Annual Report
2015-2016

Birbal Sahni Institute of Palaeosciences, Lucknow

An Autonomous Institute under Department of Science & Technology
Government of India, ***New Delhi***

We are grateful to
the Department of Science and Technology,
Government of India, New Delhi,
to
the Governing Body
and
the Research Advisory Council
of the Institute for
continued support and guidance

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September 2016

BSIP at a *Glance*

Prof. Birbal Sahni, FRS established the Institute in the year 1946 for development of the science of Palaeobotany visualizing its potential to understand the origin and evolution of plant life, and to use the knowledge of fossil plants in resolving various geologic problems, including exploration of fossil fuels. The Institute is named after him as the Birbal Sahni Institute of Palaeobotany (BSIP). It is devoted to develop both basic and applied aspects of Palaeobotany, and has adopted an integrated and multidisciplinary approach for fulfilling its aim and objectives:

- to develop palaeobotany, including palaeopalynology, in all its botanical and geological aspects,
- to constantly update the data for interaction with allied disciplines,
- to co-ordinate with other knowledge centres in areas of mutual interest, such as early life, exploration of fossil fuels, vegetation dynamics, climatic modelling, conservation of forests, etc., and
- to disseminate palaeobotanical knowledge.

BSIP's main mission is to achieve excellence in R&D work through a dedicated scientific team and continuous development of palaeobotany through integrated scientific approach with innovative ideas in basic and applied research; interpret the data gathered in relation to plant life evolution and geological processes; and to understand environmental evolution through time.

Initially, the Institute laid emphasis on fundamental aspects of Indian fossil floras. Later, the research activities were diversified to include biostratigraphic dating, correlation of surface and subsurface sediments, and exploring areas favourable for fossil fuel deposits. The main research work is concerned with the understanding of plant evolution through geological time. Emphasis has been made to derive knowledge about the diversification of Precambrian life, diversity, distribution and inter-basinal correlation of Gondwana and Tertiary floras, coal/lignite quality and to understand the interaction between the climate and change of vegetation in Quaternary Period.

The palaeofloristic scenarios of bygone eras help us figuring out the past climatic and environmental changes. But it is important to tag these climate change events to a time scale. Scientists also study tree-rings to deduce palaeomonsoon/climate. Dating and study of samples of archaeobotanical interest is critical to understand the evolution of culture and civilization. Work is also done on the organic petrology to evaluate the quality of lignites/ coals for their economic utilization, besides depositional conditions. The samples for all these studies are collected from all over the globe including polar (Arctic/ Antarctic) regions.

The museum of the Institute is a rich repository of fossils collected from India and received from all over the world. A special attraction is the foundation stone with 77 fossils embedded by Prof. Sahni which was laid by Pt. Jawaharlal Nehru in 1949. The Institute boats of one of the richest collection of literature on the subject. It also has a herbarium for offering comparison between the past and present vegetation. The Institute has the radiocarbon dating laboratory, the only such national facility in the country. It also has the TL/OSL system useful for precise dating of archaeological artefacts and Quaternary sediments. The IRMS, ICP-MS, GC-MS systems have recently been added for the isotopic and organic geochemical analyses. The Institute holds national/international scientific meets from time to time, and publishes catalogues, atlases, etc. on special occasions, besides an international journal *The Palaeobotanist* periodically.

The Institute, now renamed as Birbal Sahni Institute of Palaeosciences, is presently functioning as an autonomous research organization under the Department of Science and Technology (DST) Ministry of Science and Technology, Government of India.

"*here we study not only fossil plants but also the rocks in which they are found*"

– Birbal Sahni (April 03, 1949)


BIRBAL SAHNI INSTITUTE OF PALAEOSCIENCES
1946
OUR EXPERTISE
Evolution
Morphology & Taxonomy
Biostratigraphy
Palaeobiogeography
Palaeoclimate & Palaeoenvironment
Geochronology & Geochemistry
Organic Petrology
Archaeobotany
Dendrochronology
Aerobiology
Industrial Palynology
Consultancy Services
Contract Research
Contract Training Services (in Palynology and Coal & Lignite Petrology)
Identification of Fossils
Scanning Electron Microscopy
Petrological Analysis
Palynological Analysis of Pre-Quaternary & Quaternary Sediments
Radiocarbon Dating

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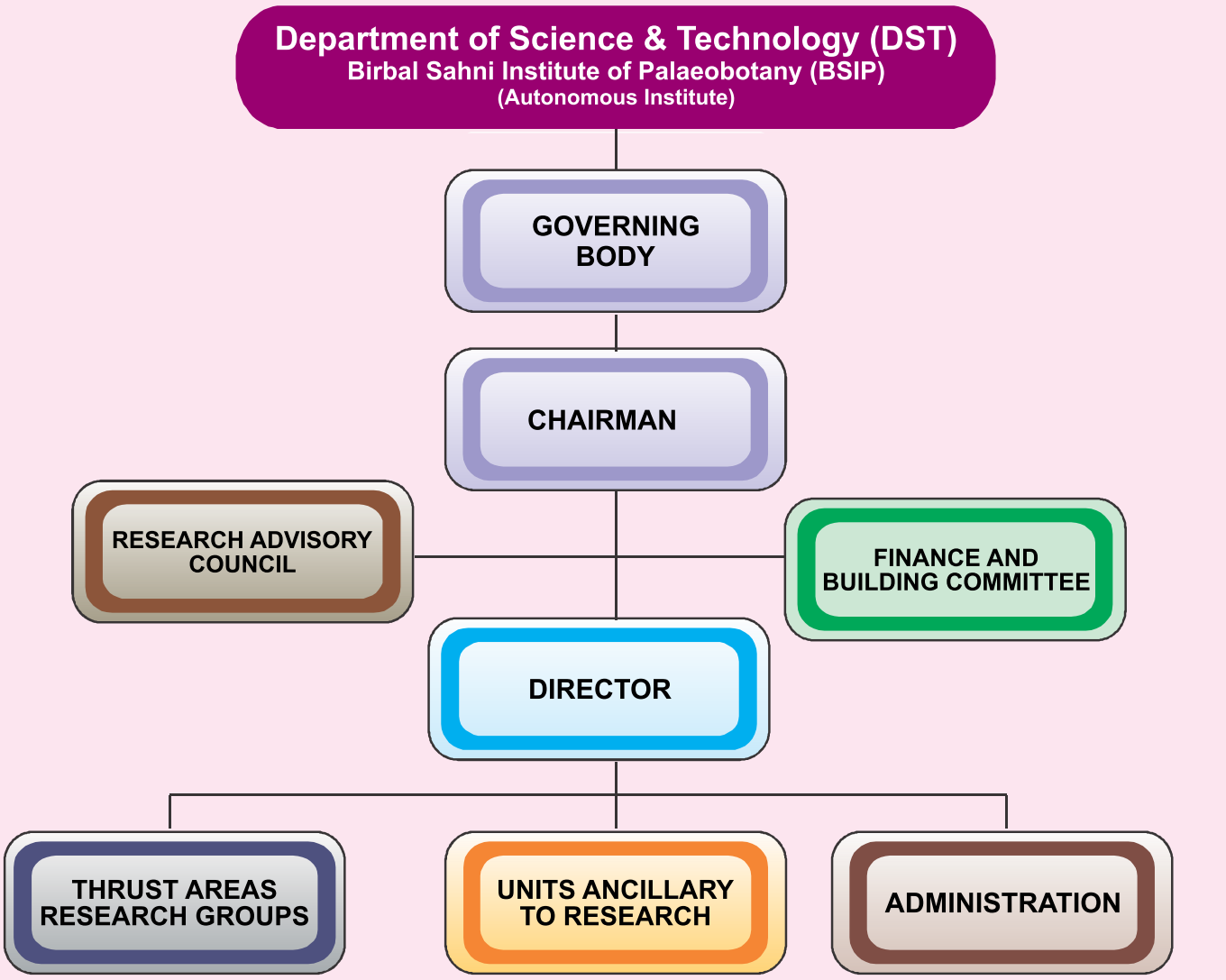
Organization Structure



Precambrian Palaeobiology
Palaeozoic-Mesozoic Megafloristics
Palaeozoic-Mesozoic Miofloristics
Terminal Cretaceous-Neogene Megafloristics
Terminal Cretaceous-Neogene Miofloristics
Marine Micropalaeontology
Organic Petrology
Quaternary Palaeoclimate
Polar Research
Dendrochronology
Palaeoethnobotany
Geochronology & Geochemistry

Research Development & Coordination Cell
Publication Division
Knowledge Resource Centre
Museum
Herbarium
Maceration Laboratory
Section Cutting Workshop
Scanning Electron Microscopy
Electronic Data Processing
Photography

Registrar Unit
Finance and Accounts Section
Establishment Section
Scientific Activities Section
Stores and Purchase Section
Works, Building & Maintenance Section
Transport & Guest House

Central Public Information Officer
Dr. B.D. Singh, Scientist-F

Vigilance Officer
Dr. Mukund Sharma, Scientist-F

Women's Forum
Dr. Alpana Singh, Scientist-F

Foreword

It is a matter of great delight for me to present the 2015-16 Annual Report of Birbal Sahni Institute of Palaeobotany (BSIP). Since its inception nearly 70 years ago, this Institute has contributed immensely to our understanding of the evolutionary history of plants. The Institute has recently been rechristened *Birbal Sahni Institute of Palaeosciences* to encourage ongoing efforts to expand the scope of research activities by bringing the much-needed multidisciplinarity and intergration of all relevant inputs needed for a holistic understanding of the evolution of organisms, climate, ecosystems and other related aspects. With a number of recently introduced analytical facilities, BSIP is now poised to take a great leap forward in palaeoscience research, including in palaeobotany, palaeoclimatology, palaeozoology, palaeobiogeography, palaeogeography, magnetostratigraphy, palaeoethnobotany, and numerous related fields, all under one roof. Several additional fields are also in the process of being introduced in the Institute. I am confident that the new name of BSIP will enthuse new energy and the Institute scientists, with nearly half of them below the age of 40 and over one-third of them women, will achieve the potential that the exciting field of palaeosciences offers.

I sincerely acknowledge the dedicated efforts made by the Research Development and Coordination Cell (RDCC) of the Institute to prepare this important document with generous support from scientists and the technical and administrative sections. Sincere thanks are also due to the Department of Science and Technology (DST), Government of India and the Governing Body and Research Advisory Council of the Institute for their constant encouragement and support. On behalf of BSIP, I look forward to the continued support from all of the above in days to come.

(Sunil Bajpai)
Director

Research Highlights

Birbal Sahni Institute of Palaeosciences (BSIP, erstwhile Birbal Sahni Institute of Palaeobotany), established in 1946, is devoted to development of both fundamental and applied aspects of Palaeobotany and allied Earth System Sciences, especially focusing on past plant life, palaeoclimate and palaeobiogeography. Research on Palaeobotany and allied disciplines is being conducted on sedimentary sequences from Archaean to Recent (3200 Ma to 400 AD) with an integrated and multidisciplinary approach. To achieve the targets of the XII Five Year Plan, 14 research projects have been initiated under the umbrella of eight identified Thrust Areas, besides documentation and digitization of data. Some of the significant outcome of scientific research during the year 2015-2016 is summarized as under:

1. **Early life and environment: Evidence from Indian Precambrian basins**
   - Report of a characteristic early Cambrian trace fossil– *Treptichnus pedum* from the Nagaur Formation (Rajasthan); indicating the Precambrian-Cambrian boundary in the Marwar Supergroup.
   - Record of carbonaceous remains and micro-invertebrates from the Samaria Formation of Bhander Group (western Vindhyan Basin) in Chambal Valley, Rajasthan.
   - Indication of Neoproterozoic age for the upper part of Chhattisgarh Supergroup, based on the occurrence of eukaryotes *Obruchevella–Melanocyrillium* from the sediments of Raipur Group.
2. **Phanerozoic terrestrial and coastal ecosystems: Biostratigraphical, palaeoenvironmental, palaeoecological and palaeobiogeographical aspects**
   - Record of the plant fossil assemblage (of orders Equisetales, Glossopteridales & Cordaitales) from the early Permian Barakar Formation of Sharda mine, Sohagpur Coalfield (MP).
   - Report of early Permian megaspores from the Index Seam of the Goutham Khani coal mine, Kothagudem area (Godavari Graben). Presence of crowded diverse spines on the megaspores indicates their early appearance during the Barakar Formation.
   - Documentation of the spores-pollen assemblages from the Palaeozoic sequences of Wardha-Godavari Valley (AP), Ib-River (Odisha), Bokaro (Jharkhand), Sohagpur (MP), and Ramkola-Tatapani (Chhattisgarh) coalfields in order to work out their significance in biostratigraphical and palaeoenvironmental interpretations.
   - Recovery of fresh water diatom frustules with the tests of thecamoebians from the Permian sediments of Chamba and Godavari basins; indicating the existence of diatoms prior to the Permian-Triassic boundary.
   - Delineation of the Permian-Triassic boundary at the contact of coal/shale-bearing upper part of the Middle Member and the lower part of the Upper Member of the Pali Formation (between 1164.10-1075.15 m depth), based on the palynoassemblages from Sohagpur Coalfield.
   - Indication of the Permian-Triassic boundary in the Iria Nala section near Premnagar in Ramkola-Tatapani Coalfield, based on the macrofossil and palynofloral assemblages.
   - Recovery of the pteridophytic spore genus *Callumispora* in the form of tetrads from the early Triassic sediments of Talcher Coalfield (Mahanadi Basin).
   - Record of the palaeo-wildfire evidence in the form of charcoal (of fragments of tracheids with homogenized cell walls) from the late Permian Zewan Formation of the Kashmir region.
   - Identification of three floral assemblages from the early Cretaceous fluvial sediments of the Gangapur Formation (Pranhita-Godavari Basin) consisting of ferns and gymnosperms.
   - Report of the microsporophyll genus *Caytonanthus* from the lower Cretaceous beds of Tekan area of South Rewa Gondwana Basin.
   - Indication of warm and humid climatic conditions in western India during the early Eocene time in contrast to hot and dry climate prevailing there at present, based on fossil woods record from the lignite mines of Gujarat.

- Record of dipterocarps from the Siwalik sediments of Nepal Himalayan foot-hills suggests that they have migrated from the Southeast Asian region during early Miocene, and later on became extinct due to prevailing of unfavorable condition.
- Discovery of a fossil wood showing resemblance with tribe Oleinae from Jheria, Chhindwara district (MP). This is the oldest record of the genus *Olea*.
- Recognition of a pronounced –ve Carbon Isotope Excursion of about 2.0‰, in the middle part of Panandhro lignite mine succession (Kachchh Basin, Gujarat) which can be well-correlated to the Second Eocene Thermal Maximum (ETM2) event.
- Documentation of several new peridinioid dinoflagellate species prior to Palaeocene/Eocene boundary from the lignite-bearing succession of Giral mine (Barmer Basin, Rajasthan); providing clues regarding evolution of *Apectodinium* dinoflagellate lineage from low latitudes.
- Recovery of Maastrichtian palynological assemblage from the thin sedimentary beds exposed near the village Rangapur, Andhra Pradesh (Deccan Intertrappean).

3. Integrative marine micropalaeontology: Focus on high resolution biostratigraphy, sea level changes, palaeo-oceanographic and palaeoclimatic events

- Evidence of two hyperthermal events– Palaeocene-Eocene Thermal Maxima (PETM) and early Eocene Thermal Maxima2 (ETM2) in the Ranikor Barsora section (late Palaeocene-early Eocene) of east Khasi Hills, Meghalaya, based on the carbon isotopic study.
- Generation of elements analysis data of the sediments from Jathang section, east Khasi Hills to corroborate with biotic proxy records for better understanding of the then prevailing climatic conditions.
- Recovery of early Cretaceous age calcareous nannofossils from the Ghuneri and Katesar members of the Umia Formation (Kachchh Basin).
- Indication of a fairly conducive environment for the survival of the algal forms along with other biogenic components, based on biofacies analysis of the Long Formation exposed near Butler Bay in Little Andaman Island.

4. Organic petrology: Characterization of solid fossil fuel for depositional and utilizational aspects

- Evaluation of the Tertiary lignites from Valia (Cambay Basin), Gurha (Bikaner Basin) and Surkha (Saurashtra Basin) mines, and Permian coal from Sravanapalli area of Belampalli Coalfield (Godavari Basin).
- Indication of the potential of lignite-bearing sequences to produce hydrocarbons, based on the types of kerogen (organic matter) and TOC contents.
- Indication of a significant contribution of high microbial activity and epicuticular waxes from higher plants to the organic-rich sediments of Warkalli Formation (southern Kerala).

5. Quaternary palaeoclimate reconstructions, vegetation dynamics and relative sea level changes

- Recognition of four distinct phases of climate oscillation, vegetation response and human occupation in Cachar district of Assam, based on the palynological records from Chatla wetland.
- Evidence showing the mangrove/estuarine ecosystem since 6-7 ka in the north-eastern part of Krishna River Delta (Andhra Pradesh); indicating palaeo-shoreline about 10 km inland from the present shoreline and present slightly above the present day mean sea level.
- Documentation of peripheral and core mangroves taxa through palynological study of surface samples (mud) from the Jharkhali of South 24 Pargana Division (West Bengal).
- Compilation of the granulometric dataset of sediments from the palaeolakes of Ladakh in relation to the depositional environmental changes within the lakes from post LGM to 5 ka.
- Recognition of four climatic phases and anthropogenic signatures in the Dokriani glacier valley (Wester Himalaya), based on the pollen analysis of a sedimentary profile covering entire Holocene time.

- Analysis of phytoliths from dominant grasses and surface soils of four different forest types indicates that the temperature and evapo-transpiration were the most influential for differential distribution of grass phytolith assemblages with rising elevation in the eastern Himalayas.
- Indication of rapid glacial retreat during the pre-Holocene, followed by a warmer period during early Holocene time in Ny-Alesund region (Arctic), based on the quartz grain micro-texture along with ^{14}C AMS dates. Mid- and late Holocene is marked by a predominantly glacial environment.
- Development of four century (from *Cedrus deodara*) and seven century (from *Pinus gerardiana*) long tree-ring chronologies from the data sparse Kishtwar (J&K) region.

6. Domestication of plants, early farming and ecosystem dynamics during Holocene/ Anthropocene

- Evidence for the exploitation of botanical resources by ancient settlers through remains from ancient sites Biland Khera (Hardoi district, UP) and from Kanishpur (Baramullah district, Kashmir).

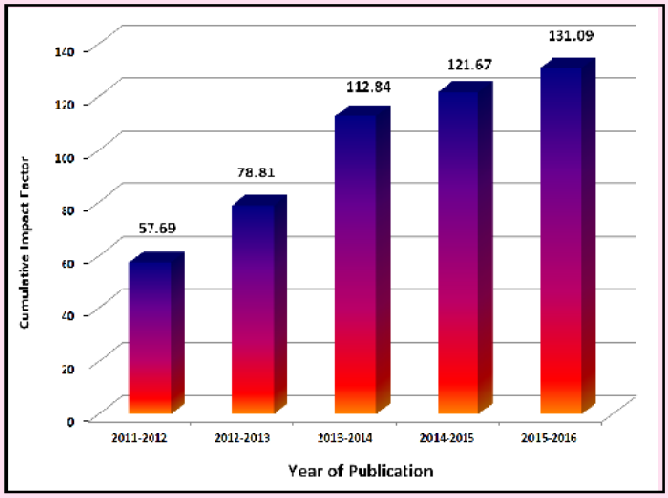
7. Geochronological and geochemical parameters for high resolution dating, correlation, palaeoclimatic, tectonic and provenance studies

- Dating of sediment samples from the archaeological sites and lake shores and also the standard and background samples.
- Installation of the GC-MS, IRMS, ICP-MS, and XRD equipments for state-of-the art facilities of geochemical analyses. Calibration procedure is performed as per the requirement of the individual instrument.

8. India-Asia collision and Himalayan uplifts: palaeobotanical and associated biotic signatures from sedimentary records of western Himalaya

- Recovery of nannofossils from the Basgo Formation at Taruche-Saspoche section overlying Ladakh batholiths; hosting stratigraphically mixed coccolith cocktail, with approx. 80-90% late Cretaceous and 10-20% early Palaeogene components.
- Recovery of ostracodes and fish remains (dentition only) from the samples of Taruche-Saspoche area, Indo Tsangpo Suture Zone (Ladakh region).

Integrated collaborative research activities in several spheres with institutions in India and abroad (Brazil, China, Germany, Nepal, Netherlands, Sri Lanka, UK, USA, etc.) have helped to expand scientific knowledge. The collective research efforts are expressed in the form of 112 published papers. Four Ph.D. degrees were awarded during the year. Four scientists were deputed abroad (Brazil, China, Sri Lanka, USA) for study purposes and two scientists participated in the Indian Scientific Expedition to Antarctica. Two scientists were awarded CAS-Presidents International Fellowship Initiative: PIFI Fellowship to work in China. Nine scientists were deputed for attending various conferences abroad (in China, France, Germany, Japan and Russia). Forty six scientists, 3 Birbal Sahni Research Scholars, 3 Technical and one Administrative staff, and 7 Project Fellows were deputed to attend various national and international conferences/ workshops held in the country. About 98 research papers were presented in these scientific meetings at different centers of India and abroad.



Cumulative Impact Factor of Published Research Papers

An international conference on *3rd NECLIME Asian Meeting* was successfully organized during February 2016. The conference was attended by scientists from Senckenberg, Germany, USA, and eight institutions of India. A national conference on *Palaeogene of the Indian Subcontinent* was also successfully hosted jointly with GSI (Northern Region) during April 2015 in which researchers from twenty-five institutions of the country were participated. Besides, a workshop on *Depositional Environment Systems* was also organized in the Institute, conducted by Prof. I.B. Singh of Department of Geology, University of Lucknow during August 2015.

Foundation Day

The Institute celebrated its 69th Foundation Day on September 10, 2015. On this occasion the Chief Guest Prof. Deepak Pental, Former Vice-Chancellor of the University of Delhi, and Director, Centre for Genetic Manipulation of Crop Plants (CGMCP), New Delhi paid rich tributes to Prof. Birbal Sahni, and delivered the "18th Jubilee Commemoration Lecture" on the topic *Polyploidy and Angiosperm Evolution*. Talking on the origin of and explosion in the number of flowering plants during earth's history, he said that this was a result of polyploidy, which is the phenomenon of change in the number of paired sets of chromosomes from 2 to 3 or more. The flowering plants owe their origin to polyploidy.

As the Guest-of-Honour Prof. A.K. Tripathi, Director, CSIR-Central Institute for Medicinal and Aromatic Plants (CIMAP), Lucknow delivered an interesting talk in Hindi on *The Plants of Medicinal Importance* to mark the beginning of Hindi *Pakhwara* celebrations in the Institute. He mentioned that plants have to adopt more as they, unlike animals, don't have the freedom to move in a situation of stress. The stress can lead to production of metabolite, and this is one of the reasons for their medicinal properties. On the occasion, both the guests also planted trees in the BSIP campus. Earlier, Prof. Sunil Bajpai, Director welcomed the guests and scientists from outside the Institute who attended the function.

Founder's Day

The Institute celebrated its Founder Professor Birbal Sahni's 124th birth anniversary on November 14, 2015. On this day, the Institute's staff and distinguished guests from other organizations offered *Pushpanjali* on the *Samadhi* of Prof. Birbal Sahni, FRS in the campus. Same day following Memorial Lectures were organized:

Dr. James B. Riding of the Environmental Science Centre, British Geological Survey Keyworth, Nottingham, UK delivered the "45th Birbal Sahni Memorial Lecture" entitled *The use of Palynology and Geochemistry together in Mesozoic Geology*. He elaborated a detailed account of how pollen and isotope based data can help us understand the past climatic and environmental changes.

Prof. Robert E. Riding of the Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, USA delivered the "61st Sir Albert Charles Seward Memorial Lecture" entitled *Microbial Carbonates: Processes and Products through Earth History*. He pointed out that these carbonates are made by micro-organisms and are sensitive indicators of biological and chemical conditions of the past.

Prof. Ashutosh Sharma, Secretary, Department of Science and Technology, Govt. of India presided over the function, who appreciated the achievements of Institute. He said that BSIP has performed outside the scale when we consider the financial input and intellectual output, and

has created a treasure of unique knowledge bank. Prof. Sharma advised the young scientists that they should keep eyes on the short and the long term goals both. The fact is that today it's an age of inter- and multi-disciplinary research, and no bright mind always works only in a very narrow domain keeping a narrow identity. Earlier in his welcome speech, Prof. Sunil Bajpai, Director briefed about the Institute's achievements. Many guests and scientists from outside the Institute attended the function. On this occasion, certain Institute's medals were also awarded to staff members.

Conference on Palaeogene

A National Conference on *Palaeogene of the Indian Subcontinent* was jointly organized at GSI (Northern Region) and BSIP, Lucknow during April 23-24, 2015. The conference was inaugurated in the auspicious presence of Padma Bhushan Prof. K.S. Valdiya, Shri Harbans Singh (DG-GSI) and Prof. D.M. Banerjee (President, INSA-IUGS). Overall, the representation of delegates was from various institutions (AMD-Hyderabad, NGRI-Hyderabad, WIHG-Dehradun, ONGC-Dehradun, UPES-Dehradun, PRL-Ahmedabad, GMDC-Ahmedabad, PDPU-Gandhinagar, RGIPT-Rae Bareli, IIT-Roorkee, IIT-Bombay, DGM-J&K, INCOIS-Hyderabad, AMDER-New Delhi, etc.) and universities (Bangalore, BHU-Varanasi, Calcutta, Delhi, Guwahati, Kurukshetra, Manipur, Nagaland, Panjab, Presidency-Kolkata & Tribhuvan-Nepal), besides from Durgapur Government College-WB, Govt. Institute of Science-Aurangabad, GSI and BSIP.

In all, six scientific sessions were held, excluding a separate session on International Geological Congress Committee-2020, to highlight the geological importance of the Palaeogene period spanning about 42 million years (from approx. 65-23 Ma BP). A total of 8 keynote lectures were delivered, with four each for the 1st and the 2nd day. Three sessions (and a session on IGC-2020) were on the inaugural day at GSI in which 15 papers were orally presented. On the next day, 21 papers were presented at BSIP distributed in another three sessions. Poster sessions were also held at both venues with 12 posters each on the day. The diverse themes of the conference included issues related to stratigraphic correlation of the Palaeogene sequences of the Indian subcontinent, fossil records (both flora & fauna) in an evolutionary, palaeobiogeographic and the paleoclimatic context, rise of the Himalaya and related events, and also the exploration of fossil fuel resources from the Palaeogene sedimentary basins of the country.

The scientific session-I on the Cretaceous-Palaeogene boundary event preceded by the keynote lecture of O.P. Pandey (NGRI); stressing on the geophysical evidence in the context of K-T boundary asteroidal impact, crust-mantle structure and geodynamics of the western continental margin of India. Further, Jyotsana Rai (BSIP) reported the discovery of nannofossils from Deccan Intertrappean deposits of central India, and she also presented a comprehensive account of nannofossils from the Indian subcontinent. Dipankar Saikia (NGRI) presented the geophysical evidence on the lateral variation in the Moho characters beneath the eastern Himalaya. The session-II was dedicated to the energy and mineral resources of the Indian Palaeogene. In his keynote lecture, Sudhir Shukla (ONGC) emphasized the importance of foraminiferal studies used in hydrocarbon exploration. D.U. Vyas (GMDC) elaborated the lignite/mineral explorations in relation to industrial growth in Gujarat. Pradeep Pandey discussed the occurrence of uranium mineralization in the Palaeogene sediments of NW Himalayas. Last session-III of the day covered the geodynamic evolution and sedimentation pattern of the Palaeogene sequences of the Indian Subcontinent. In his keynote presentation, B.P. Singh (BHU) discussed the sedimentation pattern and

transgression–regression events during Palaeogene. In another keynote address, K.S. Misra (UPES) discussed the tectonics of the Palaeogene basins on the basis of high-resolution seismic data from the Bay of Bengal and eastern half of Arabian Sea.

The session-IV of the conference was continuation of the theme at BSIP, and the day began with a keynote lecture delivered by O.N. Bhargava. He pointed out the controversies surrounding the stratigraphy of the Palaeogene sequences of Lesser Himalaya, brought to focus the need for new researches. During the session, B.P. Singh elaborated the facies analysis and depositional environment of the early Palaeogene Naredi Formation (Kachchh Basin). K.M. Sharma (GSI, Kolkata) discussed field observations of the Palaeogene succession in Shimla Hills. S.R. Mishra (GSI, Lucknow) presented the sedimentological and fossil data from the Subathu Formation of Mussoorie and Garhwal regions.

The focus of the session-V was on the palaeoclimatic and palaeoenvironmental signatures, derived through biotic and geochemical proxies. J.S. Ray (PRL), in his keynote lecture, discussed the provenance of Palaeogene sediments in Andaman forearc and its implications based on geochemical studies. Gaurav Srivastava (BSIP) illustrated the quantification of warming events during the Palaeogene in India as evidenced from fossil climates. Jyoti Srivastava (BSIP) highlighted the effect of global warming on the diversity pattern in mangrove palm *Nypa* from South Shillong plateau. Neeraj Awasthi (PRL) showed geochemical and isotopic data from the sedimentaries of Andaman Forearc Basin, and supported the idea of prevalence of monsoon system possibly in late Eocene. V.V. Kapur (BSIP) emphasized the importance of basal Eocene land mammals from the lignite-bearing Cambay Formation of Surat district (Gujarat).

The session-VI discussed the issues related to Palaeogene biochronology and biogeography. Overall Cretaceous-Palaeogene biogeography of the Indian subcontinent was highlighted in a keynote talk by Ashok Sahni (Lucknow). Prabha Kalia (Delhi) explained the biostratigraphic significance of Eocene-Oligocene foraminifers from the Arabian Sea and western tropical Indian Ocean. Rahul Garg (BSIP) discussed the biochronology of the lignite-bearing succession (Kharsalia Formation) of Bhavnagar district (Gujarat), based on dinoflagellate cysts record. Kapesa Lokho (WIHG) highlighted the foraminifer fossil records from the Eocene sedimentaries of the Naga-Manipur Hills, Indo-Myanmar range. M.R. Rao (BSIP) discussed the age and palaeoenvironment of the Panandhro lignite mine succession of western Kachchh.

The conference brought scientists, academicians and research scholars on a single platform to discuss and debate the present and future challenges in research on the Indian Palaeogene sequences. The scientific deliberations are expected to lead to further studies on the Palaeogene successions of the Indian subcontinent.

On the 1st day, a special session was also organized related to the 36th International Geological Congress-2020 to be held in New Delhi. This event will be hosted jointly by the Ministries of Mines (MoM) and Earth Science (MoES), with the assistance of the Indian National Science Academy (INSA). During this session, Marvin D'Souza (Working Office-cum-Secretariat, New Delhi) gave a detailed presentation and highlighted the preparedness of the Indian geoscience community for this mega event.

NECLIME Asian Meeting

NECLIME (Neogene Climate Evolution of Eurasia) is an open international network of scientists working on the Cenozoic palaeoclimate evolution in Eurasia and related changes of continental ecosystems. It holds annual meetings, has working groups and advisers for specific topics, thus bringing forward scientific exchange, joint projects, and integration of the results obtained. One of the thrust areas of ongoing research at BSIP is palaeoclimate reconstruction and concerned scientists are working in this field. Hence, an *International Conference on 3rd NECLIME Asian Meeting* was organized at the Institute during February 23-27, 2016.

The conference was inaugurated by Padma Bhushan Prof. K.S. Valdiya, and was attended by scientists and scholars from Senckenberg, Germany, USA, WHIG (Dehradun), IISC (Bengaluru), French Institute (Pondicherry), IIT (Mumbai), NCAOR (Goa), Punjab University (Chandigarh), BHU (Varanasi), and Lucknow University, besides from BSIP. Prof. Sunil Bajpai, Director delivered the welcome address followed by brief introduction of NECLIME by Dr. Volker Mosbrugger, Director Senckenberg and one of the founders of NECLIME. Dr Vandana Prasad, Organizing Secretary, introduced the theme of the conference.

A total of 24 oral presentations including 7 keynote lectures in 5 sessions and one poster session (including 22 posters) were discussed on February 23rd and 24th. Theme of 1st session– Palaeobiogeography and biodiversity and climate was led by a keynote talk delivered by D.L. Dilcher (USA) on low latitude migration patterns of shared Asian and American tropical floral elements: their early evolution and dispersal. This was followed by another keynote lecture on geo-biodiversity hotspots: past, present and future by Volker Mosbrugger (Germany), and two presentations. Divya Bhaskar (Bengaluru) discussed the phylogenetic diversity of Western Ghats forests, and Rajesh Agnihotri (BSIP) illustrated the spatio-temporal trends of temperature and precipitation over the Indian subcontinent during 2001-2015.

Under the 2nd theme– Climate and fauna, keynote addresses were delivered by Sunil Bajpai (BSIP) on the topic Tertiary mammal faunas of India: an overview of recent advances, and by Angela Bruch (Germany) on the environment of *Homo erectus* in Java based on pollen data. The keynotes were followed by three scientific deliberations. Susanne Haupt (Germany) elaborated the palaeodiet of *Homo erectus* in early Pleistocene deposits of Sangiran (Java, Indonesia), while Christine Hertler (Germany) emphasized the palaeoecological significance of a vertebrate fossil (*Duboisia santeng*) from the same deposits at Sangiran. Rajeev Patnaik (Chandigarh) briefly gave an account of Neogene climate and mammalian faunal dynamics of the Indian subcontinent.

Under the 3rd theme– Palaeoclimate reconstruction, Torsten Utescher (Germany) delivered the keynote talk on Cenozoic climate and vegetation patterns in Eurasia: an outline of Neclime research and methodology. Poonam Verma (BSIP) outlined the quantitative reconstruction for the early Eocene climate, based on palynomorphs preserved in the amber of Vastan lignite mine succession (Gujarat). Shailesh Agarwal (BSIP) provided evidence of early Eocene hyperthermal event in the Panandhro lignite deposit of western India. Vandana Prasad (BSIP) provided evidence of effect of past global warm events on the vegetation pattern on fossil palynomorphs from Palaeocene-Eocene succession of Meghalaya. Eva Niedermeyer (Germany) presented the reconstruction of palaeoenvironments based on geochemical biomarker studies

The 4th theme– Quaternary and Neogene records began with A.D. Singh's (Varanasi) keynote address on Neogene-Quaternary low-mid latitude climate variability and its linkages to the evolution of ocean gateways. Following the keynote, Anjum Farooqui (BSIP) discussed the diversification and extinction of *Nypa* pollen during Quaternary period in India. A.K. Ghosh (BSIP) provided an overview of early Miocene to late Pliocene palaeoclimate based on evidence from siliceous and calcareous microfossils from Andaman and Nicobar basin. M.R. Rao (BSIP) summarized the palynostratigraphy and palaeoecology of Neogene sediments of India, while Gaurav Srivastava (BSIP) described pre-monsoon and post-monsoon rainfall in Konkan region during the late Pleistocene.

