

# ANALYSIS OF METALLIC COMPOSITIONS OF KUSHANA COPPER COINS OF ORISSA STATE MUSEUM

V. Vijayan<sup>1</sup>, T. R. Rautray<sup>1</sup>, B. Mallick<sup>1</sup>, Jayanti Rath<sup>2</sup>, R. K. Choudhury<sup>1</sup>, C. B. Patel<sup>2</sup>

<sup>1</sup>*Institute of Physics, Bhubaneswar, India-751 005*

<sup>2</sup>*Orissa State Museum, Bhubaneswar, India-751 014*

## Abstract

Analysis of metallic compositions of coins can provide valuable information regarding coin minting, methodology, provenance, art, culture and economics of the minting time. External Proton induced X-ray emission (PIXE) is a good scientific method for non-destructive analysis of coins preserved in museum. Ten Kushana copper coins (3<sup>rd</sup>-4<sup>th</sup> century A. D.) from the Orissa State Museum, Bhubaneswar have been analysed, for the first time, by using an external beam PIXE facility at Institute of Physics. Our study reveals that copper is the main constituent of the Kushana coins, with minor/trace elements like titanium, iron, and nickel, zinc, lead and bismuth.

## Introduction

A nomadic tribe, known to the Chinese as *Yaeh-Chi*, left their homeland on the Chinese frontier early in the 2<sup>nd</sup> century B. C. and arrived in the Oxus region and settled in Bactria. After having dwelt there for about a century, a prince of the *Kue-Shuang* (Kushana) branch of the *Yuechchis* invaded Parthia or parts of the Indo-Parthian realm in Afghanistan and occupied central Afghanistan, Gandhara and lower swat valley. His successors spread their rule in the region of northern India, which had hitherto escaped foreign invasion. The Kushanas occupied the land upto Varanasi in the east and had extended considerably beyond the Indian frontiers in the west. They had, thus built a vast empire, which lasted for about a century.

The earliest copper coins of Kushanas in India were issued by Kujula Kadphises. The earliest of them bear the bust of the Hermacus, the last of the Bactrian ruler, on the obverse and Herakles on the reverse. The obverse of these coins bears the well-known variety of standing figure of the king dressed in Indo-Scythian costume. The reverse contains the standing deity with crescent (some times on right side and often in left side of the effigy) This symbol represents (Mao) the moon God. These coins are of die-struck types. They are quite heavy in weight.

The abundant finds of Kushana copper coins from several parts of Orissa i.e. Mayurbhanj, Keonjhar and Balasore implies that these might have continuous trade relation of imperial Kushanas of Northern India with ancient Orissa. The possibility of the Kushana copper coins being treated as currency (tentatively from 3<sup>rd</sup> to 4<sup>th</sup> century A. D.) of this region may not be ruled out.

The Orissa State Museum possesses a rich collection of Kushana coins of different rulers i.e. Wima Kadphises, Kanishka, Huvishka and Vasudeva. The several hoards of imitation Kushana coins (popularly known as Puri Kushana coins) found in different parts of Orissa suggest that these coin types gained much popularity in ancient Kalinga. It may be mentioned that such Puri-Kushana coins have been discovered from stratified deposit from the excavated site of Sisupalgarh (ancient Kalinganagar) near Bhubaneswar. Interestingly, these coins have been dated between 2<sup>nd</sup> and 4<sup>th</sup> century A. D..

Coins were introduced as trade things of daily usage in Asia and Europe in 6<sup>th</sup> century B.C.. The commonly used metals in minting coins include gold, silver, copper, iron, tin, lead and zinc. First step of a numismatist's work, the visual examination, may not always be sufficient to classify the coins, which requires elemental analysis. Metallic compositional analysis of ancient coins shows increasing interest in recent years and can give valuable information on different aspects of life, politics, society, religion, art, culture, economy and metallurgy of the minting time [1]. External proton induced x-ray emission like technique is most widely used for analysis of metallic compositions of coins due to its well-known features like multi elemental capabilities, high sensitivity and simple or virtually no need for sample preparation stage [2-3]. First step of a numismatist's work, the visual examination, may not always be sufficient to classify the coins, which requires elemental analysis.

## **Experimental**

The proton beam of 3 MeV energy was obtained from the 3 MV tandem type pelletron accelerator of Institute of Physics, Bhubaneswar, and collimated by a graphite collimator to a beam size of 2-mm diameter. The beam was extracted into air using a Kapton<sup>TM</sup> foil (8-micron thickness) at the exit point of a vacuum scattering chamber [4]. The coins were kept in air over a sample stand making an angle of 45<sup>0</sup> to the beam direction. The coins were irradiated with maximum beam current of 20nA. A Si (Li) detector having energy resolution of 170 eV at 5.9 KeV was placed at 90<sup>0</sup> with respect to the beam direction was used to detect characteristic X-rays emitted from the target [5]. A 25-micron thick aluminium absorber (with 6% hole) was kept in front of

the detector to attenuate the bremsstrahlung background and the dominant low energy X-ray peaks. Spectra were recorded by using a PC based multi channel analyzer. The data was analysed using GUPIX software.

## Results & discussion

The copper Kushana coins have been found in abundance in several parts of Orissa and its contiguous regions. Their discovery shows that the Kushana copper coins were actually treated as currency of this region [1]. The imitation Kushana coins are popularly known as “Puri-Kushana” coins among the scholars. The obverse of these coins bear the well known variety of standing figures of a Kushana type king and pointing with his right hand downwards or curved upwards and left arm extended. The reverse shows the Kushana figure, properly intended for the figure of moon-god with right arm curved upwards and crescent above the left shoulder.

