

IIT Gandhinagar, August 23-24, 2012
Workshop on
Indian Archaeology, Epigraphy and Ancient History

ABSTRACTS

Dr Shanti Pappu

Prehistoric Archaeology in India:
Introducing Key Issues and Future Prospects

This paper presents an overview of recent issues and debates in the study of prehistoric archaeology. We present a brief overview of Indian prehistory in the context of recent studies and questions topics related to early hominin dispersals, lithic technology, palaeoenvironments and behavioural variability of populations, over a period beginning around 2 million years ago. We then situate our recent research along the southeast coast of India (Tamil Nadu), in this perspective. Our multidisciplinary approach aims at investigating the nature of prehistoric sites in this region, establishing a chronology, and examining how populations adapted to past environmental changes. We present an overview of recent aspects of our research including excavations at Attirampakkam, palaeoenvironments at this site, implications of recent attempts to date the site, and lithic technology, use of satellite remote sensing and GIS and digital technology in prehistory. We discuss future directions which prehistoric archaeology in India should take to situate it on par with studies being conducted elsewhere in the world, and ways in which collaborate research with other institutes of science and technology, may aid in establishing new directions for this subject.

Since 2000, Dr Shanti Pappu has conducted excavations at the Palaeolithic site of Attirampakkam, Tamil Nadu. She is founder-secretary, Sharma Centre for Heritage Education, Chennai, and joint editor of Man and Environment, journal of the Indian Society for Prehistoric and Quaternary Studies, Pune. She has published two books and more than 20 research publications in peer-reviewed national and international journals, as also one children's book and popular articles.



Dr. Kumar Akhilesh

New Approaches in Prehistoric Archaeology:
Examples from Tamil Nadu

This talk specially focuses on the methods used in our multidisciplinary project focussing on excavations at the site of Attirampakkam, and regional surveys of over 8000 km² in Tamil Nadu. Excavations at Attirampakkam, revealed a long and complex history of occupation, beginning with the earliest Acheulian tool-making Lower Palaeolithic populations. This early occupation has recently been dated with a mean average age of around 1.05 million years, through palaeomagnetic measurements and direct ²⁶Al/¹⁰Be burial dating of stone artefacts. These results not only situate this site as the oldest Lower Palaeolithic Acheulian site in India, but have significant implications in terms of debates on population dispersals across Eurasia. Rock magnetics, clay mineralogy and other sedimentological studies indicate changing environments at this site over a period of almost a million years. Studies of prehistoric stone tool technology indicate skill and planning exercised in raw material choices, tool manufacture and use. Our program of experimental replication of ancient lithic technology is aimed at interpreting the archaeological assemblage excavated with a view towards understanding cognitive strategies of ancient hominins. We also discuss applications of satellite remote sensing data in prehistoric research, in developing predictive models to locate new sites, and in planning for heritage management. We examine how these studies are important in the context of South Asian prehistoric archaeology.

Dr. Kumar Akhilesh is a Senior Research Fellow at the Sharma Centre for Heritage Education, Chennai and co-director of the research project on prehistory and palaeoenvironments at Attirampakkam and other sites in Tamil Nadu. He specializes in stone tool technology, and he is currently involved in a project on applications of satellite remote sensing and GIS in archaeology for purposes of research and heritage management. He is also involved in community heritage education programs and is co-ordinating the design of museum exhibits.



Dr. Parth Chauhan

**The Importance of India in Human Origins Studies
with Special Reference to the Siwalik Hills
and the Narmada Basin**

The Indian Subcontinent is critically located in the centre of the Old World and thus has significant relevance for revealing early human dispersals and adaptations within an Asian context. This position can also help scientists link global scientific data related to ancient climatic changes including the evolution of the monsoon, associated environments and geographic variations, modern human genetics and long-distance animal migrations and evolution. While other important regions such as Africa, Europe, the Levant and eastern Asia have received many decades of scientific attention, the importance of India for understanding human evolution has begun to be

appreciated only in recent decades. Recent discoveries in India, coupled with new knowledge of potential areas for future research, have established a promising intellectual horizon for future researchers. Within the Indian Subcontinent, a large number of archaeological and related sites are known and have been studied, though absolute dates and other scientific data are direly wanting for global comparisons and hypotheses-testing. Almost all parts of this ecologically diverse region are very rich and diverse in such records and this presentation highlights two of them: the Siwalik Hills, which run parallel with the Greater and Lesser Himalaya and the Narmada Basin in central India. Both regions are long known by scientists and laymen for their rich records of paleontological and Paleolithic evidence spanning 18 million years and at least 800,000 years, respectively. Both need to be studied for various reasons, but most because they both temporally complement each other and have yielded different types of datasets. The Siwalik Hills is critical for studying the ecological and palaeoclimatic contexts of the earliest hominin dispersals from Africa to Southeast Asia. The Narmada Basin is important as it is located in the centre of India and thus probably acted as an important corridor of movement for both animals and humans, and has yielded the only pre-modern human fossils in South Asia. Recent research results and future prospects for Paleolithic research are outlined for both of these regions in the context of global theories of human dispersal and evolution.

Dr. Parth Chauhan is a paleolithic archaeologist with an interest in the prehistory and paleoanthropology of the Old World, Eurasia and the Indian subcontinent. He was visiting researcher to the Physical Research Laboratory, Ahmedabad, and the Deccan College, Pune. He is currently research associate at the Stone Age Institute (Gosport, USA), and the Department of Anthropology, Indiana University; he has many papers and two co-edited books to his credit.



Dr. Pramod Joglekar

**Review of Current Status of Indian Archaeozoological Studies
and Directions for Future Research**

The study of animal remains found in archaeological contexts is called 'archaeozoology' or 'zooarchaeology'. This important branch of archaeology helps studies of animals, primarily, but not exclusively, from archaeological contexts. The primary goal of archaeozoological research is to shed light on the relationships between humans and animals and the consequences of these interactions for both humans and their environment. Archaeozoologists use a variety of data sources: animal bone remains from butchery or cooking activity; rock paintings that illustrate hunting strategies; and hoof impressions. More recently DNA analysis of animal bones, lipid analysis of dairy or adipose fat residues in vessels, and stable isotope studies of human and animal diets have expanded this repertoire.

