

A report on

Workshop on Indian heritage metallurgy: Recent developments and future directions

by

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The workshop of Indian Heritage Metallurgy organised by INEA, had been an insightful gathering. The engaging discussions in Recent Developments and Future Directions have not only been ardent in newer platforms but have opened their doors to researchers and students. The confluence of Metallurgy with Archaeology and Heritage has paved a way for wider interdisciplinary research. Dr. Baldev Raj's opening lecture served as an introduction to the prospects of combining several scientific techniques with the cultural fields. Dr. Baladev Raj also set the stage for the workshop by highlighting the projects which have been successfully completed by the archaeometallurgists in our country. His talk was characterized by interesting anecdotes such as the *Nataraja* at CERN which is sure to inspire any Indian metallurgist. Dr. Baldev Raj's talk was very informative in terms of the characterization facilities available for studying ancient artefacts such as Centre for Nuclear Sciences in Delhi for carbon dating and Neutron activation analysis at IGCAR, Kalpakkam etc.

Dr. Saxena, Director of Science, ASI then gave an overview of their approach and process to conserve, preserve and restore heritage buildings and metal objects. He highlighted the importance of continuing with tried and tested methods as opposed to latest processes which have no proven track record, and may harm the monument over time. Upon coming to the topic of metal objects, sculptures for restoration and repair, he stressed in the fact that scientific studies and analysis of the same is crucial, which further enhances the knowledge for authentication or identification of fake antiquities.

After characterization, another important area concerning the heritage metal objects, conservation was discussed by Dr. Jeyarajfom Hezibah Institute of Heritage Conservation. He discussed non-interfering methodologies to restore many types of heritage objects.

Prof. Vasant Shinde's proposal on Digital Museum was both well received and thought provoking though unfortunately he was unable to attend the conference.

Prof. Deshpande of COEP, Pune spoke about the iron and steel metallurgy in ancient India. His talk began with the precursor Copper smelting in Mehrgarh to the beginning of full-fledged Copper technology in India from Afghanistan to Inamgaon in Maharashtra. The talk established through the tangible evidence found in Mahurjhari, in the form of a failed forging, how iron smelting was developed through the method of trial and error.

Dr. Jaikishen spoke about the rich iron and steel heritage of India since the megalithic period and on finds of wootz production sites in the Telangana region and also mentioned the accounts of swords in historical accounts such as Al Beruni's writings. His work provided useful insights into

our understanding of the use of raw materials in iron and steel production in antiquity which forms one of the NIAS group's core interests on the heritage of the production of wootz steel in Deccan.

Dr. Parameswaran of IGCAR, Kalpakkam solved the mystery of an ancient coin's chemical composition which was found in *Tamirabharani* river. The talk also covered, in brief, the principle of working of the various characterization techniques used in this study.

Dr. Ananthasivan of DAE discussed the analytical and spectroscopic techniques used in the analysis of heritage objects. Dr. Venkatraman's talk focussed on the nuclear techniques for precise characterization of ancient objects. Spectroscopy in its simplest definition refers to the detection of the excitation energy of electrons, thereby identifying the elements. These days spectroscopy has been successfully employed to do quantitative analysis on materials. Techniques such as Inductively coupled plasma (ICP), Direct current plasma (DCP) and Microwave induced plasma (MIP) etc come under the category of emission spectrometers. Each spectroscopic technique has its own merits and limitations. For e.g. Optical emission spectrometer (OES) or ICPMS is not portable and hence, can't be used for on site analysis. Techniques such as Thermal ionization mass spectrometry (TIMS) have been used in to evaluate the age of earth. Age was calculated depending on the ratio of various isotopes like $U^{238}:U^{235}$. Isotopes differ in mass but not charge. Hence for a given voltage at the detector, two isotopes have different trajectories depending upon the mass.

The next day of the workshop began with the tour of the ancient city Thanjavur. Starting from the Brideswara Temple and commencing at the SaraswatiMahal Library, the group was led by Dr. Mudali who effectively and enthusiastically completed the tour within few hours. After the tour the team was lead for another round of discussions by Dr. Jai Kishan who spoke about the Indian cannons, Dr. Jeyraj who further spoke about the conservation techniques of metallic objects and Dr. Dr. B. Venkatraman who spoke about precise characterisation of ancient metallic objects by emerging Nuclear Techniques.

Ultimately the study and conservation of Ancient Metallic Artefacts play a crucial role in understanding dormant technologies of ancient Indians. Based on the continuing traditions of these technologies as extensively researched by Prof. Sharada Srinivasan, the clarity of origin of these techniques becomes less and less debatable and the issues of provenance come to light, as illustrated in the work of Prof Sharada Srinivasan on high-tin bronzes from Indian and Southeast Asian antiquity. In the light of the NIAS group's familiarity with the work of Prof Sharada Srinivasan in archaeometallurgy and study of Indian metallurgical heritage and study south Indian bronzes it was very interesting to also be able to interact with and gain from the insights of IGCAR colleagues such as Dr. Kamachi Mudali in such areas of materials heritage studies. The skills of experts like Dr. Jeyaraj have further put them to safer environments for the generations to witness.

In the concluding session, all the participants were invited to talk about their experience, areas of interest and the possibilities of future contribution and collaborations. Dr. Mudali suggested that groups could approach INAE for funding and guidance for projects in this direction. Dr. Saxena, too invited the group to attend the centenary celebration of ASI in Delhi which may also be a great learning and sharing platform. The session concluded with a brilliant cultural performance by the students of Sastra University.