AN EXAMINATION OF SOME METAL IMAGES FROM NĀLANDĀ

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CONTENTS

1. INTRODUCTION

NĀLANDĀ was, to use Broadley's words, 'the most magnificent and most celebrated seat of Buddhist learning in the world'.[1] With its traditional origin in the third century B.C. at the time of Aśoka, or even earlier,[2] it gained importance between the fifth and seventh centuries A.D., more accurately during the period intervening between the visits of the Chinese pilgrims Fa-hien (405-11), who saw only a modest establishment here, and Hiuen Tsang (630-45), who admiringly describes the glory of the monasteries at the place, the erudition and renown of its teachers and the disciplined life of its students.[3] Nālandā became the chief centre of the Mahāyāna school of Buddhism, and its influence radiated far and wide.

2. THE BRONZES OF NĀLANDĀ

The ruins of Nālandā, in District Patna, Bihar, have been extensively excavated.[4] Considering the extent of the ruins, the number of stone images unearthed in the excavations is relatively small. The Nālandā artist was evidently a master in modelling small pieces, probably because he was an adept in producing bronzes which could not easily be made in large sizes. Nālandā was a centre of a flourishing metal-industry, and more than five hundred excavated bronze images, mostly of Buddha and Mahāyāna Buddhist deities, ranging in date from the eighth to twelfth centuries, testify to the high technical and metallurgical knowledge which the craftsman had attained in bronze-casting and

[1] A. M. Broadley, *Ruins of the Nālandā Monasteries at Burgaon* (Calcutta, 1872).

[2] F. Anton von Schiefner, *Tāranāthas Geschichte des Buddhismus in Indien* (St. Petersburg, 1869).

[3] J. Legge, *A Record of Buddhist Kingdoms* (Oxford, 1886), p. 81; T. Watters, *On Yuan Chwang's Travels in India* (London, 1904), II, pp. 164 ff.

[4] *An. Rep. Arch. Surv. Ind.*, 1922-23 and subsequent years; A. Ghosh, *Guide to Nālandā*, 3rd. ed. (Delhi, 1946).

metal-working. Artistically, the images show an elegance of form, good proportion and graceful expression (pls. XIV and XV).

The influence of the Nālandā school of bronze sculpture was not confined to the frontiers of India but found its way to the Eastern Archipelago, where a large number of Buddhist bronzes recovered from different sites demonstrate a close stylistic and iconographic affinity to the Nālandā tradition.[1] It is interesting to remark in this connexion that according to Tāranātha, the Tibetan historian of Buddhism of the seventeenth century, Nāgārjuna, the famous Mahāyāna philosopher and alchemist of the second century, lived and studied at Nālandā.

3. INDIAN BRONZES AND THEIR TECHNIQUE

Indian bronzes have a long history behind them, going back to the times of the Harappa culture.[2] Hardly any bronze specimens are available after the disappearance of that culture till we come to the first-second centuries A.D., of which period Taxila has yielded a few specimens;[3] they are not, however, very impressive in finish and workmanship. During the Gupta period metal-casting reached a very high level of technical excellence and metallurgical skill, and life-size images were cast, as is evident from the fifth-century copper image of Buddha from Sultanganj, District Bhagalpur, Bihar, now in the Birmingham Museum.[4]

Contemporaneously with Nālandā, there were other schools in north India where this form of plastic art was practised. Kurkihar, District Gaya, Bihar, has, for example, yielded some two hundred and forty bronzes of the same period and art-tradition as Nālandā.[5] A hoard of Buddhist bronzes, of a somewhat earlier period, has been found at Sirpur, District Raipur, Madhya Pradesh.[6]

South India had a tremendous activity in metal-working during the Choḷa period (ninth-thirteenth centuries), which saw the culmination of the art and produced the finest bronzes of south India. Nagapattinam, District Tanjore, Madras State, has yielded nearly four hundred solid and elegant Buddhist bronzes of great artistic merit.[7] The art continued in south India throughout the succeeding centuries, but the climax of workmanship ended with the Choḷa period.