The common aims for archaeozoological studies are:

1. Palaeo-environments and environmental change in the past
2. Hunters and their relationship with the prey
3. Origins of animal domestication
4. Development of animal breeds
5. Animals in the economic, social, and belief systems of ancient societies
6. Formation of archaeological sites and associated archaeofaunal assemblages

Archaeozoologists work both in the field (during excavation process) and in the laboratory. When an archaeozoologist participates in archaeological excavations he/she:

- consults with the excavation directors to provide insight into the nature of animal deposits,
- identifies the techniques most appropriate to the recovery, processing, and preservation of the faunal remains,
- helps to excavate animal remains to ensure that they are recovered in good condition, document the species excavated, and note the context of deposition,
- provides feedback to excavators that may be helpful in their characterization of specific deposits or in their plans for further excavation,
- collects and prepares the remains of modern animals to build comparative collections that are essential to the identification archaeofaunal remains,
- studies modern habitats, animals, and human groups in the region to provide a better foundation for understanding past environmental conditions and animal exploitation patterns.

In the laboratory, an archaeozoologists works to:

- identify archaeofaunal remains to ascertain the species present and the relative frequency of the different taxa and their various body parts,
- measure animal remains to identify specific taxa or to characterize the size of animals in the past to better understand the conditions in which they lived or were kept,
- study butchery scars and other human, animal, or naturally induced marks on animal remains to reconstruct butchery techniques, food preparation methods and to better understand the changes that took place in the archaeofaunal collections during and after burial,
- identify the age and sex of the animals and the season of death to learn about past human hunting, gathering, fishing, or husbandry strategies and the population structure of ancient animal populations,

- analyze the chemical, isotopic, or genetic content of archaeofaunal remains to identify the species present, trace evolutionary relationships between ancient and modern species, characterize the food eaten by human and animals in the past, and identify environmental changes.

In India, the Deccan College Post-Graduate and Research Institute (Now a Deemed University) has unique Archaeozoology Laboratory - the only one in whole of South Asia. The Archaeozoology Laboratory is designed to conduct specialised research on various aspects of past animals and their interactions with humans and environment. At this laboratory research is conducted on remains of past animals that come in form of bones, teeth, antlers, shells and objects made of animal remains. We have specialization in dealing with mammals, birds and molluscan remains. Computer-based analysis is unique feature of the laboratory. Here an internationally accepted protocol of analysis, reporting and preserving animal remains is used. The Archaeozoology Laboratory has a comprehensive reference collection of animal skeletons. Research on remains of all animal groups recovered from all cultural periods is undertaken. Collaborative research with other University Departments, State Departments of Archaeology and the Archaeological Survey of India is also undertaken. Individual scholars from India and abroad with prior permission often consult the reference collection.

The faunal studies in Indian archaeology (archaeofaunal studies or archaeozoological studies) began nearly eight decades ago. During this period, a lot of progress occurred in certain aspects of archaeozoological studies: - (a) the way animal bones are treated at the site, (b) the importance attached to studying animal remains from archaeological sites, (c) the variety of data sources and their relevance, (d) the nature of questions asked from the archaeofaunal data, and (e) use of technological changes occurring in collection and interpretation of archaeological record. A clear shift in the outlook of both archaeologists and the specialists (archaeozoologists) is visible. Though earlier viewed as a marginal contributor to general archaeological inquiry, archaeozoological approaches progressed to have own complex research objectives. In recent years new methodological approaches (e.g. quantification and molecular biology) emerged with entirely different tools necessary for analysis and interpretation. However, still there is scope for making progress in many aspects of the archaeozoological studies. This article focuses on what can be done for (a) making identifications secure through better reference collections, (b) making collection and recovery of faunal material in such a way that more advanced questions about site formation/destruction could be addressed, (c) equipment and institutional infrastructure for better manpower development, and (d) use of information and communication technology for archives and database management of all India archaeofaunal data.

References

- Allchin, F.R. 1969. Early Domestic Animals in India and Pakistan, in *The domestication and Exploitation of Plants and Animals* (P.J. Ucko and G.W. Dimbleby Eds.), pp.317-322. London: Gerald Duckworth.

- Alur, K.R. 1990. *Studies in Indian Archaeology and Palaeontology*, Dharwad: Shrihari Prakashana.
- Clason, A.T. 1979. *Wild and Domestic Animals in Prehistoric and Early Historic India*, Lucknow: Ethnographic and Folk Culture Society.
- Joglekar, P.P. 2006. Faunal Studies in India: Methodological Issues and Prospects, in *Proceedings of the Pre-Symposium of RIHN and 7th ESCA Harvard-Kyoto Roundtable* (T. Osada Ed.), pp. 32-52. Kyoto: Research Institute for Humanity and Nature.
- Joglekar, P.P. 2007. Animal Remains as Indicators of Formation Processes: a Case Study of Chalcolithic Walki, Maharashtra, India, in *Proceedings of the Seminar on Site Formation Processes and Archaeological Record 1999* (K. Paddayya, S.G. Deo and Richa Jhaldiyal Eds), pp. 231-237. Pune: Deccan College.
- Joglekar, P.P. 2007-2008. A Fresh Appraisal of the Animal-based Subsistence and Domestic Animals in the Ganga Valley, *Pragdhara* 18: 309-321.
- Thomas, P.K. 1989. Utilization of Domestic Animals in Pre-and Protohistoric India, in *The Walking Larder: Patterns of Domestication, Pastoralism and Predation* (J. Clutton-Brock Ed.), pp. 108- 112. London: Unwin Hyman.
- Thomas, P.K. and P.P. Joglekar 1994. Holocene Faunal Studies in India, *Man and Environment* 19 (1&2): 179-204.
- Thomas, P.K. 2000-2001. Contributions of the Deccan College to Archaeozoological Research, *Bulletin of the Deccan College Post-Graduate and Research Institute* 60-61: 77-95.
- Thomas, P.K. 2002. Investigations into the Archaeofauna of Harappan Sites in Western India, in *Indian Archaeology in Retrospect Volume II: Protohistory* (S. Settar and Ravi Korisetar Eds.), pp. 409-420. Delhi: ICHR and Manohar.

Dr. Pramod Joglekar has been engaged in research and Post-Graduate teaching at Deccan College since 1987. He has been involved in numerous research projects of archaeology and archaeozoology dealing with Palaeolithic, Mesolithic, Neolithic, Harappan, Chalcolithic, PGW and Iron Age-Historic sites of the Indian subcontinent. He has been since 1991 joint editor of Man and Environment journal of the Indian Society for Prehistoric and Quaternary Studies, Pune. He has authored or co-authored / co-edited eight books and published over 110 research papers, and authored and translated popular books, including some for children.



