

Two papers on Ostracoda were presented by S. P. Jain (Chandigarh) and M. S. Rao (Waltair). Jain's paper on "Ostracodes from the Bagh beds of Madhya Pradesh" dealt with a rich assemblage of species and its value in fixing the age of the beds. Rao's paper on "Recent Ostracoda from the continental shelf of East Coast of India" dealt mainly with the evolution of the environment as indicated by the fauna.

The paper by S. B. Bhatia and A. K. Mathur (Chandigarh) on "Some Pliocene Charophyta from the Siwaliks" was the only contribution on fossil algae. It provided an account of a rich charophytic flora from the Middle Siwalik rocks of the Himalayas and was considered as a major addition to the knowledge of the charophytic remains from India which were, until recently, from the central regions of the country only. The paper by S. S. Gowda and S. S. Kumar (Bangalore) on "The Microfossils from the Type Rocks of Dharwar Group" dealt with the acritarchs and their significance in the classification and correlation of the Dharwar Group of rocks in Mysore State. Implications of this discovery of microfossils in the correlation of other Precambrian rock formations of India with the Dharwar Group of

rocks were also discussed. The paper by B. S. Venkatachala (ONGC, Dehra Dun) with the title, "Palynological studies in the ONGC—A Review" covered different aspects of the research applied in the exploration for oil and natural gas by the Commission.

In the Review Session, the following participants representing different centres reviewed the work going on in their respective centres: Prof. B. S. Tewari (Chandigarh), Dr. P. Kalia (Delhi), P. P. Kumar (ONGC, Dehra Dun), Dr. S. N. Singh (Lucknow), Dr. M. S. Srinivasan (Varanasi), Sri M. V. A. Sastry (GSI, Calcutta), Dr. M. S. Rao (Waltair), Dr. V. Ragothamman (Madras), Dr. S. S. Gowda (Bangalore) and Dr. V. Venkatachalapathi (Mysore).

On the third day, the field excursion to the Archaean fossil localities near Chitradurg was not such a success as was anticipated because of very bad weather. However, a visit to the Ingaldal Mines of the Chitradurga Copper Company was a great reward to the participants, thanks to the authorities of the Company.

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CHEMICAL TREATMENT, PRESERVATION AND ANALYTICAL STUDY OF PAUNAR COINS

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PAUNAR (20° 47' N, 78° 42' E) is today a small village in Wardha Taluk of Wardha District in Maharashtra State. Recent excavation in the village has shown that it is a place of much antiquity¹. In 1965 when the foundation of Village Panchayat School was being laid, a beautiful, globular, spouted copper vessel with a fitting lid came to light (Fig. 1). It was found to contain a hoard of coins. Professor S. B. Deo, Head of the Department of Ancient History, Culture and Archaeology, Nagpur University, identified the coins as Vishnukundin coins.

Professor Deo brought these coins, 310 in all, to the Department of Archaeology and Ancient History, M.S. University of Baroda, for their chemical treatment and preservation. When

it was suggested that an analytical study in a few coins might reveal interesting data on



FIG. 1. Globular, spouted copper vessel beside the hoard of Vishnukundin coins which it contained. Coins are covered with corrosion incrustation.

them, he very kindly permitted us to choose five coins. The analytical study revealed two hitherto unknown coinage alloys of the past, and an altogether new technique in minting.

The coins were thinly covered with greenish corrosion compounds. In corrosion cover they looked like corroded copper coins. In most of

Figure 2 shows a representative collection of the coins after their chemical treatment and preservation.

ANALYTICAL STUDY OF THE COINS

A quantitative chemical analysis of the five coins yielded the following results :

| Sr. No. of coins | Cu | Fe | Sn | Pb | Zn | Ag | Al | Mn | Co | Ni | As | Bi | Sb | Undetermined | Total |
|------------------|-------|-------|------|------|----|----|----|----|----|----|----|----|----|--------------|-------|
| 1 | 74.60 | 21.76 | 3.20 | 0.30 | tr | .. | tr | .. | tr | tr | .. | tr | .. | 0.14 | 100 |
| 2 | 73.77 | 22.0 | 3.35 | 0.37 | tr | .. | tr | .. | tr | tr | .. | tr | .. | 0.11 | 100 |
| 3 | 71.91 | 23.21 | 4.41 | 0.24 | tr | .. | tr | .. | tr | tr | .. | tr | .. | 0.23 | 100 |
| 4 | 77.31 | 22.10 | .. | 0.42 | tr | .. | tr | tr | tr | tr | .. | tr | .. | 0.17 | 100 |
| 5 | 77.21 | 22.31 | .. | 0.26 | tr | .. | tr | tr | tr | tr | .. | tr | .. | 0.22 | 100 |

the coins the die struck legends and designs were discernible in spite of the corrosion. Figure 1 illustrates the coins in corroded condition.

The surface of the coins was found to be covered with macro and micro cracks. The metal of the coins was brittle. An analytical study in the corrosion incrustation of the coins revealed copper, iron and tin compounds in 218 coins and copper and iron compounds in rest of the coins. Three coins from the former group and two from the latter group were selected for quantitative chemical analysis discussed below. The fifth coin selected for analysis revealed an iron core while a sample piece was cut from it.