The traditional method of bronze-casting in India has been the *cire perdue* or 'lost wax' process, wherein the subject is first modelled in wax and then evenly covered with clay; the wax is later removed by melting and into the clay mould thus left is poured molten metal or alloy for casting a solid image. In the case of hollow images, such as were made in Nepal, the subject is first modelled in clay; this core is then evenly coated

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[1] E. J. Bernet Kempers, *The Bronzes of Nālandā and Hindu-Javanese Art* (Leiden, 1933).

[2] J. Marshall, *Mohenjo-daro and the Indus Civilization* (London, 1931), I, pp. 44-45; M. S. Vats, *Excavations at Harappā* (Delhi, 1940), I, p. 381. M. Sanaullah, in Vats, *op. cit.*, thinks that the *cire perdue* process was probably unknown to the Harappans, but in view of the available evidence the statement is untenable.

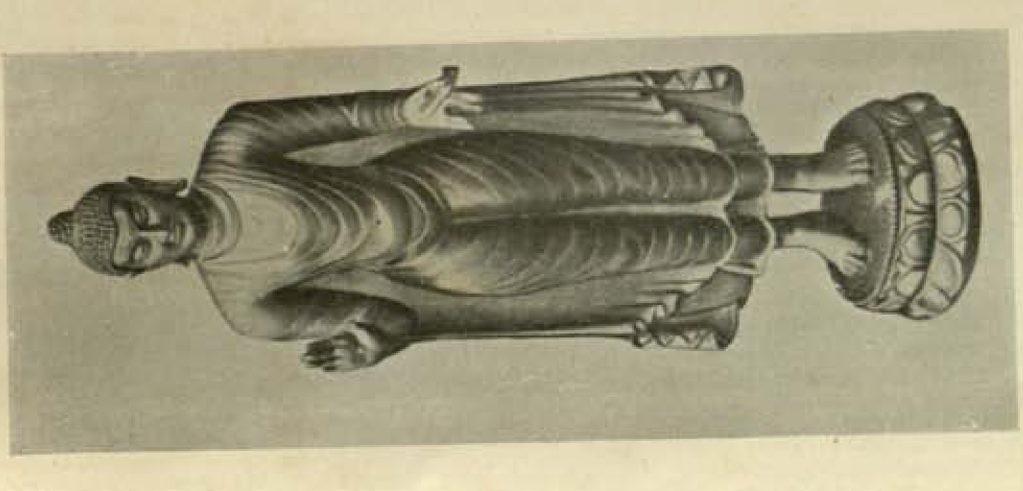
[3] J. Marshall, *Taxila* (Cambridge, 1951), pls. 185-86.

[4] For illustration, see A. Coomaraswamy, *History of Indian and Indonesian Art*, pl. XLI.

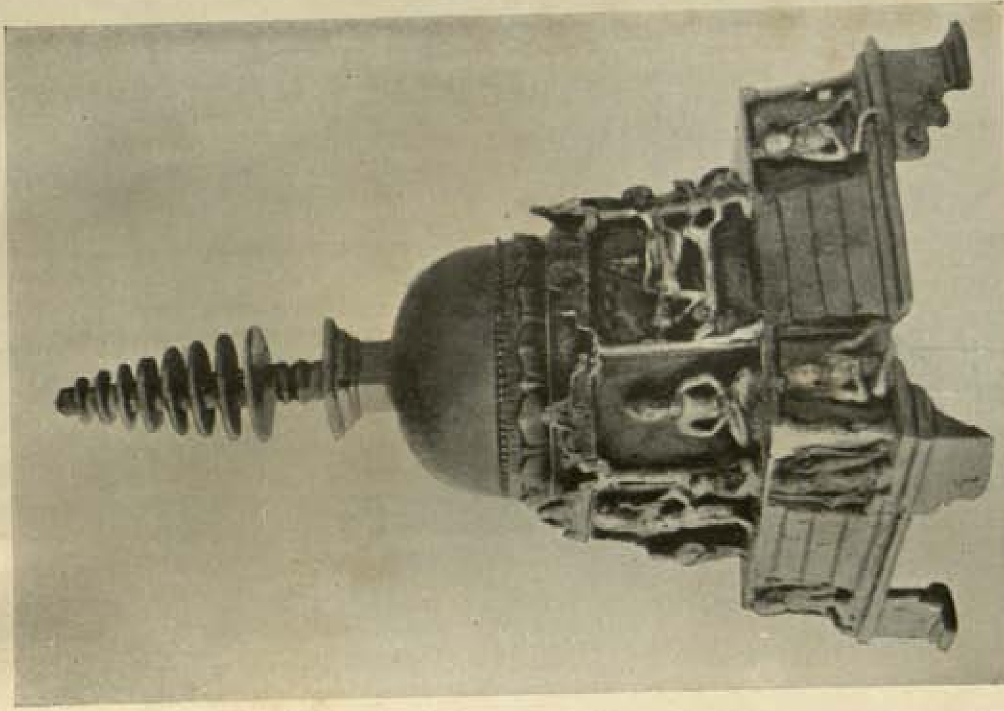
[5] Some of the Kurkihar bronzes are described and illustrated by K. P. Jayaswal in *Jour. Ind. Soc. Oriental Art*, II (1934), pp. 70 ff.

