



Science in Archaeology and Archaeo-materials. Anun Kumar Biswas (ed.). D. K. Printworld (Pvt) Ltd, New Delhi. 2005. 374 pp. Price: Rs 1800.

Archaeology is concerned with the scientific study of prehistoric people by analysis of their remains and their artifacts through earth excavations. Indian archaeological studies started in the nineteenth century and were confined initially to art and architecture of the historic period guided by literary references, edicts, inscriptions, etc. The earliest scientific archaeological work was initiated by James Prinsep of the Asiatic Society, Kolkata (1799–1840), who tried to transform ‘scholastic archaeology’ to ‘field archaeology’. He was able to decipher the Asokan Brahmi script. This, according to historian Vincent Smith, ranks in importance with the deciphering of the hieroglyphics of Egypt and the cuneiform writings of Babylonia. India has an ancient and continuing civilization and is rich in archaeological sites.

There are two streams in archaeology – the older, traditional and the recent one taking help of scientific techniques. During the last few decades several scientific techniques like carbon dating, remote sensing, genetics and molecular biology, and many scientific instruments have come into the scene, which have revolutionized the scope of archaeological investigations and made them more conclusive. The modern archaeologist should know the basics of the new techniques and the use of sophisticated instruments.

The ranges of commonly used dating techniques are: thermoluminescence 8000–10,000 yrs BP; radiocarbon dating 10^5 yrs BP, fission track 10^5 to 10^6 yrs BP. Radiocarbon dating, one of the most commonly used techniques since its inception in 1960, can date a large variety of samples. It is based on measuring the rate of β -decay of ^{14}C nuclei. Its range is $\approx 50,000$ yrs. Accelerator Mass Spectrometry (AMS), developed simultaneously in 1977 at the universities of

Rochester and Toronto, directly measures the ^{14}C nuclei present in the sample rather than their β -activity. It is faster, requires less sample and increases the range by a factor of two compared to the normal radiocarbon dating. Electrostatic Tandem Accelerators are the optimum choice for setting up an AMS facility. An AMS facility based on a 3 MeV Pelletron has been set up in the Institute of Physics, Bhubaneswar and can be used for dating archaeological samples. The shroud of Turin, supposed to be the burial cloth of Jesus Christ, was AMS-dated by three Western laboratories to around AD 1360. This is in agreement with the first display of the cloth at a church in France in AD 1357.

The earliest remote sensing was through aerial photography. This was followed by radar imaging with all weather capability. Remote sensing by Earth Orbiting Satellites was born in 1968, when Apollo astronauts telecast images of the earth showing the Great Wall of China and pyramids in Egypt. Between 1988 and 97, India launched four remote sensing satellites, IRS-1A to ID. Images taken by IRS-IB between 1993 and 2000 showed ancient sand-dune complexes in West Bengal one of which at Medinipur, on excavation, showed ancient potteries and artifacts. Since 1990, satellites operating in the microwave region with Ground Penetrating Radar (GPR) possibilities have come into use. These GPRs can provide precise images of the soil down to 1 m in clayey soils and down to 25 m in sandy soils. From the literature, it is known that a number of sites of Harappan civilization existed on the banks of the Vedic river Saraswati, which dried up long ago. Scientists are making efforts to locate the palaeochannels of Saraswati by remote sensing and other scientific techniques.

Bioarchaeology relates to archaeology of biological fossils. The earliest firmly dated evidence of 2.5×10^5 yrs BP for *Homo erectus narmadiensis* in India comes from the discovery of a skull cap in Hathnora near Hosangabad, Madhya Pradesh. Analysis of variations in human mitochondrial DNA, Y-chromosomal DNA, etc. led to some broad conclusions about the origin and evolution of modern humans. Geneticists studying human evolutionary pathways have brought out that despite enormous morphological, cultural and linguistic diversities among different population groups of the world, there are no genetic differences between them. Human skeletal studies of people of Indus Valley Civilization have not demonstrated widespread

racial heterogeneity, nor evidence of large-scale deaths due to violence. These observations do not corroborate the dubious theory of Aryan invasion of India (p. 16). Palaeo-botanical studies revealed that the earliest evidence of tilled agricultural field in the world is in Kalibangan I, India.

