TECHNICAL NOTES

THE RED PAINT, LIME-WASHES AND PLASTERS ON BHUVANESWAR AND KONĀRAK TEMPLES

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Red paint on the Mukteśvara temple

SOME of the important temples at Bhuvaneswar and a few sculptures of the Konārak temple, Orissa, appear to have been coated white, plastered and painted red. M. M. Ganguli[1] says that the red paint does not seem to be a simple compound but a complex mixture of several ones in definite proportions, and in his support quotes from the *Bṛihat-saṁhitā* (lvi, 1-3), which states that the paste is composed of the precipitate of unripe *tinduka* and *kapitthaka* (*katbelā* in Hindi) fruits, blossom of *śālmalī* (silk-cotton, etc., boiled in a quantity of water and mixed finally with exudation of *sarja* tree or turpentine, resin, linseed etc. The possibility of another paste consisting of *lākshā* (lac), the kernel of the *bel* fruit, turpentine etc. is also entertained by him.

A sample of the red paint from the Mukteśvara temple at Bhuvaneswar was found on analysis to be free from organic matter. Nitrogen, as tested by Lassaigne method, was found absent and no carbonaceous matter could be detected. It was found to contain 36·42 per cent of Fe_2O_3 which accounts for the red tint. A sample of red ochre was collected from the Bhuvaneswar market for comparison with the red paint from the Mukteśvara temple and was found to contain 58·8 per cent of Fe_2O_3, being free (like the red paint) from manganese oxide (MnO), a common impurity in haematite. The ferric oxide content shows that it is not a high grade local red ochre, which is reported to contain about 84 per cent to 91 per cent of ferric oxide.[2] The analytical data of the two samples are given below for comparison :—

Samples	$-H_2O$	$+H_2O$	Sand and clay	[3]Fe_2O_3	Mno	CaO	MgO	TiO_2	P_2O_5	SO_3	Total
Red paint from Mukteśvara temple ...	1·95	16·42	40·97	36·42	Nil	2·24	1·17	...	...	1·56	100·73
Red ochre from Bhuvaneswar market ...	2·01	8·42	28·90	58·80	Nil	1·10	·13	Nil	Nil	Nil	99·36

[1] *Orissa and Her Remains* (Calcutta, 1912), pp. 253ff.

[2] J. Coggin Brown, *India's Mineral wealth* (Oxford 1936), pp. 106ff. The Fe content of Orissa haematite is 60%-64%; therefore Fe_2O_3 is 84%-91%.

[3] These figures include Al_2O_3 if any.

From the figures of the above table, it can be inferred that the red paint on the Mukteśvara temple was either a poor quality of red ochre or a mixture of clay with a high grade local red ochre (haematite)[1] free from manganese oxide. For tinting the blocks of stones, the powder was crushed fine, mixed with plain water and the blocks dipped in this solution or painted with a brush. In some cases the red paint was applied after lime-wash. Different shades of red can be obtained from iron oxides and have been given various trade names, i.e., Chinese red, Naples red, Terra Rosa[2], Indian Red, Light Red, etc.[3] Thus the results of the analysis do not lend support to the conjectures of Ganguli.

Whitewash and plaster

Lime and gypsum are commonly employed in whitewashing, plasters and mortars. To know what was the composition of the white coatings on the Bhuvaneswar group of temples, the examination and analyses of a few samples were taken up, and it was found that lime had been applied on the temples in different stages, as there were distinctly separate thin layers. On the sculptures of the Liṅgarāja temple there is a layer of thin lime-plaster, probably meant to hide bad workmanship.[4] The proportion of lime to sand in this plaster is 3 : 1. The thin white coatings on the Paraśurāmeśvara and Mukteśvara temples and on the Konārak one are very rich in lime content ($CaCO_3 + MgCO_3$ being 90·59 per cent, 96·63 per cent and 91·54 per cent respectively) and do not seem to contain any intentionally added sand. These are therefore simple lime-washes—each wash being represented by one separate coating. The number of these coatings differs in different temples and sculptures. From chemical analyses it is difficult to say whether the source of this lime is shell, limestone or *kankar*.[5] The lime-plaster from inside the *vimāna* of Konārak is ·56 cms. in thickness and consists of 4 parts of lime and 3 parts of sand. This is a coarse plaster and forms the first coat on the stone-surface. The plaster is contaminated with chlorides because the monument is situated near the sea. The tables below give the analyses of the above samples of lime-wash and plasters as well as the analyses of a few specimen of plaster from Nālandā, Mohenjo-daro, Harappā and Egypt, included here for comparative study.

[1] D. N. Wadia, *Geology of India* (London 1919), p. 302.
[2] J. W. Mellor, *Inorganic and Theoretical Chemistry*, III, Fe, (Pt. II), (London 1923), p. 782.
[3] *Technical Studies* (Lancaster, Pennsylvania), April 1939, pp. 230 and 235.
[4] Ganguli, *op. cit.*, p. 259.
[5] Brij Narayan, *Detailed Specifications for Orissa* (Orissa, P.W.D.)