[6] *Indian Archaeology* 1954-55—*A Review* (New Delhi, 1955), p. 24.

[7] T. N. Ramachandran, *The Nāgapaṭṭiṇam and other Buddhist Bronzes in the Madras Museum*, Bull. Madras Govt. Mus., N. S., VII, no. 1 (Madras, 1954).



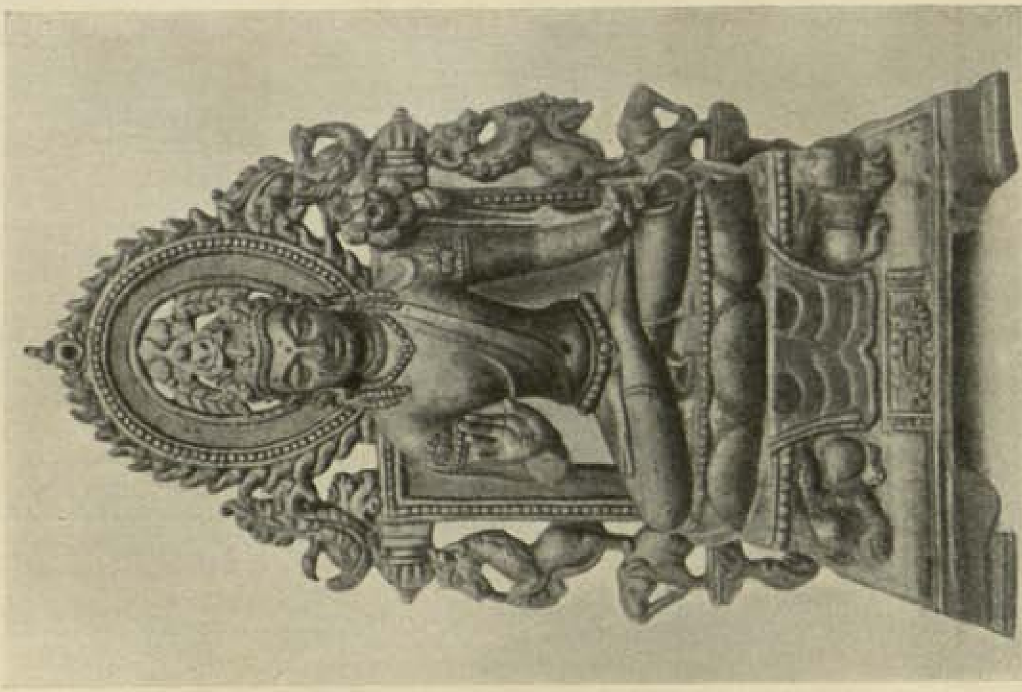
A



B

Bronzes from Nālandā. Height, A, 11 in., B, 1 ft. 4 in.

A



B

Bronzes from Nālandā. Height, A, 1 ft. 8 in., B, 1 ft.

with wax, which in turn, is coated with a layer of clay. After dissolving the wax away by heating, the mould is used for casting the bronze.