Dr Kuldeep Bhan

Some Important Aspects of Harappan Craft and Technology

The purpose of this paper is to discuss some aspects of craft production and organization during Harappan Phase of Gujarat which corresponds with the Integration Era. The data for presentation will be mainly derived from three recently excavated sites - Gola Dhoro (Bagasra), Nagwada and Nageshwar. Nevertheless the data obtained from others sites of Gujarat will also be viewed in conjecture, in order to have a holistic view of the organization and production of stone bead making, shell working and faience production. The interpretations are based on the rigorous recording and analysis of the archaeological data and the application of specialized ethnoarchaeological and experimental studies that has led to the development of more appropriate interpretive models.

A possible organizational pattern emerges from the available evidence, since we have detail information now available on the stone bead making and shell working from the above mentioned sites of Gujarat. Both Gola Dhoro and Nagwada have revealed intensive and efficient manufacturing evidence and show very specialized techniques were used in the transportation of semiprecious stones into beads. Comparisons with the ethnoarchaeological studies from Khambhat has indicated that the Harappan stone bead industry of Gujarat was more flexible, independent form of production as compared to centralized production, controlled by the political elite represented by the manufacturing center of Chanu-daro. While the analysis of shell industry, has revealed three levels of production with sites like Nageshwar and Gola Dhoro at the top of hierarchy. The studies have highlighted the importance and dependence of larger urban Harappan settlements on small settlements for the procurement of raw material as well as finished goods.

Dr. Kuldeep Bhan is professor in the Department of Archaeology and Ancient History, Maharaja Sayajirao University of Baroda, and has taught South Asian archaeology and ancient technology. Over the past 25 years, he has collaborated in major excavations at several important settlements of the Indus Civilization in Gujarat, as well as numerous other settlements that belong to periods both preceding and following the Harappan cities. As former director and curator of the Archaeological Museum of the Maharaja Sayajirao University of Baroda, he prepared exhibitions that have toured in India and abroad. At present, Dr. Bhan is overseeing the development of a digital artifact database to archive the vast array of antiquities excavated by the Department of Archaeology at MSU.



Dr. K. Krishnan

Scientific Approaches towards the Study of Ancient Indian
Ceramics and its Cultural Relevance

Scientific analyses of archaeological artefacts have been gaining popularity among the researchers over the last two decades in India. A great majority of these studies deal with the characterization of the artefact material. These studies have enabled us to explain various cultural processes such as exchange, trade, migration, imitation, innovation etc. Archaeological ceramics is one of such artefacts that have been subjected to various analyses using a set of scientific techniques. These studies have helped in determining the tentative provenance of the raw material of certain specific kinds of ceramics, identifying methods of its paste preparation techniques, reconstruction of different stages of manufacture, use of certain vessels forms and the reuse of ceramics as an ingredient in the ceramic paste itself. The paper will demonstrate how archaeologists have incorporated various analytical techniques on a variety of archaeological ceramics from the Indian sub-continent to address the above

mentioned cultural issues. The paper will also highlight the scope of future research in this field.

Dr. K. Krishnan is professor and head, Department of Archaeology and Ancient History, The Maharaja Sayajirao University of Baroda. He has researched protohistoric (including Harappan) and early Historic ceramics by incorporating traditional archaeological, ethnographic and scientific methods, resulting in an understanding of craft specialization, development of technology and its impact on ancient South Asian Society. He is also engaged in reconstructing palaeoclimate in central and western India. He has completed four research projects dealing with ancient technology and palaeoclimatology and is currently working on a project dealing with the emergence of urbanism in South Asia. He has co-authored two books and published numerous papers.



Dr. K.S. Saraswat

**Some Important Features of Archaeobotany in Northern India:
The Past Three Decades**

The presentation is aimed to focus on some recent advances made in the archaeology of north Indian plains during last three decades, which has changed the earlier sketchy picture, through collaboration of some field – archaeologists for the systematic generation of botanical data during the excavations on their sites.

Empirical studies of a mass of data generated from early Neolithic and Chalcolithic settlements in the Middle Ganga Plain have firmly established that co-existing Harappan Civilization earlier regarded to have splendid in isolation from Ganga Plain, did have substantial influences on the crop economy. Diffusion of Harappan crops such as barley, wheat, lentil, pea, etc. in the rice growing region of Middle Ganga Plain and adjoining Vindhyan regions during 3rd-2nd millennia BC, have made a turning point in the archaeological lexicon to have established direct or indirect cultural contact of the region with the Harappans in the north-west. Indeed, one gets the impression that it was the development of an effective food production and the concomitant agricultural development, in no small part, owing to the fact that there must have been contiguous ecological zones right from north-western India where the highly advanced Harappan cultures were flourishing, up to the regions of Bihar. These diverse ecological zones were exploited agriculturally in different ways and evolved through different cultural stages, and their geographical and cultural closeness allowed the varied subsistence economy to interact and inter-stimulate each other. Far more important is the introduction of rice cultivation in the Early Harappan times in Haryana and Punjab. It is now no longer necessary to vacillate the spread of food grains from the north-western India to Middle Ganga Plain and vice-versa, during 3rd

and 2nd millennia BC and indubitably as a consequence of the movement of different cultural groups. Botanical approach has now opened an avenue for archaeologists, anthropologists, cultural historians and those who are interested in the long-distance diffusion to resolve the problems of trans-regional adaptations, to give a more comprehensive picture in the archaeological context of northern India, especially in reference of Middle Ganga Plain.

Excavations at Lahuradewa by U.P. State Archaeology Department have marked for the first time in India to have uncovered the beginning of an early occupational phase in the Middle Ganga Plain, during 10th-9th millennia BP. Primordially the evidence of agricultural activities is displayed by the remains of domesticated rice, directly dated by AMS radiocarbon determination during 9th millennium BP, contemporaneous to the beginning of agriculture in West Asia and China as well.

Some other new aspects emerged other than the agriculture, include an unique evidence of the use of reetha (soapnut) as herbal detergent (substitute for soap) and the compound preparation of shampoo by mixing reetha, shikakai and anwala from Early Harappan times (2750-2500 BC) – spotlighting on the standard of Hygiene; and the cultivation of grapes, lemon, sem-bean, parijat, jasmine, karonda, pomegranate and henna – reflecting to arborihorticulture and gardening during Harappan times.

Further, an archaeological narrative regarding the use of herbal medicines has also been reflected in the Middle Ganga Plain during 2nd-1st millennia BC, by the remains of some rational herbal-drug yielding plants extolled in modern pharmacological practices.

One of the most absorbing headway in the world archaeological lexicon has turned up in the findings of the remains of American custard-apple, amaranths, tobacco, sunflower and Mexican-poppy, to suggest transoceanic contacts between the Orient and Americas, much before the claimed discovery of the New World by Columbus.