In the last theme– Quaternary climate and vegetation dynamics, Pradeep Srivastava (Dehradun) gave keynote address on a sub-centennial scale Holocene climate record from Garhwal. Martina Stebich (Germany) provided Holocene history of climate, vegetation and anthropogenic disturbance from core monsoon zone of central India from lacustrine sediments of Lonar Crater (Maharashtra). Oindrila Biswas (Kolkata) gave nice account of grass phytolith assemblages along the tropical-temperate elevation gradient of the eastern Himalayas, to assess the reliability of phytolith indices for climate reconstruction. Navya Reghu (Pondicherry) presented the modern pollen spectrum from southern east India: analogue of Quaternary vegetation reconstruction. Holocene quantitative climate reconstructions based on pollen data from North Sikkim was shown by S.K. Sah (BSIP). Finally, A.K. Arya (Lucknow) presented the retreat pattern of Glaciers and evidences of neotectonism: a study of Gangotri Glacier, Garhwal Himalaya.

In addition, two days post-conference field trips were also organized on 26th and 27th February in the vicinity of Lucknow city, in Kalpi and Nawabganj areas which provided glimpses of fluvial geomorphologic architecture, fossiliferous Quaternary sedimentary sequences and archaeological sites in the Ganga Plains. The conference provided a unique opportunity for discussions and overviews on diverse aspects of the palaeoclimatic reconstructions. It was strongly proposed to take initiative for joint research work involving scientists from Senckenberg (Germany) and BSIP to solve various climate related issues of Palaeogene, Neogene and Quaternary time span.

Outreach Activities

BSIP displayed exhibits in an exhibition organized at Pragati Maidan, New Delhi on the occasion of 35th India International Trade Fair during November 14-27, 2015.

BSIP participated in the India International Science Festival (IISF-2015) organized at Indian Institute of Technology, Delhi during December 04-08, 2015.

On demand, BSIP displayed plant fossils (through the ages) at 5th Annual Festival (Rural Mela) of Simonee village in Banda district (UP) during December 13-17, 2015.




BSIP erected an exhibition at Mysore University during 103rd Indian Science Congress Association from January 03-07, 2016.




Research

Thrust Areas and Projects

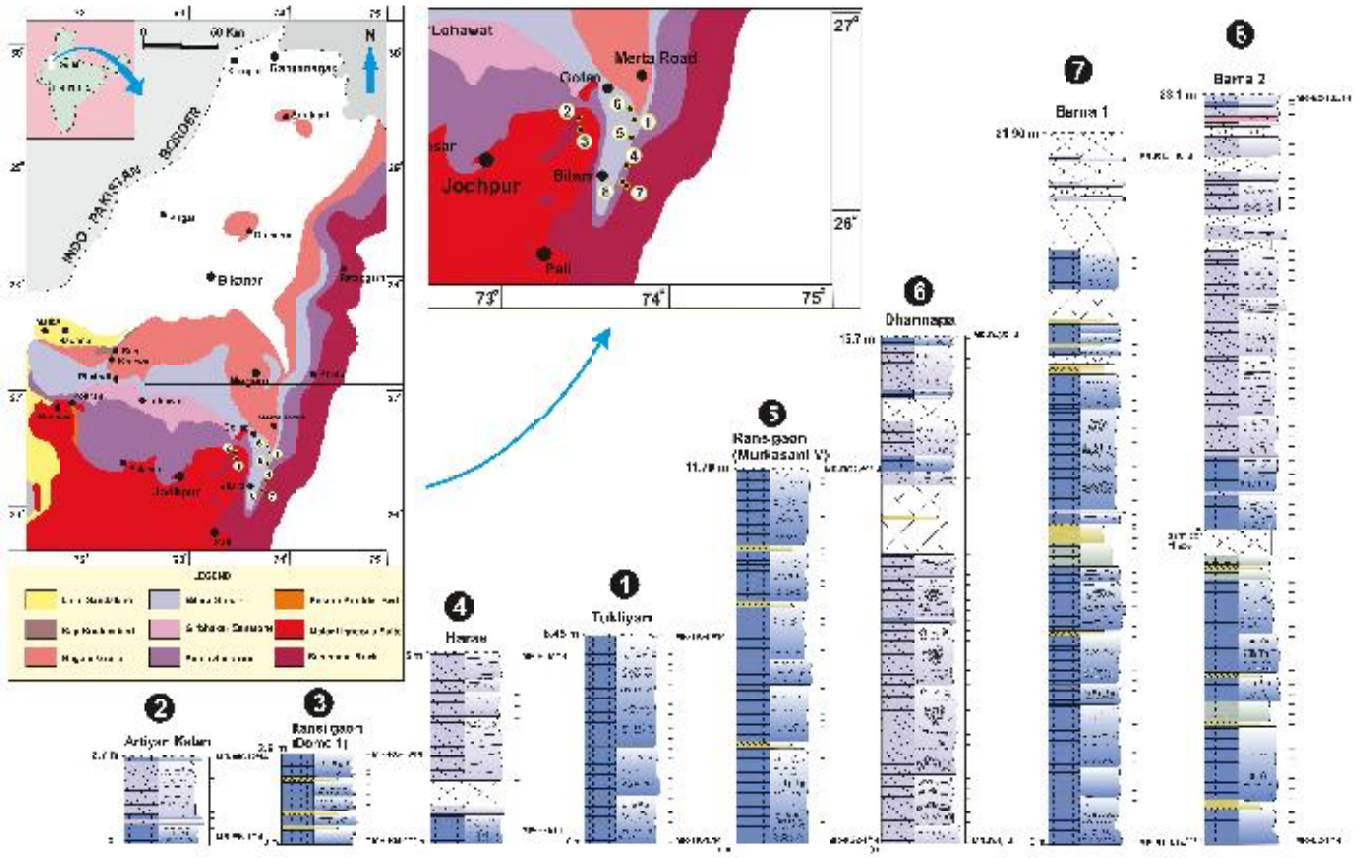
Thrust Area 1: EARLY LIFE AND ENVIRONMENT: EVIDENCE FROM INDIAN PRECAMBRIAN BASINS

Precambrian Palaeobiology Group

Project- 1.1: Palaeobiological, biostratigraphical and evolutionary aspects of the Precambrian biota: Evidence from Neoproterozoic basins of India

Investigators: Mukund Sharma, S.K. Pandey, A.H. Ansari & Bandana Dimri

The Bilara Group, a carbonate sequence of the Marwar Supergroup, is sandwiched between the underlying Ediacaran fossil-bearing siliciclastic Jodhpur Group of rocks and overlain by an assemblage of the Cambrian trace-fossils bearing siliciclastic Nagaur Group. *Treptichnus pedum*, a characteristic early Cambrian trace fossil, has been reported from a bed in the Nagaur Formation which a part of Nagaur Group comprising Nagaur and Tunkliyan Formations. Various other characteristic Cambrian trace fossils have been documented from very restricted exposure (~20 m) of the Nagaur Formation at Dulmera in Bikaner district, Rajasthan. The Bilara and Nagaur Formations are two units of the Marwar Supergroup which hold promise for demarcating Precambrian-Cambrian boundary. The first appearance datum of *T. pedum* is considered as an indicator of the Pc-C boundary in any geological succession. The occurrence of *T. pedum* in the Nagaur



Systematically measured lithologs of the Bilara Group Carbonates exposed in 8 different mines. Profound negative carbon isotope excursion equivalent to Shuram Anomaly has been noted in the Bilara Carbonates

Formation implies that the Pc-C boundary in the Marwar Supergroup lies either within this formation (~300 m thick) or in the immediately underlying carbonate rocks of the Bilara Group.

Shifts noted in the carbon and oxygen isotopic values of the carbonate rocks around the boundary are very distinctive and universal. Most profound and pronounced negative carbon excursion noted in the Ediacaran aged Shuram Formation of the Oman is considered to have potential equivalents worldwide. Because of the unusual magnitude (below -10‰), spanning over long duration (>10 Ma) and limitations of correlation in Neoproterozoic basins representing meaningful oceanographic event, such abnormal features are considered very useful in understanding the carbon cycle. Comprehensive isotopic studies are not available on the Bilara Group of rocks, though the carbonate rocks of this group are considered most potential candidate of Pc-C boundary sequence. Therefore, detailed studies of the carbonate sequences exposed in 8 mines have been sampled at 15 cm interval. 600 carbonate samples are processed for inorganic and bulk organic $\delta^{13}C$ and $\delta^{18}O$ geochemistry to demarcate the Pc-C boundary as well as Shuram Anomaly representing large ^{13}C negative excursion both in magnitude and duration (EN-3, >-6‰, 570-555 Ma) within the Bilara Group. Plots of the $\delta^{13}C$ preliminary data along with lithologs match the characteristic profile of Pc-C boundary. Also, the presence of $\delta^{13}C$ >-6‰ over a significant depth (~7 m) is a strong evidence for the presence of Shuram type Anomaly in the Bilara Group. Detailed litho-logs have been prepared and data are being processed.

The Salkhan Limestone (>1600 Ma) of the Vindhyan Supergroup has been studied for understanding the evolution of life forms in the extreme environment during the late-Palaeoproterozoic to early-Mesoproterozoic. Well-preserved large sized coccoidal microfossils and resting stages of the heterocystous cyanobacteria (akinetes) are recorded in the thin sections of chert from the Salkhan Limestone. Taxonomically differentiable single and double walled akinetes are recorded and are interpreted as young and mature akinetes respectively. Apart from the microfossils, the doubly-terminated quartz crystals and fan-fabrics are also recorded from the same formation. Occurrence of the akinetes suggests pulses of unfavourable conditions prevailed during late-Palaeoproterozoic to early-Mesoproterozoic time period, whereas presence of doubly-terminated quartz crystals and fan-fabrics suggest development of certain pockets of shallow marine hypersaline depositional environment in the Salkhan Limestone.

Project- 1.2: Meso-Neoproterozoic palaeobiology of Chambal Valley of Vindhyan Basin, Rajasthan

Investigator: Rupendra Babu

The epilithic and entombed structures both biogenic (micro-meso-megascopic fossils) having celluloid and carbonaceous preservations, and a-biogenic representing inorganic minerals are recorded from the light-dark grey shale intercalated between lower part of non-stromatolitic carbonate horizon of Samaria Formation (Bhander Group) exposed around Kondar township (Karauli district). The biological fossil assemblage comprises 29 taxa (uni-multicelled) of planktic and benthic prokaryotes and eukaryotes (acritarchs, metaphytes & lower invertebrates). The carbonaceous impressions and compressions of metaphytic thalloid fossil assemblage (20 taxa) of algae and possible Bryophyte ranging 3-6 mm in size on the bedding surface are flat, flexible (easily corrugated) of varied shaped, with/without branched and some fragments of multicellular thalloids ?reproductive structures. The algal remains (19 taxa) are belonging to Rhodophyta, Phaeophyta, Xanthophyta and Chlorophyta. Acritarch- *Gorgonisphaeridium* and single form is characterized by three features– i) multicellular thalloid of one cell thick cushion shaped formed by the aggregation of leaf like structures, ii) seta-thread like structure associated with thalloid body, and iii) sporangium-thread like structures having swelled features (capsule) at the top is closely comparable to gameto/sporophytic stage of any genus of modern mosses in Bryophyta. The present is smaller and resembled to known *Parafunaria sinensis* from early-middle Cambrian Kaili of China. The recovered single form is significant to understand the origin of Bryophyta and shows older than Cambrian.

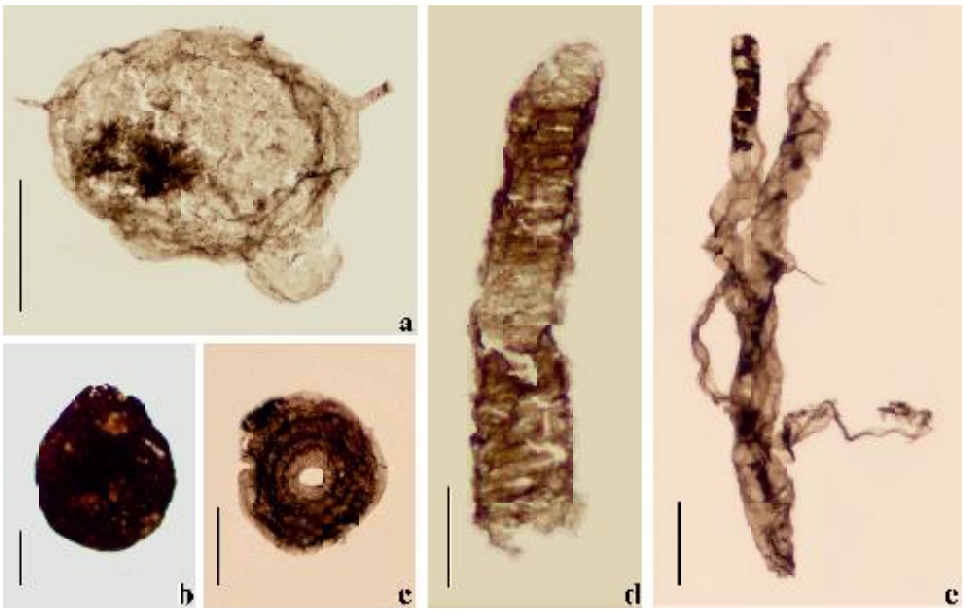
The celluloid microbiotic assemblage and a-biogenic structures (micro-halite's minerals) are also obtained from the macerated residues of carbonaceous macroscopic biota containing material. The identified forms of 9 genera of acritarchs (ornamented sphaeromorphs, acanthomorphs), algae (solitary & colonies groups of sphaeroidal cells), and trichomes (both septate & non-separate) with/without mucilaginous sheath, multicellular

thalloid are compared with known forms viz., *Osculosphaera; Baltisphaeridium* spp. *Simia, Trachysphaeridium, Eomicrocystis, Gloeocapsamorpha* spp., *Chlorogloeopsis* sp., *Thallophyca, Pomoria*. The micro-invertebrate fossils are showing trace fossils and their activity in form of burrows cf. modern annelids. Analysis of the explored data of both biogenic and a-biogenic structures suggests an early upper Cryogenian (750-650 Ma) age, and periodic intertidal, shallow marine lakeshore, mesothermal conditions during the deposition of sediments. The similar data is also known from the equivalent sediments of Australia, China, Nimbia Spitsbergen and Russian platforms. The carbonaceous remains and micro-invertebrates are being recorded for the first time from the Samaria Formation of the Bhander Group in Chambal Valley. Additionally, medium sized dolomitic stromatolites and preserved microbiotas in their laminae have been recorded from the upper carbonate sequence of Semri group exposed in Durga-mine and environs of Kurgaon village (Karauli district). The identified forma are Stratifera, *Irregularia* and *Conophyton*. The recovered biota shows dominance of coccoides followed by low amount of fragments of the filaments. Stromatolites and associated biota in laminae indicate older age (early Statherian ca 1700-1800 Ma) and stable subtidal depositional environment.

Project- 1.3: Palaeobiological investigations of the Proterozoic Chhattisgarh Supergroup in Khariar Basin and Barapahar Protobasin

Investigators: Mukund Sharma & V.K. Singh

The geochronological data suggest that the Chhattisgarh Supergroup is Palaeoproterozoic-Mesoproterozoic in age. Whereas, the palaeobiological assemblage is constituted of long ranging forms that cross the Mesoproterozoic-Neoproterozoic age and thus it brings out the dichotomy in the geochronological and biostratigraphy data that need critical assessment and suitable explanation. In view, micropalaeontological studies have been conducted on the different stratigraphic units viz., Singhora and Raipur Groups exposed in Mahasamund and Janjgir districts (Chhattisgarh). Systematically collected mud dominated sequence of Saraipali Formation (Singhora Group) have yielded acritarchs and other organic-walled microfossils (OWMs). The assemblage is dominated by large size sphaeromorphs and few acanthomorphs belonging to Sphaeromorphitae, Acanthomorphitae and Pteromorphitae subgroups of acritarchs. Exceptionally well-preserved *Tappania-Leiosphaeridia – Pterospermopsimorpha-Nucelosphaeridium* type OWMs of eukaryotic affinity are dominated in the assemblage with smaller amount of unicellular cyanoprokaryotes. Similarly, the carbonaceous black shale and cherts of Saradih Formation (Raipur Group) are dominated by the typical Vendian marker microfossils. Many of these are taxonomically resolved as eukaryotes. The occurrence of *Obruchevella–Melanocyrillium* from the sediments of Raipur Group (the horizon just below the Sukhda Tuff) suggests Neoproterozoic age (800-635 Ma) for the upper part of Chhattisgarh Supergroup.



Age restricted organic-walled microfossils from the Chhattisgarh Supergroup
a) *Tappania plana* Yin, **b**) *Melanocyrillium hexodiadema* Bloeser, **c**) *Glomovertella eniseica* Hermann, **d**) *Obruchevella delicata* Reitlinger, **e**) *Valkyria borealis* Butterfield. [Scale bar = 25 µm]

In the global records, *Tappania* is the most ancient, morphologically complex, and demonstrably eukaryotic microfossil, known from the precisely dated Palaeo-Mesoproterozoic sediments of

Australian Roper Group (1492 ±3 Ma), Ruyang Group (>1600 Ma) of China, Yurubchen Formation of Siberia (1060 ±20 Ma), and Bahraich Group (Ganga Basin) and Semri Group (Vindhyan Supergroup) of India. Helically coiled microfossil *Obruchevella* - *Valkyria* - *Proterocladus* - *Melanocyrillium* - *Glomovertella* type associations are extensively known from precisely dated sediments of Spitsbergen Swanbergfjellet Formation (750-700 Ma), Doushantuo Formation (635-551 Ma) of China, Kurnool Group (south India), Vindhyan Supergroup (central India), and Krol belt of Lesser Himalaya (north India). *Obruchevella* is considered as marker taxa of Vendian System (650-541 Ma). In addition, fresh carbonate samples from the Raipur Group and volcanic tuffs from the Singhora and Raipur Groups have been collected to resolve the geochronological problem. Possible remnants of carbonaceous higher algae have also been collected from the Saraipali and Chhuiapali Formations of Singhora Group.

Thrust Area 2: PHANEROZOIC TERRESTRIAL AND COASTAL ECOSYSTEMS: BIOSTRATIGRAPHICAL, PALAEOENVIRONMENTAL, PALAEOECOLOGICAL AND PALAEOBIOGEOGRAPHICAL ASPECTS

Palaeozoic-Mesozoic Megafloristics Group

Project- 2.1: Palaeofloristics and palaeoecology of Palaeozoic rocks of Singrauli and Kuresia coalfields (Son-Mahanadi Basin) and northwest Himalayas (Himachal & Uttarakhand)

Investigators: K.J. Singh & Anju Saxena

Around 55 meso- and megafossil specimens collected from the sediments of Takche Formation (early to middle Silurian) exposed near the villages Takche and Losar, and from the Poh/Lipak Formation (early-late Carboniferous) sediments exposed near Tabo village in the Kaza district of Spiti Valley have been processed, photographed and done their preliminary studies. The fossil assemblage includes trace fossils, brachiopods, bivalves, corals, impression and compression specimens of small bifurcating axes (?*Cooksonia* & Psilophytes), conifer axes, *Triphyllopteris* sp. and *Diplothmema* sp.

A manuscript entitled 'In-situ occurrence of *Vertebraria* roots in the Raniganj Formation of Singrauli Coalfield and its palaeoecological significance' has been finalized. The study records exceptionally well-preserved in-situ *Vertebraria* Royle axes (rooting structure of glossopterid plants) and the horizontally preserved *Glossopteris* leaves. The finding is unique in the sense that it is the first record of its kind, as both the in-situ preserved roots that too in such a large number and big in size are found in the close vicinity of the allochthonously preserved *Glossopteris* leaves. These beds of Raniganj Formation (late Permian) can be attributed to represent both allochthonous (horizontally preserved *Glossopteris* leaves) as well as autochthonous (vertically preserved *Vertebraria*) modes of preservations in the same sedimentary sequence. Another manuscript entitled

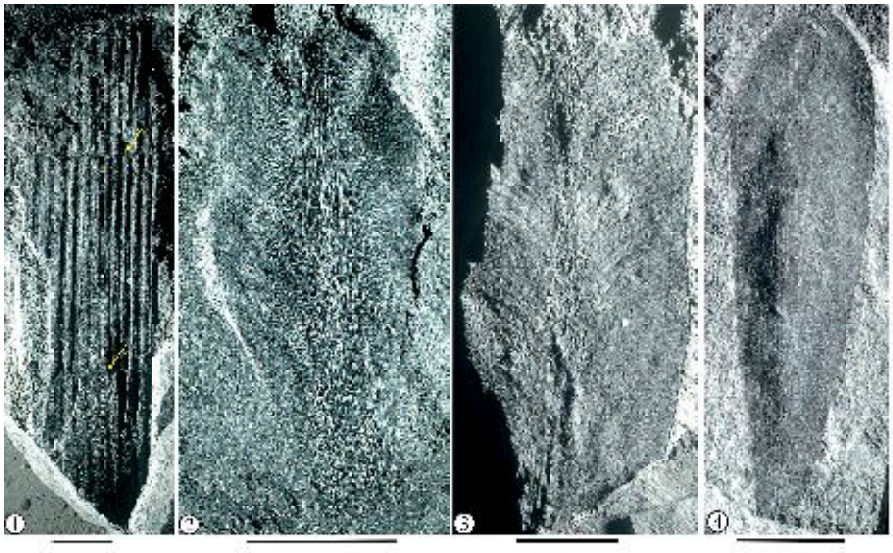
Trace fossils (burrows) procured from the Takche Formation of Spiti Himalaya

'Macrofloral assemblage from the early Permian Barakar Formation of Singrauli Coalfield, Son-Mahanadi Basin, India' has also been finalized. Well-preserved macrofloras, belonging to early Permian (Artinskian) lower Barakar Formation, have been reported from Bina Colliery of the coalfield. The floral assemblage mostly represented by leaves and stem casts belong to two groups and three genera, namely Glossopteridales (*Gangamopteris* & *Glossopteris*) and Cordaitales (cf. *Noeggerathiopsis*). The macroflora is dominated by the group Glossopteridales. The groups Lycopodiales, Sphenophyllales, Equisetales, Filicales, Ginkgoales, Cycadales and Coniferales are completely missing in the assemblage, which demonstrates that the vegetated area might not be adequately cool and humid to facilitate the growth of these shades loving plants.

Project- 2.2: Palaeobotanical investigations from Johilla and Sohagpur coalfields, South Rewa Gondwana Basin: Implications for basinal correlation and evolutionary, biostratigraphical and palaeoecological aspects

Investigators: Rajni Tewari, S.S.K. Pillai & Deepa Agnitotri

Well-preserved plant fossil assemblage has been recorded for the first time from the Barakar Formation of Sharda open cast mine, Sohagpur Coalfield (MP). The assemblage comprises the orders Equisetales (represented by unidentifiable leafless equisetalean axes bearing nodes & internodes), Glossopteridales (*Gangamopteris intermedia* & 7 species of *Glossopteris*) and Cordaitales (*Noeggerathiopsis hislopii*). The floral assemblage is broadly comparable with those described from the Barakar Formation of Damodar, Mahanadi, Wardha, Godavari, Rajmahal and Satpura Gondwana basins of India. Since the known records of plant megafossils from the Sohagpur Coalfield are meagre, recovery of rich plant fossils from the Sharda mine substantiates the geological and geographical distribution of the *Glossopteris* flora in India in general and that of the Sohagpur Coalfield in particular, and reflects its significance in the formation of coal in the area. Besides, a variety of platyspermic and radiospermic gymnospermous seeds comprising *Cordaicarpus zeilleri, Samaropsis feistmantelii, Samaropsis goraiensis* and *Rotundocarpus striatus* have been described from the Middle Member of the Pali Formation of Johilla Coalfield, which is equated with the Raniganj Formation of the Damodar Basin.



Plant megafossils from Sharda mine of the Sohagpur Coalfield : **1**) Equisetalean axis (nodes are indicated by arrow), **2**) *Gangamopteris intermedia,* **3**) *Glossopteris giridhiensis*, **4**) *Noeggerathiopsis hislopii*

A variety of megaspores showing laevigate, granulate, verrucate, connate, baculate and spinate exosporia have been isolated from the sediments of Dhanpuri OCP (Sohagpur Coalfield). In addition, palynological investigations from 1300 m thick bore-hole (SNB-1) around Jaisinghnagar area in the western part of the coalfield have been carried out (with Saurabh Gautam, Ram Awatar & Shreerup Goswami). Lithologically, these sequences are designated as the Pali Formation. However, the investigation reveals presence of 3 distinct palynoassemblage zones belonging to late Permian-Triassic ages in ascending order. The palynoassemblage-I (*Striatopodocarpites magnificus-Crescentipollenites fuscus*) recorded between a depth of 1213.40 and 1164.10 m showing dominance of striate bisaccate pollen taxa and is late Permian (Raniganj) in age. The palynoassemblage-II (*Lundbladispora densispinosa-Densoisporites playfordii*) recovered amidst a depth of 1054.30-956.00 m and showing dominance of cavate/cingulate spores indicates an early Triassic age. The palynoassemblage-III (*Aulisporites astigmosus-Falcisporites nuthallensis*) recorded between a depth of 404.40 and 53.60 m and characterized by the dominance of *Aulisporites astigmosus* is equated with a late Triassic (Supra-Panchet) age. The Permian-Triassic boundary is delineated at the contact of coal/shale-bearing upper part of the Middle Member and the lower part of the Upper Member of the Pali Formation (between 1164.10-1075.15 m depth). At the P/T boundary, the abrupt change of the palynoflora is marked by the disappearance of the striate bisaccate pollen grains and the appearance of the non-striate bisaccate grains in association with cingulate-cavate/zonate trilete spores. The Permian/Triassic palynofloras recorded in the South Rewa Gondwana Basin show close similarities with those of the uppermost Bainmedart Coal Measures (McKinnon Member) and Flagstone Bench Formation of east Antarctica.

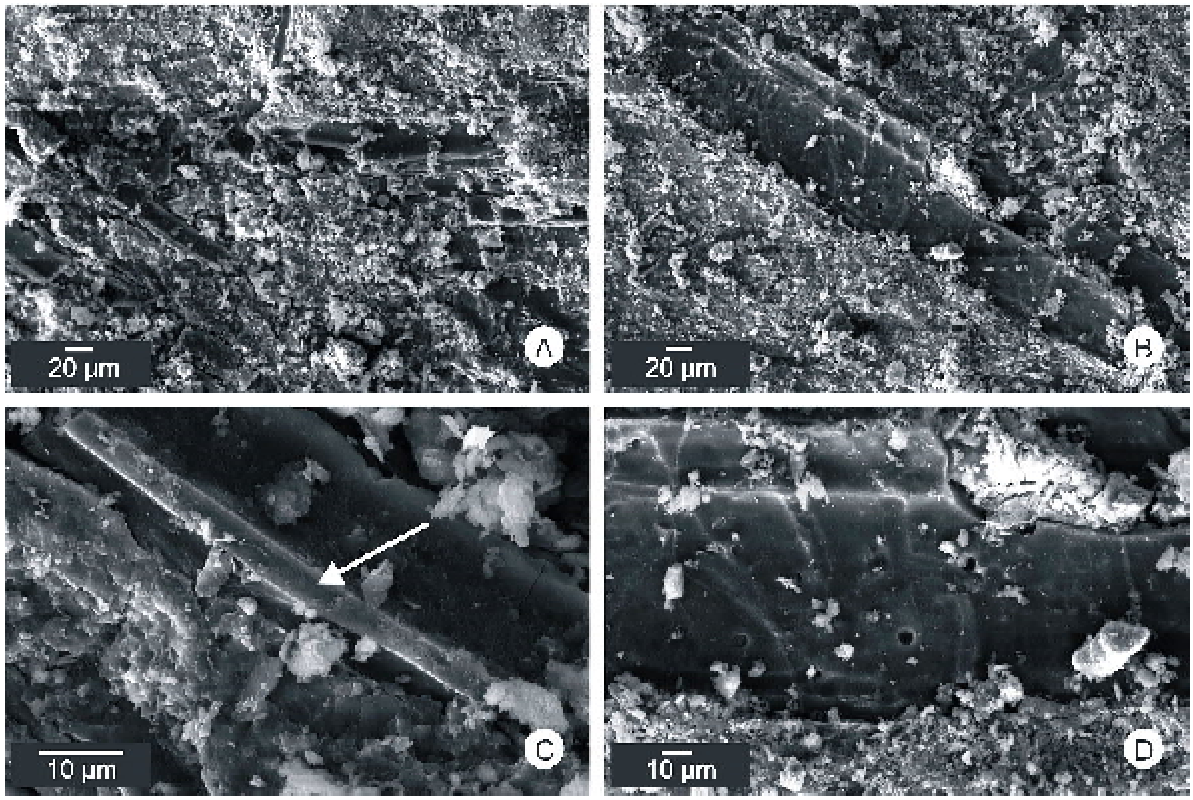
Project- 2.3: Mega- and microfloristics of the Permo-Carboniferous sediments of Kashmir Region: Evolutionary, biostratigraphical, palaeoecological and palaeophytogeographical implications

Investigators: Rajni Tewari, S.S.K. Pillai, Deepa Agnihotri & Kamlesh Kumar

The palaeo-wildfire evidence in the form of charcoal has been recorded for the first time from the late Permian Zewan Formation of the Kashmir region, northwest Himalaya (with Andre Jasper, Dieter Uhl, SK Pandita, José RW Benicio, EF Pires, Átila AS Da Rosa & GD Bhat). This evidence is in the form of fragments of tracheids which show homogenized cell walls, a characteristic feature of charcoal. Considering that palaeo-wildfire studies provide important palaeoecological information, the study is significant as it allows reconstructing new information about environmental conditions during the deposition of the sediments of the Late Permian Zewan Formation.

Section of Zewan Formation (late Permian) exposed at Zewan spur, Srinagar

Well-preserved palynoassemblage has been recorded from the Fenestella Shale Formation (Carboniferous) of Gund Village, Banihal area for the first time (with Ram Awatar). The assemblage is dominated by monosaccate pollen grains. However, trilete spores and bisaccate grains are scarce. Correlation of the palynoassemblage with similar strata of India and other Gondwanan countries has been carried out.



SEM images of: **A**) Charred fragments of tracheids within sediment, **B**) Fragment of large tracheid, **C**) Tracheid fragment exhibiting homogenized cell wall (indicated by arrow), **D**) Enlargement of B with biseriate pits on tracheid wall

Project- 2.4: Gondwana floristics of India (Wardha-Godavari Basin) and Antarctica: Evolutionary, biostratigraphical, palaeoecological and palaeophytogeographical significance

Investigators: Rajni Tewari & Arun Joshi

Early Permian megaspores have been reported for the first time from the Index Seam of the Barakar Formation from Goutham Khani open cast coal mine, Kothagudem area (Godavari Graben). The megaspore assemblage includes 3 genera (*Biharisporites, Jhariatriletes* & *Singhisporites*) and 10 species. Besides adding to the existing knowledge of the megaspores from the graben, the comparison of the megaspores from the mine with those of the other Indian Lower Gondwana basins, and other areas of the Godavari Graben reveals that majority of these differ in the presence of dense ornamentations on their exosporia. Presence of such crowded diverse spines on megaspores of this study indicates their early appearance during the Barakar Formation. An analysis of the developmental pattern of the exosporium architecture of Lower Gondwana megaspores in general, indicates that during the early Permian Talchir and Karharbari formations, the megaspores had simple outer layer with usually smooth, granulate, verrucate and sometimes baculate/connate ornamentations whereas, dense spinate, complex exosporia were more common during the Barakar and the Raniganj formations indicating fresh water aquatic conditions. As such, the spinate megaspores of Kothagudem region also point towards terrestrial aquatic conditions.

Megaspores from the Goutham Khani coal mine of Kothagudem area: **A**) *Singhisporites surangei*, **B**) *S. nautiyalii*, **C**) *S. indica* (scale bar = 100 µm)

Investigations carried out on the *Glossopteris* floral assemblage from the Barakar Formation of the Prakasham Khani open cast mines II and IV, Manuguru area (Godavari Graben) reveal presence of *Phyllotheca indica,* equisetalean axes, *Gangamopteris-cyclopteroides,* 14 species of *Glossopteris,* and *Noeggerathiopsis hislopii.* This study adds to the knowledge of the *Glossopteris* flora of India, especially that of the Godavari Graben from where the plant fossil records are poor. The floral assemblage compares fairly well with those recorded from the Barakar Formation of other Lower Gondwana basins of peninsular India. The data have been compiled in the form of Ph.D. thesis. Additionally, a field excursion has been undertaken to different open cast and underground mines of Bandar and Umrer coalfields of Wardha Basin, Maharashtra during which, plant mega fossils (comprising glossopterids, equisetalean axes, lycophytes, sphenophytes, conifers, variety of seeds & fructification *Arberia*), rock samples for the recovery of megaspores and seeds, and charcoal samples for palaeofire studies are collected (with SSK Pillai & Deepa Agnihotri).

An overview of Makardhokra mine, Umrer Coalfield (Nagpur district)

Project- 2.5: Palaeobiology of Mesozoic Gondwana of Pranhita-Krishna-Godavari basins

Investigators: A. Rajanikanth & Chinnappa Chopparapu

Taxonomy, morphology, ecology and floral diversity of the early Cretaceous sequences of the Krishna-Godavari Basin have been studied; showing the floral dominance of Bennettito-Coniferous association. Bennettitalean members predominates the floral assemblage and were a mixture of auto-allochthonous elements and constitute local to regional flora. Comparison of the flora with coeval floras brings its similarity with the early Cretaceous flora of the Cauvery and Rajmahal basins. The composite picture of the flora indicates prevalence of warm and humid conditions during the time of deposition. Paralic/fluvio-marine depositional setting is inferred based on the associated marine indicators

Thinnfeldia vemavaramensis n. sp. from the Vemavaram Formation of Prakasam district

The flora from the early Cretaceous (Berriasian-Aptian) fluvial sediments of the Gangapur Formation (Pranhita-Godavari Basin) consists of ferns and gymnosperms. Three assemblages have been identified based on the relative association of various floral elements. First assemblage is principally composed of gymnosperm flora *Elatocladus*, along with *Torreyites*, *Taxites* and *Harrisiophyllum*. Second includes fern (*Cladophlebis*, *Gleichenia*) and gymnosperm (*Pachypteris*, *Taeniopteris* & *Pityospermum*) flora. Third assemblage mainly constitutes *Ptilophyllum* along with *Pagiophyllum* of gymnosperm. These assemblages are interpreted as representing three communities, occupying three sub-environments within the river floodplain. Away from the river channel was probably occupied by first assemblage, the riverbanks by second assemblage and the openland/ lowland area by the third assemblage. Analysis of flora from the basin highlighted the conifer dominance, in both abundance and diversity, and the flora is more closely comparable with Satpura Basin and Western Australian early Cretaceous floras.