This summary account of ancient Indian bronzes shows that the art of casting bronzes went back to remote antiquity and was practised till recent times. These bronzes give us an idea of the beginning, development and decadence of the art through the ages.

4. CHEMICAL ANALYSIS

No chemical analysis of the Nālandā bronzes, representing as they do a very important stage in technical skill and metallurgical knowledge of ancient India, seems to have been published so far, and very little is known about their forging, casting, soldering, heat-treating, etc. It was, therefore, thought desirable to institute a systematic enquiry into these problems by undertaking a detailed examination of a few representative Nālandā bronzes. The present paper embodies the result of chemical analysis carried out by the writer and records, for the first time, some scientific data about them.

Most of the bronze specimens were covered with green patina and corrosion-products when excavated out. For the preparation of the specimens for quantitative chemical analysis the patina and corrosion-products were removed, and the sound metallic core, wherever available, was selected for analysis. The results of chemical analysis are given in the accompanying table (p. 56).

One sample, completely mineralized, gave the following composition:—
Cu, 70·69; Sn, nil; Pb, nil; Fe, 0·60; Zn, 5·40; Ni, tr.; total 76·69.

When calculated to 100 per cent, the composition becomes:—
Cu, 92·17; Sn, nil; Pb, nil; Fe, 0·78; Zn, 7·04; Ni, tr.; total 99·99 %.

The sample, therefore, represents an alloy of copper and zinc, in other words brass.

From the table it will be seen that specimens 7, 8, 10 and 17 are composed of copper containing minute amounts of tin; specimens 9, 11, 16 and 18 are brass; and the remaining specimens represent bronze. Most of them contain appreciable quantities of lead, which was evidently added to render the alloys more fluid and better-suited for casting. Specimen 11 is of brass, as it contains more than 7 per cent of zinc. Specimens 3, 4, 5, 13 and 14 are high-tin bronzes, containing 14·62 to 23·68 per cent of tin. The four copper specimens, 7, 8, 10 and 17, contain small amounts of tin, lead, zinc and iron as impurities. Most of the specimens contain minute amounts of nickel, and the others contain traces of it. It is significant that no specimen is completely free from nickel. Only three specimens, 11, 12 and 13, have been found to contain traces of arsenic, and specimen 6 contains an appreciable amount of antimony. Another significant fact revealed by these analyses is the presence, in small quantities, of zinc in most of the specimens. The presence of arsenic in traces in a few specimens only indicates that the method of smelting copper was more refined than in the Harappan times, as objects from that culture have been found to contain a much higher proportion of arsenic as an impurity.[1]

5. SOURCES OF THE MATERIAL

As the number of bronzes unearthed at Nālandā is very large, it is evident that the Nālandā craftsman must have had a copious supply of copper for casting the images.

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[1] Marshall, *op. cit.*, II, p. 484.

No. and description	*Sn*	*Pb*	*Cu*	*Fe*	*Zn*	*Ni*	*As*	*Sb*	*So₃*	*Mn*	*Total*
1. Sound metallic core	9·10	5·00	79·60	5·80	...	tr.	...	...	...	0·30	99·80
2. Sound metallic core	8·99	3·12	82·19	4·16	1·81	0·11	...	...	...	...	100·38
3. Heterogenous core	16·19	2·78	76·98	0·36	...	0·05	...	...	...	...	96·36
4. Sound metallic core	23·68	...	75·54	tr.	...	tr.	...	1·8	...	...	99·22
5. Sound metallic core	14·62	2·64	81·23	0·92	0·44	tr.	...	...	...	...	99·85
6. Heterogenous and corroded core ...	7·88	...	79·71	3·21	4·82	tr.	...	1·48	...	...	97·10
7. Sound metal ...	1·19	2·22	91·62	1·39	2·61	0·18	...	...	...	...	99·21
8. Corroded metal ...	0·08	0·04	97·14	0·48	...	0·09	...	...	...	...	97·83
9. Sound metallic core	0·40	2·08	79·58	1·12	1·64	1·20	...	...	...	...	100·02
10. Sound metallic core	0·20	0·05	97·85	0·77	0·10	0·20	...	...	...	...	99·17
11. Sound metallic core	1·15	3·10	85·25	2·41	7·54	0·09	tr.	tr.	...	...	99·54
12. Corroded metallic core ...	8·90	5·17	80·20	3·86	...	0·09	tr.	tr.	...	...	98·22
13. Sound metallic core	15·60	2·55	78·75	2·30	...	0·18	tr.	tr.	...	...	99·38
14. Sound metallic core	15·09	3·06	80·84	1·30	0·05	0·08	...	...	...	...	99·98
15. Sound metallic core	8·70	5·93	82·15	2·67	0·06	0·42	...	...	0·31	...	99·93
16. Sound metallic core	0·74	3·03	78·95	1·47	15·15	0·65	...	...	...	...	99·99
17. Slightly corroded metallic core ...	1·93	...	93·07	2·07	1·91	tr.	...	...	...	...	98·98
18. Sound core ...	1·29	...	79·98	2·57	16·00	tr.	...	...	...	...	99·84