Reality is that the data, whatever generated, falls far short of expectations, in the most culturally passive Indian region. Problems of early man's exploitive relationship with plants are of continuing relevance to open up avenue of synchronic analysis, almost deterministic of cultural perspectives in the broader archaeological contexts.

Dr. K.S. Saraswat is one of India's leading palaeobotanists. After a career of teaching botany, he was a scientist at the Birbal Sahni Institute of Palaeobotany, Lucknow (and Emeritus Scientist there from 2003 to 2006). He is currently a National fellow of the Archaeological Survey of India and has published over 40 research papers.

Dr. Rakesh Tewari

**Major turns in Ganga Valley Archaeology (1971-72 – 2011-12):
A Review**

About 40 years ago, it was generally believed that 'the Ganga Plain was a monotonous flat mass of marshy land consisting of thick forests which was not hospitable for human settlements; the migrants from the west around 700 BC cleared these forests with iron artifacts and colonized it on large scale.' The investigations carried out in last 40 yrs by the Archaeologists in collaboration with Geologists, Palaeobotanists, Anthropologists and experts from other scientific disciplines have changed almost all of these concepts. Now, we have a lot of new evidence regarding the ancient landscape and geomorphology of the Ganga Plain, prehistoric human activities and settlements, beginning and expansion of early farming and settlements and their interactions with distant areas in 3rd and 2nd millennium BC, besides appearance of iron in 2nd millennium BC in this part of the country. This presentation aims to underline some of such major developments in brief.

Dr. Rakesh Tewari has 32 years of experience in field archaeology in Uttar Pradesh, Uttaranchal, Bihar, Chhatisgarh, Madhya Pradesh, Maharashtra and south India. He has been Director, U.P. State Archaeology Department, Government of Uttar Pradesh since 1989, and has over 150 publications to his credit (including books / monographs / research papers / edited volumes). He is also the founder editor of Pragdhara, annual journal of the U.P. State Archaeology Department (19 issues published).



Dr. K.K. Thaplyal

Guilds in Ancient India

Definition – Guild was an association of people of one caste or different castes residing at one place and following the same profession. There were guilds of carpenters, smiths, potters, weavers, oil-millers, flour-makers, etc.

Why guilds were formed? – To meet challenges of robbers and safeguard themselves against unscrupulous chiefs and kings, to avoid cut-throat individual competition, to have a greater bargaining power and greater say in fixing prices and in other economic issues, and to undertake large scale works.

Antiquity of guilds – for lack of documentary evidence, it is difficult to say whether or not guilds existed in the Harappan civilization, which had highly developed industries. There is difference of opinion whether such words as *sreni*, *puga* etc., which were used for guilds in historical period also connoted the same in the early Vedic period. The Upanishad and Jataka literature show the existence of guilds from the sixth century BC.

The components of guilds—The guilds had three-tiered structure—the General Assembly, the Executive officers and the Guild-head, each with a well defined jurisdiction, power and functions. The chief could punish an errant member and the Assembly could remove a wicked chief. In inter guild disputes, the king intervened. The membership of the Assembly could be obtained through written contract, or recommendation of a prestigious person or through ordeals. At times new guild was branched off from the existing guild. In some cases some guilds joined together and formed a large corporation, as is seen in the corporation of the bankers, the merchants and the artisans known from seals unearthed at Vaishali.

Factors responsible for development of guilds—Emergence of larger kingdoms facilitated raw materials from and selling finished goods to distant places. Emergence of large cities was conducive to the development of crafts. Increased use of iron was helpful in creating agricultural and industrial surplus. Jainism and Buddhism gave better social status to the vaishyas and the shudras.

Characteristic features of the guilds—(i) Localization of trade—There were villages of the carpenters, smiths, potters, etc., and in cities areas were ear-marked for different crafts. This was helpful to guilds in meeting and discussing their problems, learning from each other, convene frequent meetings and evolve their laws. It was convenient for the government to collect taxes. (ii) Heredity of profession—Though membership of the guild was open to people of all castes, yet living in the same locality and following the same profession led to the formation of profession based castes. The hereditary nature of profession had the advantage that a child could learn the craft of his father with ease and in natural course. (iii) Guilds could migrate yet they kept up their obligations. A guild migrated from Lata in Gujarat to Mandasor in Madhya Pradesh.

Apprenticeship—For attaining better proficiency, one was to undergo training for a pre-decided stipulated period under a master craftsman, who provided him food and shelter. The trainee was to serve his master, who would have the right over objects manufactured by the trainee.

Guild laws—Guilds enjoyed considerable autonomy, and had the authority to enact their own laws, which were honoured by the king, and were given due consideration in passing judgement involving guild members. Breaking guild laws or causing harm to the cause of guild entailed severe punishment.

Prestige of guilds—The kings consulted the guild heads in economic matters, honoured them, offered gifts to them, provided them separate pavilions for witnessing theatrical performances. They had their own offices, insignia, and seals, and a few of them issued coins.

Sources of guild-income—Membership fee, profits earned by guilds, fines recovered from the errant members, and gifts from kings were the main sources of the income of guilds.

Items of expeniture—Procuring raw material, travelling, transport of raw material and finished goods, payment of octroi duties, paying wages, and performing pious and charitable works were the items of expenditure.

Functions of guild—The functions of guild were: procuring of raw material, location of markets for finished goods, completion of the work undertaken from the state or private individuals, quality control of goods manufactured by the guild, fixing prices of the manufactured articles, evolving guild laws and ensuring their compliance, performing acts of piety and charity, such as digging of tanks for water, erecting shrines, undertaken by the guild of its own, and helping the poor and the destitutes—acts which formed part of the charter of the guilds, looking after the family of the members who died, loaning money to needy artisans and merchants. One of the most important functions of the guilds was that they acted like banks, and performed works with the interest accruing from the permanent fixed deposit, as per the wishes of the depositor. In one inscription two rates of interest—9% and 12% per annum have been mentioned, whereas the rate mentioned in ancient texts is 15% per annum. The guild-heads acted as judges for the guild members, and were also one of the judges in the State courts.

Factors responsible for the decline—In north India the development of guilds was at its peak in the Gupta period and thereafter they declined gradually. Decline in trade and commerce, decline of urban settlements, unsettled political condition, the turning of people following a profession hereditarily into a professional caste, kings and commoners making direct donations to the temples and the monasteries instead of giving it through guilds, were some of the reason of the decline of guilds. In south India guilds continued to flourish in the post-Gupta period and a few of them had branches in other countries as well.