Review of Indian early Cretaceous flora signifies homogenity of composition with regional variations. Similitude of basinal floras with marginal differences is attributed to taphonomic limitations and taxonomic angularity. A perusal of available data brings out an opportunity for novelty in floral composition and variable associations dictated by prevailed environmental conditions. The eastern, western and central regions of India hold distinct litho units encompassing plant megafossils (leaf, wood/axis, seed, fructification & associated marker forms). Remarkable tenacity of certain plant groups, which even found in modern flora, and vulnerability of many taxa constitute a blend of extinct and extant. The appearance and extinction of certain taxa can be explained as a cumulative effect of evolutionary and climatic factors. Perpetuation of gondwanic floral elements during the early Cretaceous along with newly evolved floral components testifies evolutionary innovations and changing ecological constraints.

Project- 2.6: Mesozoic palaeofloral diversity, biostratigraphy and palaeoclimatic studies in Saurashtra and Kachchh basins

Investigators: Neeru Prakash & Neelam Das

The plant fossils collected from blackish-grey shale of the locality Motayex (Kachchh Basin) contain mainly bennettitales (*Ptilophyllum, Ctenozamites, Pterophyllum, Bucklandia, Williamsonia* flower & *Weltrichia*), conifers (*Elatocladus, Brachyphyllum, Pagiophyllum, Araucarites,* male cone of *Araucaria, Podozamites*), pteridosperms (*Pachypteris*) and few pteridophytes (*Cladophlebis* & *Equisetites*). Due to the

Ptilophyllum cutchense

dominance of bennettitales and conifers, the floral assemblage is coeval to Bhuj flora of Kachchh and Sehora flora of Jabalpur Formation (Satpura Basin).

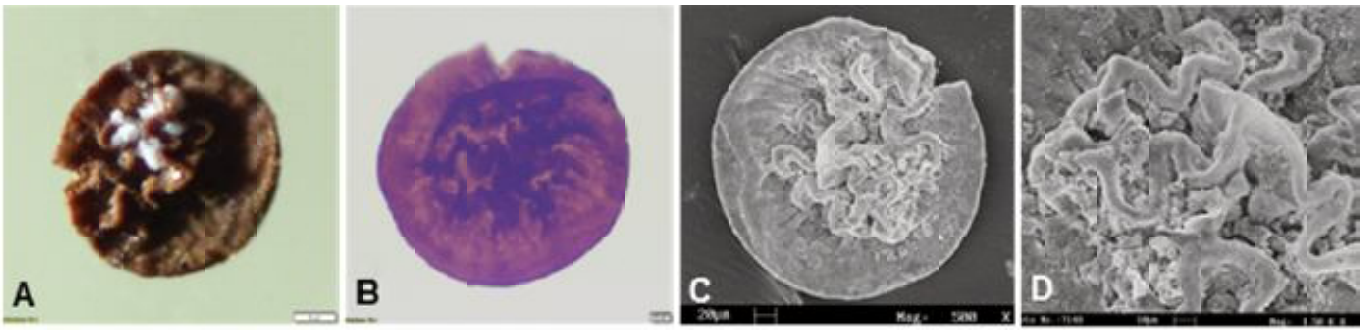
Detailed study of the floral composition of Himmatnagar Sandstone Formation (Gujarat mainland) has shown that the flora is less diversified and relatively inadequately known. Numerically, flora is dominated (63%) by pteridophytic frond genera *Matonidium indicum* and *Weichselia reticulata* along with the representation of 23% conifers (*Pagiophyllum*, *Brachyphyllum* & *Araucarites*) and 7% each with pteridosperms (*Pachypteris*) and cycads. Bennettitales, pentoxylales and Ginkgoales are altogether absent. The overall assemblage is more like that one's met with Dharangdhra and Gardeshwar Formations of Gujarat.

Project- 2.7: Floral diversity, biostratigraphy and palaeoecology of the Triassic sequence from South Rewa (Ramkola-Tatapani Coalfield) and Satpura Gondwana basins

Investigators: A.K. Ghosh, Ratan Kar & Reshmi Chatterjee

Samples from the Iria Nala section near Premnagar in Ramkola-Tatapani Coalfield (Chhattisgarh) have yielded well-preserved macrofossils, megaspores and palynofossils representing the Permian-Triassic transitional flora. The macrofossil and palynofloral assemblages clearly indicate the possibility of Permo-Triassic boundary in the section. For further resolution of P-T boundary, 31 samples (coal, carbonaceous shale, shale, sandstone) have been collected across the Raniganj and Panchet Formations for isotopic analysis ($\delta^{13}C$ studies). Besides, 9 coal, carbonaceous shale and sandstone samples are collected from a section of Raniganj Formation exposed at Mangra-Dhora Nala for the analysis of megaspores and ä^{13}C studies. Further, 7 shale, siltstone and sandstone samples are collected from a typical section of Talchir Formation exposed at Uro Nala for isotopic studies and palynological analysis. Additionally, a megaspore assemblage has been reported for the first time from the Panchet Formation (early Triassic) of Tatapani-Ramkola Coalfield. The megaspore assemblage is represented by *Banksisprites pinguis, Biharisporites sparsus, Hughesisporites galericulatus, Hughesisporites variabilis, Nathorstisporites hopliticus, N. reticulates, Erlansonisporites cerebrates, Noniasporites harrisii* and *N. triassicus,* out of which *N. triassicus* is new to science.

Based on the palynological study of the Panchet Formation, two distinct palynozones have been demarcated from the samples of the same outcrop those yielded megaspores and macrofossils represented by *Dicroidium hughesii*, *Desmiophyllum* sp., *Yabiella* sp., *Glossopteris angustifolia*, scale leaf of glossopterids (*Eretmonia* sp.) and equisetaceous stems referable to *Paracalamites* sp. Palynozone I is represented by the dominance of *Falcisporites* (28%)–*Klausipollenites* (17%), whereas, in ascending order Palynozone II is characterized by *Densipollenites* (32%)–*Lunatisporites* (28%). In addition, critical reassessment of the plant macrofossils from different localities of the Parsora Formation and interpretation on the age of the formation, integrating the data of lithostratigraphy, plant macrofossils and palynozonation have been done to resolve the age of the Parsora Formation in Johilla Coalfield, South Rewa Basin.



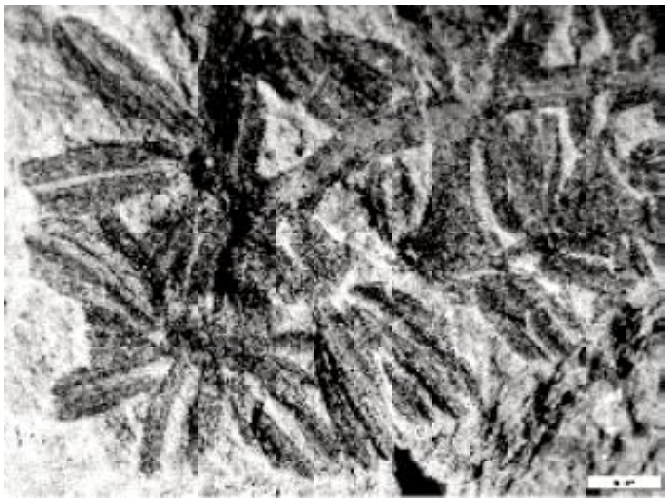
Noniasporites harrisii from the Panchet Formation of Ramkola-Tatapani Coalfield

A) Megaspore in dry state showing the proximal face with ornamentation, **B**) The same megaspore in wet condition (after gradual maceration), **C**) SEM of the proximal face of megaspore showing sculptural elements, **D**) SEM of the proximal face of megaspore showing raised trilete rays and presence of number of fine rills or exoexinal projections in the contact area

Project- 2.8: Morphotaxonomic study of plant fossils from Tekan locality of South Rewa Basin

Investigators: Neeru Prakash & Neelam Das

Plant fossils have been mostly obtained from the buff coloured clay, shale and lenticular bedded mudstone of the early Cretaceous age from Tekan area. They are belonging to pteridophytes (*Todites*, *Onychiopsis*), pteridosperms (*Pachypteris*, *Caytonanthus*), bennettitales (*Ptilophyllum*), and conifers (*Allocladus*, *Araucarites*, *Elatocladus*, *Pagiophyllum*, *Brachyphyllum*). The flora is dominated by conifers and pteridophytes. The recorded floral assemblage is resembles to some extent with Gangapur flora of Pranhita-Godavari Basin (Andhra Pradesh), as both are rich in conifers and pteridophytes. However, the broad-leaved bennettitalean remains are prevalent in quite good number in Gangapur Formation. Occurrence of the microsporophyll genus *Caytonanthus* in Tekan bed makes it different and unique from many contemporary sequences of Upper Gondwana sediments. This pollen organ genus has been recorded for the first time from Indian sedimentary basin. *Caytonanthus* palaeogeographic distributions along with its plausible southern origin through ancestral group like Glossopteridales are surmised. Additionally, megafossils studies have also been carried out from the early Cretaceous sediments of Bansa beds. The palaeo-vegetation is comprises of *Equisetites*, *Todited*, *Gleichenites*, *Cladophlebis*, *Sphenopteris*, *Pagiophyllum*, *Brachyphyllum*, *Desmiophyllum*, *Elatocladus*. The palynological study revealed the occurrence of gymnospermous pollen grains of Araucareaceae and Podocarpaceae. Further work is in progress.



Pollen organ genus *Caytonanthus*

Palaeozoic-Mesozoic Miofloristics Group

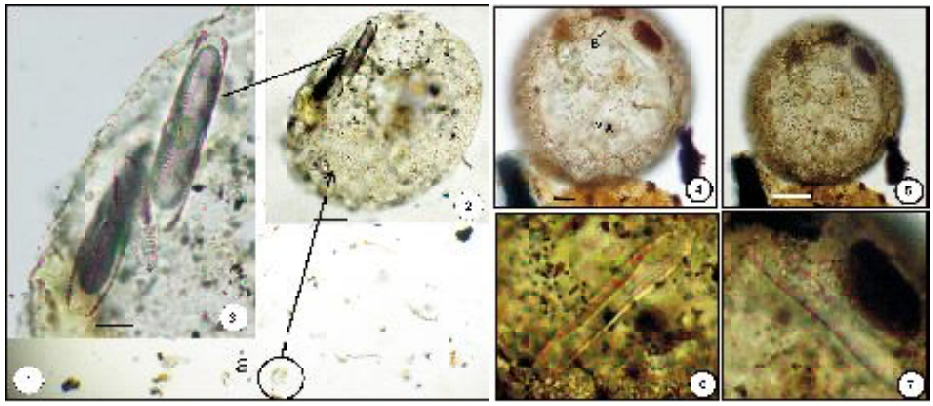
Project- 3.1: Palynology of Gondwana sediments of Satpura-Wardha-Godavari basins: Biostratigraphical, palaeoenvironmental and palaeophytogeographical implications

Investigators: Neerja Jha, K. Pauline Sabina, Neha Aggarwal, Harinam Joshi & Shreya Mishra

Diverse assemblages of testate amoebae have been recorded from the early Permian Manjir Formation of northwest Himalaya and late Permian Raniganj Formation of Godavari Graben (AP). On the basis of shell morphology and morphometry, about 31 testate amoebae species have been identified. The ratio of shell diameter and aperture diameter of early and late Permian fossil and extant specimens does not show any significant difference which elucidates the survival of these testate amoebae during two major events of mass extinction showing insignificant morphological changes in stressful environmental conditions over the geological timescale. In addition, fresh water diatom frustules (resembling the extant *Nitzschia* type) with the tests of thecamoebians (*Centropyxis aculeata*, *C. arcelloides*, *Arcella vulgaris* & *A. excavata*) recovered from Permian sediments (±251-299 Ma) of Chamba Basin (HP) and Godavari Basin has been documented; indicating the existence of diatoms prior to Permian-Triassic boundary.

Dispersed organic matter studies in Permian sediments of Mammakannu area of Godavari Graben have been carried out for palaeoenvironment interpretations. Total four palynofacies associations representing the different palaeoenvironments have been identified in 380 m deep sequence in bore-hole MMK-19. Palynofacies Association-A, dominated by structured terrestrial, has been interpreted as proximal to fluvio-

deltaic source in an oxic environment. Palynofacies Association-B, dominated by degraded terrestrial, reflects low energy dysoxic-anoxic (fresh water swamp) palaeoenvironmental conditions. Palynofacies Association-C, dominated by charcoal, is indicative of deposition in oxic environmental conditions due to either its proximity to terrestrial source or redeposition of organic matter from fluvio-deltaic sources. Palynofacies Association-D, dominated by terrestrial palynomorphs, has been attributed to the suboxic-dysoxic (fresh water peat) environmental conditions in lower energy setting.



1) Location of the fossil specimen (a) along with the Permian palyomorph from early Permian sediment of Chamba Basin, **2**) Enlarged view to show the pennate diatom frustules as xenosomes on the shell/test of *Centropyxis arcelloides*, **3**) Enhanced structure of the diatom as xenosomes on the shell, **4-5**) Fossil specimen *Arcella vulgaris* in aboral (4) and oral (5) views from late Permian sediment of Godavari Graben showing two pennate diatom frustules (A & B), **6-7**) Enlarged views of the diatom

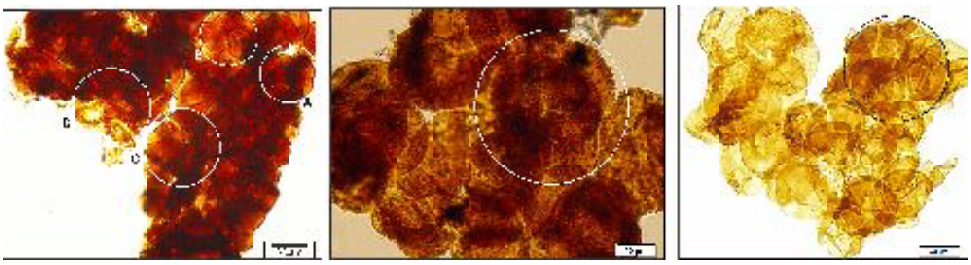
Palynological investigations of 448 m deep borecore (A/333) samples from 5B Incline area of Kothagudem sub-basin, Godavari Graben have revealed two distinct palynological assemblages. Palynoassemblage-I (425.50-448 m) is characterized by the dominance of non-striate bisaccates and sub-dominated by striate bisaccates. Palynoassemblage-II (202-240 m) is characterized by dominance of striate bisaccates along with some stratigraphically significant taxa; indicating late Permian (Raniganj) affinity. On the basis of palynoflora Artinskian and Guadalupian age has been assigned to Palynoassemblage-I and Palynoassemblage-II, respectively. By the stratigraphical division of the palynofacies associations, three intervals (I1-I3) are documented.

Project- 3.2: Palynostratigraphy, palaeoclimate and evolutionary trends of palynofloras in Gondwana sequences of Son-Mahanadi–Damodar basins

Investigators: K.L. Meena & Srikanta Murthy

A rich assemblage of palynomorphs (miospores & megaspores) has been recorded from the bore-hole IBKAN-2 drilled in the Kuraloi Block-A, south-west part of the Ib-River Coalfield, Jharsuguda district, Odisha (with SSK Pillai, Rajni Tewari & Arun Joshi). The miofloral assemblage shows prominence of cingulate, zonate, taeniate, non striate and non saccate palynotaxa; indicating an early Triassic age and is comparable with the palynoassemblages of the same age known from the Damodar Basin. The megaspore assemblage includes 8 genera and 15 species. Since Triassic palynomorph and megaspore records are not well known from India, this first report from the early Triassic of Mahanadi Basin substantiates the earlier database, besides being applicable in age determination, basinal correlation and biostratigraphy.

The palynological data of late Permian succession from the open cast mine section at Sawang, Bokaro Coalfield (Damodar Basin) have been finalized. On the basis of the palynocomposition, the section has been dated as late Permian age (lower Raniganj Formation – lower Lopingian). Further, age determination for the sequence has also been inferred from its comparison with similar palynoassemblages from other Gondwana coalfields of Damodar, Son-Mahanadi,



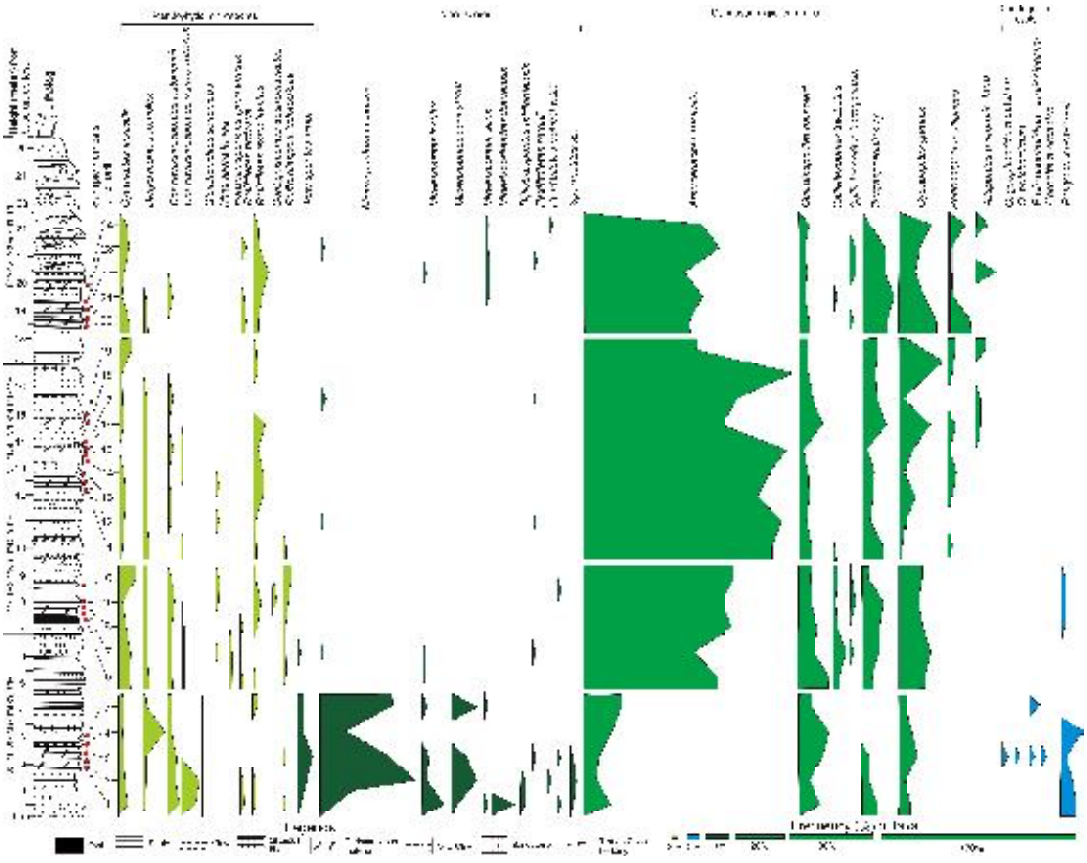
Spore tetrads in fragmented sporangia

Rajmahal, Wardha-Godavari and Satpura basins of India and across the Gondwana. Palynological composition of present study indicates warm and medium-high humidity. Additionally, the recovered pteridophytic spore which had affinity assigned to the genera *Lundbladispora* and *Callumispora*, along with their sporangial remains have been traced from the subsurface Triassic sediments of bore-hole No. TTB-10 from Talcher Coalfield (Mahanadi Basin). However, this is first record of genus *Callumispora* found in the form of tetrads. The palynoassemblage associated with tetrads has been assigned an early Triassic age.

Project- 3.3: Sedimentary organic matter, palynofloral characteristics and depositional environments of the Early Cretaceous sediments of Kachchh and Saurashtra basins

Investigator: Madhav Kumar

Sedimentary successions exposed through mining activities and river cuttings near Trambau village of Kachchh district (Gujarat) comprise mudstone, carbonaceous shale, thin coal seam, siliceous clay, shale and sandstone of the Bhuj Formation (early Cretaceous). These sediments yielded abundant mega- and microspores, conifer pollen grains, dinoflagellate cysts and *Botryococcus* colonies. The palynoflora of the studied stratigraphic succession are identified into two palynozones (acme zones) on the basis of their dominance over other palynoassemblage viz., megaspore species *Minerisporites cutchensis* at the base, and *Araucariacites australis* pollen grain in the upper part. The basal *Minerisporites kutchensis* zone represents abundant pteridophytic spores and dinoflagellate cysts, while upper *Araucariacites australis* zone comprise of abundant conifer pollen grains and pteridophytic spores. The stratigraphic distribution of palynoflora exhibit transition of vegetation from dominantly heterosporus ferns and other pteridophytes colonized in the habitat situated along the sea cost to the continental non-marine swamps where arboreal conifer vegetation were thrived luxuriantly. The first and last appearance datum of various taxa in the stratigraphic succession defines FAD/LAD of various palynoflora and development of vegetation during late Aptian-early Albian age. A majority of palynoflora documented in various strata of the studied section are also recorded from contemporaneous sediments of other late gondwanic basins of the southern hemisphere.



Frequency distribution of early Cretaceous palynoflora in sedimentary succession near Trambau (Kachchh)

Terminal Cretaceous-Neogene Megafloristics Group

Project- 4.1: Tertiary plant mega remains of northeast India: Floristic and climatic changes

Investigators: R.C. Mehrotra & Gaurav Srivastava

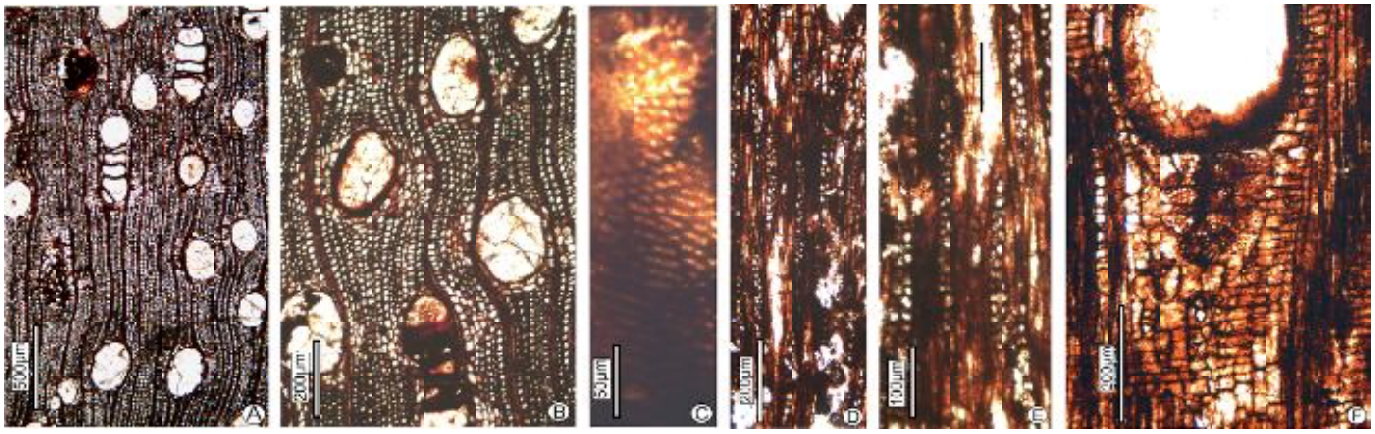
A large number of plant megafossils have been collected from the late Oligocene sediments of Makum Coalfield (Assam) and Namchik Coalfield (Arunachal Pradesh). An *in situ* fossil wood from the Makum Coalfield is systematically studied and identified to the family Lecythidaceae. Besides, the herbarium of Forest Research Institute, Dehradun has been consulted and identified many fossil leaves belonging to families Fabaceae, Anacardiaceae, Rutaceae, Combretaceae and Fagaceae.

In-situ fossil woods (arrows marked) in the mudstone from the Makum Coalfield (Assam)

Project- 4.2: Plant mega remains from the Tertiary successions of western India and their bearing on palaeofloristic and palaeoclimatic interpretations

Investigators: R.C. Mehrotra & Anumeha Shukla

Two fossil woods resembling to extant genera *Holigarna* (family Annacardiaceae) and *Gynocardia* (family Achariaceae) have been described from the early Eocene sediments of Tarkeshwar (Surat district) and Valia (Bharuch district) lignite mines of Gujarat, respectively. The modern analogues of the fossils are found in semi-evergreen to evergreen forests of Indian subcontinent indicating warm and humid climatic conditions in western India in contrast to hot and dry climate prevailing there at present.



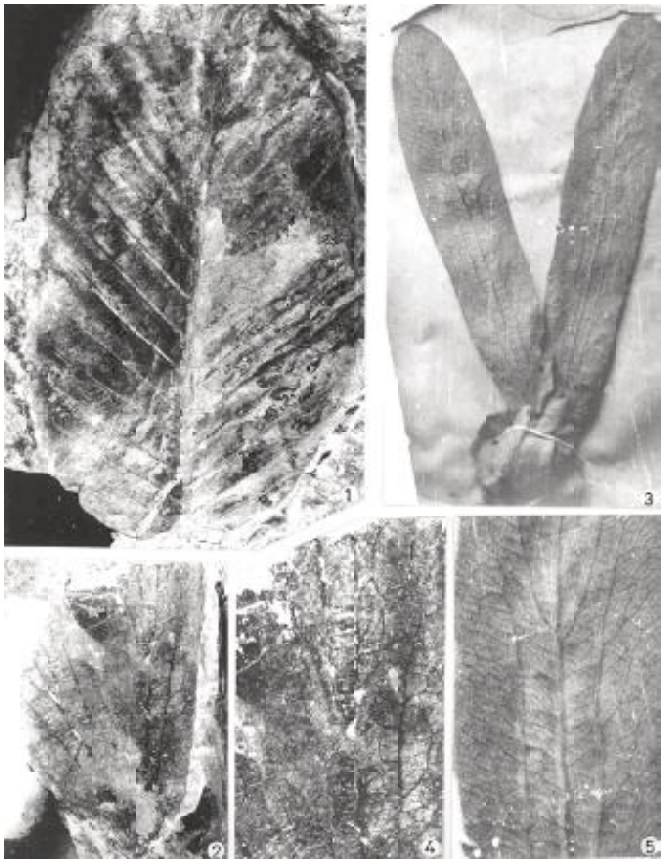
Holigarnoxylon assamicum Prakash & Awasthi
A) Cross section showing shape, size and distribution of vessels, **B**) Enlarged to show parenchyma pattern, **C**) Showing intervessel pits, **D**) Tangential longitudinal section (TLS) showing distribution of rays, **E**) TLS showing structure of rays and fibres, **F**) Radial longitudinal section showing heterogeneous ray tissue

Project- 4.3: Siwalik floral diversity and palaeoclimatic changes in the Himalayan Foreland Basin

Investigator: Mahesh Prasad

Investigation on the plant megafossils from Churia group of western Nepal revealed the presence of fossil wood, leaves and a fruit of a phytogeographically important genus– *Dipterocarpus* Gaertn. f. of the family Dipterocarpaceae, with three new form species (*Dipterocarpus nepalensis, D. miocenicus* & *D. churiensis*). The analysis of present day distribution of the comparable forms of fossil remains indicates that all the extant species of this genus do not grow in the sub-Himalayan zone of India and Nepal. They are presently distributed in the evergreen forests of Southeast Asian region (Myanmar, Malaya, Java, Borneo, etc.). This suggests that after rise of Himalaya, drier condition was prevailed due to which such moist loving species could not survive there. Based on the present and past distribution of the comparable extant species of *Dipterocarpus*, the phytogeography as well as route of migration of the genus has been discussed. The finding of dipterocarps in the Siwalik sediments of Himalayan foot-hills of Nepal suggests that they have migrated from the Southeast Asian region during early Miocene, and later on became extinct due to prevailing of unfavorable condition. An attempt has also been made to categories the already known species of *Dipterocarpoxylon* having almost similar anatomical features.

A detailed study on the plant fossils from Tanakpur area revealed the occurrence of 20 fossil taxa. Coexistence approach suggests that the area in the Himalayan foot-hills of Uttarakhand enjoyed a tropical climate with MAT 21-27 °C and MAP 1900-3500 mm during the Mio-Pliocene times. Thus, it may suggest that fossil flora recovered from the Siwalik of Tanakpur area coexist in such climatic ranges during middle Miocene time. In addition, over 80 fossils (leaf, fruit & seed impressions) collected from the Siwalik sediments of India and Nepal have been identified after consultation in Central National Herbarium, Howrah. Also collected a variety of plant fossils and palynological samples from the Siwaliks of Sarkaghat (in Mandi district), Hamirpur, Jawalamukhi and Ranital (in Kangra district) areas of Himachal Pradesh, and from Haridwar (Dehradun district) of Uttarakhand.

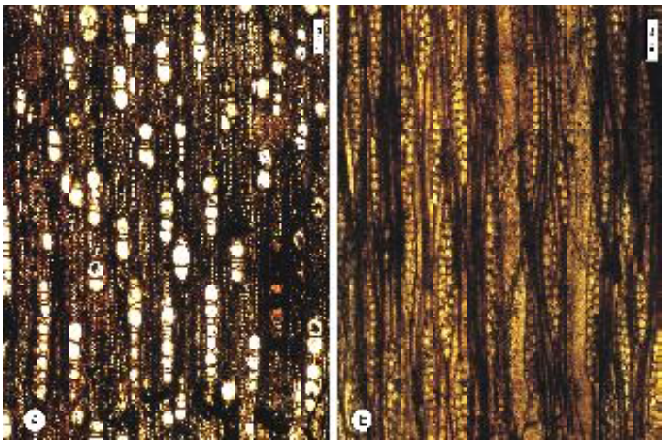


Dipterocarpus (Dipterocarpaceae) from Siwalik (Churia) Formation of Western Nepal: **1**) Fossil leaf, **2**) Fossil fruit wing, **3**) Modern fruit wing, **4**) A part of fossil fruit wing magnified (x2.5) to show the internal details, **5**) A part of modern fruit wing magnified (x2.5) to show similar details

Project- 4.4: Megaflora from sedimentary sequences associated with Deccan Traps: Diversification of angiosperms in India

Investigator: Rashmi Srivastava

A fossil wood showing resemblance with tribe Oleinae (*Olea* & *Chionanthus)* from Jheria, Chhindwara district (MP) has been studied and finalized. This is the oldest record of the genus *Olea*. Another manuscript dealing with a fruit of *Palmocarpon drypeteoides* comb. nov., which was previously described as



Olea wood– *Oleoxylon deccanense*: **a**) TS showing diffuse porous wood with vessels in long radial multiples and scanty paratracheal parenchyma, **b**) TLS showing 1-3 (mostly 2) seriate rays

Euphorbiocarpon (Mehrotra et al., 1983), has been finalized from Ghughua Fossil National Park, and nearby areas of Dindori district (MP). These fruits show resemblance with the extant palm genera *Butia* (Becc.) Becc. and *Maximiliana* Mart. of the family Arecaceae and also discuss its biogeographic implications.

Among the dicotyledonous woods studied from Dhangaon, Mandla district (MP), a wood showing resemblance with the woods of Conneraceae. Photo-documentation, observation and identification of dicot woods are under progress. Two fossil woods showing resemblance with the family Achariaceae are also studied. Further work is in progress. Additionally, in order to identify fossil palm fruits, a number of modern palm fruits have thoroughly been examined in the living collections at Smithsonian Institution (Washington DC), Montgomery Botanical Center (Miami), and at the herbarium of Fairchild Tropical Botanical Garden (Miami, Florida). A number of fruits collected from Dhangaon are morphologically similar to the Madagascar-Malesian distributed genus *Orania*. Further work and identification is under progress.

Terminal Cretaceous-Neogene Miofloristics Group

Project- 5.1: Biota from Palaeogene lignite-bearing sequences of western India: Climatic, tectonic, stratigraphic, ecologic and biogeographic signatures

Investigators: Sunil Bajpai, Madhav Kumar, Vandana Prasad, Hukam Singh, Poonam Verma, Shailesh Agrawal, V.V. Kapur, & Priyanka Monga, Rahul Garg & M.R. Rao

Microforaminiferal linings, the inner organic remnants of the benthic foraminifera, occur frequently in the palaeopalynological preparations. The linings usually get buried in the organic-rich shallow marine sediments and provide a useful data regarding their burial processes in the host sediments. Their occurrence in lignite-bearing succession in the Cambay Basin, Gujarat and in the early Palaeogene subsurface sediments of Upper Assam is studied to define morphology and depositional environments. The number of chambers and size of the linings categorize them into various morphological groups viz., Uniserial type II, Biserial type II, Planispiral type II, Planispiral type III, Planispiral type IV, Trochospiral type I and II of which two morphotypes (Planispiral II & Trochospiral I) are most common in the palynoassemblages. Morphological attributes of various microforaminiferal linings along with other palynomorphs viz., spores, pollen grains, dinoflagellate cysts and fungal fruiting bodies indicate near shore, marine shelf depositional conditions of the studied sections.

The Panandhro lignite mine succession in Kachchh Basin has been studied for both palynological and bulk carbon isotope inferences. All 40 samples from the mine section are found productive and yielded a diverse palynological assemblage including dinoflagellate cysts. The lower part of the succession yielded rich palynomorphs, but are devoid of dinoflagellate cysts. In the middle part, an early Eocene palynomorph assemblage is recovered along with long ranging dinoflagellate cysts (*Apectodinium homomorphum, Operculodinium centrocarpum, Polysphaeridium subtile, Cleistosphaeridium* sp. & *Spiniferites* spp.). In the upper part of section, the dinocysts become more frequent, whereas terrestrial palynomorphs are less diverse represented largely by Arecaceae and Araceae. The moderately diversified dinocyst assemblage recorded just above the uppermost lignite seam contains *Muratodinium fimbriatum*, *Homotryblium tenuispinosum*, *H. tasmaniense* and *H. floripes*. The overall assemblage of studied succession has an age range of early Ypresian-early Lutetian based on the combined data on dinoflagellate cysts and associated spore-pollen

assemblage. We recognize that a pronounced –ve Carbon Isotope Excursion of about 2.0‰, in the middle part of the succession can be well-correlated to the Second Eocene Thermal Maximum (ETM2) event. The present study implies that there is no significant age difference between the exposed subsurface lignitic successions of Kachchh Basin and Cambay Basin. The work reiterates that the vertebrate-bearing level at Panandhro lignite mine is Lutetian in age.