In this connexion it may be observed that in Hazaribagh District in Bihar extensive remains of ancient copper-workings have been found.[1] Here copper pyrites occurs together with a little galena and zinc blende. Since most of the Nālandā alloy-specimens from the images have been found to contain both zinc and lead, it is very likely that the Hazaribagh copper-ore was used by Nālandā artisans for smelting copper for their bronzes. The Hazaribagh copper-workings, it may be observed, are only about 200 miles away from Nālandā.

[1] J. Coggin Brown, *India's Mineral Wealth* (Oxford, 1936), p. 90.

The source of tin which was used for casting bronzes can also be traced to Hazaribagh District, where the tin-ore casseterite has been found in four localities.[1] The tin-mines of Hazaribagh are no doubt at present poor, but they may have been richer in early days and may have formed a very convenient source of the metal at Nālandā. The results of the analysis show that in nine specimens, the proportion of tin ranges between 7·88 per cent and 23·68 per cent, whereas four specimens show tin between 1 and 2 per cent, and only two contain less than 1 per cent. The presence of tin to the extent of only 1 to 2 per cent cannot be considered as an intentional addition. These six specimens of the latter group are not bronze, but three of them are really brass as they contain more than 7 per cent zinc; the remaining three of this group can be described as copper objects containing small amounts of tin, zinc and lead as impurities.

It is significant that most of these specimens are free from arsenic but nickel is invariably present, if in traces. Minute traces of impurities present in ancient objects are of special importance, as sometimes they are characteristic of the ores from which the metal was smelted and hence serve as valuable clues to the source of the original ores. In the absence of facilities for spectrographic work, this aspect of the problem could not be investigated, but the chemical analysis has shown that the Nālandā bronzes are characterized by the presence of nickel.

6. CONCLUSION

The data recorded here show that both bronze and brass were used for casting images. The close proximity of tin and copper mines of Hazaribagh was largely responsible for the growth of metal-casting at Nālandā, and high-tin bronzes were not rare. A systematic metallurgical examination of a sufficiently large number of representative bronzes, together with a spectroscopic examination, can furnish material evidence regarding the metallurgical processes employed at Nālandā, and to this extent, the analytical data based on chemical examination are incomplete. The results presented in this paper are, nevertheless, essential to a clear understanding of the composition of alloys employed and the sources of the metals used. Further examination is, however, under way and is likely to contribute materially to our knowledge of ancient metallurgy.

The author's grateful thanks are due to his colleagues in the Department for the preparation and preliminary examination of the samples and the photographs.

[1] Coggin Brown, *op. cit.*, p. 103.