The guilds played an important role in ancient Indian economic and social life They were in a way a form of local-self government. Their contribution in the prosperity of the land was immense. It is remarkable that in their charter it was stated that a part of the profit of the guild will be used for works related to religion or to works of public welfare. Their prestige was such that even kings deposited money with them. Even after migration they fulfilled their obligations. By enacting their rules and by treating the cases relating to guild by the guild head they lightened the burden of state courts. Their importance was recognised by kings who tried to keep them on their side. The large guilds would have had some influence on royalty, yet they did not indulge in active politics and never tried to capture political power.

Prof Kiran Kumar Thaplyal served the Archaeological Survey of India (1957-60), and the Lucknow University (1960-96), ultimately heading its Department of Ancient Indian History and Archaeology and becoming Emeritus Professor. Epigraphy was one of the subjects he taught to the post-graduate students. He was a Fellow of the Indian Institute of Advanced Study, Shimla, and a member of Central Advisory Board for Archaeology

(Govt. of India). He has published more than 100 research papers, and authored eight books on ancient India.



Dr. R.K. Mohanty

Situating Sisupalgarh: An Early Historic City in Kalinga

Early part of 1st millennium B.C saw the emergence of India's second urbanisation, initially the Janapadas and later 16 Mahajanapadas, which dominated mostly the political scenario of Northern India. However, Kalinga (situated in the east coast comprising part of modern Odisha and Andhrapradesh) didn't find a place among the Mahajanapadas. We come to know about the past glory of region more during the Ashoka's invasion to Kalinga. Though Kalinga was immediate neighbour to Magadha under Chandragupta and Bindusar, predecessor of Ashok, remain unconquered while major part of the subcontinent was under their sway. Kalinga war was not usual also, records left reveal a devastating history and the repercussions influenced the cultural melee of the continent through Buddhism. To understand some of the contemporary life ways, power position, socio-cultural-economic conditions, their interplay, Sisupalgarh, situated on the south eastern edge of modern Bhubaneswar was undertaken for intensive exploration and excavation. This is one of the best preserved fortified early Historic city. It was formally delineated by a rampart and moat covering over 1 sq. km. It had eight gateways two in each side. Beyond the fortification, there were extensive settlement, probably supported the requirement of the people living inside. Five seasons excavations accompanied by Geophysical methods of magnetic radiometry and Electric Resistivity survey has given the evidence of structural remains, houses, monumental building, gateways, configuration of the rampart, lanes, by-lanes, water management systems and other cultural remains. The 6 to 7 meter deposit belonging to the different period, beginning with 6th-7th century BC reveals the importance of the place and the position of Sisupalgarh in the regional archaeological context. The monumental pillar area of Sisupalgarh is one of the most dramatic examples of standing architecture in the ancient urban centre.

The investigation to the life ways of the people of Sisupalgarh suggests that it was a strong regional centre for maintaining distribution of regional resources as well as arranging systematic, continuous resources for internal consumption of a population around 25 thousand. It also served as a centre of inspiration for the surrounding ritual landscape within the city and in the neighbourhood. The recent radio carbon dates tells us that the fortified city was established as early as second quarter of 1st Millennium B.C. and continued its urban character till 5th-6th c. A.D. Later, when its neighbourhood temple city of Bhubaneswar was emerging, Sisupalgarh was in decline as a well organized urban settlement. To understand the relationship prior to the emergence of this city, its contemporary settlements and trading activity and relations, investigations are carried out at the port centres of Manikpatna and the Neolithic-Chalcolithic-early historic site of Golbai Sasan. While trying to explorer the regional settlement pattern

and urban centres, it was observed that Sisupalgarh served as one of the most important centre located almost in the centre of Kalingan territory. The other known contemporary cities were Radhanagar and Jaugada. These three cities are separated by 80-100 km. and are located on the major rivers or their tributaries with forest on one side and fertile alluvial soil on the other side stretching up-to the Bay of Bengal. This environment provided resources for the growth and sustenance of these urban centres through the exploitation of forest products, agricultural products and marine resources.

Recent fieldwork at rural settlement in Eastern Odisha has provided additional information about the interactions that these cities had with their rural surroundings, indicating not only a strong economic integration but also the cultural integration of the coastal region once known as Kalinga. The investigation of regional settlement to bracket both the spatial and chronological developments of the Early Historic urban phase has revealed spectacular evidence suggesting why Kalinga was so powerful.

The chronological portion of the study has focused on the settlement of the pre-urban period (Golbai Sasan) and a settlement of the post-urban period (the port site of Manikapatana). At Golbai Sasan, investigations confirmed the presence of 7.5 meter cultural strata that included a substantial Neolithic and Chalcolithic deposit along with subsequent occupation. At Manikapatana, excavations and intensive survey indicate that the site was occupied from the 5th-6th century A.D. until the 17th -18th century A.D. with material remains suggesting contact with Southeast Asia, China, Ceylon and South India.

The spatial portion of the study is currently underway and focuses on the remarkable recent discovery of two fortified settlements that appear to be smaller exact copies of Sisupalgarh. The site of Talapada, located 60 km. southwest of Bhubaneswar city, is marked by a square fortification that measure 550 meters on each side with four gateways. Another similar fortified site was discovered near Berhampur town, located 40 km. south of the Early Historic city of Jaugada in southern Odisha. The antiquity of Dantapuri, Dist. Srikakulam, Andhra Pradesh, probably the southernmost city of Kalinga about which very little was known, was investigated. This is the largest circular fortified city discovered in India during Early Historic period. These newly – discovered sites, located at strategic distances from the largest urban settlement, provide the opportunity for examining the cultural and political dynamics of the Early Historic period in the region.

Dr. R.K. Mohanty is an archaeologist with wide experience in excavation as well as technical aspects of archaeology, such as archaeometallurgy. He is currently professor in Proto and Ancient Indian History, Dept. of Archaeology, Deccan College, Pune and has many publications to his credit, in particular in connection with Sisupalgarh.

Dr. Y.S. Rawat

Vadnagar Excavation and Buddhist Remains of North Gujarat

Recent discovery of the ruins of a Buddhist monastic establishment at Vadnagar during scientific excavation by Gujarat State Archaeology has reconfirmed that north Gujarat was once a very important region which provided firm footing for the development of many Buddhist centres. Vadnagar findings also corroborate the travel records of the famous Chinese pilgrim Hiuen Tsiang who visited Vadnagar (ancient Anandapur) in the mid-7th century CE. The discovery of Buddhist monastery and stupas at Vadnagar inspired the author to search for its linkage with the nearby Taranga known for its Buddhist connection. In the process valuable remains have been brought to light at this site too. These findings have established that north Gujarat could be a promising area for Buddhist studies in western India. Traditionally north Gujarat has been known as 'Anarta' whose capital was Anartapura. However, archaeologically the name Anarta appears for the first time in the Junagadh inscription of the Kshatrapa king Rudradaman datable to mid-2nd century CE. In the light of recent evidences the author has identified Taranga as the ancient Anartpur whose downfall led to the flourishing of Vadnagar.

