical sciences". It should be mentioned that a person with a basic knowledge of mathematics with interest in the history of science will benefit a great deal by going through the book. The author must be congratulated for making the book as lively and interesting as his other book, *Computer from Pascal to Von Neumann.*

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