Dinoflagellate biostratigraphic analysis has been carried out on lignite-bearing succession from Giral mine, Barmer Basin. The cyst assemblages are rich and well-preserved, and several significant Paleocene age marker forms are identified. The study also documents several new peridinioid dinoflagellate species prior to Paleocene/Eocene boundary and provide significant clues regarding evolution of *Apectodinium* dinoflagellate lineage from low latitudes. Besides, the palynological studies from Matanomadh (Gujarat), Matasukh and Barsinghsar (Rajasthan) lignite mines are under progress. The samples from Barsinghsar lignite mine (Bikaner basin) have been processed for the recovery of microvertebrates, but are found unfossiliferous. Additionally, bulk carbon isotopic analysis of 107 samples from Giral lignite mine using Isotope Ratio Mass Spectrometer coupled with Elemental Analyser have been completed. Data interpretation is being carried out.

Amber extracted palynological analysis from Vastan lignite is potentially rich for the mixed vegetation, dominated by angiospermic pollen and sub-dominated by pteridophytic spores. The algal, fungal and other associated vegetative entities are also moderately preserved in the amber. Present documented floral assemblage indicates tropical-subtropical evergreen rain forest environment with humid climatic conditions during amber formation and sedimentation. The low land

Amber extracted pollen from Vastan lignite mine
a) *Dipterocarpus*, **b**) *Matanomadhiasulcites*, **c**) *Striacolporites*

vegetation was covered by mangrove swamp and fresh-water vegetation with shady plants. The fresh-water swamp and water-edge elements were brought to the sight of deposition by the river channels. The dominance of the arecaceous palynoflora suggests proximity of the near-shore environment, and is indicative of thick vegetation. The assemblage is closely comparable with that recorded from other lignite-bearing sequences of Cambay as well as Barmer, Bikaner and Nagaur basins of Rajasthan, and the sediment rich Kachchh palynoflora. Many pollen taxa of the families Meliaceae, Bombacaceae, Annonaceae and Liliaceae are of common occurrence in Eocene palynofloral assemblages.

Project- 5.2: Palynology of the Deccan Volcano-sedimentary Province (Central India) and the Khasi Hills (Meghalaya)

Investigators: R.S. Singh & M.F. Quamar

Late Cretaceous sediments from various sites exposed in Khasi Hills have been chemically processed. Thin deposits of arenaceous/clayey bands in between the thick pile of glauconitic arkosic sandstone are palynologically productive. The assemblages include pteridophytic spores, angiosperm pollen, 'Normapolles' pollen group, fungal remains and dinoflagellate cysts. Well representation of *Azolla cretacea*, *Ariadnaesporites intermedius* and *Triporoletes reticulates* in the assemblages recovered indicate a Maastrichtian age of the sediments. However, presence of *Oculopollis orbicularis* which ranges from Santonian to Maastrichtian; *Krutzschipollis spatiosus,* a well-documented species within the middle part of the Maastrichtian, and *Nudopollis* spp. restricted to the Maastrichtian-Danian are significant as their concurrent occurrence indicate an early Maastrichtian age. The palynoassemblages, in general, are dominated by the pteridophytic spores and fungal remains (spores & fruiting bodies) indicating a warm and humid climate during the time of deposition of these sediments. Freshwater influence in the marine depository basin is marked by the presence of aquatic freshwater ferns (*Ariadnaesporites*, *Azolla* & *Minerisporites*) belonging to Salviniaceae indicating marginal depository sites.

The overlying Palaeogene deposits have yielded a characteristic palynological assemblage showing that most of the late Cretaceous palynomorphs producing plants

became extinct by then. Palynological assemblage is also recovered from the thin sedimentary beds exposed near the village Rangapur, Andhra Pradesh (Deccan Intertrappean) indicating a Maastrichtian age for this bed. The palynoassemblage is dominated by the pteridophytic spores indicating a warm and humid climate during the time of deposition. The associated aquatic freshwater spores along with abundant algal remains indicate that the deposition took place under lacustrine conditions.

Project- 5.3: Palynological investigation of the Miocene sediments of Mizoram and Tripura

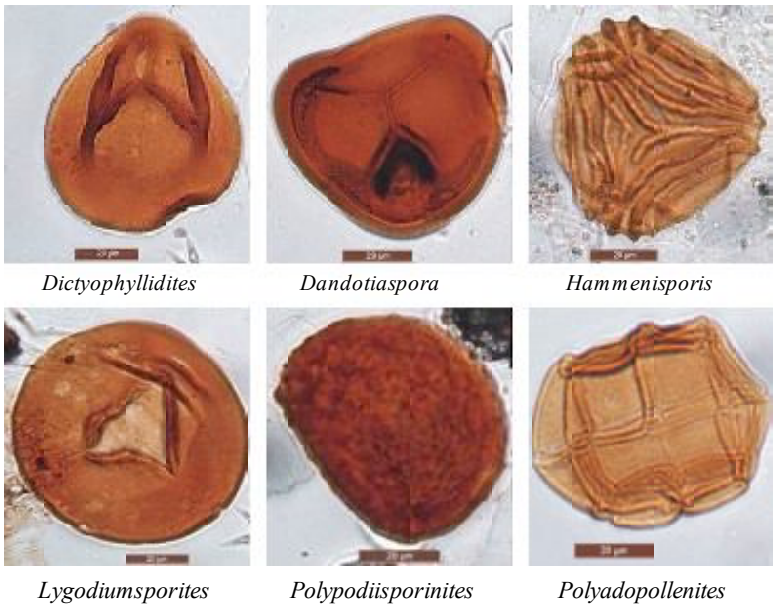
Investigator: B.D. Mandaokar

A rich and moderately diversified palynological assemblage comprising 124 species belonging to 97 genera has been described from surface samples of Amarpur representing the middle Bhuban Formation of Tripura Basin. The palynoassemblage is dominated by pteridophytic spores (16 genera, 32 species), angiosperms pollen grains (37 genera, 44 species), fungal remains (14 genera, 14 species), gymnosperms pollen (4 genera, 9 species), dinoflagellate cysts (11 genera, 10 species) and other reworked pollen grains (15 genera, 15 species). The palynoflora subdivides the sediments into three cenozones, namely *Pteridacidites vermiverrucatus* cenozone, *Malvacearumpollis bakonyensis* cenozone, and *Albertipollenites crassireticulatus* cenozone, respectively. The assemblage is typically indicative of a tropical to subtropical warm humid climate with high rainfall in a delta distributary channel under shallow marine influence. The terrestrial elements of upland flora and low land vegetational flora tend to merge with fresh water constituents. The dominant pollen elements (*Spinizonocolpites, Palmaepollenites, Malvacearumpollis*) suggest evidence of brackish water mangrove swamp along the coastal line. The stratigraphically significant taxa suggest an early Miocene (Aquitanian-Burdigalian) age. A comparison of the present palynoassemblage with other contemporaneous Tertiary assemblages of India reveals closed similarity with floras of Bengal, Mizoram, Assam, Meghalaya and Kerala basins. Moreover, palaeoclimate and environment of deposition have also been discussed on the basis of palynotaxa.

Project 5.4: Palynological investigation of Palaeogene sedimentary rocks of Garo Hills, Meghalaya: Palaeoecological and palaeogeographical interpretations

Investigator: GK. Trivedi

Palynological study of the Tura Formation (Palaeocene-lower Eocene) exposed along Tura-Dalu Road section, West Garo Hills has been carried out. The palynoassemblage recovered is rich and diversified consisting of algae, fungi, bryophytes, pteridophytes, gymnosperms, and angiosperms, besides reworked Gondwana palynofossils. The assemblage also consists of dinoflagellate cysts. It is observed that the assemblage is dominated by pteridophytes and angiosperms. Presence of gymnospermous pollen *Pinuspollenites, Podocarpidites* suggests that the topographically elevated areas were not far away from the basin of sedimentation and they had been transported from these uplands in the north. The recorded palynoassemblage indicates that the area enjoyed moist, warm, humid, tropical to sub tropical climate. *Lanagiopollis,*



Some of the palynomorphs recovered from Tura Formation, Meghalaya

Lakiapollis, Pellicieroipollis are tropical rain forest elements which indicate that the area enjoyed heavy rainfall during Palaeocene-lower Eocene times. Presence of dinoflagellate cysts along with the pollen of Arecaceae suggests that the deposition of these sediments took place under shallow or marginal marine coastal environment with fresh water swamps nearby. The coast might have been bordered by mangroves (*Nypa – Spinizonocolpites*) and other coastal elements.

Occurrence of Gondwana palynofossils in the Tura Formation is due to reworking. Permian palynofossils viz., *Indotriradites* in the assemblage indicates that the Permian sediments were extensively exposed, however presently they occur as a small patch of Lower Gondwana deposits at Singrimari, north-west of the studied area. This could possibly be the source area for the Permian palynomorphs. The study also records the early Triassic palynomorphs viz., *Klausipollenites* which indicates that these sediments also existed along with the Permian sediments. The Triassic sediments might have been totally eroded and redeposited or may be present in the subsurface.

Thrust Area 3: INTEGRATIVE MARINE MICROPALAEONTOLOGY: FOCUS ON HIGH RESOLUTION BIOSTRATIGRAPHY, SEA LEVEL CHANGES, PALAEO-OCEANOGRAPHIC AND PALAEOCLIMATIC

Marine Micropalaeontology Group

Project- 6.1: Study of Late Cretaceous-Early Palaeogene successions of South Shillong Plateau: Implications for climate and relative sea level changes

Investigators: Vandana Prasad, Anupam Sharma, Abha Singh & Jyoti Srivastava

Based on dinoflagellate biostratigraphy, late Palaeocene-early Eocene age has been assigned to Ranikor Barsora section of east Khasi Hills. Carbon isotopic study (in collaboration) reveals two hyperthermal events– Palaeocene-Eocene Thermal Maxima (PETM) and early Eocene Thermal Maxima2 (ETM2) in the section. In an attempt to trace the palaeobiodiversity, representative genera and species of different plant families during pre- and post-warming interval have been analyzed. A considerably high diversity of fossil pollen of Meliaceae has been observed from base Ypresian (~54 Ma) post PETM. Seven different types of pollen are identified in the assemblage which are grouped in to two fossil genera *Meliapollis* and *Tetracolporites*. The nearest living relative (NLR) analysis suggested the affinity of fossil pollen with the extant *Walsura trifolia*, *Toona ciliata*, *Melia azedarach* and *Dysoxylum* sp. of family Meliaceae restricted to tropical wet evergreen rainforest of southern Western Ghats of India and Malesia, Sundaland of SE Asia. It also suggests PETM induced development of warm climate and high precipitation with lesser number of dry months, a climatic condition suitable for the proliferation of wet and evergreen members of Meliaceae in the paleoequatorial region. Absence of Meliaceae pollen in the Palaeogene records of SE Asia further suggests that these wet and evergreen tropical lineages of family Meliaceae must have originated in Gondwana continents and dispersed from India into SE Asia once the land connection between the Indian and Asian plate was well established during the middle Eocene (49-41 Ma). Hence, the present study also supports the 'Out of India' Hypothesis.

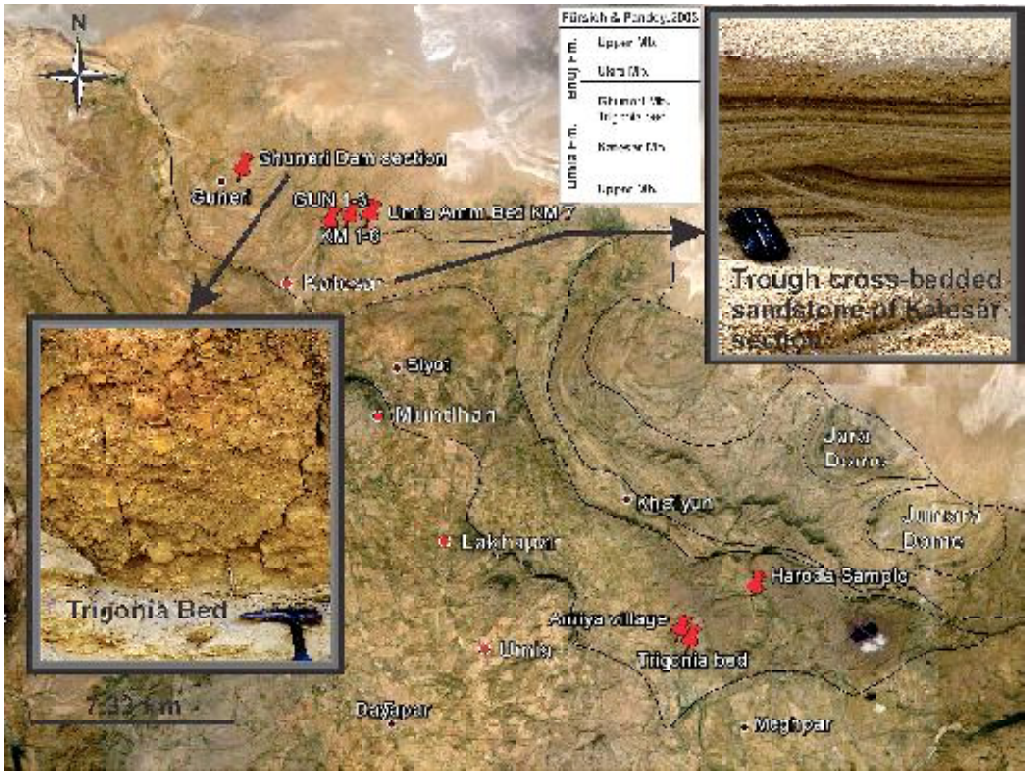
In continuation to biotic proxy records deciphered earlier on the Jathang section of east Khasi Hills, elements analysis of the sediments has also been carried out for better understanding of the then prevailing climatic conditions. In the lowermost section of the sequence (sample no. JTS 3-10), silica is increasing while alumina is decreasing, while the most mobile sodium, calcium and intermediately mobile potassium values are invariably consistent. From sample nos. JTS 12-19 all highly and intermediately mobile elements (Si, Na, K) show very low values having least values in sample nos. JTS-12-15; indicating very high degree of chemical alteration. In the Chemical Alteration Index (CIA) plot also, it is very clear that average CIA of the samples JTS12-15 is 97.83, while in JTS1-11 and JTS 17-30 the values are 94.96 and 92.73, respectively. Since all the CIA values are >85%, it is very clear that sediments have experienced very high degree of chemical weathering (average shale CIA is ~75%). It implies that enough water in the form of precipitation must have been available along with good drainage for flushing

and substantial residence time so that the sediment evolved to become chemically highly mature. It is also important to note that during the deposition of the entire section, the conditions remained more or less consistent, however the subtle change in parameters about 3-4% difference in CIA index, in the middle part of the section during body of the CIE indicates a phase much warmer and wetter climate, facilitating the extreme weathering in the catchment.

Project- 6.2: Calcareous nannofossils from western Indian Jurassic continental shelves: Biostratigraphic, palaeoenvironmental and palaeogeographic implications

Investigators: Jyotsana Rai & Abha Singh

Kachchh is a pericratonic rift basin occupying the western sector of Indian plate which formed during breakup of Gondwanaland in late Triassic. It displays marine fossiliferous sedimentary rocks of early Jurassic to late Cretaceous age followed by effusive Deccan Traps. The Mesozoics are encompassed by marine Tertiary and Quaternary sediments. The Mesozoic rocks crop out in six major uplifts, i.e. Kachchh mainland and island belts of Pachchham, Khadir, Bela, Chorad and Wagad uplift. Calcareous nannofossil data of early-late Jurassic age from Patcham, Chari and terminal Umia Formations (Bhuj Member) have been generated, but need for nannofossil data from Katrol (Umia Member) and overlying Katesar (Berriasian-Valanginian) and Ghuneri (Hauterivian-Barremian) Members of Umia Formation was felt and the data from the latter has been generated.



Physiographic map showing early Cretaceous nannofossil and other macrofossils-bearing (ammonite, *Trigonia, Modiola* & ichnofossil) localities in Kachchh

Moderately preserved and rare in abundance calcareous nannofossils have been recovered from the Ghuneri and Katesar members. The Ghuneri section is exposed east of the village Guneri. It contains large scale trough cross-bedded fine to coarse grained sandstones with rare shell lenticles. An exception is a nearly 2 m thick unit containing three ochre to dirty yellow coloured shell beds, commonly called as 'Trigonia Bed'. The samples collected between the shell beds yielded poorly productive early Cretaceous age nannofossils. The section of Katesar Mb. is exposed within and at the sides of dry river bed. It displays huge deposition of fine to medium grained sandstone which exhibits low angle, large scale trough cross bedding. Only 2 samples (KM-7 & KM-8) from the Katesar Member, out of 8 samples, have yielded early Cretaceous age nannofossils. In both the sections the assemblage is dominated by *Watznaueria* spp., *Nannoconus* spp. and *Retecapsa* spp. In addition, a field excursion has been undertaken around Kachchh Mainland, and covered several sections representing Katrol and Bhuj Formations.

Project- 6.3: Micropalaeontology of the Subathu sediments of Lesser Himalaya, Himachal Pradesh

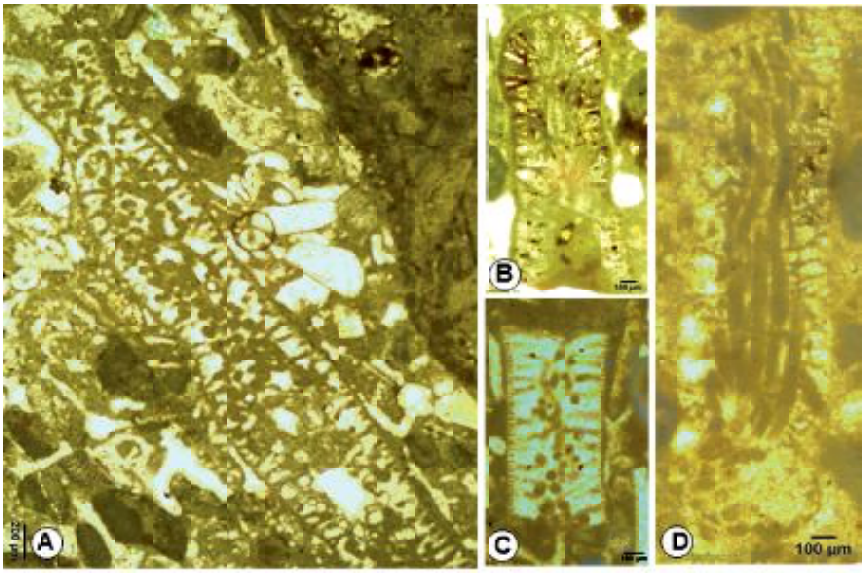
Investigator: V.V. Kapur

The project has been merged with the Project- 13.1 with prior approval of the Research Advisory Council of the Institute.

Project- 6.4: Biofacies analysis of the Cenozoic sediments of Andaman-Nicobar Basin and its implications for palaeogeography, palaeoecology and palaeobathymetry

Investigators: A.K. Ghosh & Abhijit Mazumder

Biofacies analysis of the Long Formation exposed near Butler Bay in Little Andaman Island indicates existence of 3 distinct biofacies that varies from foraminiferal algal biomicrite or wackstone to foraminiferal biosparite or grainstone. Based on planktic foraminifera, a Tortonian age has been assigned for the outcrop. The calcareous algal forms are represented by the genera *Lithothamnion, Phymatolithon, Lithoporella, Lithophyllum, Spongites, Sporolithon, Amphiroa, Corallina* and *Halimeda*. In some instances, the melobesioid, mastophoroid and sporolithoid non-geniculate coralline red algae form rhodoliths. In addition, coral and bivalve fragments, planktic foraminifers are also common in thin sections along with benthic foraminifers represented by *Amphistegina, Lepidocyclina, Nummulites*, miliolids and texularids. The overall assemblage indicates a fairly conducive environment for the survival of the algal forms along with other biogenic components.



Halimeda spp. from the algal-foraminiferal grainstone-packstone facies of Long Formation (Tortonian) exposed near Butler Bay in Little Andaman Island (Hut Bay)

Inglis and Long Formations are exposed in the Havelock Island of South Andaman, which is the largest island of the Ritchie's Archipelago. Detailed micropalaeontological analysis of the samples of Inglis Formation exposed near Vijay Nagar has been done. Based on nannofossils (NN4-NN5 Zone) the sequence has been precisely dated as Burdigalian-Langhian (21-13 Ma). The age has also been reconfirmed by marker radiolarians (RN4 Zone). The sediments also yielded well-preserved diatoms represented by both benthic and planktic species. The diatom biozones have been demarcated with the help of CONISS cluster analysis and further reasserted by SHEBI analysis. PCA has been done on the abundance of diatom taxa to test the relatedness. Benthic/Planktic ratio of the diatoms indicates the evidence of sea-level fluctuations.

The type area of Neil West Coast Formation is situated in the west coast of Neil Island. Based on planktic foraminiferal assemblage (*Globorotalia tosaensis* i.e., N21 Zone to *Globorotalia truncatulinoides* i.e., N22 Zone) it has been dated late Pliocene to Pleistocene. The upper unit i.e., the Limestone Member (Pleistocene) of the formation is dominated by foraminiferal-algal facies along with planktic foraminifers, corals, gastropods and echinoid spines. The coralline red algae are represented by both non geniculate and geniculate forms. The diversity and abundance of coralline algal forms are less in comparison to the benthic foraminifers. The texture of the facies is basically grain supported and poorly sorted. Only a single foraminiferal-algal grainstone facies has been recognized. The overall biofacies analysis indicates a near shore environment of deposition with high energy condition and increased hydrodynamic activity.

Project- 6.5: Phytoplankton response to palaeoclimatic fluctuations along the Kerala-Konkan Coast

Investigators: Vandana Prasad, Biswajit Thakur & M.C. Manoj

The study of diatoms, palynofacies and geochemical proxies in sediments give vital information regarding the depositional environment, hydrodynamic conditions, proximal-distal trends and run-off related changes. In this context, the Cherai core sediments of Vembanad wetland (Kerala) have been studied for biotic (diatoms, palynofacies & dinoflagellates) and abiotic proxies (geochemical analysis). The diatom assemblage in the core (36 cm) is well-recorded, and is marked by the presence of *Navicula* spp., *Nitzschia* spp., *Pleurosigma*, *Diploneis*, *Gyrosigma*, *Surirella*, *Achnanthes*, *Amphora* spp., etc. The availability of nutrients and other physico-chemical aspects play major role in the growth of algal communities dominated by diatoms in the estuarine system. The dominance of brackish diatom– *Nitzschia panduriformis* in the assemblage indicating enhanced freshwater influence due to high discharge during monsoon period is also witnessed. Along with the prevalence of marine centric diatoms, the freshwater benthic diatoms in the top sediments of the core indicate high anthropogenic activity, thus indicating shallowing of the wetland at Cherai. The study from the Cherai beach provides evidence of changes in the runoff due to monsoonal fluctuations and marine incursion from the sea. The palynofacies and dinoflagellate cysts study shows dominance of dinoflagellate *Bitectatodinium spongium* over other dinocysts and indicate warm and humid climate during the deposition of these sediments. Besides, the geochemical analyses of the samples are processed for REE analysis, major and minor oxides and heavy metals for pollution and anthropogenic activities.

Diatom *Diploneis smithii* from Cherai core sediments

The diatoms and palynofacies studies from the Bougatty core have been carried out to know the distribution pattern of marine and terrestrial palynomorphs and diatoms in Bougatty Barmouth, Vembanad wetland ecosystem. The studies show varying assemblages of freshwater, brackish and marine diatoms at different levels in the core along with differential and varying palynofacies components. The variations in the frequency of dinoflagellate cysts and palynofacies components reveal varying environmental settings in the depositional system. The dinoflagellate cyst *Bitectatodinium spongium* shows dominance over other dinocysts and indicates prevalence of warm and humid climate during the deposition of these sediments. The AMS Radiocarbon dates are awaited for giving high resolution inferences about palaeoenvironment and palaeoclimatic conditions.

Thrust Area 4: ORGANIC PETROLOGY: CHARACTERIZATION OF SOLID FOSSIL FUEL FOR DEPOSITIONAL AND UTILIZATIONAL ASPECTS

Organic Petrology Group

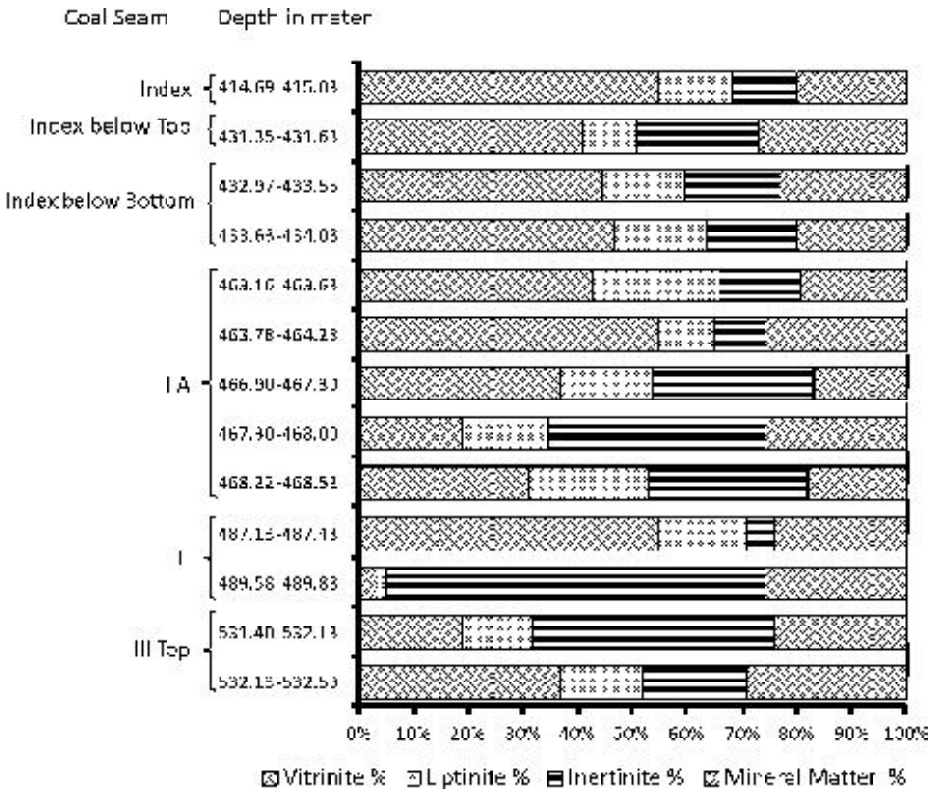
Project- 7.1: Petrology of coals from Wardha-Godavari Valley Coalfield and its impact on coal bed methane potential and depositional environments

Investigator: O.S. Sarate

Petrographic study of the coal seam succession intersected in bore-hole No. SBS-182 from Sravanapalli area of Belampalli Coalfield (District Adilabad) has been completed. The random vitrinite reflectance ($R_{o\ mean}$%) values of the Index, Index below top and Index below bottom seams range between 0.56% and 0.61% , whereas the seams IA and I have shown the reflectance variation between 0.52% and 0.54%, which suggest that all these coal seams have attained high volatile bituminous C stage of rank. The lowermost III top seam has shown low

reflectance deviation of 0.45-0.46% and therefore has reached sub-bituminous B stage in the area.

The ternary mineral matter-free plotting suggests that the topmost Index and its underlying Index below top and Index below bottom seams exclusively contain vitric type of coal. Seam I and III top are represented by vitric and fusic coal types, whereas IA seam is marked by vitric, fusic and mixed types of coal constitution. The facies diagram has indicated the Index, Index below top and Index below bottom seams have exclusively been deposited during wet moor with intermittent moderate to high flooding, whereas IA and III top seams have experience change in climate to alternate oxic and anoxic moor conditions and I seam witnessed change to oxic (dry) moor with sudden high flooding.

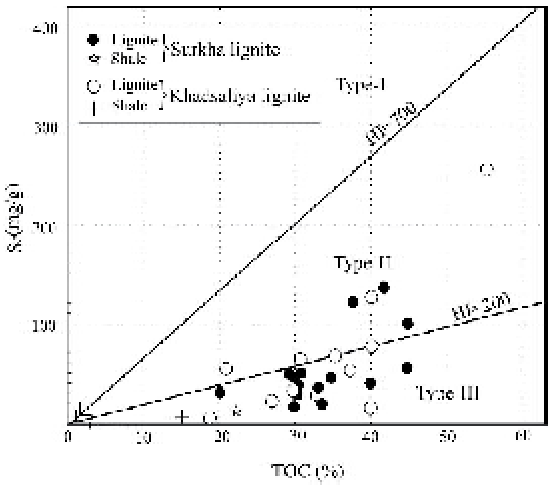


Maceral constitution of the coal seams intersected in bore-hole SBS-182 of Sravanapalli Dip Side Block, Belampalli Coalfield, Godavari Valley

Project- 7.2: Organic matter characterization of western Indian lignites through petrological studies

Investigators: Alpana Singh, B.D. Singh, R.P. Mathews & V.P. Singh

The nature, type and amount of organic matters and their relation to depositional conditions have been discussed along with significance in hydrocarbon source potential of the Eocene lignites/shales from Surkha and Khadsalia mines (Saurashtra Basin, Gujarat). The macerals of huminite group show dominance over the liptinite and inertinite macerals. The petrographic indices (tissue preservation, gelification, ground water & vegetation) are indicating that the precursors of peat were deposited under limno- to the telmatic regime with mesotrophic hydrological conditions. The particulate organic matters are dominated by the phytoclasts followed by amorphous OM and palynomorphs. The huminite reflectance values (0.31-34% $R_{r\ mean}$) show a good correlation with gross calorific values (3891-3917 cal/g) and average T_{max} values (416-418 °C); indicating immature nature of the lignite deposits (also influenced by high moisture contents). The lignite contains high TOC (up to 35 wt.%) and low ash yields along with moderately high carbon contents and volatile matter yields. Evidently, the organic matters are of types III-II admixed kerogens, and have the potential to produce hydrocarbons upon maturation.

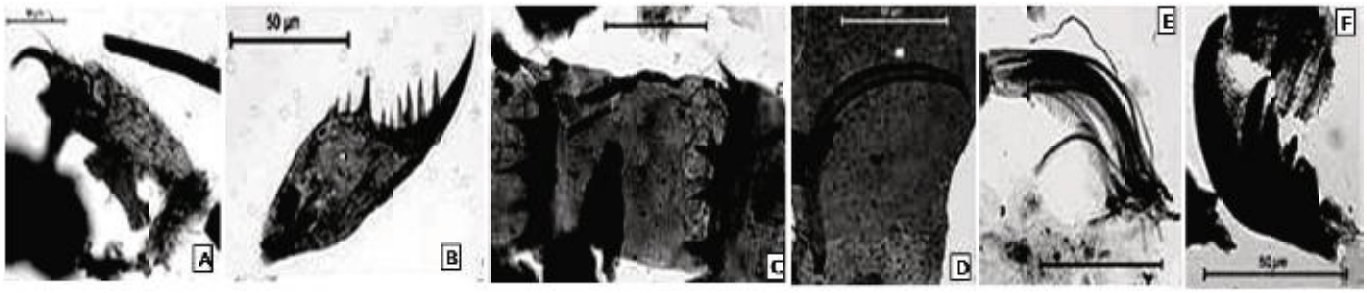


Rock-Eval pyrolysis data of Surkha and Khadsaliya lignites, Saurashtra Basin showing S2 *vs*. TOC plot

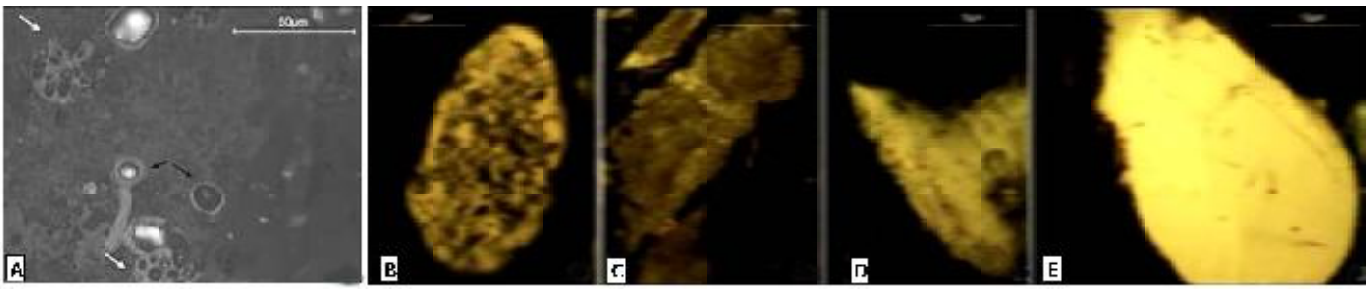
The study of Valia lignites (Cambay Basin, Gujarat) has revealed that they are dominantly composed of huminite (av. 70%), followed by liptinite (av. 17%) and inertinite (av. 5%) macerals. The types of huminite suggest that the seam is formed from mixed vegetal source (woody forest vegetation, herbs & shrubs). The petrographic indices are suggesting that the lignite-forming peat was accumulated in limno-telmatic conditions under mesotrophic to rheotrophic hydrological regimes in a marine influenced (indicated by pyrite: av. 3%) coastal environment. The Rock-eval data shows the average pyrolysis temperature (T_{max}) is 414 °C and is in accordance with average $R_{r\ mean}$ value (28%; low rank B). The S2 varies from 72.92 to 353.38 mg HC/g in lignites, whereas 0.22 to 45.07 mg HC/g in shales. The average TOC is 45.24 wt.% in lignites and 7.93 wt.% in shales.

Lignites from Gurha mine (Bikaner Basin, Rajasthan) are also found to be rich in huminite group of macerals, followed by liptinite and inertinite groups. The petrographic indices suggest limno-telmatic environmental and ombrotrophic to mesotrophic hydrological conditions of the palaeomire. Palynofacies study has revealed the dominance of phytoclasts followed by AOM and minor palynomorphs. Organic geochemical analysis reveals the presence of hopanoids, oleananes, etc.; indicating high organic matter input from higher plant and microbial activity. The T_{max} (av. 419 °C) and $R_{r\ mean}$ (av. 0.26%) values indicate the immaturity of the organic matters. However, the high TOC content and type II-III kerogens indicate the potential of studied sequence as a source of hydrocarbons.