The weight of the studied Kushana copper coins varied from 4.57 to 10.52 grams as given in Table1. The variations in the concentrations of metals in the coins are as follows: The concentration of copper varied from 80.54 to 95.84 %, the concentration of zinc varied from 0.30 to 6.99 %, the concentration of iron varied from 0.85 to 9.50 %, the concentration of lead varied from 0.56 to 13.39 %. The analysis also reveals the presence of other metals such as titanium (0.09-0.65 %), nickel (0.12- 0.88 %) and bismuth (0.11-0.76 %). The metallic compositions of Kushana copper coins are given in Table2 and the photograph of the Kushana coins are shown in Fig.1.

Table.1: Weight and dimensions of Kushana copper coins

Coin No.	Weight (gm)	Diameter (cm)
Coin1	10.52	2.3
Coin2	8.99	2.3
Coin3	9.03	2.1
Coin4	8.38	2.2
Coin5	4.57	2.0
Coin6	7.05	2.1
Coin7	9.35	2.1
Coin8	8.52	2.1
Coin9	9.52	2.1
Coin10	5.90	2.0

Table.2: Concentrations (in %) of various metals in Kushana copper coins

Metal	Coin1	Coin 2	Coin3	Coin4	Coin5	Coin6	Coin7	Coin8	Coin9	Coin10
Titanium	0.25	0.09	0.15	0.16	0.22	0.20	0.13	0.59	0.49	0.65
Iron	3.77	1.06	1.00	1.04	1.21	1.18	0.85	3.84	7.19	9.50
Nickel	0.12	0.31	0.22	0.24	0.25	0.26	0.19	0.88	0.23	0.30
Copper	88.11	93.55	80.54	93.82	92.52	95.41	95.84	86.24	81.80	84.03
Zinc	1.21	0.30	1.81	1.90	1.89	1.92	1.53	6.99	2.29	3.03
Lead	4.92	4.16	13.39	2.49	2.41	0.56	0.20	0.85	7.09	2.08
Bismuth	0.45	0.33	0.70	0.11	0.33	0.20	0.11	0.25	0.76	0.27

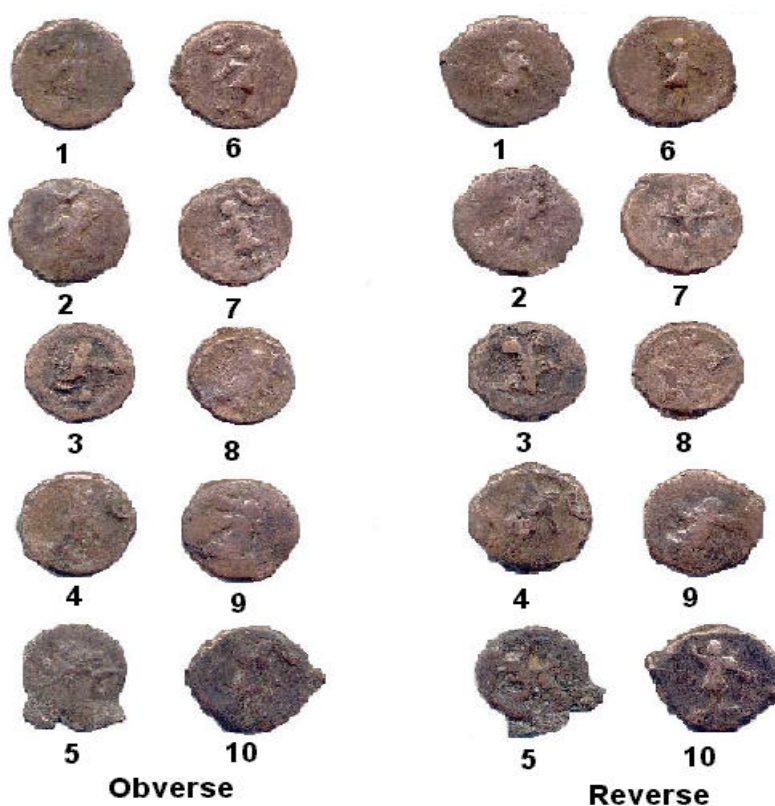


Fig. 1 Both sides of Kushana copper coins

### Conclusion

The ancient Kushana copper coins have been analysed non-destructively using the external PIXE set up at Institute of Physics, Bhubaneswar in collaboration with Orissa State Museum. The analysis reveals that copper is present as the major element in the Kushana coins alongwith minor/trace elements like titanium, iron, nickel, zinc, lead and bismuth.

## References

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Dr. V. Vijayan is the Health Physicist of Institute of Physics, Bhubaneswar-5  
Shri. T.R.Routray is the Project Assistant of Institute of Physics, Bhubaneswar-5  
Shri. B.RMallick is the Scientific Assistant of Institute of Physics, Bhubaneswar-5  
Smt. Jayanthi Rath is the Assistant Curator of Orissa State Museum,  
Bhubaneswar-14

Dr. R. K. Choudhury is the Director of Institute of Physics, Bhubaneswar-5  
Dr. C. B. Patel is the Superintendent of Orissa State Museum, Bhubaneswar-14