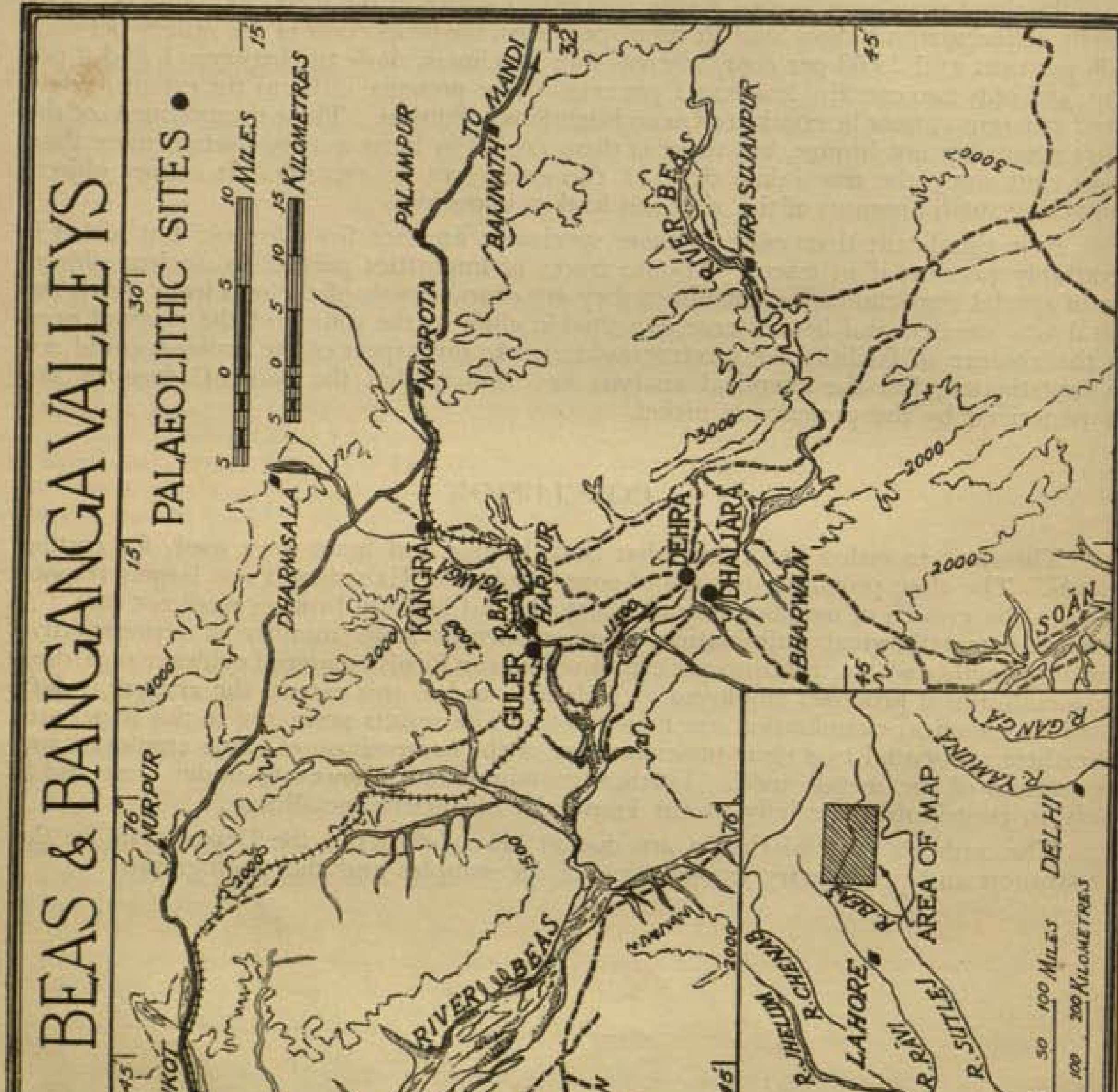
BEAS & BANGANGA VALLEYS
PALAEOLITHIC SITES
MILES
KILOMETRES
PATHANKOT
NURPUR
DHARMSALA
KANGRA
NAGROTA
PALAMPUR
BAIJNATH
TO MANDI
GULER
HARIPUR
R. BANGANGA
DEHRA
DHALIARA
BHARWAIN
TIRA SUJANPUR
RIVER BEAS
MUKERIAN
SOAN
R. INDUS
R. JHELUM
R. CHENAB
LAHORE
R. RAVI
R. SUTLEJ
R. BEAS
AREA OF MAP
DELHI
R. YAMUNA
R. GANGA

Fig. 1