The examination of carbonized wood along with lignites from Kapurdi mine (Barmer Basin, Rajasthan) has yielded abundant fungal components and arthropod appendages. Under SEM, the wood section shows tyloses, a physiological process as a response to fungal infection. Scolecodonts and annelid body parts are also recovered from the sediments; indicating the peat biomass was a thriving habitat for detritivores. In the lignite beds, which underlay and overlay the carbonized wood section, the maceral funginite is found to be associated with resinite; pointing that the funginite inclusion was not accidental but encapsulation of fungi by exuded resin of the plant as a defense mechanism. The degradation of the humic matter (huminite) is attributed to the fungal infestation as well as fungal activity in the peat mire. This fungal-faunal interaction resulted in alteration of the organic matter and origin of the macerals belonging to inertinite group.



Different body parts recovered from lignite associated sediment of Kapurdi mine : **A**) Limbs of arthropod (beetle?), **B**) Mandibles with teeth to grip the prey or food, **C**) A body segment of annelid, **D**) An annelid larva?, **E**) Heavily ciliated radioles used in filter feeding, **F**) Scolecodont.



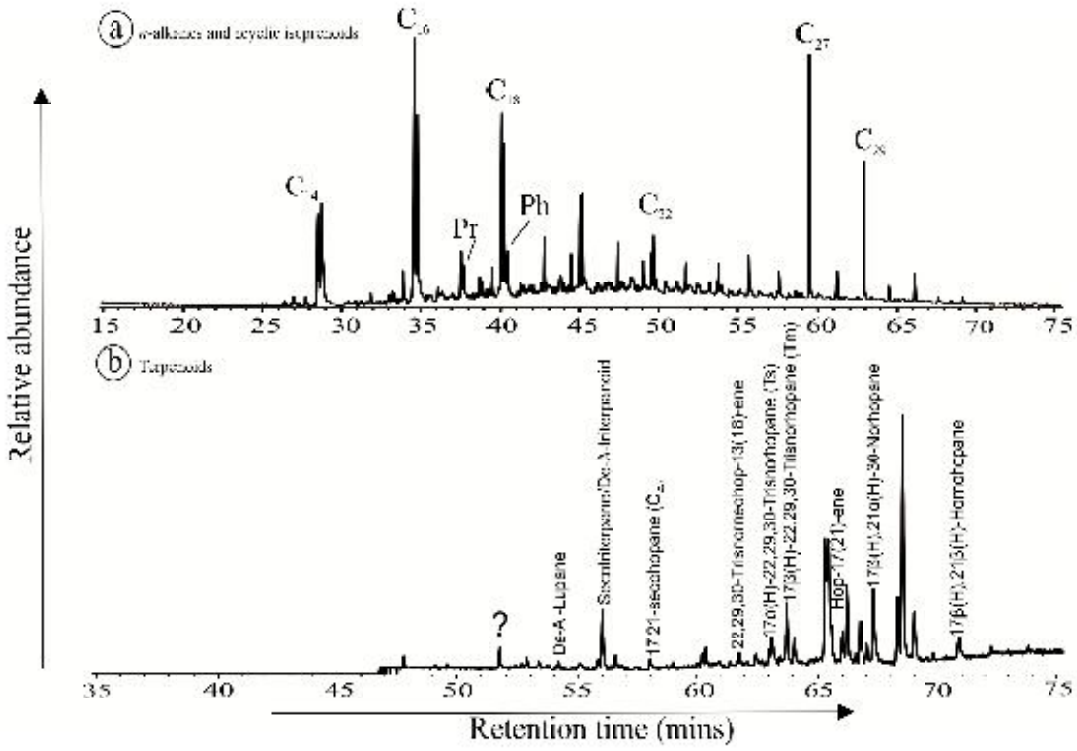
Representative macerals of Kapurdi lignites : **A**) Fungal components in a detrohuminite groundmass (white arrows for fungal sclerotia, black arrows for fungal spores: incident white light), **B-E**) Resinite containing inclusions of fungal filaments/hyphae (fluorescent light)

Project- 7.3: Organic petrographical and geochemical characterization of Tertiary lignite bearing sequences of south India

Investigators: B.D. Singh & R.P. Mathews

The lignite and associated shales have been sampled from mine-I and mine-II of the Neyveli field (TN). Proximate analysis of the lignites has been done in the laboratory of RGIPT, Raebareli (with A.K. Singh). The analysis involves the determination of moisture, ash, volatile matter and fixed carbon contents in weight percentage. The analysis reveals that lignites from both the mines are high in moisture contents (range: 15.65-36.30 wt.%), moderately high in volatile matter yields (19.65-49.46 wt.%) and low ash contents (vary between 1.54 & 40.16 wt.%). The fixed carbon contents of the lignites range from 12.94 to 26.99 wt.%. Additionally, the solid bitumen from the lignite-bearing sequence has been examined based on the FTIR spectroscopic method. The data shows an intense aliphatic CH_x stretching peaks between 3000-2800cm^{-1}, medium absorption of OH stretching, aromatic C=C, and deformation peaks; suggesting the highly aliphatic nature of the solid bitumen.

Organic geochemical, maceral (huminite) reflectance and palynofacies studies of the organic-rich sedimentary sequence of Warkalli Formation from the Warkalli Cliff section (southern Kerala) have been compiled. The GC-MS analysis reveals a bimodal distribution and abundance of *n*-alkanes from *n*-C_{12} to *n*-C_{33}. This indicates a significant contribution of high microbial activity and epicuticular waxes from higher plants to the peat biomass. Further, high amount of hopane derivatives are also suggesting high bacterial activity in the peat biomass. Oleanane type triterpenoids suggest the vegetal contribution from the angiosperm wood forest. The distribution of the hopanes detected indicates an immature stage of the organic matter, which is in agreement with the huminite reflectance values (av. 0.28% R_r); indicating immature nature of the sediments. The pristane/phytane (Pr/Ph) ratio implies variable redox conditions during sedimentation. The phytoclast group (63-87%) dominated the dispersed organic matter with subordinate amount of amorphous organic matter (4-35%). The organic geochemical and the visual kerogen (evaluated by palynofacies) observations are in agreement to each other.



The partial mass chromatograms of Warkalli sediment extracts showing the distribution of (**a**) *n*-alkanes, acyclic isoprenoids and (**b**) terpenoids

Thrust Area 5: QUATERNARY PALAEOCLIMATE RECONSTRUCTIONS, VEGETATION DYNAMICS AND RELATIVE SEA LEVEL CHANGES

Quaternary Palaeoclimate Group

Project- 8.1: Holocene climatic variations and vegetation succession in endangered wetland ecosystems and adjacent reserve forests in Brahmaputra and Barak valleys, Assam

Investigators: S.K. Bera & Swati Tripathi

The palynological examination of 30 surface soil and mud samples has been performed in order to establish modern pollen/vegetation relationship from Chatla wetland situated in Cachar district. The study largely revealed that *Barringtonia acutangula* (local name Hazil), despite being an enormous pollen producer and the dominant forest constituent (70-80%) in and around the wetland, is recorded mostly in low frequencies (8-10%), attributable to its low pollen dispersal efficiency (entomophilous in nature) as well as poor pollen preservation (flood prone region) in the sediments. Other arboreal associates constitute of *Emblica, Lagerstroemia, Duabanga,* Anacardiaceae, *Syzygium* and Combretaceae. The assemblages revealed the dominance of non-arboreal pollen taxa (NAPs: herbs) over the arboreal pollen taxa (APs: trees & shrubs). Among the APs, trees constitute on average 28.92% of the pollen in the total pollen rain, whereas the average contribution of shrubs is only 2.24%. Among the herbaceous taxa, Poaceae (grasses) has a relatively high frequency (av. 21.20%). The NAPs, on the whole, constitute on average 48.51% of the pollen in the total pollen rain. Cereal, Chenopodiaceae, Lamiaceae, Amaranthaceae, Caryophyllaceae, Brassicaceae, *Artemisia* and *Xanthium* reflect the pastoral activities in the study area.

The palynological records have demonstrated four distinct phases of climate oscillation, vegetation response and human occupation in Cachar district of Assam. At the upper column of 100 cm deep sedimentary sequence, the presence of higher frequencies of cereal and hinterland taxa along with scarce appearance of trees is well-registered. Thus, the study portrays that the region experienced a warm and relatively dry climate in the recent past owing to anthropic activities along with reduction in monsoon precipitation. One 200 cm deep exposed trenched sedimentary profile from Rani Garbhanga reserve forest of Kamrup district has been dated back to 1,200 cal BP. Palynological assessment is in progress.

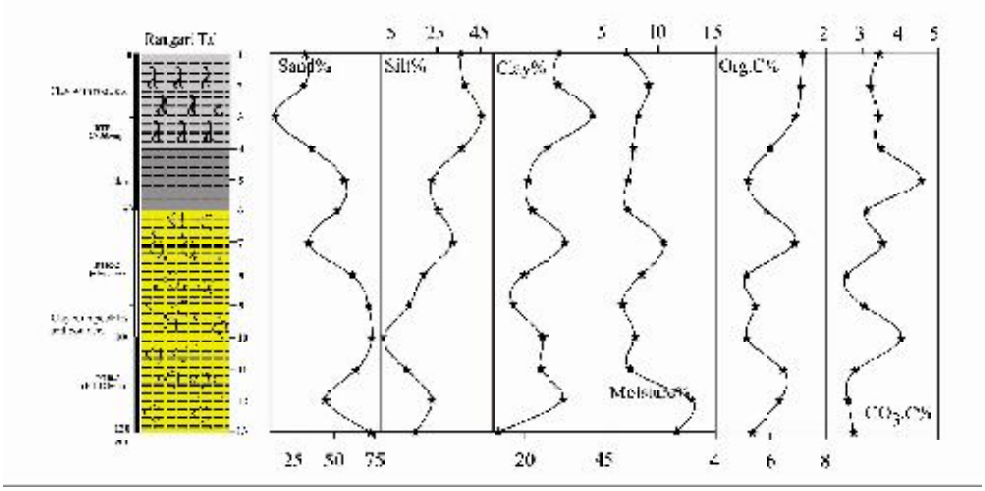
A) View of Sal (*Shorea robusta*) forest in Rani Garbhanga RF (Kamrup district), **B**) View of Chatla wetland surrounded by *Barringtonia acutangula* in Cachar district

Project- 8.2: Reconstruction of Quaternary vegetation dynamics and climate change in southern Madhya Pradesh

Investigator: Kamlesh Kumar

A lake profile from Rangari Tal (lat. 21° 44' 59.25" N, long. 78° 45' 35" E), situated about 35 km south of Chhindwara city in the vicinity of Rangari village, has been studied. The lake is big in expanse and irregular in shape, measuring 300 m in length and 150 m in breadth. In the geochemistry, textural analysis by hydrometric method and TOC by Loss on ignition method are calculated. In the grain size analysis sand, silt and clay

fraction has been calculated. The sand percentage varies from 13-73%, which increases from surface to bottom of the profile. Silt and clay range from 1.2-45% and 11-41%, respectively and decreasing from surface to bottom. Moisture content ranges between 6 and 13%, and organic carbon between 5 and 7%, while inorganic carbon varies from 2.5 to 4.5% in the profile. The major and trace elements are analyzed by ICP-MS. The major oxides include Na_2O (0.35-1.72%), MgO (1.45-4.41%), Al_2O_3 (14.57-15.98%), K_2O (0.47-0.64%), CaO (0.26-1.07%), MnO (0.24-0.78%), and Fe_2O_3 (20.73-23.52). Similarly, trace elements comprise V (152-320 ppm), Cr (79-120 ppm), Co (68-150 ppm), Ni (87-117 ppm), Cu (258-301 ppm) Zn (162-208 ppm), Ga (30-34 ppm), Sr (52-143 ppm), Cd (0.1-0.2 ppm), Ba (219-336 ppm) and U (0.7-1.2 ppm). Stable carbon isotope ($\delta^{13}C$) of the profile has also been done, and the values range between -22‰ and -16.7‰.



Textural variation, moisture, organic carbon, and inorganic carbon variations in the Rangari profile

Clay fraction has been separated from the samples and clay mineralogy has been done on Xpert[3] Powder (PANanalytical) machine from 3-40^{0}2θ value. After scanning the data has been run on Xperthighscore programme. It is found that most dominated clay mineral is kaolinite followed by chlorite and smectite. The presence of kaolinite shows relatively warm and humid climate, while presence of chlorite shows relatively cool and dry climate.

Project- 8.3: Quaternary palaeoclimate reconstruction and palaeovegetation dynamics in the central Ganga Plain

Investigators: Anju Saxena, Anjali Trivedi & Kamlesh Kumar

The analysis of 24 surface samples from the Chinatmani Tal, Farrukhabad district has been accomplished to study the pollen deposition pattern. The study has revealed dominance of non-arboreal pollen and relatively low frequencies of arboreal pollen. The major tree taxa recorded are *Madhuca indica, Acacia nilotica, Holoptelea, Syzygium*. The under representation of most of the trees could be recognized to low pollen production because maximum of them are of entomophilly as well as relatively less frequent presence in the forest floristic. In totality, the tree taxa constitute average 19% of the total pollen deposition. The selective preservation of their pollen in the surface sediments cannot be denied. The grasses, Cheno/Am, Tubuliflorae, Liguliforae, *Polygonum*, etc. are the major non-arboreals. The encounter of Cerealia, *Brassica*, *Cannabis sativa*, etc. envisages the proximity of agricultural land. Aquatics and fungal remains are also recorded in good values. Additionally, pollen sequence of a 4.5 m deep sediment core has also been completed from the Cintamani Tal. The study has revealed the five climatic oscillations. The presence of open vegetation is dominated by grasses, Asteraceae, together with the scanty occurrence of trees viz., *Holoptelea* and *Symplocos*, etc. The retrieval of *Potamogeton*, *Trapa* and *Nymoiphdes* denotes the prolonged existence of the lake. The sedges and *Polygonum serrulatum* inhabited the lake margin abundantly.

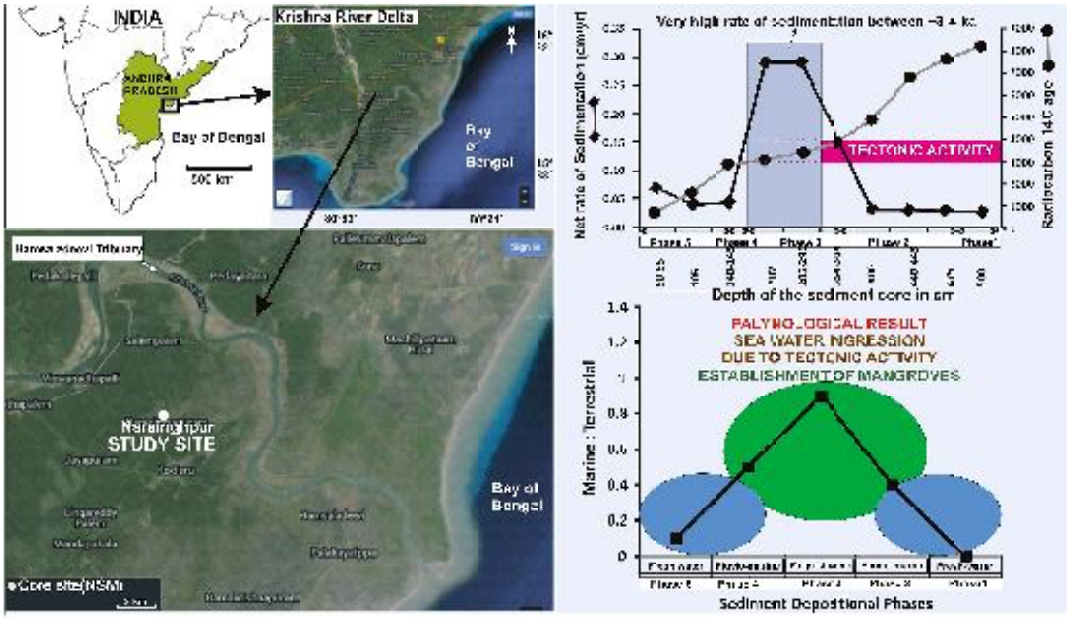
A paper on pollen rain deposition pattern of Sevan Tal, Raebareli district (UP) has been accomplished based on the analysis of 10 surface samples from the lake margin. The study has revealed the relatively lower frequencies of arboreals in contrast to non-arboreals. *Acacia* and *Holoptelea* are the dominant forest elements. Other trees, despite occurring appreciably in the forest, are sporadic owing to their low pollen productivity. Poaceae, sedges, Asteraceae, Chenopodiaceae/

Amranthaceae, Caryophyllaceae, etc. are the major non-arboreals. The consistent presence of Cerealia pollen indicates the proximity of human habitation. Besides, a manuscript based on surface sample of Kikar Tal has been revised, and another manuscript based on multi-proxy record from sedimentary profile of Lasodha Tal (central Ganga plain) is finalized in relation to vegetation, climate and culture evidences since 21.7 cal. BP.

Project- 8.4: Late Quaternary vegetation and climate studies from lakes of Andhra Pradesh and northwest Uttar Pradesh

Investigators: Anjum Farooqui, S.K. Shukla & Ranjana

Palynological study has been carried out in a 500 cm deep sediment core deposited since ~8.2 ka in the northeastern part of Krishna river delta (Narsinghpur), to understand the trends in relative sea level (RSL) and climate/geomorphological changes during Holocene. The entire core shows high salinity and is fine clayey-silt with intermittent bands of sandy layer/shell particles. The period from 8.2-7.2 ka shows no marine palynomorphs, but later between 7.2 and 4.0 ka records of back mangroves such as *Avicennia* and its associates indicate fluvio-marine ecosystem suggesting that the sea encroached land to about 10 km from the present shoreline. The highest diversity of terrestrial and mangrove pollen is recorded between 7.0 and 3.0 ka indicating warmer and humid climate and high RSL. However, between 3.0 and 4.0 ka, a sudden rise in net rate of sedimentation (from ~0.03-0.34 cm/yr.) is recorded thereafter, a decline in mangroves indicate a retreat in RSL until present which is attributed to tectonically controlled changes in the region. In the vertical stack of studied core, the evidence of 6-7 ka global transgressive event is ~10 km inland and present slightly above the present day mean sea level indicating upliftment of about 1 to 1.5m in the region.



Palynological study of a sediment core from Narsinghpur, Krishna River delta, Andhra Pradesh

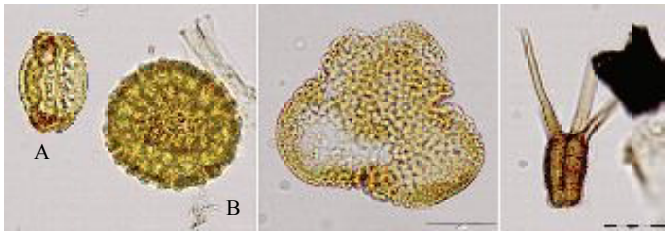
Twenty-one surface samples have been studied for pollen/spores, thecamoeba and diatom. Similar study is also carried out in 100 and 200 cm sedimentary profiles collected from freshly dug out trench close to Nawabganj Bird Sanctuary (Unnao). The diatom assemblage (in 100 cm profile) was predominant with benthic diatom species and conversely lacking planktonic diatom species. The down-core data showed occurrence of cold water species in the lower part which drastically declined in the upper part of sediment core. The diatom inferred productivity showed to be greater in the past compared to the recent past sediment. The study in a 200 cm deep trench reveals the limnological characteristics of the Nawabganj lake along with vegetational succession since ~4 ka. Additionally, field work has been carried out in Sandi Bird Sanctuary of Hardoi district (UP) and collected two sedimentary profiles (~200 cm each) from the dried lake and 21 surface samples from the exposed lake bed for palynological study. Samples are also collected from the existing lake in the nearby area Ruiha Garhi, for palynological and thecamoebian study.

Project- 8.5: Vegetation succession and climate change in Garo Hills, Meghalaya and adjoining areas since Holocene

Investigator: S.K. Basumatary

The generated palynodata (from 130 surface samples) from the south Garo Hills have reflected the different forest types, namely evergreen, riparian and deciduous which exactly display the current vegetation in the region. The major evergreen elements chiefly *Elaeocarpus*, *Castanopsis* and *Mesua* along with *Nepenthes khasiana* are strongly indicative of the high monsoonal activity in the region. A 1.7 m sedimentary soil profile from Baghama reserve forest has also been pollen analyzed; showing three phases of vegetation and climate succession. In the first phase, the existence of tropical deciduous forest composing of *Salmalia*, *Duabanga*, *Lagerstroemia*, Anacardiaceae, and *Mesua*, *Schima* and *Salmalia* is observed; indicating warm and humid climatic condition in the region. The comparative low value of arboreal taxa has been observed in the second phase which suggestive of the deterioration of the forest under the relatively less humid climate in response to the relatively low monsoonal activity in the region. In the third phase, the presence of cerealia along with *Brassica*, *Corriandrum*, and *Solanum* are strongly indicative of the human activity in and around the vicinity area.

A view of Deeplai wetland of Lower Assam



Barringtonia sp. (A) & *Polygonum* sp. (B) Salmalia Tetraploa

The pollen analysis on bat guano samples from Pine Cave of south Garo Hills indicates mainly the tropical evergreen forest consisting of *Elaeocarpus, Mesua, Castanopsis* and *Syzygium* which exactly display the surrounding vegetation. The recovery of deciduous and riparian elements such as *Dillenia*, *Salmalia*, *Duabanga* and *Ficus* are strongly indicative of the deciduous and riparian forest in and around the vicinity area. A 1.5 m sedimentary soil profile collected from the Deeplai wetland of Lower Assam has also been pollen analysed. The generated palynodata reflected the three vegetation and climatic succession in the region.

Project- 8.6: Quaternary mangrove ecosystem dynamics and sea level changes of the Mahanadi Delta and comparative assessment with Sundarbans Delta

Investigator: Shilpa Pandey

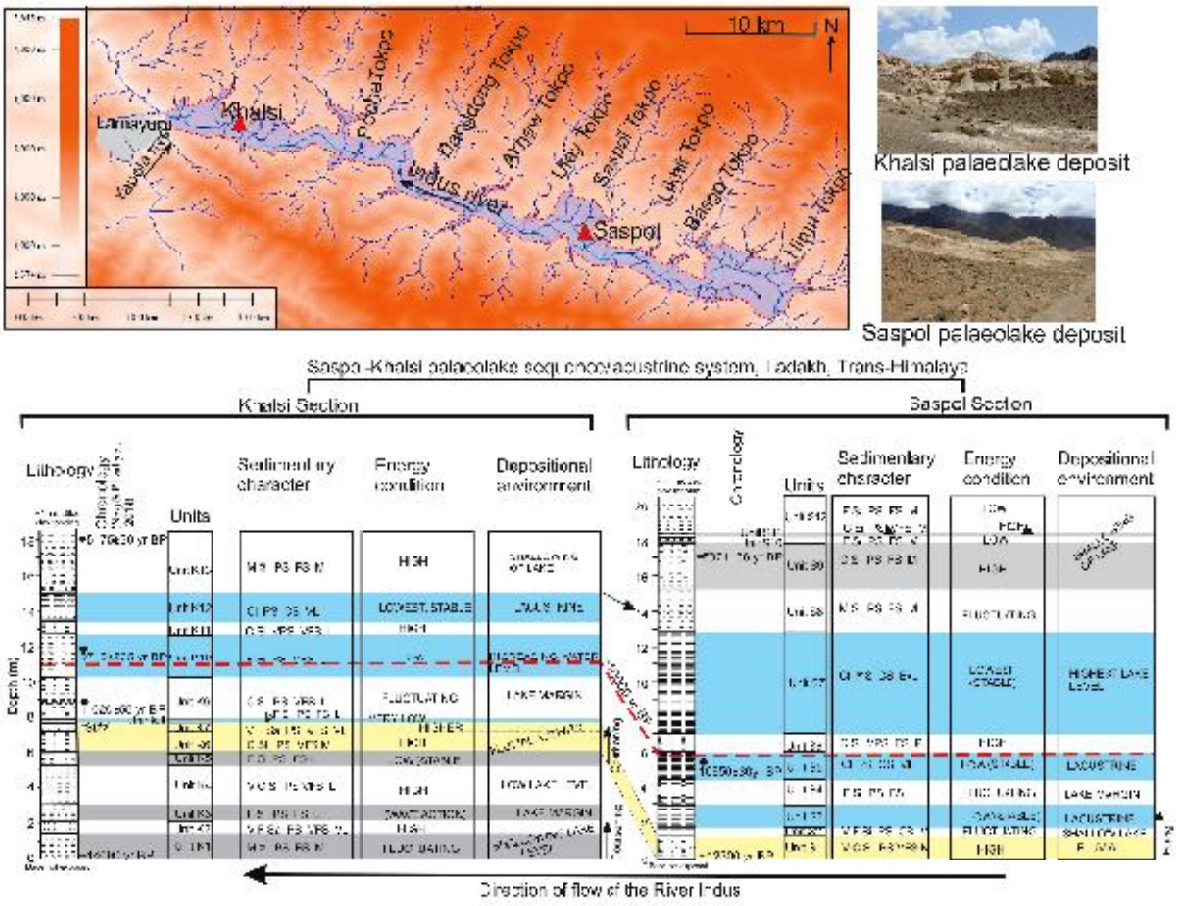
Around 14 surface samples (mud) collected from the South 24 Pargana Division, West Bengal have been chemically processed for palynological investigations. The pollen spectra from Jharkhali (JH 1–14) exhibited high frequency of *Rhizophora mucronata* with a wide range (25-35.5%), followed by *Sonneratia* and *Aegiceras corniculatum* (9-19.5%). The other peripheral mangroves such as *Terminalia* (3-11.5%) and *Pongamia* (3-5.5%) attained moderate values. *Excoecaria agallocha* (9-19.5%) is the only taxa represented by moderate values among core mangroves, whereas *Xylocarpus* and *Aegialitis* are poorly represented. Poaceae (21-38.5%) is the major constituent of ground flora, and Chenopodiaceae and Cyperaceae showed low frequencies. Monolete and trilete spores (5-6.6%) are also encountered in low values. Additionally, honey, spider webs and sediment profiles have also been collected from the area for Melissopalynology and pollen studies.

For modern pollen rain studies, about 14 surface sediment samples have been collected from the Deulbadi area of South 24 Pargana Division. The palynological investigations of the samples are under progress. Pollen analysis of a 4.65 m sediment profile collected from the Lothian Island is also under progress. The entire profile is mainly composed of silt and clay. Based on initial results, the Lothian profile is marked by the dominance of mangrove pollen mainly *Rhizophora* and *Sonneratia*). Other taxa such as *Acanthus*, *Avicennia*, *Excoecaria*, *Bruguiera*, *Xylocarpus*, *Heritiera*, *Nypa fruiticans* and *Phoenix palludosa* are abundant. Rhizophoraceae pollen had diminished in the terminal part of the profile, regains its supremacy followed by *Sonneratia apetala*. Mangrove associates, such as *Terminalia* sp., *Barringtonia racemosa* and *Pongamia pinnata* are also represented in moderate values. Most of the recovered palynomorphs are comparable with the present-day mangrove vegetation of the study area. The vegetational changes corresponding to the climatic fluctuations can be temporally fixed once AMS radiocarbon dates are available (as 5 samples have been sent to Poland).

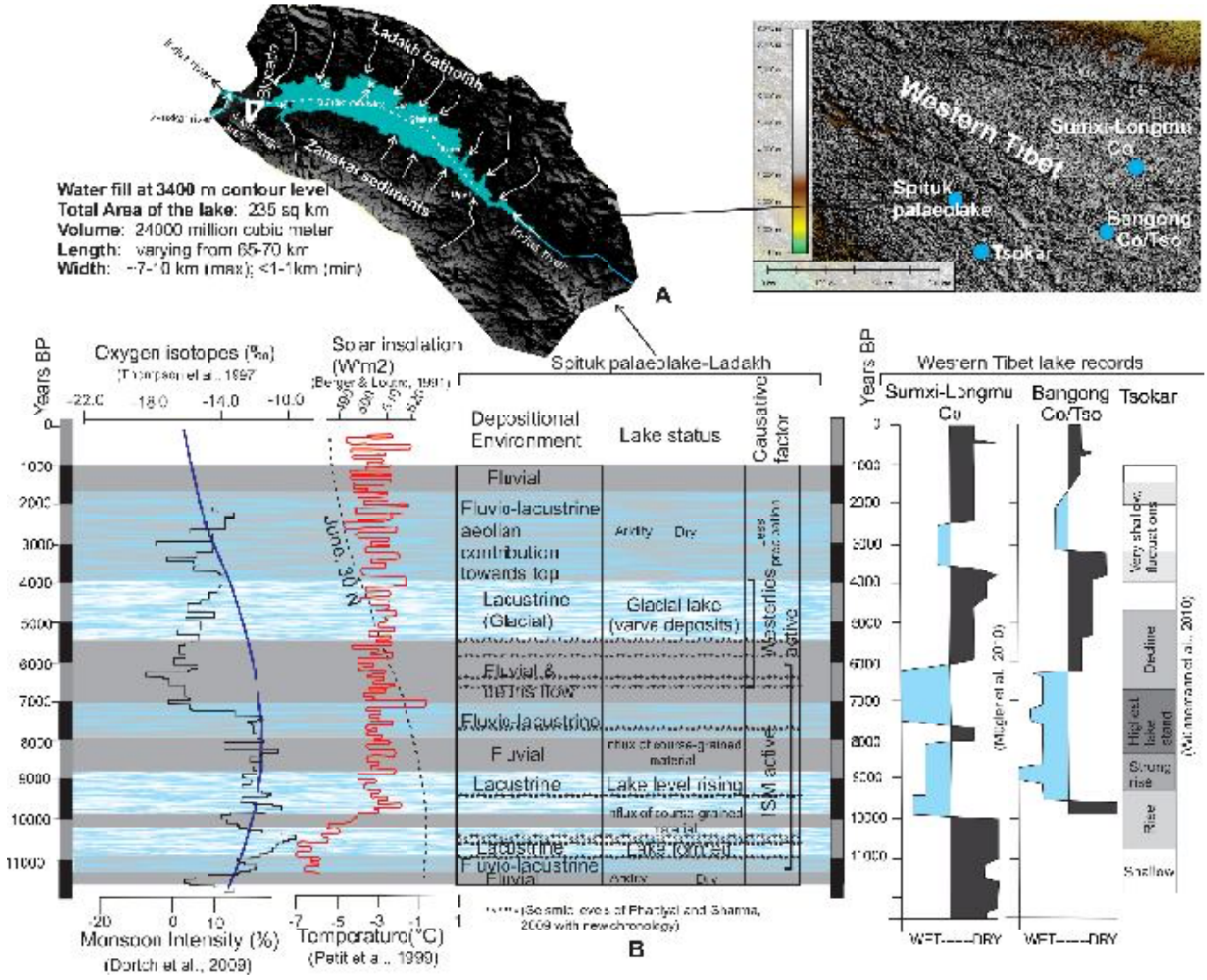
Project- 8.7: Geomorphological and tectono-climatic signatures in Trans and Tethyan Himalaya during Quaternary Period: A multi-proxy approach

Investigators: Anupam Sharma, Binita Phartiyal, S.N. Ali, P. Morthekai & Debarati Nag

Soft sediment deformation structures which exhibit exogenic nature and are seismically triggered, preserved in the geodynamically active Himalaya, provide excellent example of the palaeoseismic records of the Quaternary lacustrine and fluvio-lacustrine facie records in the Trans and Tethyan Himalaya. Seismic activity around 27 ka, 23



Palaeolake sections of Ladakh sector– Comparison of the sedimentary character, energy condition and depositional environment of the two sections (Saspol & Khalsi) of a single valley lake system (Sa: sand, V C Si: very coarse silt, C Si: coarse silt, M Si: medium silt, F Si: fine silt, V F Si: very fine silt, Cl: clay, MS: moderately well-sorted, PS: poorly sorted, VPS: very poorly sorted, VFS: very fine skewed, FS: fine skewed, CS: coarse skewed, P: platykurtic, M: mesokurtic, L: leptokurtic, VL: very leptokurtic, ExL: extremely leptokurtic)



A) Water fill model of the palaeolake showing its extent in a DEM background. The contour level of fill is taken as 3400 m asl, **B)** Comparison of the distribution of Spituk palaeolake deposits in the Indus valley (Ladakh Sector) to the Guliya Ice core (Thompson et al., 1997), monsoon intensity, temperature, solar insolation, Sumxi-Longmu Co and Bangong Co, and Tsokar lake records; showing the major climatic events during the Holocene

ka, 17-19 ka, 11-10 ka and 6 ka along the Karakorum Fault and Indus Suture Zone in the Trans Himalayan region is recorded. While in the Tethyan Himalaya SSDS are recorded reoccurring nine times between 90 ka to 7 ka at intervals with evident records at ~7, ~12 and ~50 ka, although a systematic chronology is still required for the assessment of recurrence intervals of these palaeo-earthquakes.

The dataset of granulometric studies of sediments from the palaeolakes of Ladakh, by measurement of the sedimentary structure and texture and statistical parameters has been done to shed light on depositional environmental changes within the lake from post LGM to 5 ka. Blockage of River Indus by Lamayuru dam burst during the deglaciation, after LGM and subsequent increase inwater level led to the formation of a ~55 km Saspol-Khalsi palaeolake having a surface area of 370 km^2. Grain size studies show a polymodal nature of sediments for both the sections. However, sediments of the lower/downstream section (Khalsi) show a poorer degree of sorting and coarser grain size and high energy depositional condition as compared to the sediments of Saspol section (positioned upstream) due to the location of the sections within the lake system. It is noticed that in

high altitude arid region, the valley lakes of large sizes may vary greatly, horizontally as well as vertically in the sedimentological characteristic owing to local stream input, inflow intensity from the catchment, outflow velocity of water channels, lithology and valley width in different sites.

Spatial and temporal setting of Spituk palaeolake (12600-240 cal yrs BP) has been analyzed for palaeoclimate reconstruction, using sedimentological, mineralogical, mineral magnetic and geochemical proxies. This lake was formed after Older Dryas as a result of river blockage by precipitation induced debris flow and seismicity. Two lake phases between 12600-9000 and 5500-3200 cal yrs BP show stable lake conditions and have synchronous relationship between high variation in monsoon intensity, high $\delta^{18}O$ values in the Guliya core, rise in temperature and high solar insolation. A short but cold pulse is recorded at 11300-11000 cal yrs BP within the first phase of the lacustrine environmental setting (Younger Dryas). The older phase is indicative of warmer and humid conditions, resulting from the Indian Summer Monsoon, while the younger lake phase can be seen as the westerlies. Arid and cold stages are also recorded prior and between the two lake phases.