Dr. Y.S. Rawat has taken part in many archaeological excavations in Haryana, U.P., Andhra Pradesh, Ladakh and Gujarat. The sites he explored belong from the Neolithic to the historical periods and he has published many papers about them. He is currently Director, Gujarat State Archaeology, Government of Gujarat.



Dr Sunil Gupta

Indian Ocean Archaeology:

A Global Program from an Indian Base

The Indian Ocean stretches from the Red Sea to the South China Sea, incorporating the core littoral regions of the Arabian Sea and Bay of Bengal. The monsoons - wind systems that seasonally reverse direction - define the environment of this maritime space. The littoral regions of the Indian Ocean witnessed prehistoric migrations, dispersals of flora and fauna, emergence of some of the greatest civilizations (Mesopotamia, Indus, Southern Arabia), development of maritime technologies and spread of trade networks. The Indian Ocean in antiquity was therefore much more than a watery outlier. While there have been recent attempts to historically consolidate the early Indian Ocean world, the material cultural processes on the littorals are still thought of as marginal to those which created large riverine civilizations in the interiors.

The Indian Ocean Archaeology programme evolved out of my doctoral research on the Archaeology of Indo-Roman Sea Trade (1st-3rd century AD). The study of maritime commerce between the Roman Empire and India allowed me to research evidence from excavations at key port sites in the Red Sea, Gulf of Aden, the Persian Gulf and the Arabian Sea regions. After the doctoral programme was completed in 1998, the Indian Ocean framework naturally became a broader area of interest. A one year post-doctoral fellowship at the International Research Centre for Japanese Studies, Kyoto (1998-99) gave me the opportunity to study early exchange networks connecting the eastern Indian Ocean sphere to the Far East. A special object of study in this regard were small glass beads (Indo-Pacific beads) produced in the Bay of Bengal sphere and imported into Japan in large numbers in the early centuries AD. In 2002-03, I was field director of excavations at Kamrej, an Early Historic port on the estuary of the River Tapi which as trading with the Red Sea region and the Persian Gulf in the first millennium AD. The Kamrej excavations were reported in the first issue of the Journal of Indian Ocean Archaeology launched by the Indian Archaeological Society in 2004. I have continued to edit the JIOA which has an international editorial board and is attracting contributions from all over the Indian Ocean region and the western world.

It is necessary to emphasize that Indian Ocean Archaeology is not just a research initiative centred around maritime trade and long distance contact. Most of the Old World Civilizations flourished along the Indian Ocean rim. The Nile floods which sustained the Egyptian Bronze Age civilization are caused by the monsoon rains which fall on the Ethiopian highlands. The Iron Age cities of Yemen that rose around 1000 BC can be compared with similar urbanization processes in the Gangetic Valley (the rise of Kausambi) in the same period. In an expanded time scale the Indian Ocean world is a platform for prehistoric studies. An article published in the Journal of Indian Ocean Archaeology focused upon hominid migration into Indonesia. The transmission of botanical cultivars (millet, rice) is tied closely to rise of maritime communities and watercraft technologies as far back as the 5th millennium BC. In the Early Historic period (BC-AD transition), the emergence of powerful littoral polities like the Aksumite kingdom in Ethiopia-Eritrea and the rise of Hadhramaut on the Yemen coast rivaled those on the Indian coastlands like the Kshatrapas and the Satavahanas on the western coast and the Pandyas and Cheras in south India. Together, these littoral kingdoms were 'Indian Ocean' polities driving long distance trade across the seas. Many ports and market towns were expressive of urbanization processes on the coast and were conduits through which new techno-cultural traditions passed to the interiors.

The Indian Ocean Archaeology framework can be structured widely in space/time and can sustain research in 'comparative study of civilizations', 'trade and civilization', 'prehistoric and historic migrations', 'maritime connections', 'ancient technological transmissions' among several other themes. The lateral thinking and trans-national scope of the programme would potentially take studies bound within national frameworks to a higher level. If this perspective were to grow, MA and Phd level students in Tanzania would become familiar with Indian archaeological data and

stratigraphic categories and Indian students would know about the Neolithic – early Iron age transitions on the East African coast.

Indian Ocean Archaeology is a new framework of research which is being vigorously promoted by various institutes, universities and governments along the Indian Ocean rim and the western world. To cite some recent examples we can point to the first conference on Heritage of the Indian Ocean held on the French island territory of Reunion in November 2011. In November 2012 there is a conference on the Indian Ocean World System at Perth, Australia. As an important Indian Ocean country and situated at the pivot of major sealanes, India needs to acquire a high status in the scholarship of the Indian Ocean world. This is already happening. In November 2011, I participated in a seminar organized by the Embassy of India at Abu Dhabi on Indo-Arab Relations across the Ages. The seminar proceedings, which have several contributions on maritime connections, are already in the press. Given the various initiatives like the launch of the Journal of Indian Ocean Archaeology and the involvement of the MEA in expanding Indian research footprints, the Indian Ocean Archaeology programme needs to be institutionally adopted in India with a view to facilitating international level research on the Indian Ocean World and also to broaden the base for South Asian Archaeology in space and time. This can be done by creating a Centre for Prehistoric and Historic Archaeology of South Asia and the Indian Ocean World.

Dr. Sunil Gupta has been Assistant Keeper (Head of Education and Research) at the Allahabad Museum since 2002. His interests include History and Archaeology of the Early Indian Ocean World (prehistory to 1st millennium AD); Ancient South Asia; Silk Route Studies among others. He took part in excavations in Uttar Pradesh, Rajasthan, Gujarat (in particular at Kamrej, an ancient port on the banks of the River Tapi), also in China, Japan and Tanzania. He authored two books, many papers, and is editor of the Journal of Indian Ocean Archaeology.



Dr. T.S. Ravishankar

What Ails Indian Epigraphy?

At the outset, I whole heartedly congratulate the IIT Ahmadabad for taking this initiative to hold this two-day seminar and sessions on Indian Epigraphy & Numismatics. It is a laudable fact that, keeping in line with the proverb “better late than never”, the leading IITs of our country are showing great concern over the discipline of epigraphy, which is under the threat of extinction, though being the most interesting and much needed subject to preserve our culture and tradition for the posterity. The IIT, Kharagpur, Ramaiah College, Bangalore and BIT Pilani and many other Heritage Institutes have evinced keen interest in bringing to light our great epigraphical heritage which is one of the primary source for writing authentic history

of our great country. There is no sacrosanct point, if we, openly admit that the epigraphical studies is facing unprecedented grim situation with the dwindling of the tribe of epigraphists.