In the last several years many sophisticated scientific instruments and experimental techniques are being used in archaeological investigations. To know the elemental composition of an archaeological sample we have spectrometers, direct readers and X-ray fluorescence (XRF) set-ups. Portable XRF systems using ^{241}Am are available for *in situ* examination of large objects. X-ray diffraction (XRD) provides a rapid and accurate method for identification of crystalline phases. Local phase identification in the scale of 1 to 100 μm can be carried out by the micro XRD technique using intense monochromatic X-rays produced in a synchrotron. Mössbauer spectroscopy is the most suitable method for studying corrosion products of iron. Metallography is the art and science of examining the macro and microstructural features on the surface of a body. Metallography can be carried out on large-size objects using a mobile, high quality microscope positioned appropriately on the object. For looking at surfaces on a microscale, one has to use a Scanning Electron Microscope (SEM). SEM has the additional advantage of performing qualitative and quantitative compositional analysis using EDS (energy dispersive spectroscopy) and WDS (wavelength dispersive spectroscopy) attachments generally available with modern SEMs.

Ancient Indians made significant contributions to the technology of iron, copper and zinc. The antiquity of iron in India goes back to 1300 BC and of copper and zinc to a few millennia BC. During the period 100 BC to AD 600 iron technology in India saw many peaks, including fabrication of the Delhi Iron Pillar (DIP) in AD 370. The pillar is 7.2 m high, its diameter tapering from 42 cm at the bottom to 30 cm towards the top and weighed six tons. Scientific investigations revealed that the pillar was made of wrought iron of 99.7% purity by hammer-welding lumps of hot pasty iron. Historian James Ferguson remarked in 1910, that ‘The iron pillar of Delhi opens our eyes to an unsuspected state of affairs, to find Hindus at that age capable of forge-welding a pillar of iron, larger than any that have been forged even in Europe up to a very late stage and not frequently even now. It is

almost equally startling to find that after exposure to wind and rain for centuries, it has remained unruined and the capital and inscriptions are as clear and as sharp as when put up fifteen centuries ago'. The rustless nature of the pillar is attributed to low carbon and high phosphorus content of the iron, microstructural heterogeneity and adhered protective film. In 2001, Baldev Raj and his colleagues from Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam made detailed studies of the DIP using acoustic methods, *in situ* metallography, XRF, etc. Balasubramaniam and his colleagues from IIT, Kanpur are making in-depth studies on the dust characterization of DIP and other historical iron objects using various surface analytical techniques like optical microscopy, SEM and Mössbauer Spectroscopy.

India was also famous for the 'magical' Wootz steel (1.6% C), which was exported to the Middle East for making high-quality Damascus swords for several centuries. Many researchers have the conviction that the science and technology of Wootz steel can be harnessed to develop a super-plastic high strength alloy for present-day automobiles (p. 335).

Copper was the first metal that dominated human history. In Mohenjodaro, copper of 99–100% purity was made. Pure copper was made using silica as flux. The technological prowess of ancient Indian metallurgists can be gauged by the massive 5th century AD statue of the standing Buddha at Sultangung, Uttar Pradesh, 2.25 m high and weighing one ton, discovered in 1864. Metal workers of those days knew alloying copper with zinc, tin, etc. In South India, the technology and art of making bronze icons of exquisite symmetry and beauty was well known. The IGCAR group studied some of these bronzes using metallography, XRF, SEM, etc. They observed that the science and technology of South Indian bronzes is relevant to today's investment casting methodology used for making gas turbine blades and many other intricate high-technology components (p. 335).