Project- 8.8: Late Quaternary climate and glacial history from the western Himalayan region

Investigator: P.S. Ranhotra

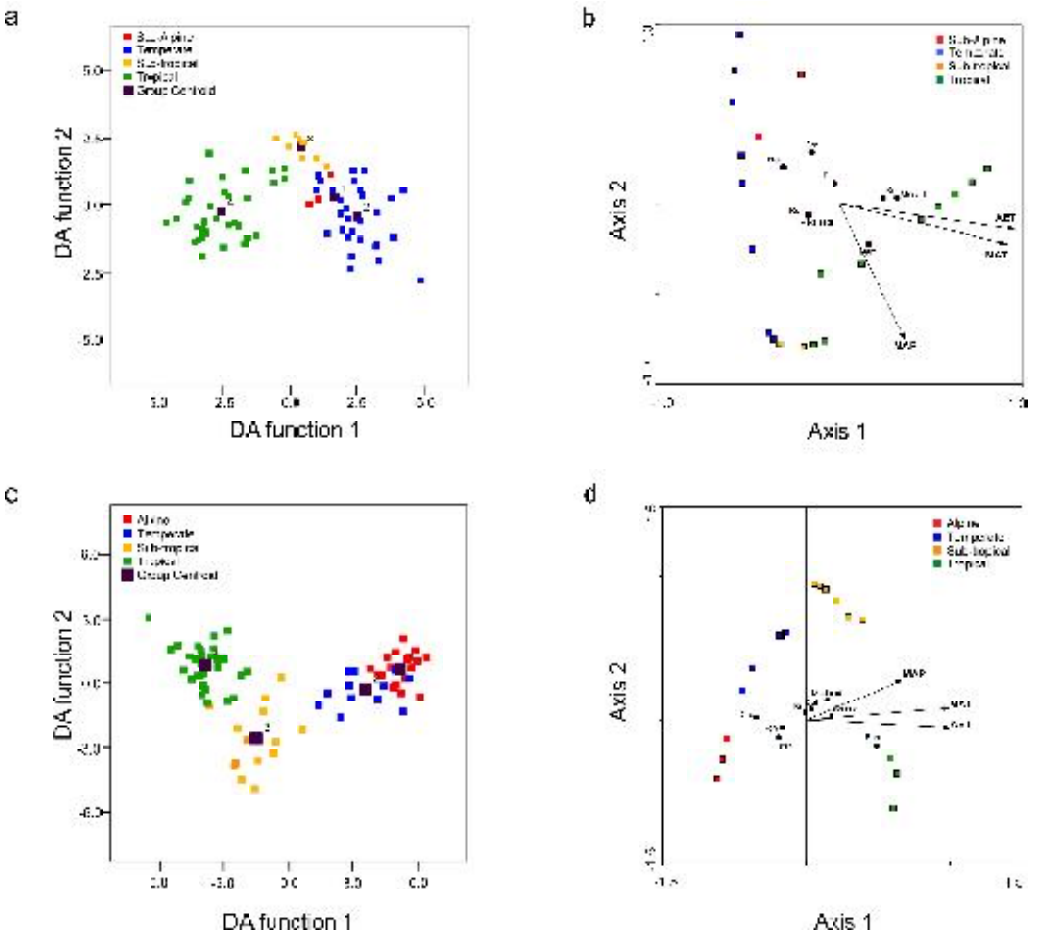
The palynological analysis of a 125 cm deep sedimentary profile from the Dokriani glacier valley covering entire Holocene time has put forth four climatic phases as well anthropogenic signatures. Since ~5,000 till ~3,600 cal. yrs BP the dominance of *Quercus, Pinus* and other arboreals indicate moist climate as compared to modern time. Since ~3,600 cal. yrs BP the *Pinus* and *Abies* increased with corresponding decline of *Quercus*. The steppe taxa showed noticeable increase signifying comparatively dry condition. Subsequently, from ~2,350 till ~1,175 cal. yrs BP the climate again reverted to moist. Apiaceae reached to its maximum, whereas steppe elements show little decline. Since ~1,175 cal. yrs BP (825 AD) the dominance of *Quercus* and *Pinus* again reversed, and *Abies* and *Betula* increased noticeably. Apiaceae became to its lowest values, whereas Polygonaceae, ferns, Ranunculaceae, etc. increased. The impact of anthropogenic forcing in vegetation change since ~2,500 cal. yrs BP (~500 BC) can be discussed based on much decline of *Betula* and *Quercus* as these are used for fire-woods, and also sudden decline of Apiaceae might be linked with grazing. Tree line shift to higher altitude with the retreat of glacier can be conferred based on the observed general continuous rise in pollen frequencies of *Pinus*, *Abies, Picea*, *Cedrus* and other temperate taxa since ~5,000 cal. yrs BP till recent.

Modern pollen analysis of surface samples (moss & sediments) from the Nachiketa and Mahidanda areas near Uttarkashi (Garhwal Himalaya) has been completed. The study qualitatively correlates the present pollen and vegetation distribution at this altitude. The maximum representation of *Pinus* pollen is obvious from the Mahidanda area as presently the area is forested by *Pinus roxburgi*. At Nachiketa, though the above 50% vegetation cover is of *Quercus leucotrichophora* but the representation of this Oak pollen is lower than that of *Pinus roxburgi,* though later growing densely on the distant slopes. The quantitative analysis of the modern pollen distribution is under progress. Additionally, vegetation and climate during later part of Pleistocene to major part of Holocene (14,000- 3,417 yrs BP (16,600-3,660 cal. yrs BP)) has been reconstructed from Rukti, Sangla valley, Kinnaur, Himachal Himalaya. Based on pollen data the area exhibits a continuation of mixed conifer-broad leaved forest since ~14,000 yrs BP followed by several phases of expansions of broad-leaved taxa especially *Quercus* sp. or invasion of conifers especially *Pinus* sp. with an increase (warm-moist) or decrease (cool-dry) of south-west monsoon (SWM), respectively. Considering this assumption, climate was warm-moist during 16,600 to 13,300 cal. yrs BP that reverted to cool-dry ~11,466 yrs BP, followed by increasing SWM during early Holocene time ~10,772 cal. yrs BP.

Project- 8.9: Vegetation based reconstruction of Late Quaternary climate of the eastern Himalayas

Investigator: Ruby Ghosh

The phytoliths from 66 dominant grasses and 153 surface soils from four different forest types along the c.130e4000 m a.s.l. elevation gradients in the Darjeeling and Arunachal Himalayas have been analysed to infer the potential and limitations of grass phytolith assemblages and indices to reconstruct vegetation vis-à-vis climate in these Himalayan mountain regions. Grass short cell phytolith assemblages from modern grasses show significant variability with rising elevation. To test the reliability of the above observation, phytoliths from the soil samples are subjected to linear discriminant analysis; classifying 85.3% and 92.3% of the sites to their correct forest zones in the Darjeeling and Arunachal Himalayas, respectively. Relative abundance of bilobate, cross, short saddle, plateau saddle, rondel and trapeziform types allow discrimination of the phytolith assemblage along the elevation gradient. Canonical correspondence analysis on the soil phytolith data further revealed their relationships with the climatic variables. Temperature and evapotranspiration were found to be the most influential for differential distribution of grass phytolith assemblages with rising elevation in the eastern Himalayas. The reliability of phytolith indices (Ic, Iph & Fs) are also tested for tracing the dominance of different grass subfamilies in the eastern Himalayas. Ic proved to be most reliable in discriminating C_3/C_4 grass along the elevation gradient, while Iph and Fs proved to be less reliable.



Results of discriminant analysis (DA) and canonical correspondence analysis (CCA) of surface soils from the Darjeeling Himalaya (a-b) and Arunachal Himalaya (c-d): **a**, **c**) DA of the samples on the key grass phytolith assemblages showing the first two axes scores; **b, d**) CCA ordination diagrams showing key grass phytoliths from different forest zones along the elevation gradients and their relationships with climatic variables [Climatic variables are represented by arrows, phytolith types by dark dots and coloured squares represent soil samples from different vegetation zones (Bi: bilobate, Cro: cross, Sh sad: short saddle, Med sad: medium saddle, Bam: bambusoid saddle, Ron: rondel, Trap: trapeziforms, Bul: bulliform cells)]

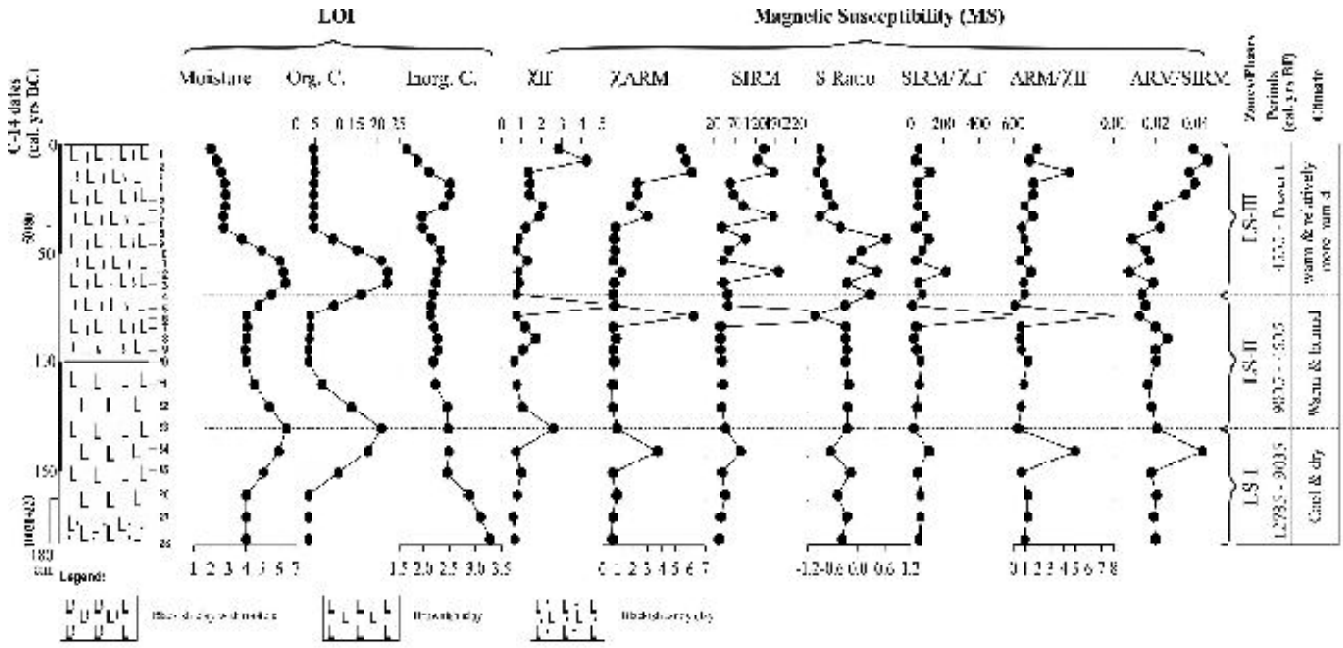
Non-pollen palynomorphs have been studied from surface soil samples collected along a tropical to temperate elevational gradient (138-3566 m) of Darjeeling Himalaya to explore the modern vegetation-climate relationship in this part of the Himalayas and to further use this data for more precise late Quaternary palaeoclimate interpretations. The result has been complied and finalized.

Project- 8.10: Quaternary vegetation and climate change in north and northwestern regions of Chhattisgarh

Investigator: M.F. Quamar

Pollen analysis of a 2.25 m deep sediment profile from Anandpur Nursery Lake of Koriya district demonstrates four-fold vegetation and climate change during the late Quaternary. Open vegetation under dry climate with reduced monsoon precipitation was replaced by open mixed tropical deciduous forest under a warm and moderately humid climate with increase in monsoon precipitation in the region. Further, open mixed tropical deciduous forest continued to grow with some fluctuations (decreasing trend) in the forest elements under a warm and relatively less humid climate with weak monsoon. Finally, the mixed tropical deciduous forest took over and replaced the open mixed tropical deciduous forest under a warm and more humid climate with increase in monsoon precipitation. The temporal explanation of the reconstruction of palaeovegetation of the area and contemporary palaeoclimate could me made with the availability of ^{14}C dates, which are awaited. In addition, pollen analysis of 12 surface samples/moss polsters collected from the vicinity of the Lake has been accomplished to understand the pollen deposition pattern on the area in question. The recovered palynoassemblage has revealed the dominance of non-arboreals over the arboreal taxa.

Environmental magnetism and loss-on-ignition studies have been done (with N.K. Meena of WIHG and Anupam Sharma & Kamlesh Kumar of BSIP) on Lakadandh Swamp samples (from 1.8 m deep profile) in the core monsoon zone of India; suggesting ISM precipitation variability during the late Quaternary and are correlated with pollen data. The study demonstrated tree savannah vegetation between ~12,785 and ~9,035 cal. yrs BP (cool & dry climate; reduced precipitation). The early part is comparable with the Younger Dryas. Between ~9,035 and ~4,535 cal. yrs BP, the open mixed tropical deciduous forest suggesting a warm and moderately humid climate is identified and relates partly to the Holocene Climatic Optimum. Since ~4,535 cal. yrs BP to Present, mixed tropical deciduous forest took over; indicating increase in precipitation.



Magnetic susceptibility and Loss-on-ignition curves of the Lakadandh Swamp profile, Koriya district
[the inferences are inter-related with the published pollen results (Quamar & Bera, 2015)]

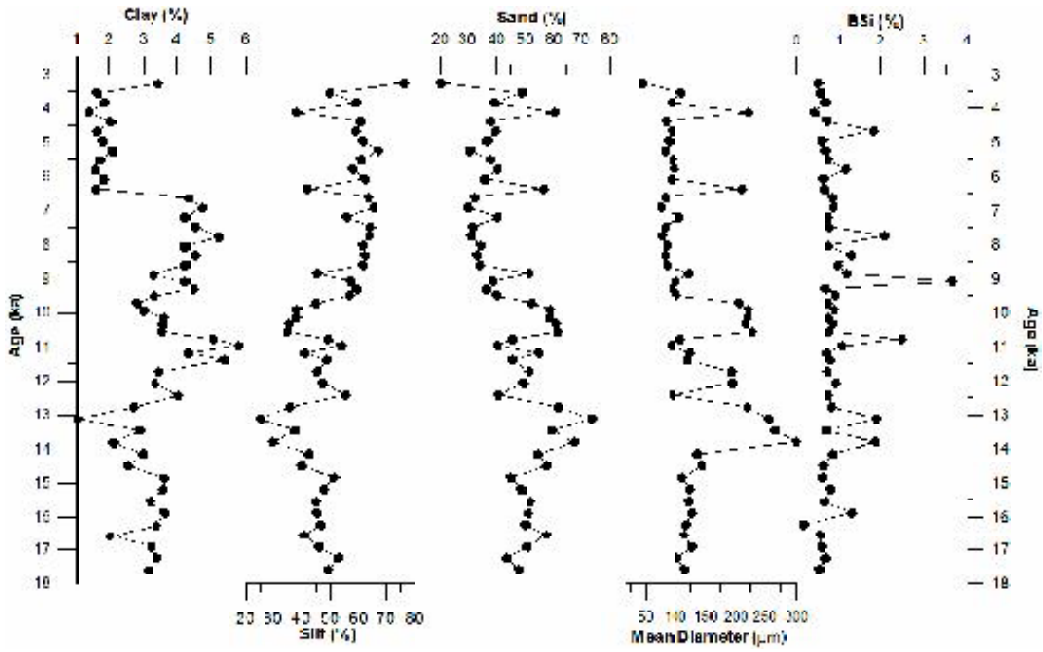
Polar Research Group

Project- 9.1: Deciphering the Quaternary climate history of the Polar Regions: Multi-proxy studies from Antarctica and Arctic

Investigators: Ratan Kar, Abhijit Mazumder & Pawan Govil

Palynological studies on 72 surface samples around Ny-Alesund, Svalbard (Arctic) have been continued. Though, it is a vegetation sparse region, the ground vegetation is well-represented by ephemeral herbaceous taxa. However, the pollen yield is inexplicably poor, and is being relooked to interpret the pollen-vegetation relationship. Palynological studies on thirty samples of a 1.5 m trench dated to ~18,000 yrs BP has also been undertaken. Here also, the yield of palynomorphs is poor and other parameters like foraminifera, ostracodes, diatoms are being explored to deduce the palaeoclimatic conditions of the region. Twenty sediment samples from 1 m long trench cutting section are studied to understand the palaeoclimatic changes in and around Ny-Alesund. Due to absence of any microorganism, the study is mainly concentrated on the quartz grain microtexture and morphology. The top 40 cm of the section shows the presence of predominant glacial signatures in quartz grain microtexture within fine-grained sand (with humus & rootlets in the topmost part). The next 40-55 cm represents some aeolian activities along with glacial signatures in fine-grained sandy sediments with an intercalating thin humus layer. The bottom most part, in addition to glacial markers, exhibits some aqueous evidences as well within coarse sands and occasional shell pieces. These results along with ^{14}C AMS dates reveals rapid glacial retreat during the pre-Holocene period (19.1-10.9 yrs BP), followed by a warmer period during early Holocene (10.9-8.1 yrs BP). Mid- and late Holocene (8.1 yrs BP to Recent) is marked by a predominantly glacial environment along with some melt water streams originating from the glaciers and flowing into the fjord.

One research proposal is submitted and presented for participation in 35th Indian Scientific Antarctic Expedition. The objectives are to identify potential sampling sites for OSL dating samples and to collect sediment cores. Total 5 fresh water lake sediment cores, 4 trial trenches and 7 samples for OSL dating have been collected from different islands, near Bharati Station. In Schirmacher Oasis, total 4 fresh water lake sediment coring and 6 trenching is done from different levels of L-69 lake. Additionally, water, algal mat, moss and hard rock samples are also collected from Schirmacher Oasis and Larsemann Hills for developing the modern analogues. One land locked lake sediment core (L-51) has been analyzed for sedimentological and geochemical proxy to decipher the palaeoenvironmental variations in Schirmacher Oasis. AMS radiocarbon dates on the 1 meter length of the core shows the time span of 3.2 to 17.6 ka BP. This data shows one prominent interglacial period within ~13 ka BP and ~6.5 ka BP sandwiched between two glacial episodes within ~15 ka BP and ~13 ka BP and within ~6.5 ka BP and 3.2 ka BP. The present core does not exhibit any microfossils.

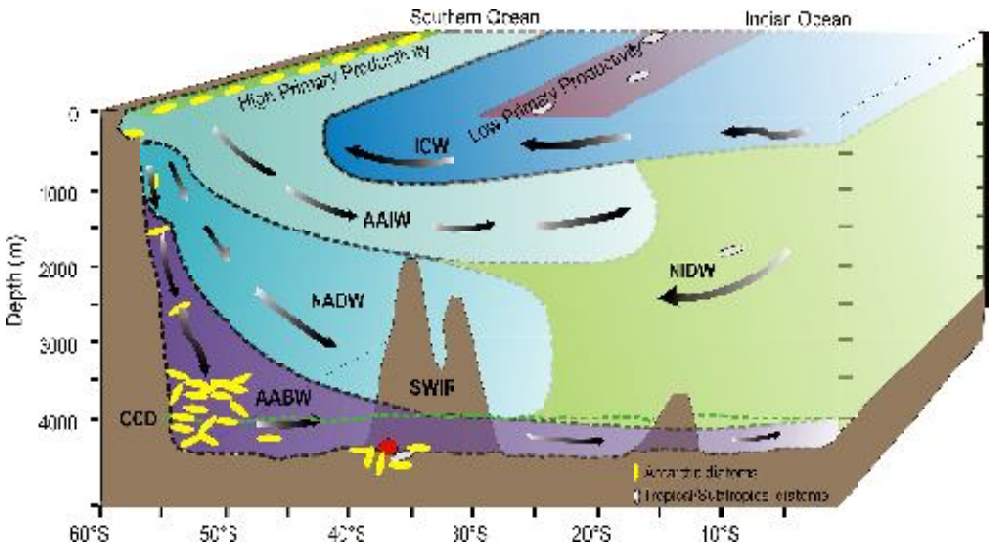


Sedimentological and biogenic Silica (BSI %) in lake sediemnt core L-51 of the Schirmacher Oasis

Project- 9.2: Study of Quaternary climatic conditions of the Polar Regions using integrated multi-proxy data

Investigator: Vartika Singh

Study of relative abundance data of dinoflagellates and thecamoebians from the Kongsfjorden surface sediments shows higher amount of thecamoebians in the middle part of fjord. The presence of thecamoebians is negligible in the outer fjord. The possible controlling factors for the presence and abundance of thecamoebians are probably salinity and nutrient availability. The rare occurrence of diatoms in the surface sediments (despite their significant presence in the water column) is an important observation, which is possibly due to grazing by zooplanktons. The relative abundance data of different forms is thus significantly able to provide important inferences on the influence of different factors including ocean currents, salinity, melt water discharge, etc. Besides, the study of carbonaceous particles is also being continued (by using SEM equipped with Energy Dispersive X-ray Spectroscope, jointly with NCAOR, Goa) along with the other organic matter contents mentioned above. The concentrations of C, O, Na, Cl, Al, Si, S, Cl, K, Ca, Ti, Mn and Fe in the particles have been quantified from various parts of the fjord and provide a direct evidence of pollution due to human influence. The identification of carbonaceous particles was further validated by high concentration of carbon.



Schematic oceanography model for the transport and deposition of Antarctic biogenic sediments in the Southern Indian Ocean: representation of water masses and their movement, depicting lateral sediment transport and deposition [Red dot represents the location of studied sample. The presence of Carbonate Compensation Depth (CCD) at about 4000 m depth is marked by a broken green line]

The Optical Luminescence dating has revealed ages of 29.9 ±3.1 ka and 67.8 ±6.4 ka, respectively for the upper and lower part of the trench T1. The basal part of the trench T2 has been dated to 18.2 ±1.6 ka. The dates show no inversion or irregularity. However, a proper validation of ages needs calculation of modern dose rates of the luminescence signal for which some more sediment samples are highly desired from surface (topmost exposed) layer of the studied trenches.

Dendrochronology Group

Project- 10.1: High-resolution palaeoclimatology of western Himalaya

Investigators: R.R. Yadav & K.G Misra

The tree-ring samples of *Cedrus deodara* and *Pinus gerardiana* from various climate stressed localities of Kishtwar, Jammu and Kashmir have been collected for long-term climate reconstruction over the region. The extensive survey of Kishtwar is done to select old forests for sampling. The samples of *Cedrus deodara* and *Pinus gerardiana* are crossdated and developed four century and seven century long tree-ring chronologies, respectively from the data sparse region. The climate reconstructions are in progress and expected to provide long-term precipitation variability over the region and also comparable with the tree-ring data of Lahul-spiti, Himachal Pradesh.

Project- 10.2: Tree-ring analysis from high altitude areas of Himalayan region: A comparative approach with emphasis on the eastern sector

Investigator: S.K. Shah

All the tree-ring core samples of 4 conifer taxa (*Abies densa, Larix griffithiana, Juniperus indica* & *Tsuga dumosa*) and 1 broad-leaved taxa (*Betula utilis*) collected from north Sikkim, eastern Himalaya during field trip of 2014 have been polished for further processing and cross-dating. Based on the cross-dated tree-ring samples from north Sikkim, three tree-ring chronologies have been developed. These are– a 259 years (AD 1755-2013) long *Abies densa* tree-ring chronology based on 105 core samples, a 396 years (AD 1618-2013) long *Abies densa* tree-ring chronology based on 51 core samples, and 178 years (AD 1836-2013) long *Tsuga dumosa* tree-ring chronology based on 31 core samples. Further analysis of tree-growth climate relationship and climate reconstruction are in progress.

Preliminary cross-dating of tree-ring samples of *Larix griffithiana* based on 100 tree cores from two sites of north Sikkim showed possibility of chronology development up to 500 years. The exact calendar year dating of these samples are in progress. In addition, tree-ring samples of *Cedrus deodara* and *Pinus roxburghii* collected earlier from Uttarkashi (Uttarakhand), western Himalaya is cross-dated and measured. Five chronologies of *Cedrus deodara* and one composite chronology of *Pinus roxburghii* based on two sites are prepared.

Thrust Area 6: DOMESTICATION OF PLANTS, EARLY FARMING AND ECOSYSTEM DYNAMICS DURING HOLOCENE/ ANTHROPOCENE

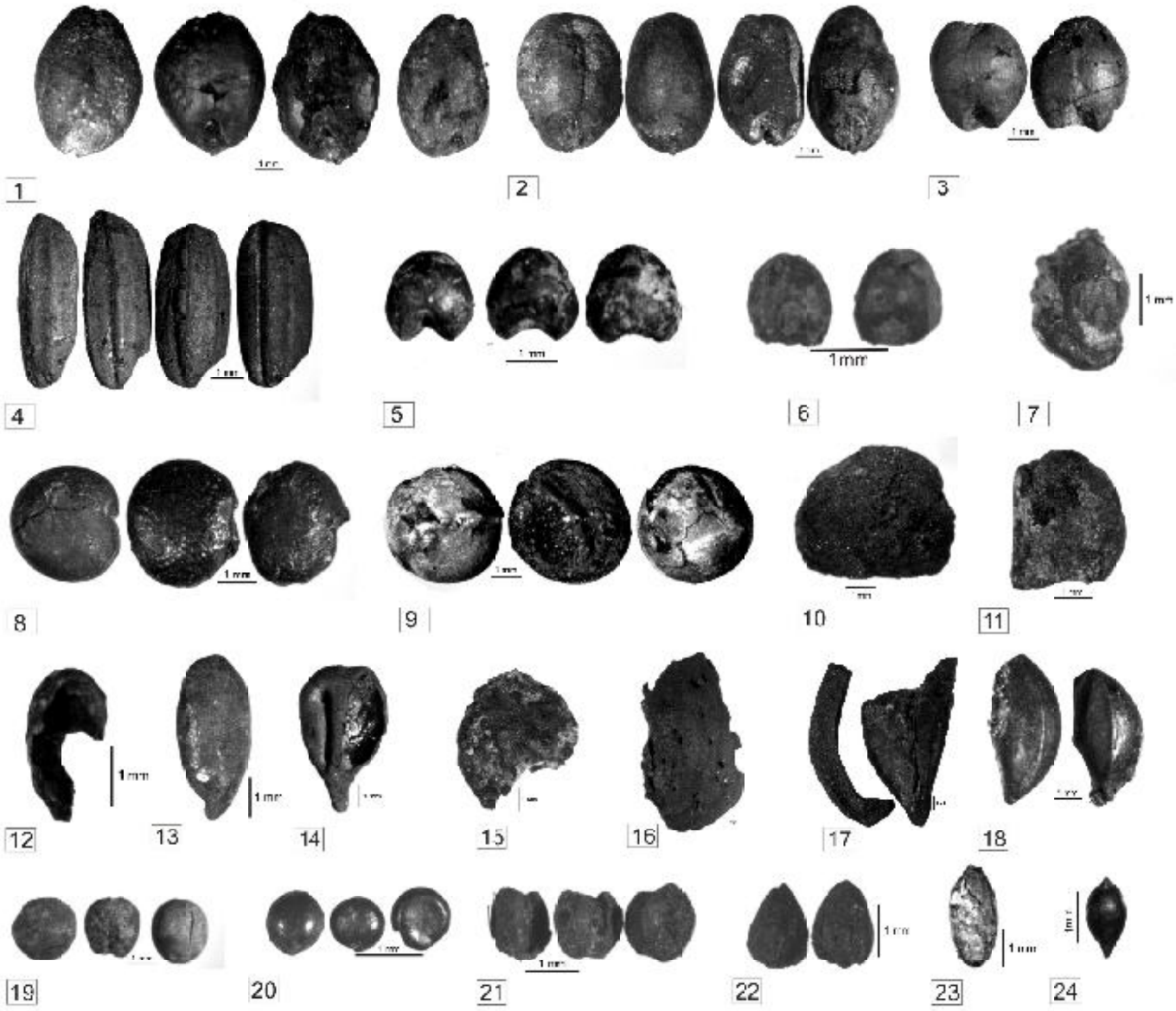
Palaeoethnobotany Group

Project- 11.1: Palaeoethnobotany: Ancient man, plants and environment in northern, eastern and northwestern India

Investigators: Chanchala Srivastava & A.K. Pokharia

The palaeoethnobotanical investigation has been carried out on carbonized seeds and fruits from the cultural horizons of Shunga, Kushan, Gupta and post-Gupta to Early Medieval Periods at archaeological site Biland Khera in Hardoi district (Kothawan Tehsil) of UP. Field crop remains and their associates recovered from the ancient site belong to cereals (cultivated rice, barley), millet (sawan), legumes/pulses (black/green gram, horse-gram, grass-pea), oil-seed (linseed), weeds and wild taxa (blue stem grass, day flower faint), cheno-ams, spider weed, tickclover, goosegrass, hairy indigo, sleepy catchfly, red spinach, common vetch, jujube. The crop economy at this archaeological site (200 BC-800 AD) shows a double cropping system of winter crops as well as summer crops. The weeds and wild taxa species occurring in the cultivated fields, may be taken as dependable evidence of crop and weed association. Further, these also support the well-watered and marshy area around the settlement site.

Archaeobotanical samples from Early Historic site Kanishpur in Baramullah district of Kashmir datable to 100-300 AD have been analysed. The finds include the remains of *Oryza sativa* (rice), *Hordeum vulgare* (hulled barley), *Triticum aestivum/durum* (free threshing wheat), *Triticum sphaerococcum* (dwarf wheat), *Lens culinaris* (lentil), *Pisum arvense* (field pea), *Lathyrus sativus* (grass pea), *Macrotyloma uniflorum* (horse gram), *Sesamum indicum* (sesame), *Linum usitatissimum* (linseed) as major crops, however few minor crops viz., *Setaria* cf. italica, *Panicum miliaceum* and *Echinochloa* sp. are also recorded. Remains of *Juglans* cf. *regia* (walnut), *Prunus* cf. *amygdalus* (almond) and *Vitis vinifera* (grape) suggest the role of these fruits also in the dietary of the settlers. Associated with these as an admixture, the remains of *Vicia sativa*, *Chenopodium album*, *Polygonum* sp., *Rumex* sp., *Andropogon* sp., *Scirpus* sp., *Ziziphus nummularia* and *Emblica officinalis* as weeds and other wild taxa have also been recorded.



Macroremains from Kanishpur, Kashmir (100-300 AD): 1. *Hordeum vulgare*; 2. *Triticum* cf. *Aestivum/durum;* 3. *Triticum sphaerococcum*; 4. *Oryza sativa*; 5. *Panicum miliaceum*; 6. *Echinochloa* sp.; 7. *Setaria* cf. *italica*; 8. *Lens culinaris*; 9. *Pisum arvense*; 10. *Lathyrus* cf. *sativus* 11. *Macrotyloma* sp.; 12. *Sesamum indicum*; 13. *Linum usitatissimum*; 14. *Vitis vinifera*; 15. *Ziziphus* cf. *nummularia;* 16. *Prunus* cf. amygdalu*; 17.* Juglans *cf.* regia; 18. *Emblica officinalis;* 19. *Vicia sativa;* 20. *Chenopodium* cf. *album;* 21. *Polygonum* sp.; 22. *Rumex* sp.; 23. *Andropogon* sp., 24. *Scirpus* sp.

Thrust Area 7: GEOCHRONOLOGICAL AND GEOCHEMICAL PARAMETERS FOR HIGH RESOLUTION DATING, CORRELATION, PALAEOCLIMATIC, TECTONIC AND PROVENANCE STUDIES

Geochronology and Geochemistry Group

Project- 12.1: Carbon dating and its application in Quaternary studies

Investigator: C.M. Nautiyal

A new glass system assembled for carbon dioxide, acetylene and benzene preparation has been tested for vacuum successfully. Several necessary materials and chemicals like standard oxalic acid are procured and system maintenance is carried out for efficiency. A total of 134 samples of charcoal, carbonate, wood, sediment,

standard oxalic acid and background have been processed for benzene and radiocarbon counting using Liquid Scintillation Spectrometer is carried out. In all, counting of 131 samples is carried out that included in-house and consultancy samples, standards and background materials. The 98 dates calculated and calibrated have been used to build up the vegetational/ climatic evolutionary studies during late Quaternary period for different areas by various workers in and outside the Institute. These also included samples for our joint studies such as Loktak lake sediments (Manipur), deltaic region (near Bay of Bengal) and Dokriani glacial valley. Dating of charcoal samples from archaeological sites of Himachal Pradesh is also continued.

Project- 12.2: Development of OSL, geochemical and stable isotope laboratories

Investigators: Anupam Sharma, Rajesh Agnihotri, Pawan Govil, Kamlesh Kumar, Shailesh Agrawal, S.N. Ali, P. Morthekai & M.C. Manoj

The fabrication work of the TL/OSL and Geochemistry labs for hosting the already procured instruments has been completed. GC-MS, IRMS, ICP-MS, XRD, Milli-Q Water system, Particle Size Analyzer, etc. are shifted to the new lab. The concerned engineers/ technical staffs for various instruments are contacted for installation of the equipments. Subsequently, the installation of individual instruments is completed by the respective company engineers. Calibration procedure is performed as per the requirement of the individual instrument. In case of some of the instruments, stability for quality data generation has been achieved. However, in instruments such as ICP-MS, Particle Size Analyzer, the calibration against the international reference material is in process and hopefully this exercise will also be completed very soon. Besides, several small equipments which are essentially required for chemical treatment of samples are also purchased and installed, e.g. hot plate, microwave digestion system, furnace, high resolution electronic balance, etc.