My presentation would mainly focus on the present status of epigraphical studies and the probable remedial measures to be undertaken to generate or rekindle the interest among the budding scholars in general and students of Ancient History & Archaeology in particular. It is suggested that there is a need to evolve a national policy to introduce subject of Epigraphy & Numismatics from 8th standard level in a phased manner so as to inculcate our great culture and also make the students to understand the importance of history for the better future. When the subject is introduced from high school level the wrong notion that the epigraphy is a tough subject to pursue can be dispelled. Also there is a need to arrange for short-term courses to teach the basics of epigraphy in all the Universities across the country in order to encourage the students of History & Archaeology with study of any Dravidian language and/or Sanskrit/Hindi at Degree/P.G. level, to take up the study of epigraphy. Further, lack of knowledge of Sanskrit, the mother of all Pan Indian languages, Prakrit, local dialect and classical languages like Kannada, Tamil and Telugu has badly affected the epigraphical studies. In general, it can be said without any hesitation that the study of humanities on the whole has been put on the back burner.

At this juncture, as the Head of the Epigraphy Branch for Sanskrit and Dravidian Inscriptions, I have to make a mention that, some time back, Secretary (Culture), Govt. of India had convened a meeting headed by Mrs. Kapila Vastayana and attended by myself and many other high level officials including the UGC Chairman to review the status of epigraphical studies and to plan the measures to resurrect the waning interest in it. A broad consensus that was reached was to reorient the study in the departments of Universities where it was taught and to introduce where it is not available.

Another major problem which has significantly contributed to the present pathetic scenario is the inordinate delay in filling up of vacancies in the govt. sector whether it is Central or State government offices. As a result of this, the second and third line of scholars is not available. Earlier, in any department or University, there used to be number of good scholars. Now, it is the collective responsibility of all to make all out efforts to resurrect this discipline from the threat of extinct. Epigraphical and archaeological heritages have no barriers. Each and every student, let he/she be from any discipline, should feel and understand that we have legacy of great heritage which needs to be preserved for posterity. I would like to conclude with the well known statement that “without past there is no present and without present there is no future”.

Dr. T.S. Ravishankar has served the Epigraphy Branch of the Archaeological Survey of India for more than three decades and is currently the Director of the Branch. He has established his expertise in deciphering Sanskrit

inscriptions and worked as an expert numismatist at Delhi customs office to examine coins. From more than 15 years, he has been teaching the students of Post-Graduate Diploma in Archaeology at the Institute of Archaeology, Archaeological Survey of India, New Delhi. He participated in many archaeological excavations at different locations (an important one being Ayodhya) and authored many scholarly articles in English and Kannada to reputed journals.



Dr Chithra Madhavan

Sanskrit Inscriptions of Tamil Nadu

The inscriptions of Tamil Nadu, which are the main sources for the history of this region, number several thousands. Of these, the majority are in Tamil, the local language. However, there are a very large number of epigraphs composed in Sanskrit, the earliest of which are the records of the Pallava dynasty, datable to approximately 5th century A.D. Sanskrit inscriptions of other dynasties like the Pandyas, Cholas, Vijayanagara and Nayak rulers have also been discovered. In addition are the epigraphs of the chieftains and also of rulers from outside the Tamil region who have left behind their Sanskrit inscriptions, mostly during invasions. All these epigraphs are found incised either on the walls of temples or on sheets of copper (copper-plate inscriptions). They are vital as sources of history as they provide authentic data about the political, economic, social and cultural aspects. A study of these epigraphs also makes it clear that their authors were conversant with Sanskrit literature from other parts of India like the works of Kalidasa. There are also many features in common with the Sanskrit inscriptions found in other parts of India and goes a long way in proving that Sanskrit was the lingua franca. Many of the Sanskrit inscriptions of Tamil Nadu provide data that are not found either in Tamil epigraphs or in literature. They are therefore vital for the study and documentation of the ancient and medieval history of Tamil Nadu.

Dr. Chithra Madhavan is an historian and epigraphist of south India, also with expertise in temple art. She has authored five books on those topics, as well as numerous academic papers and popular articles. She contributed more than a hundred articles on Temple architecture and allied subjects to the recently published 11-volume Encyclopaedia of Hinduism. She has worked as guest lecturer in the University of Madras and is now guest faculty at Kalakshetra and DakshinaChitra (for the Diploma course in Arts Management) in Chennai.



Dr. Mayank Vahia

Simulations and Other Techniques to Understand Civilizations

Recent developments in the field of computer simulation and information management as well as graphics and network studies have an enormous potential in the study of archaeology. These include studies of connectivity between various sites, parameters of social relevance as well as studies of diffusion of people and ideas which can be studied in an agent based manner as well as in the form of pure material diffusion. Taking the example of Harappan Civilisation we will demonstrate the powers of such techniques in understanding our past.

Dr. Mayank Vahia is a professor at the Tata Institute of Fundamental Research, Mumbai, and has worked on a variety of subjects in astrophysics, history of astronomy and science education. His most recent contribution is a project to understand the origin and growth of astronomy in the India. This interdisciplinary programme involves collaboration with a large group of researchers from a variety of fields of social and physical sciences. It has identified several potentially astronomical observatories in south India, and revealed the structure and grammar of the Indus script and studied evolution of Harappan Civilization. He has published more than 200 research papers.



Dr. Onkar Dikshit

**Center for Archaeological Sciences and Technologies (CAST)
at IIT Kanpur**

The last two decades have witnessed employment of scientific methods and information technology in archaeological investigations. Whereas historians and archaeologists in the advanced countries have been quick to deploy these advanced ideas and techniques in their work, their counterparts in India have been hesitant, even apprehensive, about engaging in a dialogue with the scientific community. After several rounds of interactions between scholars and national and state institutions working in the area of history and archaeology with scientists and technologists, the Indian Institute of Technology Kanpur established the Center for Archaeological Sciences and Technologies (CAST) in January 2008. The aim of this center is to nucleate and strengthen application of sciences and technologies in archaeological applications, cultural resource management and capacity building by educating users on the use of modern technologies and scientific methods. This presentation will outline the activities of CAST.

Dr. Onkar Dikshit is a professor at the Civil Engineering Dept., IIT Kanpur. He has worked in the areas of Surveying, Remote sensing, GPS, GIS, image

processing and pattern recognition applications for various engineering, archaeological and resource management problems. He has pioneered technical collaborations with archaeologists in India.