A brass vase containing 34.54% zinc found in Taxila provides evidence that making pure zinc metal was known to Indians before the 4th century BC. Archaeological investigations in the 1980s in the Zawar region of Rajasthan led to the spectacular discovery of distillation equipment for industrial-scale production of zinc metal. Zinc extraction is a difficult technological process. The design of the furnaces used in Zawar was copied by William Champion

in 1748 for his plant in England. The debris of over six lakh tons of used retorts around Zawar corresponds to about one lakh tons of zinc metal production during 13th to 18th centuries. The pioneering process of zinc production in India was formally recognized in 1989 by the American Society of Metals as an 'International Historical Landmark for Metallurgy'. The IIT Kanpur team has a programme to recover an estimated 5000 to 6000 tons of zinc metal present in the huge amounts of used retorts and glassy slag (p. 131).

Here are a few comments: Chapter 11 on 'Copper and Copper Alloys in Archaeological Perspective' by Prasanta Dutta, which reads like a treatise on metallurgy of copper and its alloys with little to say on archaeology, is unnecessarily long for the intended readership. To some extent the same might be said of chapter 10.

In chapter 5, p. 85 last para, it is mentioned that 'the common components of a sensor system are shown in this table', the table is not there. In the same chapter on p. 87, para four, the mentioned next diagram does not exist. In chapter 3, p. 48, the author mentions that the AMS technique of carbon dating increases the age determination range by a factor of 10^2 to 10^3 compared to the β counting method. He mentions on p. 51 that the AMS range is 10^5 yrs. This is a clear inconsistency. In chapter 1, pp. 5–6 archaeologist M. P. Joshi is referred to as M. C. Joshi.

As examples of exciting challenges that await modern archaeologists one may mention two items which appeared in the June 2005 issue of *National Geographic*. A whole township was discovered a few years ago in Hanoi Vietnam, while digging for constructing a new National Assembly House. CT scan investigations were carried out in January 2005 of the mummy of a Pharo, who died young in Egypt 3300 years ago. The scan pictures, analysed by a team of experts, revealed that the Pharo was nineteen years old when he died, and was 5 ft 6 inches tall and thin.

The publication of the book under review is timely. It contains a mine of information useful to traditional archaeologists as well as other scientists interested in archaeology. The editor has done an excellent job of bringing together so many expert contributors and making the compilation useful.

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Disaster Management. Harsh K. Gupta (ed.). Universities Press (India) Pvt Ltd, 3-5-819, Hyderguda, Hyderabad 500 029. 2003. 152 pp. Price: Rs 470.

India is one of the most vulnerable countries in the world to a plethora of natural disasters. While floods and droughts are recurrent disasters in a few states, tropical cyclones hit most of the east coast, which is more than 1000 km long, on a regular basis. About 57% area of the country is highly seismic in nature. The Himalayan region of the Alpine belt is seismically one of the most active intra-continental regions anywhere in the world. The current seismic activity is the result of the continental collision between the Indian and Eurasian plates.

The book under review is a compilation of seven research papers by eminent people engaged in scientific research in the area of natural disasters, edited by a geophysicist, Harsh Gupta (presently Secretary, Department of Ocean Development, Government of India). His overview on major and great earthquakes in the Himalayan region in the book portrays his vast knowledge and experience in the field. Gupta served in many important committees of the Government of India and currently is chairman of a committee set up by Department of Science and Technology on seismic research planning and monitoring in the country.

Scientific data collection and research in natural disaster formally started after 1880, when a Famine Commission submitted its report. After Independence, we had four major droughts (1965–67; 1972–73; 1979–80 and 1986–87) and some major floods, capturing the nation's attention completely, so that the entire disaster management efforts were focused on these two types of disasters. The Ministry of Agriculture was assigned the role of providing relief and rehabilitation. As these were the main focus areas, limited resources were provided for preparedness and mitigation. The two articles on flood and droughts by Kale and Rao gave a comprehensive account