It is a very well-known fact in mass spectrometry 24x7 power supply is an essential component. In order to achieve this objective, a 125 KVA auto start generator is procured and installed. There were still some issues related to high voltage power supply and therefore, a stabilizer was also procured and fixed. However, the issue of continuous power supply is still not very satisfactory and efforts are being made to ensure uninterrupted power supply. Following is the status of different major instruments of the laboratory:

Gas Chromatography-Mass Spectrometry (GC-MS)— Instrument used is an Agilent 7890B (GC system) interfaced with Agilent 5977A (MSD). The installation of the instrument has been done on 05.11.2015. The machine has been tuned for organic geochemical analysis. Various running and analytical methods are also prepared. The analysis of the soluble organic matter using GC-MS started with the extraction process in which the organic matter is powdered and extracted with dichloromethane: methanol (9:1) mixture from oven-dried samples by ultrasonication for 30 minutes. The precipitation of asphaltenes is performed using an excess of *n*-pentane/*n*-hexane. Various fractions are separated by column chromatography and then injected into the GC-MS. The GC was fitted with a HP–5MS fused silica capillary column (30 m×0.25 mm i.d., 0.25 μm film thicknesses) and helium (He) was used as the carrier gas at a flow rate of 1 ml/min. During each analysis, the GC oven temperature was held at an initial 40 °C for 5 mins, and then ramped to 310 °C at 4 °C/min, which was held for a

Gas Chromatography-Mass Spectrometer system

final 5.5 mins. Full scan (*m/z* 50-550) 70 eV mass spectra were acquired with a source temperature of 300 °C. The processing of the data has been done using Chemstation software.

Altogether, 10 samples have been analyzed until December 2015. Initially, some shale is used for the analysis. The samples include shales (including carbonaceous shales) from Kerala (Warkalli Formation) and from Ladakh. The interpretation of Warkalli data has been done. Various biomarker compounds such as hopanoids, oleananes, pristane, phytaneetc have been identified. Biomarker ratios such as (Pr/Ph) ratio, CPI index, etc. have been calculated. The data has been used further for palaeoenvironment interpretation. At present, the instrument is running perfectly.

Inductively Coupled Plasma Mass Spectrometry (ICP-MS)— ICP-MS 7700X Agilent make, chiller, Argon gas cylinder room and exhaust have been installed in November 2015. Primarily, the machine has been calibrated based on multi elemental standard solution. The raw sediment samples were powdered and prepared according to international digestion protocol in to the solution and analyzed in the ICP-MS. The indent and

Inductively Coupled Plasma Mass Spectrometer System

specification were also prepared for the auto sampler for the ICP-MS. it will help minimize the human error while changing the sample tube from one sample to another, and maximize the precision by the ICP-MS.

It is important to note that since almost all our samples are either soil/sediment or rock, and therefore, these samples need crushing up to <-250 mesh size. Since the grinding machine (Pulverizer) received in the institute was damaged in transit, the first essential step in sample preparation was initially delayed. However, necessary action has been taken to get the machine in order. Therefore, whatever little samples one could crush manually is only alternate available to prepare the sample solution. This has reduced the output of the ICP-MS significantly. Additionally, the multi element standards essentially required for the ICP-MS calibration and standardization was not received in time, so this also caused some delay. Action has since been taken to sort out these initial teething problems. Such problems are usually encountered in any newly established analytical facility, and we are now hopeful of putting everything right.

Isotope Ratio Mass Spectrometry (IRMS)— IRMS (MAT 253), Gas Bench II, Elemental Analyzer (HT) and Conflo IV have been successfully installed in the laboratory. Elemental Analyzer is connected to the IRMS through the Conflo IV. Along with this all the gas connection (reference gases and carrier gasses, e.g. helium, oxygen, carbon dioxide, nitrogen), required for smooth running of instrument, are properly placed and these connections are linked to the respective instruments. The IRMS started working properly and all pumps reached full rotational speed. Following these, the required parameters have been optimized for IRMS and leak test is conducted. Overall, the IRMS is running very successfully.

Initially, Gas Bench II was connected with IRMS and again optimized the different parameters. Along with this, cup alignment and all other parameters (leak test, linearity test, standard on-off, etc.) were conducted. As the Gas Bench was connected with IRMS, carbonate standards (e.g. Merk & NBS 18) were initially analyzed and finally, the reference CO_2 gas was calibrated. Standards were repeatedly measured to check the reproducibility. We obtained good reproducibility in all our measurements. Therefore, we have calibrated our internal standard with the help of IAEA-NBS 18 standards. As a test measurement, around 150 carbonates samples have been analyzed in the instrument. After Gas Bench, the elemental analyzer was connected with IRMS for carbon

Isotope Ratio Mass Spectrometer System

and nitrogen isotopic measurement. Initially, parameters were optimized for individual measurement of carbon and nitrogen isotope. To increase the output (simultaneous measurement of carbon and nitrogen, NC mode) the instrument was again transferred to NC mode. Different international (IAEACH3 and IAEACH6) and secondary standards (Urea, ACA, COD, Sulfha) were analyzed and finally reference CO_2 gas cylinder was calibrated. Samples analyzed in 2015 are as follows:

S. No.	Name of User	Nature of sample	No. of samples	Type of analysis
1	Shailesh Agrawal	carbonates	150	Carbon and oxygen (GB)
2	Pawan Govil	Marine sediments	100	Carbon and Nitrogen (EA)
3	Shailesh Agrawal	Plants and sediments samples	80	Carbon and nitrogen (EA)
4	P. Morthekai	Lacustrine samples	20	Carbon and nitrogen (EA)
5	V.V. Kapur	Lignite and sediment samples	100	Carbon and nitrogen (EA)
6	Vandana Prasad	Lignite and sediment samples	200	Carbon (EA)

Stable C isotopes of soil organic carbon of archeological site of northwestern Gujarat (Khirsara) are also analysed to investigate vegetation history between 4,600-3,900 yrs BP, especially focusing on transition from mature phase to late-mature of Harappan culture.

Automated solvent extractor (ASE)— ASE has been installed and proper gas connections are linked with ASE.

Luminescence Dating Laboratory— TL/OSL has been working very well and interesting results have come and some even yielded publications as well. As other instruments to estimate the dose rate (from the eqn.: age=dose/dose rate) are yet to come, only the samples (from Project 8.7 & glacial sediments of SN Ali) for which the dose rates were available, have been measured using the TL/OSL Reader. In addition, the effects of violet laser and blue diodes in the feldspar samples have been worked out. Time-resolved luminescence from the dirty quartz (contaminated by feldspar either within or at the surface of the quartz grain) has also been done, besides an attempt to directly date diatom. Collaborative work (with BHU, Varanasi) on long lasting phosphor, $CaGa_2O_4:Cr^{3+}$ to measure the band-gap of this new material using thermoluminescence has been finalized.

The TL/OSL reader was shifted to the new lab by September, 2015. By the same time, magnetic separator (LB-1) was also installed. High pure Ge (HPGe) gamma spectrometer was set up by November, 2015 and we did calibration after the standard radioactive sources were received from Board of Radiation and Isotopic Technology (BRIT). Standardization of luminescence ages (obtaining all the parameters from BSIP itself) is the ongoing research activity.

Newly installed X-Ray Diffractometer (PANanalytical: X'pert^3)

Thrust Area 8: INDIA-ASIA COLLISION AND HIMALAYAN UPLIFTS: PALAEOBOTANICAL AND ASSOCIATED BIOTIC SIGNATURES FROM SEDIMENTARY RECORDS OF WESTERN HIMALAYA

Project- 13.1: Biota from sedimentary sequences of Indus-Suture Zone, Ladakh Himalaya: Biostratigraphical, palaeoenvironmental and palaeogeobiographical implications

Investigators: Sunil Bajpai, Madhav Kumar, Jyotsana Rai, Anupam Sharma, Gaurav Srivastava, V.V. Kapur & Shailesh Agrawal

A fieldwork has been undertaken to collect samples from Taruche-Saspoche, Basgo and Khalsi areas in the Indo Tsagpo Suture Zone (ITSZ), Ladakh region. The nannofossil data recovered from all samples of TR2 profile (TR2/1-12) representing Basgo Formation at Taruche-Saspoche section overlying Ladakh batholiths hosts stratigraphically mixed coccolith cocktail, with approx. 80-90% late Cretaceous and 10-20% early Palaeogene components. The dominant nannofossils are consistently *Coccolithus pelagicus* (Cenozoic), *Watznaeuria barnesiae* (Mesozoic) and *Reticapsa crenulata* and *Cribrosphaerella eherenbergii* at certain levels. The youngest assemblage components, which may represent the depositional age of these sediments are very rare but nevertheless age diagnostic. They comprise spinose sphenoliths (*Sphenolithus radians, S. editus*); discoaters (*D. keupperi*). These species are compatible with an age corresponding to nannofossil Zones NP 12-13 (Ypresian 49.5-54.5). Only one (TR-2) out of four samples from TR profile yielded only late Cretaceous age calcareous nannofossils and Palaeogene forms are lacking.

The samples from Taruche-Saspoche area are also processed for the recovery of microbiota. Few productive levels have been identified that yielded ostracodes and fish remains (dentition only). These microfauna are photographed using FESEM. The taxonomic identification for palaeoecological/ palaeoenvironmental inferences is still pending. Samples from Kargil area, ITSZ are being processed for bulk carbon isotope analysis and geochemical analysis. Besides, two separate samples from the area are crushed and treated with Dichloromethane and Methanol to extract the lipids. Through the coloum, alkanes are separated from the lipids. Finally, these samples are analysed using Gas Chromatography Mass Spectrometer for the identification of alkanes. The samples showed the presence of short- and long-chain alkanes. Further sample analysis and data interpretation is being carried out. Sedimentological, geochemical and palaeontological evidences from the sedimentary rocks of the ITSZ in the Ladakh region may prove useful in understanding the collision process and its timing.

Thrust Area 9: PREPARATION OF BOOKS, CATALOGUES, ATLASES, DATABASES, DIGITIZATION OF LIBRARY, MUSEUM, HERBARIUM AND OTHER HOLDINGS

Project- 14.1: An atlas of Vindhyan stromatolites

Investigator: Mukund Sharma

Diversity, details of occurrences, morphometric analysis of the stromatolites of different carbonate units of the Vindhyan Supergroup have been completed. Manuscript is being finalized for submission.

Project- 14.2: Revision of Indian species of *Glossopteris*

Investigators: K. J. Singh & Anju Saxena

Figures and text-figures of 12 species of *Glossopteris* to be used in the monograph have been digitized. Old literature describing and documenting *Glossopteris* species has been consulted. Documentation work for the few more species of *Glossopteris* has also been done.

Project- 14.3: A catalogue on Upper Gondwana (Jurassic-Cretaceous) plant megafossils of India

Investigators: Neeru Prakash & Neelam Das

The catalogue is aimed to update and compile the published research papers. The alphabetical taxonomic listing of plant megafossils (family, genus, species, occurrence, short description, photographs, text-figures), author's name, year of publication, locality, age and relevant references from India are almost in final stage.

Project- 14.4: An annotated bibliography on Indian Gondwana palynology

Investigators: Neerja Jha & Neha Aggarwal

The editing and abbreviation of the abstracts in order to bring out the palynological literature on Indian Gondwana in a concise form have been finalized.

Project- 14.5: Tertiary plant megafossils from India

Investigator: Rashmi Srivastava

Sorting and preparation of references and generic/ specific details of the megafossils genera described from 2006 onwards are being continued. Further work is in progress.

Project- 14.6: Calcareous nannofossil records from India

Investigators: Jyotsana Rai & Abha Singh

The data entry of all the calcareous nannofossil taxa published from Indian successions from 1st Indian publication to the year 2015 is completed and the catalogue is in final shape.

Project- 14.7: Pollen flora of tropical deciduous forest, Assam, Northeast India

Investigators: S.K. Bera & Swati Tripathi

Pollen morphological observations of 25 arboreal plant species belonging to seven families have been studied in detail using light microscope and SEM. Besides, pollen morphometric analysis of 22 Indian varieties of *Bougainvillea* (Nyctaginaceae) have been performed through SEM. The study portrays that the *Bougainvillea* varieties are in close similarity regarding aperture (3-zonicolpate) and exine thickness (mostly 2-3 µm) and could be discriminated through shape, size and sexine ornamentation (particularly size of muri). Setting up of phenological table, photo-documentation and comparative interpretation of the pollen morphological data generated from different arborescent species are in progress.

Work other than Institute Projects

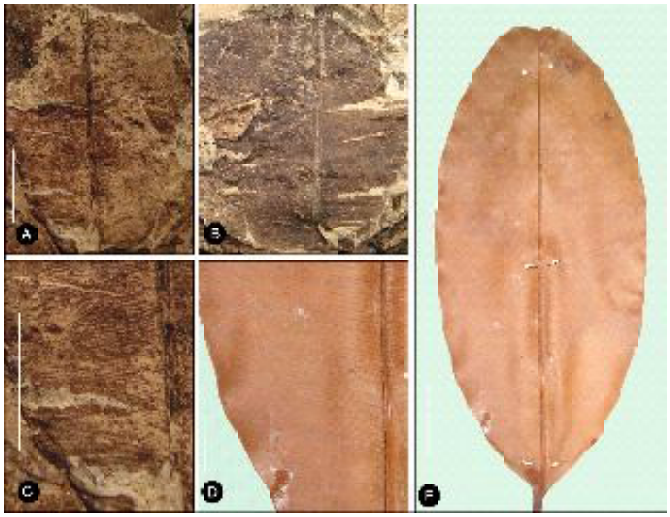
Palynological studies from 14 bore-core samples and one outcrop section (Murna Nala) from the Sohagpur Coalfield, South Rewa Basin (MP) have been compiled and finalized in the form of Ph.D. thesis. The assemblage consists of 92 genera and 192 species including a new species– *Striatopodocarpites trigonalis*. Ten palynozones (A-J) have been identified after correlating the various palynoassemblages recovered at different depths. Early Permian to late Triassic ages has been, accordingly, assigned for these palynozones. The monosaccate pollen grains continue up to the Barakar Formation. Further, it is concluded that the Pali and Tiki formations are a coeval litho-unit. The Parsora Formation is younger than the Pali-Tiki Formation. The palynological succession of the coalfield, in general, corresponds with the palynological successions known from the Damodar and other basins of India with slight variations. Despite the presence of endemic palynofloras in different parts of the Gondwana, the palynoassemblages recorded from the Sohagpur Coalfield can be tentatively correlated with similar known assemblages from Antarctica, Australia, South America, South Africa and Pakistan.

Rajni Tewari & Saurabh Gautam

Palynological dating and correlation has been done for the sediments from bore-hole No. CHB-5 drilled in Chalburdi area (Chandrapur district), Wardha Valley Coalfield. One palynoassemblage has been identified which is characterized by the dominance of an enveloping monosaccate genus *Densipollenites* along with striate bisaccate *Striatopodocarpites* and *Faunipollenites*. The other stratigraphically significant palynotaxa includes *Crescentipollenites, Arcuatipollenites, Corisaccites, Klausipollenites* and *Alisporites*. The recovered palynotaxa suggests latest Permian (Tatarian) age for these sediments, and are well-correlated with similar palynoassemblages known from various Gondwana basins.

Srikanta Murthy & O.S. Sarate

The study revealed the occurrence of a variety of megafossil flora from the Tarkeshwar lignite mine, Surat district (Gujarat). The overall floral assemblage suggests the prevalence of tropical warm and humid climate with moist deciduous to evergreen forest during the deposition of early Eocene Cambay Shale. The floral assemblage also points to the proximity of the shore line. The

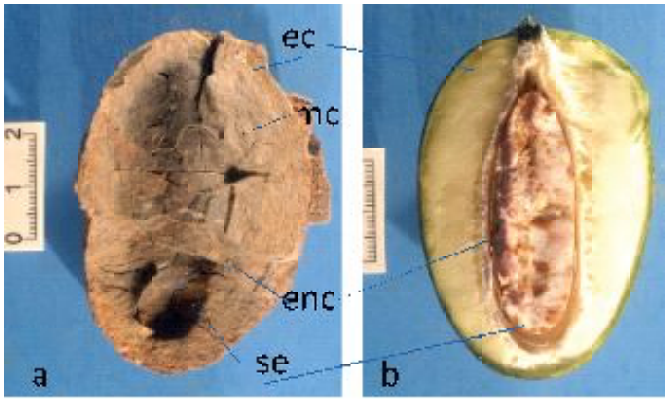


Fossil leaves of an evergreen species of the genus *Calophyllum* (Calophyllaceae), along with its modern counter part, from the Tarkeshwar lignite mine: **A, B**) *Calophyllum eocenica* n. sp. fossil leaves showing shape, size and venation pattern, **C**) A part of fossil leaf magnified to show details of venation, **E**) *Calophyllum inophyllum* Linn. modern leaf showing similarity with the fossil leaves, **D**) A part of modern leaf magnified to show similarity with the fossil leaf (scale bars = 10 mm)

foraminiferal linings and dinoflagellate cysts clearly indicate a marine environment, whereas the pollen assemblage of the family Arecaceae is indicative of a near-shore environment. Palynostratigraphic study indicates that the palynoflora is dominated by angiospermous pollen, followed by pteridophytic spores and fungal remains.

Mahesh Prasad & Hukam Singh

Study on the plant megafossils from the Mahuadanr Valley revealed the occurrence of a new fossil fruit. The



Late Tertiary fossil fruit *Mangifera* from Mahuadanr Valley, Jharkhand: **a**) *Mangifera tertira* n. sp. - Fossil fruit (splitting into two half part) showing diagnostic features, and compared with fruit (**b**) of modern taxa (ec: exocarp, mc: mesocarp, enc: endocarp, se: seed)

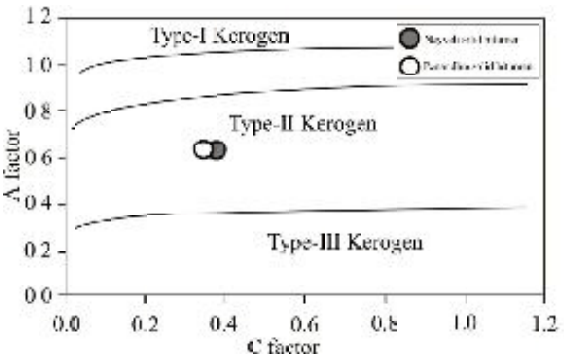
morphological and anatomical features exhibited by the fossil fruit resemble closely with the phytogeographically important taxa *Mangifera indica* Linn. of the family Anacardiaceae. The fossil record of *Mangifera* indicates that this genus originated elsewhere during early Cretaceous, like most of the other angiospermous taxa, and diversified from there in India before Palaeocene and flourished luxuriantly in the most part of the regions.

Mahesh Prasad & S.K. Singh

Upper Cretaceous continental deposits sandwiched between the two successive lava flows of Deccan volcanism in Naskal, Medak district (Telangana) yielded a diverse and rich assemblage of diatoms. A Maastrichtian (~65 Ma) age has been assigned for the sediments based on marker palynomorphs and animal fossils. The diatoms recovered are represented by species of *Aulacoseira, Ctenophora, Cyclotella, Fragilaria, Gomphonema, Hyalosynendra, Nitzschia, Pleurosigma* and *Surirella*. This is the first comprehensive record of a rich and diversified diatom assemblage from Upper Cretaceous hitherto unknown from Indian subcontinent that reveals their evolution and adaptation from marine to freshwater ecosystem.

R.S. Singh, Arindam Chakraborty & A.K. Ghosh

The hand-picked solid bitumen (viscous residue of hydrocarbon) from the Panandhro lignite mine, Kachchh Basin has been characterized through FTIR and pyrolysis



A factor (representing the changes in relative intensities of the aliphatic groups) *vs.* C factor (representing the changes in the C=O groups) plot of solid bitumens

GC-MS analysis methods. The FTIR data shows that the solid bitumen is marked by an intense aliphatic CH_x stretching peaks between 3000-2800 cm^{-1}, medium absorption of OH stretching, aromatic C=C, and deformation peaks. The pyrolysis GC-MS data shows the highly aliphatic nature of the associated lignite. A Factor *vs.* C Factor plot indicates that it is mainly composed of type-II kerogen (organic matter). The overall characteristics indicate that the studied solid bitumen is of pre-oil generation type, and formed from the increase in the thermal maturity of the lignites.

R.P. Mathews & B.D. Singh

The palynological study has been performed on 10 surface samples from Baghmara reserve forest, south Garo Hills (Meghalaya) to display the modern pollen and vegetation relationship. The recorded palynodata represents the tropical deciduous forest admixture with evergreen and riparian elements in the region. The arboreal taxa like *Shorea robusta*, *Terminalia*, *Syzygium*, *Duabanga*, *Careya*, *Schima*, and *Elaeocarpus* represents major constituent of deciduous forest. The evergreen taxa like *Duabanga, Careya, Schima* and *Elaeocarpus* along with *Nepenthes* and *Impatiens* are strongly indicative of the high precipitation.

S.K. Basumatary & Swati Tripathi

A paper entitled 'How reliable are non-pollen palynomorphs in tracing vegetation changes and grazing activities? Study from the Darjeeling Himalaya, India' has been documented and finalized.

Ruby Ghosh

Absolute abundances and size variation of diatom *Thalassiosira lentiginosa* (Janisch) Fryxell is studied in surface sediments and in 4 down-core records to infer the productivity changes and associated nutrient cycling in the Southern Ocean from last glacial to Holocene period. The results demonstrate that the size of diatom is strongly correlated with sea-surface temperature and sea-ice concentration rather than the nutrient availability. Additionally, *Fragilariopsis kerguelensis* (O'Meara) Hustedt, an endemic diatom to Southern Ocean is used for its absolute abundances and size variability from a sediment core of Indian subtropical Southern Ocean which demonstrate that the size of this species is strongly correlated with sea-surface temperature over the last 42,000 years.

S.K. Shukla

The growth-rings of khasi pine from sub-tropical forest in Manipur, northeast India are analysed to understand environmental signals present in ring-width series and intra-annual density fluctuations (IADFs). For this 28 trees are precisely dated and a ring width chronology spanning AD 1958–2014 developed. The correlation analyses between ring-width chronology and

weather data of Imphal revealed that a cool April-May-June favour tree growth. The wood anatomical features of growth-rings revealed the occurrence of IADFs in early- and late woods.

R.R. Yadav & K.G Misra

Ttransfer function model has been developed using modern pollen-climate calibration set from temperate-alpine region of north Sikkim, eastern Himalaya. The model is applied to late Holocene fossil pollen records from Yabuk, Zemu glacier to reconstruct past climate (temperature & precipitation) for the last 2992 cal yrs. BP (1042 BC). Regional and global comparisons have been made for reconstructed climate data with special reference to widely known global climate events viz., Medieval Warm Period (MWP) and Little Ice Age (LIA).

S.K. Shah

Work on already measured chemical and isotopic data of geological sites of higher Himalayas is in progress in an attempt to investigate high-resolution climate variability spanning Holocene. In addition, working on climate change issues using satellite derived climate data, available from public domain, or from publishing authors, pertaining to Indian climatic future in foreseeable times.

Rajesh Agnihotri

A pilot study has been initiated in south-eastern Tamil Nadu to study the past vegetational change. Total 20 samples (at every 10 cm) for both biotic and abiotic proxy studies and 10 samples (at every 20 cm) for luminescence chronology are collected from a 2 m trench. Based on geochemical, stable isotopic and luminescence chronological investigations, palaeoecological information for the last ~1200 years has been retrieved thus far. On-going investigations using biotic proxies and an anticipated field visit will shed more light which can lead to its finalization.

P. Morthekai

Nesly installed Raman Spectrometer System (Model-RENISHAW InVia Reflax) useful for determining the chemical composition and structure of sample, whether, solid, liquid, gas, gel, slurry or powder

Collaborative Work

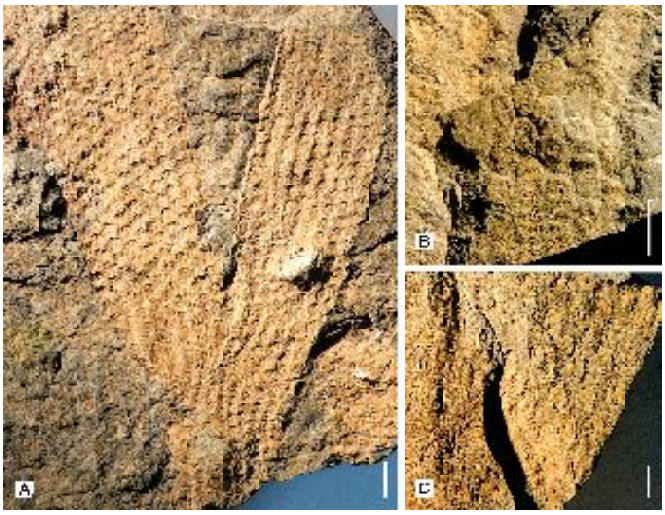
One pilot trip and one 9-days field trip have been made to Sonbhadra district for documentation of the rock art. A number of sites like Deogarh, Harna Harni, Moghalmara, Kauvakhoh, Panchmukhi, Chanainman, Lekhaniya, Kandakot, Kohbawa, and Baghmanwa are visited and location-co-ordinates, photographs, some details of local practices have been recorded. A workshop for awareness about rock art and their conservation is also organized at the district headquarter Robertsganj.

Sunil Bajpai & C.M. Nautiyal
[under an **MoU with IGNCA** (New Delhi)]

In order to assess the implication of Chitrakoot OWMs in the advent of eukaryotes in deep time, the isolation of microfossils and petrographic studies of microfossils bearing chert have been completed. For further high resolution morphological and geochemical studies, viz. FIB-TEM, FIB-SEM and Nano SIMS are in progress at Bristol University.

V.K. Singh & Mukund Sharma
[**& David Wacey** (University of Bristol, Bristol, UK)]

A paper entitled '*Spondylodendron pranabii* – the dominant lycopsid of the late Mississippian vegetation of the Kashmir Himalaya' has been finalized. All previously recorded Lycopsid taxa described from the region are reviewed in the light of fresh material collected from Manigam locality. The present lycopsids show considerable morphological variations, however their close examination revealed that all are similar and belong to a single taxon and these variations may have been due to variations in growth rate during the life of the individual plants. A new taxonomic name viz., *Spondylodendron pranabii* (Pal) comb. nov. is raised for all previously reported and the present lycopsid stems from Kashmir described earlier under various genera and species.



Spondylodendron pranabii (Pal) comb. nov.
A) Dichotomous stem with a change in leaf cushion shape below fork (scale bar = 10 mm); **B, C**) Squat, sub-hexagonal and tear-drop shaped leaf cushions on same stem fragment (scale bars = 5 mm)

K.J. Singh & Anju Saxena
[**& GM. Bhat & A.M. Dar** (Jammu University)
& Chris Cleal (National Museum of Wales, Cardiff, UK)]

The Ediacaran megascopic algal forms recorded from the Sonia Sandstone of Jodhpur Group (Marwar Supergroup) have been studied. A detailed field work is undertaken for nano-scale characterization of fossils. These fossils will be investigated for further geochemical aspects.

S.K. Pandey
[**& Natalia Bykova** (Virginia Polytech. Institute & State Univ., USA)]

Eighteen samples from Lingti-Attargu Hill Section, Spiti (Tethyan Himalaya) have been processed for recovery of palynomorphs. Seven samples yielded palynomorphs. The assemblage shows dominance of striate bisaccate pollen grains and sub-dominance of monosaccate and non striate bisaccate palynotaxa. Based on this, and the presence of stratigraphically significant but rare palynotaxa like *Klausipollenites, Lunatisporites, Goubinispora, Verrucosisporites, Lundbladispora, Lueckisporites* and *Weylandites,* a latest Permian age is suggested. The assemblage shows a broad correlation with *Densipollenites agnicorpus* Assemblage-Zone of Tiwari & Tripathi (1992), known from peninsular Indian Gondwana basins.

S.S.K. Pillai & Rajni Tewari
[& S.C. Tripathi & N.K. Swami (GSI, Lucknow)

Re-evaluation of diagnostic characters of *Gangamopteris*(?) *buriadica* Feistmantel based on the analysis of type-material, housed in the collection at the GSI, Kolkata, and other specimens, housed in distinct collections from southeastern (São Paulo, Rio de Janeiro) and southern (Porto Alegre) Brazil, respectively has been carried out. Re-examination revealed an unusual laterally infolded leaf lamina. Accordingly, leaf-shape varying from

lanceolate-spathulate to more or less ovate to obovate has been interpreted. Besides, the partial view of the lamina does not permit understanding of the true pattern of lateral veins completely due to the marginal infurling. As a consequence, an emended diagnosis of this species is proposed to include the curled lamina and venation pattern of the lateral leaf margin. Consequently, *G. buriadica* emended extends to the Paraná Basin, confirming stratigraphical (e.g. Itararé Group and Rio Bonito Formation) and geographical spread in southeast-southern Brazil. The taxonomic, taphonomic and ecological meanings of the presence of curved leaves have been briefly discussed.

S.S.K. Pillai
[& R. Iannuzzi, MECBD Oliveira & GP Tybusch (Brazil)**]**

Biostratigraphic and palaeoclimatic investigations of the Mesozoic sequences of Jaisalmer Basin, Rajasthan— under the project, a field work has been carried out. The sections covered are Thaiyat, Rewata Singh ki Dhani (contact of Hamira, Joyan & Fort Members), Bara Bag type section, Suleiman Pir section, Bhojka section, Section showing contact of Lanela Member (Baisakhi Formation), and Kaldongar Member (Bhadesar Formation), Section behind Chatrail village and Khabha Fort section. A number of fossil woods and palynological samples were collected from different sections. Plant fossils were collected from Bhadesar and Kuldhar. The collected plant fossils from iron-rich sandstone of Lalena Member are mainly belonging to bennettitales, conifers and pteridophytes. Additionally, calcareous nannofossils from the Lathi Formation has been documented and discussed as new insight into old debate.

Jyotsana Rai, Neeru Prakash, Abha Singh & Neelam Das
[under an **MoU with GSI** (Western Region)]

Palaeobotanical and sedimentological studies on Indian and Sri Lankan basins with special reference to Gondwana flora, their palaeoenvironmental and palaeogeographical implications— under the project (INT/SL/P-002 dated 11.11.2014), a field visit to various locations in Sri Lanka has been undertaken during June 15-25, 2015 in order to survey the area and see the bore-hole locations. Surface samples and four bore-holes samples have been collected for the palynological study. A variety of non pollen palynomorphs including fungal spores, hyphae and fruiting bodies, algal palynomorphs, chitinozoa, thecamoebians, scolecodonts and other animal remains have been recovered from the surface and two bore-holes samples of Weuda area. A comparative analysis of NPP from India and Sri Lanka suggested that some of the fungi and other NPP recorded in the present study may be endemic to Sri Lanka.

Neerja Jha
[& Chandra Jayasena & co-workers
(Univ. of Peradenia, Sri Lanka)]

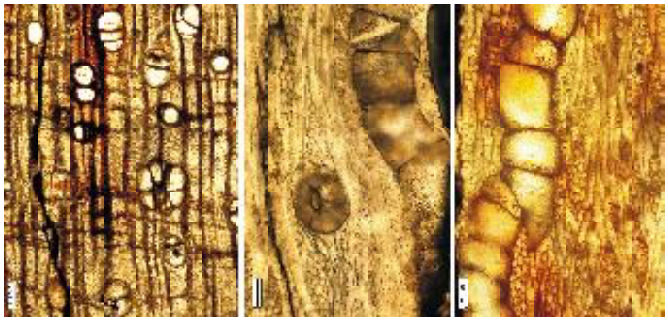
Palynology of Permo-Triassic boundary in Australasia and elsewhere— palynologial investigations on Permian-Triassic sequence in WYB-12 samples from Wybung area of Eastern Australia have revealed presence of thecamoebians in Permian and Triassic sediments and bacteria in Triassic sediments.

Neerja Jha
[& Micheal Brookfield
(Univ. of Massachusetts, Boston, USA)]

One paper entitled 'Palynodating and palynofacies analysis in Kothagudem Sub Basin, Andhra Pradesh, South India' has been finalized; highlighting the statistical interpretation [Linkage Distance Ward methods (r-Pearson)] of palynofacies studies.

Neha Aggarwal, Neerja Jha & Biswajeet Thakur
[& Marcelo de A. Carvalho (Departamento de Geologia e Paleontologia Museu Nacional/Universidade Federal, Rio de Janeiro, Brazil)]

Earth Life Transitions Programme (of NSF)— Stratigraphic refinement, systematic and biogeographic relationships of the late Cretaceous-Paleocene Deccan biota of India: during re-examination of type slides of *Amooroxylon deccanensis* Bande & Prakash, few strangely configured vessels interconnected in a sphere- or ring-like structure are observed in a large fossil trunk from the Deccan Intertrappean beds of Wardha district. Revised affinities of *Amooroxylon deccanensis* is also suggested with Moraceae (order Urticales) instead of modern genus *Amoora*, now merged under genus *Aglaia*. Besides, a review paper on various aspects of Deccan



Amooroxylon deccanensis: **a**) TS showing diffuse porous wood with parenchyma bands, **b**) TLS showing normal and circular vessel elements, **c**) TLS showing normal vessel elements and 3-4 seriate rays

Traps and Intertrappean flora is written and finalized. Additionally, type slides of a number of petrified woods from the Deccan Intertrappean localities have been re-photographed and descriptive data to be made for online website (*insidewood.lib.ncsu.edu*).

Rashmi Srivastava
[& Steve Manchester, E. Wheeler & Selena Smith (USA)
& Pieter Baas (Netherlands)**]**

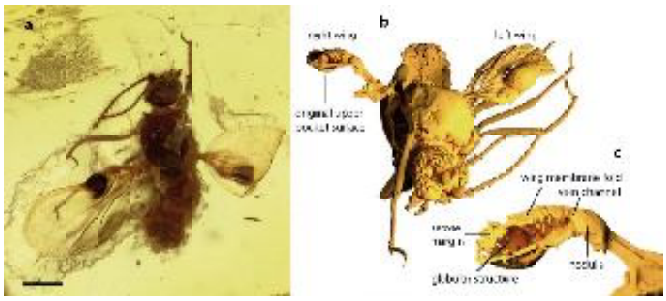
The fossils collected from the Upper Siwalik of Nepal, considered as upper Pliocene to Pleistocene in age, have been worked out. The fossils (including leaves & fruits) are systematically studied and photographed.

Gaurav Srivastava
[& D.B. Khatri & K.N. Paudiyal
(Tribhuvan University, Nepal)**]**

A diverse and rich fossil fauna of Chironomidae has been reported for the first time from early Eocene Indian amber. The assemblage consists of 192 specimens from 5 subfamilies. Chironomidae from Cambay amber represent a primarily tropical fauna and their composition in fossil record is much similar to Dominican amber, with the exception of the presence of Podonominae. The mixture of taxa with various ecological preferences implies the presence of diverse habitats in the Cambay amber forest and entrapment of the fossils from a wide range of different locally separated areas. Chironomidae are diverse and abundant in aquatic and some terrestrial habitats today with several taxa being valuable tools for the assessment of modern as well as past environmental conditions.