TABLE I

Locality, specimen and rough date	$-H_2O$	Clay and sand	Fe_2O_3 etc.	CaO	MgO	P_2O_5	SO_3	Cl	CO_2 & $+H_2O$	Total	Remarks
Lime-wash, Parasurāmeśvara temple, seventh-eighth century	·79	7·27[1]	1·84	49·22	1·14	Tr.	·63	Tr.	39·38	100·57	$CaCO_3$ = 87·61 $MgCO_3$ = 2·98 90·59
Lime-wash, Muktesvara temple, eighth century	nil	4·62[1]	·95	53·72	·48	...	·56	Tr.	40·32	100·65	$CaCO_3$ = 95·62 MgCO = 1·01 96·63
Lime-wash, figure on *jagamohana* Konārak, thirteenth century	·84	1·46[1]	1·50	51·16	·24	Nil	0·5	Tr.	44·24	99·49	$CaCO_3$ = 91·06 $MgCO_3$ = ·48 91·54
Plaster, Lingarāja temple, tenth century	·68	19·26[1]	5·62	37·30	3·12	Nil	·78	·23	33·31	100·30	$CaCO_3$ = 66·39 $MgCO_3$ = 6·35 Lime : sand 72·74 = 3 : 1
Plaster, interior of *vimāna*, Konārak, thirteenth century	3·14	35·89[1]	3·00	30·72	·16	Nil	·38	·51	25·70	99·50	$CaCO_3$ = 54·68 MgCO = ·33 Lime : sand 55·01 = 4 : 3
Plaster, Nālandā, site no. 3	2·24	27·52[1]	7·84	33·95	1·13	...	·27	...	25·84	98·79	$CaCO_3$ = 60·10 $MgCO_3$ = 2·37 Lime : sand 62·47 = 2 : 1
Another plaster from Nālandā	2·16	23·41[1]	5·54	34·78	1·30	...	·40	NaCl 2·40	30·30	100·29	$CaCO_3$ = 61·58 $MgCO_3$ = 2·72 Lime : sand 64·30 = 2 : 1
Lime-mortar,[2] Egyptian, Roman period	...	29·10	4·00	34·7	2·1	...	·9	...	29·2	100·00	$CaCO_3$ = 61·77 $MgCO_3$ = 4·41 Lime : sand 66·18 = 2 : 1

[1] The portion of the sample insoluble in 3% HCl shows clear particles of sand and clay under microscope and has therefore been accounted for as sand and clay in the analyses. It represents the sand intentionally added to lime to form plaster.

[2] A Lucas, *Anicent Egyptian Materials and Industries* (London, 1934), pp. 415ff.

TABLE II

Locality and specimen	$CaSO^4$ (hydrated)	Clay and sand	$Ca\,CO_3$	$MgCO_3$	Fe_2O_3	Alkaline salts	Moisture	Undetermined	Total	Remarks
White- wash, Ancient Egyptian, from the 'Cache of Akhanaten, XVIIIth Dynasty'[1]	1·5	11·0	87·5	...	...	...	...	...	100·0	
Gypsum-plaster, Ancient Egyptian (from tomb of Tutankhamun)[1]	78·2	10·8	11·0	...	...	...	...	...	100·0	
Gypsum-mortar, Ancient Egyptian (from the Sphinx)[1]	66·9	25·5	Tr.	·8	2·0	...	...	4·8	100·0	Lime : sand= 2 : 1
Mortar, Mohenjo-daro wall (HR-site), third millennium B.C.[2]	74·12	20·41	2·50	...	...	1·18	1·79	...	100·0	Lime : sand= 4 : 1
Mortar, Mohenjodaro vat (HR-site), third millennium B.C.[2]	Nil	21·71	69·58	...	...	5·44	3·27	...	100·0	Lime : sand= 3 : 1
Pointing of circular platform, P_6 Harappā, Trench V, Mound F, third millennium B.C.[3]	56·90	42·16	·94	Nil	...	...	Nil	...	100·0	Lime : sand= 4 : 3
Lump, Harappā, Mound F, third millennium B.C.[3]	Nil	34·85	56·01	4·81	...	...	4·33	...	100·0	Lime : sand= 2 : 1

[1] Lucas, *op. cit.*
[2] J. Marshall, *Mohenjo-daro and the Indus Civilization* (London, 1931), II, p. 689.
[3] M. S. Vats, *Excavations at Harappā* (Delhi, 1940), I, p. 469.

Thus it is seen from the above tables that the Bhuvaneswar, Konārak and Nālandā samples do not contain gypsum (hydrated $CaSO_4$) but are composed of lime and sand in different proportions, depending upon the nature of plaster or mortar required, while free use of it was made in Mohenjo-daro, Harappā and Egypt.

Summary

This work was undertaken to investigate the nature of extraneous coatings on some of the important temples of Bhuvaneswar and Konārak in Orissa and to afford a comparison of the results obtained with similar materials from Nālandā, Mohenjo-daro, Harappā and Egypt. The results of investigations are as follows :—

1. The red paint on the temples does not consist of organic matter but seems to be a simple mixture of local haematite and clay mixed to give the desired tint. The use of organic compound for red paint as suggested by Ganguli is therefore out of question.
2. The sculptures of Paraśurāmeśvara and Mukteśvara temples at Bhuvaneswar and of the Konārak temple were lime-washed at different intervals of time, and those of Liṅgarāja coated with fine plaster consisting of 3 parts of lime and 1 part of sand.
3. The inside of the *vimāna* of the Konārak temple was plastered with a coarse plaster consisting of 4 parts of lime and 3 parts of sand.
4. There is absence of gypsum in the plaster samples from Bhuvaneswar, Konārak and Nālandā, quite unlike the much older plasters and mortars of Mohenjo-daro, Harappā and Egypt.

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