Dr. Javed Malik

**Archaeoseismological Evidence from the Indo-Gangetic Plain
Foothill Zone of Himalaya and Kachchh Region**

Javed N. Malik¹, Gadhavi M S^{2, 3}, Sravanthi, S.¹, Banerjee C¹, Rastogi, B K²,
Bhattacharjee F², Singhvi A K⁴, Bhuvan V⁵

¹Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, India

²Institute of Seismological Research, Gandhinagar, Gujarat, India.

³Now at L D Engineering, Ahmedabad

⁴Physical Research Laboratory, Ahmedabad, Gujarat, India

⁵Archaeological Survey of India, Agra. UP. India

The Indian sub-continent has remained seismically active since the onset of subduction-collision (~50 Ma) between the Indian–Eurasian plates. As a result during recent geological and historic past it has experienced several large magnitude earthquake along the plate-boundary (inter-plate) encircling from south-east along the Sumatra-Andaman Arc and Himalayan belt extending from north-east to north-west, and a few within the plate (intra-plate) in Kachchh, Gujarat in western part of India. The prominent large magnitude earthquake occurred in Himalaya during 1905 Kangra (M 7.8); 1934 Bihar (M 8.4); 1950 Upper Assam (M 8.5) earthquakes (Seeber and Armbruster, 1981; Ambraseys and Bilham, 2000; Bilham et al., 2001), and the recent 2005 Muzaffarabad (Mw 7.6) testify the seismically active nature of the area. Also the same is for Kachchh region with earthquake those were experienced during 1668 Indus Delta (M7); 1819 Allah Bund (M7.8), 1956 Anjar earthquake (Ms6.1), and the recent 2001 Bhuj earthquake (Mw7.6) (Malik et al., 1999a; Bilham, 1999). Most historic records and instrumental data available so far are not so comprehensive and also little or no written records are available from much of the seismically active zones of India (Iyengar and Sharma, 1999; Bilham et al., 2001). If at all information is generated related to past earthquakes is mainly gathered indirectly from historic documents of the political history of the country or from religious scriptures [Iyengar, 2004].

The Indian sub-continent is rich in ancient civilization, where the Indus valley civilization is one of the oldest civilizations that flourished across India during 4000-4500 yrs. BP. It has been suggested that most of these settlements and the site that survived until 19th century (?) were confined along the major river system. The India is marked by variable physiographic settings, from mighty Himalayas in north, fertile alluvial plain known as Indo-Gangetic Plain; shield – cratonic area of the middle and

south India, vast coastline encircling India from two sides (i.e. by Indian Ocean in east and Arabian Sea in the west). Because of their unique geographic setting, wide range of geological processes and landscape the Himalaya and Kachchh regions have attracted attention of historians, archaeologists; geologists and geomorphologists. Since several decades archaeological investigation have been carried out including extensive excavation to understand the cultural history, pattern of town planning, trade connections with neighbouring settlements, reasons for sudden or gradual decline of civilization etc. However, a very little attempt has been made to look for the evidences or signatures of earthquake, which might have been the probable cause for the destruction of the site. A collective attempt has been made to identify the archaeoseismological signatures preserved in the ancient structures on surface and sub-surface from Gujarat and along the foothills of Himalaya.

Most prominent features identified from Ahichhatra were from GPR profiles and during excavation. These features were subsided-slumped floor/walls, waved-up brick tiled floors, fallen walls, sand dikes etc. Two sites studied from Kachchh region i.e., Dholavira and Vigukot in Great Rann of Kachchh revealed prominent evidences e.g., waved-up outer walls, slumped fortified walls and tilted walls. Also we excavated 6-8 trenches in Allah Bund region Great Rann of Kachchh. Study reveals occurrence of at least 3 major events during recent past, which were probably responsible for the disruption of major channels (?), changing the landscape and destruction of the settlements. Trench at Vigukot (considered to be survived until 1819 AD Allah Bund earthquake) revealed three prominent cultural levels overlain by sand-sheets indicative of 3 major liquefaction events, triggered by near source earthquakes. At least 2-3 events during 2.0-3.0 ka, with the most recent event during 2.0 ka, the latest event probably represent the 1819 Allah Bund.

References

- Ambraseys, N., & Bilham, R. 2000. A note on the Kangra Ms=7.8 earthquake of 4 April 1905. *Current Science.*, 79(1), 45-50.
- Bilham, R., Gaur, V.K., & Molnar, P. 2001. Himalayan Seismic Hazard. *Science*, 293, 1442-4.
- Bilham, R., 1999. Slip parameters for the Rann of Kachchh, India, 16 June 1819, earthquake, quantified from contemporary accounts. In: Stewart, I. S. & Vita-Finzi, C. (Eds) Coastal Tectonics. *Geological Society London*, 146, 295-318.
- Iyengar, R.N. & Sharma, D. 1999. Some earthquakes of the Himalayan region from historical sources. *Himalayan Geology*, 20(1), 81-85.
- Iyengar, R.N. 2004. [Profile of a Natural Disaster in Ancient Sanskrit Literature](#), *Indian Journal of History of Science*, 39(1), 11-49.
- Malik, J. N., Sohoni, P. S., Karanth, R. V. & Merh, S. S. 1999. Modern and Historic seismicity of Kachchh Peninsula, Western India. *Journal Geological Society of India*, 54, 545-550.
- Seeber, L., & Armbruster, J.G. 1981. Great detachment earthquakes along the Himalayan arc and long-term forecasting: In: Simpson, D.W. & Richards, P.G. (Eds), *Earthquake Prediction- An International Review*, AGU. 259-279.

Ms. Nisha Yadav

Understanding the Structure of Indus Script Using
Computational Techniques

Indus script has defied decipherment. Several attempts have been made in the past to decipher the enigmatic script but there is no consensus about its content. In the present talk, I will give an overview of our work on the structure of Indus script. The focus of our analysis is to check and identify specific patterns in the writing and explore its underlying logic without making any assumptions about its content or meaning. I will discuss our recent attempts to analyse the structure of Indus writing using n-gram and Markov models. Though we do not assign meaning to the signs, the study provides a glimpse into the nature and style of writing of the Indus people.

Ms. Nisha Yadav is a scientific officer at the Tata Institute of Fundamental Research. She initially worked on the instrumentation of space based telescopes, then on the project "Archaeoastronomy in Indian context". She is primarily involved in the study of the structure and nature of the Indus script. During the period she has published several papers in leading Indian and International journals. Some of her published work on the Indus Script is available at the web site www.harappa.com. Her research aims at understanding the structure of Indus script using various computational and statistical techniques and exploring its relation to other aspects of the culture.