CHEMICAL TREATMENT AND PRESERVATION OF COINS

The following process was used to remove the corrosion incrustation on the coins. First, the coins were suspended in warm 10% solution of alkaline Rochelle salt which dissolved the cupric incrustation. The cuprous incrustation was then oxidised to cupric state in warm hydrogen peroxide solution and dissolved in alkaline Rochelle salt solution. Next, the coins were suspended among zinc granules covered with 5% solution of warm sodium hydroxide, where evolved nascent hydrogen reduced the incrustation. Finally, the electrolytic reduction of the incrustation was carried out in an electrolytic bath of 2% solution of sodium hydroxide. Coins were made cathode. Pure iron rod was used as anode. Hydrogen evolved at the cathode further reduced the incrustation.

When the incrustation was removed, each coin was washed in hot and cold distilled water, dried in desiccator over silica gel and preserved with a coat of 2% solution of polyvinylacetate.



FIG. 2. The Vishnukundin coins after chemical treatment and preservation.

The above results indicate that coin Nos. 1, 2 and 3 were struck from ternary alloys consisting of copper, iron and tin. Coin No. 4 was made of a binary alloy consisting of copper and iron. Coin No. 5 contained an iron core. Its cover, as shown above, was made up of a binary alloy consisting of copper and iron. Further, it is possible to observe that in coin Nos. 1, 2 and 3, iron was alloyed with low tin bronze. In coin Nos. 4 and 5 iron was alloyed with copper. In view of the fact that all the five selected coins indicated substantial quantities of iron in them, the rest of the 305 coins were tested with magnet. The test proved that iron was present in all of them. These observations are not without significance.

While coins of copper-tin alloy and copper-tin-silver alloy are known, fusion of iron either in bronze or in copper, or the use of iron core for the purpose of minting coins has not been so far recorded. Paunar coins are the first to reveal these alloys and the iron core in ancient coinage.

Author's thanks are due to Professor R. N. Mehta for valuable discussion and to Professor S. B. Deo for bringing the coins to Baroda and giving permission to cut five coins for analysis and for his valuable comments.

1. Deo, S. B., and Dhavalikar, M. K., *Paunar Excavation*, Nagpur, 1968.

VIBRATIONAL SPECTRA AND NORMAL VIBRATIONS OF N-METHYLTHIOACETAMIDE

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INTRODUCTION

SPECTROSCOPIC studies of primary, secondary and tertiary amides received considerable attention. Studies of intermolecular associations¹, dichronic absorption studies², band contour studies of the vapour spectra³, measurement of integrated intensities of the absorption bands arising out of the stretching vibrations of the C=O and N-H groups^{4,5} and normal co-ordinate analysis⁶⁻¹⁰ gave information regarding the nature of the functional groups, orbital interactions and mixing of the skeletal frequencies arising out of the inplane modes of vibration.

In recent times, spectra of some primary, secondary and tertiary thioamides^{11,6,10} have been recorded and normal co-ordinate treatment of some of these molecules has been carried out to assign the C-N and the C=S stretching frequencies and estimate the magnitude of the coupling between these modes of vibration and to compare these results with those obtained of C-N and C=O stretching modes in the corresponding amides⁷.

EXPERIMENTAL AND NORMAL CO-ORDINATE TREATMENT

The authors have recorded the infrared spectra of N-methylthioacetamide and its N-deuterated species and have carried out the normal co-ordinate treatment in order to clarify the nature of the absorption bands arising out of the inplane modes of vibration and compare these results with those of N-methylacetamide obtained by the earlier workers. The frequencies of the functional groups of the N-methylthioacetamide and N-deuterated N-methylthioacetamide are given in Table I.

TABLE I

| N-Methylthioacetamide | | N-Deuterated N-methylthioacetamide | |
|---------------------------|-----------|------------------------------------|-----------|
| Mode of vibration | Frequency | Mode of vibration | Frequency |
| ν (N-H) .. | 3283 | ν (N-D) .. | 2380 |
| Amide II Band | 1560 | Amide II Band | 1510 |
| " III " | 1360 | " III " | 1260 |
| ν (C=S) .. | 690 | ν (C=S) .. | 680 |
| δ (N-H) \perp .. | 740 | δ (N-D) \perp .. | 515 |

The corresponding frequencies of N-methylacetamide and N-deuterated N-methylacetamide obtained by the earlier workers¹² are given in Table II for comparison.

TABLE II

| N-Methylacetamide | | N-Deuterated N-methylacetamide | |
|---------------------------|-----------|--------------------------------|-----------|
| Mode of vibration | Frequency | Mode of vibration | Frequency |
| ν (N-H) .. | 3330 | ν (N-D) .. | 2475 |
| Amide II Band | 1558 | Amide II Band | 1479 |
| " III " | 1300 | " III " | 1120 |
| ν (C=O) .. | 1647 | ν (C=O) .. | 1639 |
| δ (N-H) \perp .. | 705 | δ (N-D) \perp .. | 520 |

The frequency of the amide III band in N-methylthioacetamide is at 1360 cm^{-1} while the corresponding absorption in N-methylacetamide occurs at 1300 cm^{-1} , but the same absorption occurs at 1260 cm^{-1} in N-deuterated N-methylthioacetamide and at 1120 cm^{-1} in N-deuterated N-methylacetamide. On the other hand, the amide II, absorption occurs almost at the same frequency both in N-methylthioacetamide and N-methylacetamide, but at different frequencies in their deuterated species. It is also important to mention that the ν (N-H)