Microtendipes sp. of the subfamily Chironomidae in Eocene Cambay amber

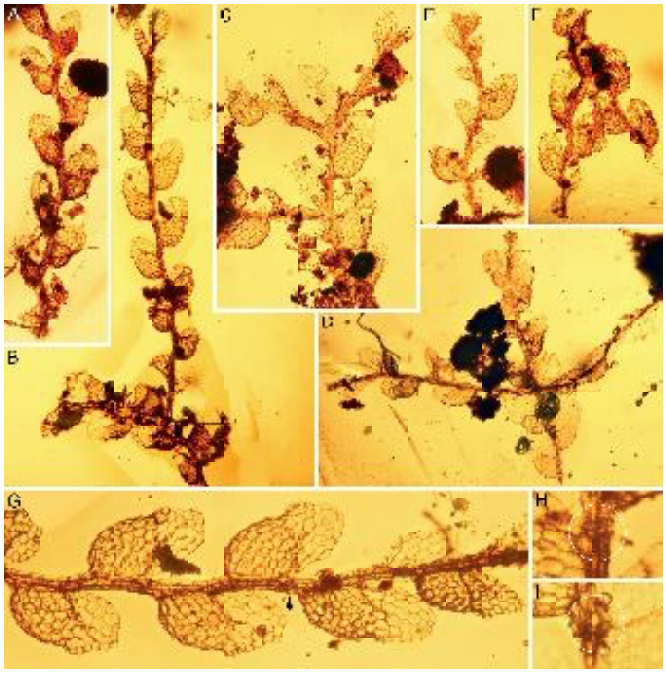
The indirect evidence for pheromone mediated mating behaviour is recorded from a biting midge (Ceratopogonidae) in 52 Ma old Indian amber. Fossil study suggests that complex pheromone producing and releasing structures on the wings which are only known from butterflies and moths so far have evolved independently in this group. In the Ceratopogonidae species *Culicoides nubeculosus* and *C. melleus*, contact pheromones have been proven to be involved in mating stimulation and precopulatory orientation. Here we report new species of the Ceratopogonid genus *Camptopterohelea* in early Eocene Indian amber and is direct evidence for sex attractant volatile pheromone emission and is found in the presence of the highly specialized wing structure. These specialized wing structures are still completely unknown from all the fossil as well extant Ceratogonidae world over.



Fossil Diptera: **a**) *Camptopterohelea odora* n. sp., **b**) 3D reconstruction from SRμCT scans, **c**) 3D reconstruction of right wing pocket from SRμCT scans

Hukam Singh
[& Frauke Stebner & Co-workers
(Bonn University, Germany)**]**

Cambay amber originates from the warmest period of the Eocene which is also well known for the appearance of early angiosperm-dominated megathermal forests. The humid climate of these forests may have triggered the evolution of epiphytic lineages of bryophytes,



Bryophytes *Microlejeunea nyiahae* sp. nov. from Eocene Cambay amber: **A-F**) Gametophytes, **G**) Portion of the shoot depicted in (B); the arrow head points to the underleaf that is enlarged in (H), **H-I**) Deeply bifid underleaves (encircled)

however early Eocene fossils of bryophytes are rare. Here we present evidence for lejeuneoid liverworts and pleurocarpous mosses in Cambay amber. The morphological structure of the investigated moss fossil is inconclusive for a detailed taxonomic treatment. Balancing available evidence, we describe the liverwort fossil (based on DNA sequence variation) as the extinct species *Microlejeunea nyiahae*, representing the oldest crown group fossil of Lejeuneaceae.

Hukam Singh
[& Jochen Heinrichs & co-workers (Bonn University, Germany)**]**

Compilation of an edited volume of book on different aspects of Palaeobotany and its allied disciplines is in progress. Process of review has been initiated. The book will include articles/research papers contributed by authors from India and abroad.

A.K. Ghosh
[& D.K. Chauhan (Univ. of Allahabad)**]**

Four diatom taxa viz., *Eunotia minor* (Kützing) Grunow, *Achnanthidium minutissimum* (Kützing) Czarnecki, *Lemnicola hungarica* (Grunow) Round & Basson and *Navicula radiosafallax* Lange-Bertalot have been reported from Kotulpur area of West Bengal based on SEM observation and modern diatom taxonomic trends. Except *Eunotia minor* (Kützing) Grunow all the taxa are new records to eastern India, while *Navicula radiosafallax* Lange-Bertalot is new to India.

A.K. Ghosh
[& J.P. Keshri & S. Roy (Univ. of Burdwan)**]**

Work on the study of sediment cores (Site 1404 & 1405) of Oligocene-Miocene transition for Post Cruise Research of IODP Expedition 342 is being finalized. Finalization of manuscript is in progress.

A.K. Ghosh & Arindam Chakraborty
[& Shipboard as well as shore based Scientists (of IODP Expedition 342)**]**

The diatoms and heavy metals (Cr, Mn, Co, Ni, Cu & Zn) from the Vasishthi River Estuary (in Ratnagiri district of Maharashtra) have been studied in conjunction to decipher biotic-abiotic relations to characterize the estuarine ecology of estuary. Based on the different proportions of diatom assemblage (at generic & species level), four ecological zones are identified. Zone I (VAS 9-12) shows dominance of planktic centric forms *Cyclotella* and *Thalassiosira*; indicating higher water

Diatom *Thalassiosira eccentrica*

levels and space for floatation. Zone II (VAS 8-6) indicates nutrient loading and moderate eutrophic conditions in the estuarine complex landwards. Zone III (VAS 3-5) shows dominance of *Navicula*, *Nitzschia*, *Frustulia*, *Fragilaria*, *Gomphonema* species which are results of high eutrophic environments. Zone IV (VAS 1-2) with lowest frequencies of *Cyclotella* and *Thalassiosira* and asymmetrical proportions of other characteristic forms shows mixed hydrodynamic conditions. The zonal distribution indicates anthropogenic activities, effluents supply and watershed characteristics for varying proportions of diatom assemblage. The presence of *Gomphonema parvulum* and *Synedra ulna* diatoms indicate high toxicity due to prevalence of heavy metals. The study indicates long-term detrimental effects on biodiversity of the estuary and mangroves in the Vasishthi River estuary.

Biswajeet Thakur
[& Rajani Panchang (IISER, Pune)**]**

The study of diatoms from 11 samples of Calc tuff sediments has been carried out in order to get information about the variations in primary productivity. The diatoms are recovered in all the sediments though the assemblage and frequencies varied from sample to sample. The frequently occurring diatoms are *Synedra*, *Navicula*, *Pinnularia*, *Tabellaria*, *Stauroneis*, *Surrirella*, etc. The study is under progress.

Biswajeet Thakur
[& P.K. Sarkar (Fergusson College, Pune)**]**

Pollen, diatoms, TOC, N and isotopes studies on the core samples from the Loktak lake have been used to reconstruct palaeoclimate and palaeoenvironment due to

Indian monsoon variability in the NE part of India. Based on the pollen assemblages, two climatic zones have been identified. Zone II (0-60 cm) indicating relatively dry climate, while Zone I (60-122 cm) shows warm and humid climate. The diatom study shows dominance of *Eunotia* species followed by low occurrence of *Synedra ulna*, *Nitzschia* sp., *Gomphonema parvulum*, *G. accuminatum*, etc. indicating an acidic environment. The diatoms indicate varying hydrodynamic condition in the lacustrine depositional system. The different isotopic associations ($\delta^{15}N, \delta^{13}C$ & C/N ratio) indicate differential climatic conditions during depositional episode of sediments which is also supported by statistical value of R^2.

Biswajeet Thakur, Swati Tripathi, S.K. Basumatary, Ruby Ghosh & C.M. Nautiyal
[& Supriyo Das (Presidency College, Kolkata)**]**

Carbonate-rich deep sea sediments (as drill cuttings, depth between 2145-3405 m) from Barracuda Petroleum Exploration Well at Mannar Basin have been studied for nannofossils and palynomorphs. An abundant and extremely diversified nannofossil assemblage (75 species belonging to 30 genera & 20 families) together with a very less productive assemblage of palynomorphs is encountered. Based on the zonal marker taxa and other age-diagnostic species, the 1260 m thick well section has been dated as middle Palaeocene to early Miocene.

Abha Singh
[P.A.S.R.D. Perera & Jagath Gunatilake
(University of Peradeniya, Sri Lanka)**]**

Rock-eval pyrolysis data of lignite and associated shale samples has been analysed for the characterization of Valia (Cambay Basin) and Gurha (Bikaner Basin) deposists. These lignite-bearing Eocene sequences have been analysed, supported with maceral composition and rank data, to assess their hydrocarbon-generating potential. Based on the studies, the kerogen (organic matter) is classified as mixed type III/type II with potential to generate both gaseous and liquid hydrocarbons on maturation.

Alpana Singh, B.D. Singh & R.P. Mathews
[& Suryendu Dutta (IIT Bombay, Mumbai)**]**

The degrees of conversion of organic matter, hydrocarbon generation potential and methane sorption capacity of Permian shales from Raniganj Coalfield have been assessed. Shales of the Barakar and Barren Measures Formations have excellent, while the Raniganj Formation shales show good to excellent TOC contents. Relationship between HI and T_{max} values of Rock-eval pyrolysis indicates that depending upon kerogen type, conversion of kerogen (organic matter) to hydrocarbons takes place at different maturities and typifying kerogen type based on hydrogen index values alone can be misleading. It is found that the organic matter abundance is a significant factor in controlling gas (methane) sorption capacity for the studied samples.

B.D. Singh
[& A.K. Varma & Associates (ISM, Dhanbad)**]**

Biomarkers, palynological and petrographic analyses have been carried out from a lignite-bearing succession of Surkha mine, Gujarat. The lignites are represented by high liptinite contents; resulting to the high values of hydrogen index. Low huminite reflectance associated with low Rock-eval T_{max} values suggest that the sediments are immature and belong to the low rank-B of coalification. The palynomorphs characteristic of hot humid tropical climate supported by the signature of Dipterocarpaceae in the biomarker study divulges that during early Eocene time the Indian subcontinent was covered by widespread thick closed rain forests thriving under the influence of tropical climate.

B.D. Singh
[& Swagata Paul & Co-workers (IIT Bombay, Mumbai)**]**

Work on the palynofacies and organic petrographic aspects have been initiated under the Research Training Fellowship for Developing Country Scientists (RTF-DCS) programme of NAM S&T Centre, New Delhi. The lignite and associated lignitic/carbonaceous clay samples from three Miocene sequences of the Tunisian basins have been processed for the microscopic studies.

B.D. Singh
[& Makel Radhwani (University of Tunis, Tunisia)]

Bulk geochemical data (proximate, ultimate & gross calorific values) have been generated on the lignites from Saurashtra (Khadsalia & Surkha fields) and Cambay (Valia field) basins. The Eocene lignites have been analysed, supported with petrographic and Rock-eval data, to assess their optimal utilization potential. The lignites contain relatively high moisture contents and low ash yields. The volatile matter yields and carbon contents are moderately high, whereas fixed carbon, sulphur and oxygen contents are average. The hydrogen and nitrogen

contents are relatively low. The huminite reflectance values (rank) show a good correlation with calorific values; indicating immature nature of deposits.

B.D. Singh, R.P. Mathews & V.P. Singh
[& V.A. Mendhe & Subhashree Mishra
(CSIR-CIMFR, Dhanbad)**]**

A palynological study has been carried out in a 100 cm deep core from Parson's valley lake, south-western ghats. The manuscript on the aspect is finalized.

Anjum Farooqui
[& Priyanka Raja & Hema Achyuthan
(Anna University, Chennai)**]**

The lacustrine sediments of 90 cm thick profile of Nikahari tal (lake; 26 sediment samples), Deoria district in the Ganga Plain have been analyzed for multiproxy study using pollen analysis, sedimentology and AMS radiocarbon date to deduce short term climate and vegetation changes since about 1350 A.D. (~550 yrs BP). The data on the aspects has been finalized.

Anju Saxena
[& D.S. Singh (CAS in Geology, Lucknow Univ., Lucknow)**]**

Pollen analysis of 40 samples of the sediment core from Caoluo wetland, Tangtou in central Taiwan (China) has been accomplished. The *Pinus* and *Cedrus* are main coniferous taxa. The main broad leaved elements are *Castenea*, *Casteneopsis*, *Fagus*, *Querecus,* Rosaceae, Acanthaceae, etc. The ground vegetation is covered by Poaceae, Asteraceae, Chenopodiaceae/Amaranthaceae, etc. Fungal remains (spores/filaments) are very frequent. The work is under progress.

Anjali Trivedi
[& Yao Yi Feng (Institute of Botany, Beijing, China)**]**

Pollen analysis of 10 surface samples from Baghini glacier, Garhwal Himalaya has been carried out. The pollen assemblages reveal an overall dominance of extra local arboreals (conifers) over the local non arboreals. Coniferous taxa are represented by *Pinus*, *Cedrus*, *Abies* and *Picea* in high values. The prominent broad leaved taxa are *Betula*, *Quercus*, *Carpinus, Corylus*, etc. The ground flora is well-represented by Poaceae, Chenopodiaceae/Amranthaceae, Caryophyllaceae, Asteraceae, Rosaceae, etc.

Anjali Trivedi
[& Ajay Mishra (CAS in Geology, Lucknow Univ., Lucknow)**]**

The palynological dataset on Kathali wetland and vicinity forest area of Meghalaya has been generated in order to characterize the modern pollen depositional pattern in relation to existing vegetation. The overall palynodata is suggestive of the tropical deciduous forest admixture with the evergreen taxa which fully coheres with extant vegetation. Pollen clumping in the palynoassemblage was highly significant and suggests their local origin and entomophilous nature.

S. K. Basumatary & Swati Tripathi
[& Abdul Jalil (Univ. of Science & Technology, Meghalaya) **& Azizur Rahman** (Deptt. of Sericulture, Govt. of Assam)]

Palynological assessment has been performed on a 40 m deep sedimentary sequence cored from Paravur palaeodelta in central Kerala (SW coast of India). The palynological record shows that *Rhizophora* is the dominant core mangrove taxa. The *Rhizophora-Sonneratia* transition from early-middle Holocene to late Holocene is considered to be the most distinctive feature of mangrove response.

Swati Tripathi
[& A.C. Narayana (University of Hyderabad)**]**

The maceration of polliniferous material procured from arborescent taxa of botanic garden of CSIR-NBRI, Lucknow is under progress for pollen morphometric analysis.

Swati Tripathi
[& P.K. Roy & Shilpi Singh (CSIR-NBRI, Lucknow)**]**

A dataset of 18 honey samples has been observed from the different localities of the Bongaigaon district of Assam. Study reveals that the majority of the honey samples are unifloral.

Swati Tripathi & S.K. Basumatary
[& GC. Sarma (Gauhati University) **& Munmun Brahma**
(Kokrajhar Science College, Assam)]

Documentation of the palynological studies of a 17.5 m thick sediment profile from Kolleru Lake, located between the Godavari and Krishna basins of Andhra Pradesh, is under progress to understand the evolution of Kolleru Lake during Holocene.

Shilpa Pandey
[& K. Nageswara Rao (Andhra University, Visakhapatnam)**]**

Palynological investigation of a 3.3 m thick sediment profile collected from a Lake in the central Himalaya has

been carried out to reconstruct Holocene climate history. Besides, pollen analyses of multiple sediment cores collected from relict lagoons of the Saurashtra coast, western India are under progress to reconstruct late Holocene climate variability and sea-level changes in the Saurashtra region.

Shilpa Pandey
[& Navin Juyal (PRL, Ahmedabad)**]**

Phytoliths from five panicoid grasses (*Chrysopogon aciculatus, Imperata cylindrica, Oplismenus burmannii, Paspalum distichum* & *Echinochloa crusgalli*), each collected separately from mesophyte dominated low saline (soil salinity <1 PSU) and halophyte-rich high saline (>7 PSU) phytoecological zones of the lower Gangetic delta of West Bengal, have been analysed for assessing whether any variability in the morphometry or assemblages can be used to distinguish the above-mentioned habitat difference. It is observed that in high salinity zones, lobate phytoliths with relatively longer shank and high frequencies of various rondels and tower morphotypes were prevalent, and cross and polylobate morphotypes were found predominantly in grasses from mesophyte dominated low salinity zones. The results of principal component analysis indicate that phytolith assemblages of taxa from high salinity zones are distinct from those in low salinity zones. The investigation may serve as basis to identify distinct phytoecological zones resulting from differences in salinity.

Ruby Ghosh
[& Subir Bera (Univ. of Calcutta, Kolkata)**]**

On the sideline of our main project of Quaternary palaeolake sediments, the water samples from the Indus and its tributaries along with first order streams were collected from the Ladakh region. The geochemical including the hydrogen, oxygen and strontium data over these samples were generated in collaboration to CMFRI, Dhanbad and PRL, Ahmadabad. The data set was finally completed in the later part of the year 2014. An abstract was published in the Himalaya-Karakoram-Tibet international workshop held at Wadia Institute of Himalayan Geology, Dehradun in 2015. A paper dealing the moisture source and its isotopic characteristics has been almost completed and will be finalized soon.

Anupam Sharma & Kamlesh Kumar
[& Amzad Lashkar, Sunil Singh (PRL, Ahmedabad) & **Pankaj Mehta** (Central Univ. Jammu)**]**

Work on a very relevant environmental issue of e-waste generation, particularly by computers and mobile phones, has been continued. The first aspect is devoted to the review work on global and national status of e-waste generation and their associated impact on the natural resources like soil, water and atmosphere. The second aspect is based on the experimental work carried out on mobile phones and leaching of toxic metals as well as organic compounds in a landfill situation is assessed. Both these work is in final stage and will be finalized soon.

Anupam Sharma
[& Meenakshi Hira (Central Univ. of HP)**]**

The piedmont zone of Vatrak River Basin in Gujarat has been studied to understand the depositional environment. Three major facies– fluvial, fluvio-aeolian and aeolian deposits are described. These formed by minor channelized streams; fluvial-aeolian interaction processes and as aeolian dune and sand sheet deposits. Palaeoclimatic interpretations aided with OSL chronology indicates that between ~55-41 ka ephemeral fluvial processes under generally semiarid conditions, governed aggradation, followed by fluvio-aeolian processes from ~41 ka to 26 ka and dominant aeolian activity after ~26 ka. This new evidence indicates the dwindling of fluvial conditions and enhancement of wind activity after ~41 ka.

Binita Phartiyal, S.N. Ali & Biswajeet Thakur
[& Rachna Raj, L.S. Chamyal (M.S. Univ., Vadodara) **& Navin Juyal** (PRL, Ahmedabad)**]**

A subsurface sedimentary profile from the temperate region of eastern Tibet has been worked out for the vegetation and climatic reconstruction. The profile is processed for the palynological investigation and the initial studies show the presence of good amount of *Artemisia, Ephedra* and Chenopodiaceae pollen thus, indicating the dry climatic regime with low precipitation. The complete palynological analysis is under progress to develop chronology.

P.S. Ranhotra
[& Y.F. Wang & Jin Feng Li
(Institute of Botany, Beijing, China)**]**

The tree-ring analysis of *Tsuga dumosa* collected from Api Nampa Conservation Area, western Nepal Himalaya has been revised. Tree-ring chronology of 357 yrs. (i.e. AD 1657-2013) is prepared and compared with

various climate records. Based on tree-growth climate relationship we developed improved version of temperature reconstruction since AD 1708. The reconstructed temperature showed good agreement with other available tree-ring temperature reconstructions from Nepal.

S.K. Shah
[& D.R. Bhuju, S. Bhandari (TU-CDES, Nepal)**,**
N.P. Gaire, S. Bhandari (NAST, Nepal)
& **U. Thapa** (Univ. of Minnesota, USA**]**

River discharge data from two gauge station of Lidder valley, Kashmir Himalaya has been procured and processed. The preliminary correlation analysis between tree-ring chronologies and river discharge data from Lidder valley showed positive correlation for June-December of current year.

S.K. Shah
[& Irfan Rashid (Univ. of Kashmir, J&K)**]**

Carbonized botanical remains from Period I have been investigated to study the plant economy of the ancient settlers at Rajghat. Period I belongs to the Pre-Northern Black Polished Ware (Pre-NBPW) culture etc. The samples though restricted in count, do suggest advanced agricultural practices at Rajghat, the ancient city Varanasi, by its earliest occupants. Plant remains from the region give evidence for variety of cereals, pulses and Asian/African millets which were cropped during 3rd–2nd millennium BCE. It is also clear from the archaeological data that the Chalcolithic communities of India were practicing skilled farming, which was adopted later by the early iron using communities of the Ganga plains. The evidence from Rajghat suggests that Pre-NBPW dwellers of the Middle Ganga plain, by and large, were towing the line of the earlier farming communities of the region.

Chanchala Srivastava
[& B.R. Mani (Archaeological Survey of India)**]**

Palaeoclimate and palaeovegetation studies are being carried out from archaeological site– Karanpura (Rajasthan) to understand the climatic conditions during third millennium BCE in northern Rajasthan. Phytolith analysis from two trenches is under progress. Besides, charred grains are sorted from seven trenches of the ancient site– Rupnagar (Punjab) to understand the palaeovegetation and palaeodiet patters of humans during early Harappan to late Harappan period. The identification of recovered macro-remains is going on (with Chanchala Srivastava). In addition, compilation of the phytolith data from the site Kopia (UP) is under process for understanding climate and vegetation dynamics of the region during late Holocene.

Sandhya Misra
[& V.N. Prabhakar & A.K. Kanungo (IIT Gandhinagar)**]**

Signing of Contract Research document (No. 6206428) between BSIP and Oil India Limited for Biostratigraphical studies of subsurface samples (drill cuttings) of Mizoram

Sponsored Projects

1. **Project— Tectono-climatic variations during Late Quaternary in the Tangtse Valley, Ladakh, NW India** (sponsored by DST, New Delhi; No. SR/FTP/ES-123/2009)

   Investigators: Binita Phartiyal & Randheer Singh (till 28.03.2015)

The project completion report has been submitted, based on the study of sedimentary architecture and palaeoclimatic data of the late Quaternary period of Tangtse Valley.

2. **Project— Integrated nannofossil-ammonite biostratigraphy of Wagad Island, Kachchh Basin: Palaeoenvironmental and palaeobiogeographic implications** (sponsored by DST, New Delhi; No. SR/S4/ES-521/2010(G))

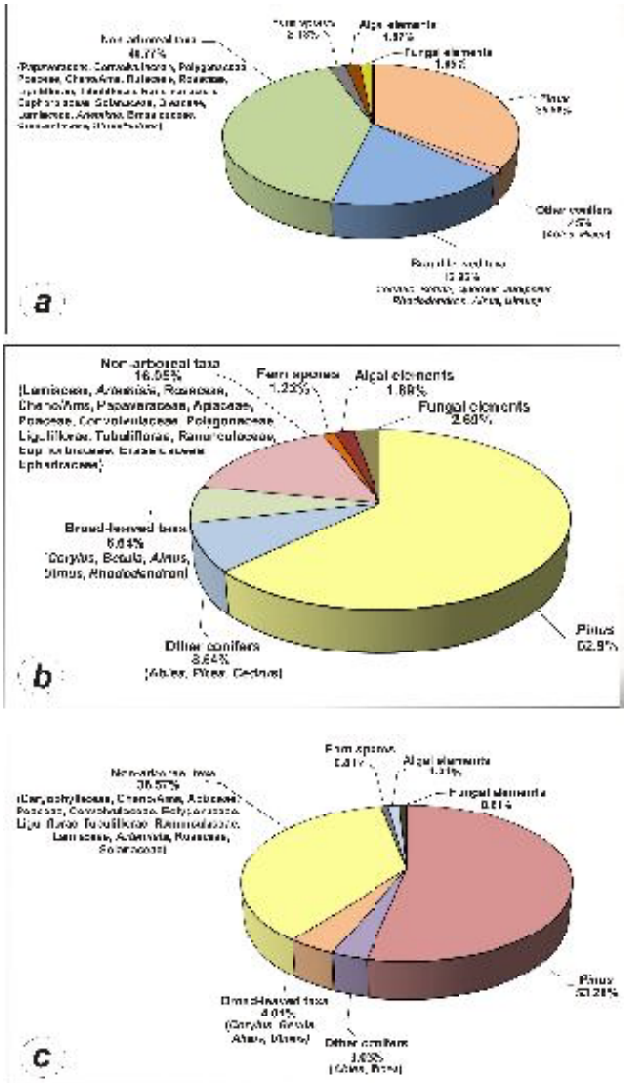
   Investigators: Jyotsana Rai, Rahul Garg & Surabhi Garg (till 12.09.2014) **[**& D.K. Pandey, Jaipur**]**

A 98 page report with 15 plates has been finalized and submitted to the SERB Division of DST. Three papers, one on the integrated nannofossil-dinocyst-ammonoid biostratigraphy from the Wagad Uplift, second on the gymnosperm fossil woods from Gangta Bet, and third on a middle Oxfordian (Jurassic) flora from the Kachchh Basin, with the earliest record of bennettitaleans from the subcontinent are finalized from the work.

3. **Project— Analysis of climatic changes during the Quaternary from glacial sites in India based on multi-proxy data** (sponsored by DST, New Delhi; No. DST/CCP/PR/07/2011(G), dated 16.11.2011).

   Investigators: Sunil Bajpai, Ratan Kar, Amalava Bhattacharyya & Ruchika Bajpai (till 30.06.2015)

Palynological studies of the collected surface and subsurface samples from areas around Hamtah Glacier (Lahaul-Spiti) and Chorabari Glacier (Uttarakhand) have been completed. The modern analogues have revealed the incompatibility between the surrounding vegetation and pollen assemblages. Different climatic phases have been reconstructed from sub-surface sediment profiles, based on the changing frequencies of arboreal and non-arboreal pollen (AP/NAP ratios). To fix the chronology of events, selected samples were dated by conventional ^{14}C, AMS and OSL methods. Besides the palynological



Composite pollen diagram showing the frequency distribution of *Pinus* and other pollen groups from ***a***) Chorabari Glacier; ***b***) Hamtah Glacier; ***c***) Chhatru Glacier

data, other physical proxies like mineral magnetism and geochemistry have also been undertaken. Reconstruction and correlation of climatic changes based on multi-proxy evidences has been attempted. Based on the pollen record in the sediments, impacts of anthropogenic activities have also been traced from high-altitude regions of western Himalaya. The project report has been submitted to DST, New Delhi.

4. **Project— Linking vadose zone microbial ecology and geochemistry in sediments core from alluvial Mahi River, western India** (Sponsored by DST, New Delhi, No. SR/S4/ES-565/2011)

Investigators: Anupam Sharma & Shazi Farooqui

Three sediments cores have been retrieved from the lower Mahi river catchment of the mainland Gujarat. Along with cores, sediments are also collected from the exposed river cliff section for better understanding of the subject. Also the aeolian samples, which constitute the uppermost few meters of the sections, are studied in detail. The textural studies, mainly the grain size analysis, confirm that the sediments are largely moderately sorted, bimodal, finely skewed and leptokurtic in nature. The bimodal character suggests that these sediments are contributed from more than one source and transported to the present sites dominantly by deflation processes. The thin section slides of bulk samples studied suggest that the quartz is the most dominant constituent supplemented by lithic fragments and very limited abundance of amphiboles and mica, however the heavy mineral separates from the bulk samples have maximum abundance of opaques followed by lithic fragments and amphiboles, pyroxenes and zircon (~2 & 0.5%, respectively) are also noticed in the samples. The appreciable amounts of lithic fragments and amphiboles in the bulk and heavy mineral fraction indicates that the provenance must have abundance of basic igneous rocks, which has experienced more of mechanical rather than the chemical weathering. A paper discussing the provenance and processes involved has been almost completed.

5. **Project— Extending the dating range of luminescence dating technique using feldspars** (Sponsored by DST, New Delhi, No. SR/FTP/ES-56/2011)

Investigator: P. Morthekai

There was a potential luminescence signal called thermally re-distributed IRSL (RD-IRSL), in feldspar which could be used to date older sediments. This signal was tested to date older sediments older than 0.78 Ma from Dhansi Formation, MP and published in Quaternary Geochronology. Four feldspar mineral specimen samples were sent to Dr. Rabiul Biswas of Okayama University of Science, Japan for ESR measurements to see the difference between the irradiated (1000 Gy from BARC, Mumbai) and un-irradiated samples. Just the measurements are over, and we are analyzing the results. On 19.04.2016, the project has been over and I am working on the publications.

6. **Project— Analysis of Holocene climate change in northeast India based on pollen data** (CSIR SRF {DIRECT} Fellowship: Grant- 09/528/(0017)/2012/EMR-I)

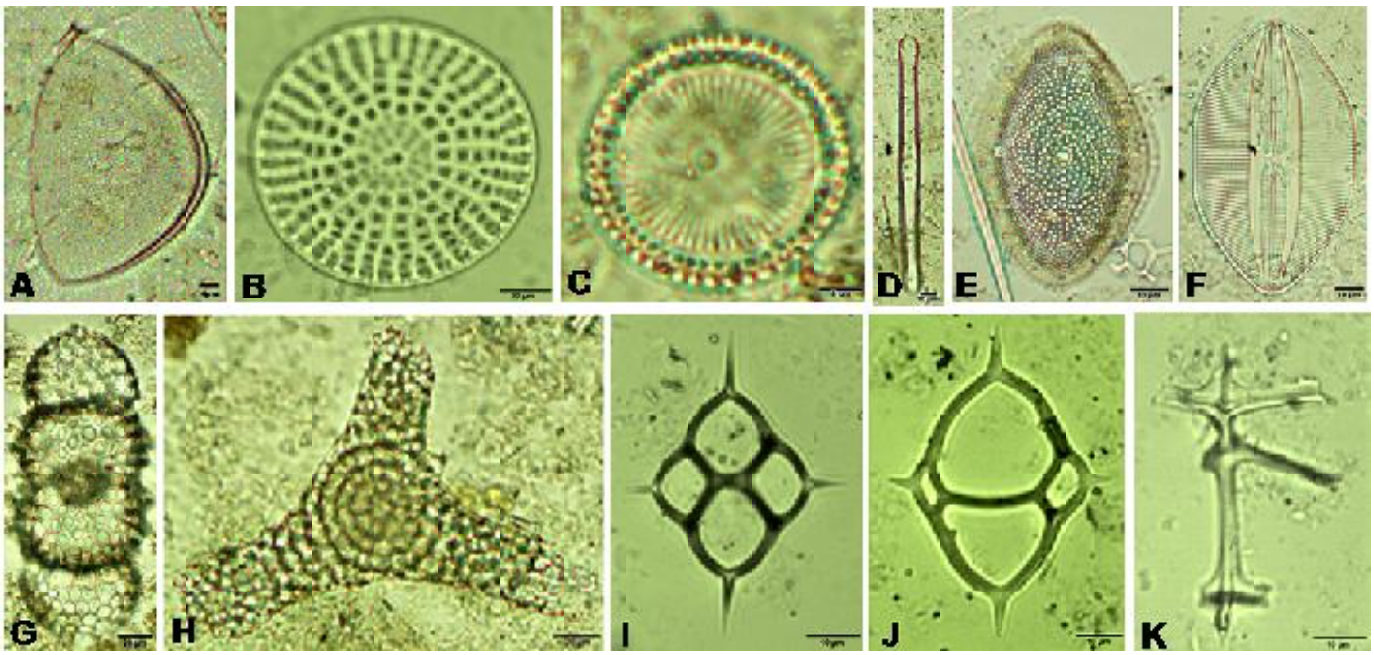
Investigators: Nivedita Mehrotra & Amalava Bhattacharyya

A manuscript has been prepared based on palynological analysis of the modern sediment data from transect in Sikkim between Lachen and Zemu glacier, and fossil sediment from Yabuk (Zemu glacier) and environmental geomagnetic data. The palynological data is compared with modern climate data and transfer function model using modern pollen-climate calibration set is prepared. This model has been applied to the fossil pollen records from Yabuk, north Sikkim to reconstruct past climate (temperature & precipitation) for the last 2992 cal yrs. BP (1042 BC). The reconstructed climate data is compared with regional and global proxy records having widely known global climate events viz., Medieval Warm Period (MWP) and Little Ice Age (LIA). In addition, palynological data of an 89 cm long sediment profile from PT Tso Lake in Tawang (Arunachal Pradesh) is analyzed along with environmental geomagnetic data and isotope data. The project is completed and the final report has been submitted to CSIR New Delhi.

7. **Project— Diversity and palaeoecology of the benthic and planktic biotic assemblages from the Neogene sequence of Andaman and Nicobar Islands** (DST Inspire Fellowship: Grant- IF120842/2013-14)

Investigators: Arindam Chakraborty & A.K. Ghosh

Late Miocene (Tortonian) outcrops of the Cave Point and Neil East Coast sections of Neil Island, Ritchie's Archipelago yielded very well-preserved diatoms. The diatom assemblages have been analyzed applying CONISS cluster and SHEBI analyses. Remarkably the dominance of ocean upwelling diatom taxa viz., *Thalassionema nitzschioides*, *Thalassiothrix longissima* and presence of cold water diatom (e.g., *Coscinodiscus marginatus*) indicates intense monsoonal activity during the late Miocene. The planktonic/benthic ratio of the diatoms reveals a clear picture of the sea-level fluctuations that may be due to terrigenous influx. Based on the planktonic foraminiferal biogeographic and isotopic analyses it has been postulated earlier that the closure of Indonesian Gateway took place during the early Pliocene. During the late Miocene, Indonesian Gateway was open and this part of the Northern Indian Ocean was well connected with the Equatorial Pacific that was responsible for a biogenic bloom in the region.



Siliceous microfossils from the Sawai Bay Formation (Zanclean) of Car Nicobar Island **A)** *Hemidiscus cuneiformis*, **B)** *Stictodiscus nankoorensis*, **C)** *Paralia sulcata*, **D)** *Grammatophora stricta*, **E)** *Actinocyclus ellipticus* var. *javanica*, **F)** *Lyrella investigata*, **G)** *Didymocyrtis avita*, **H)** *Rhopalastrum profunda*, **I)** *Dictyocha fibula*, **J)** *Dictyocha fibula ausonia*, **K)** Triaxonal (Hexactinellid)

The analysis of siliceous microfossils from Sawai Bay Section (Zanclean), Car Nicobar Island, northeast Indian Ocean yielded well-preserved diatoms, radiolarians, sponge spicules and silicoflagellates. Qualitative and quantitative analyses of the recovered microfossils have been carried out along with the estimation of $CaCO_3$. The diversity of diatoms is fair, however their abundance is poor in comparison to the radiolarians. The diversity of silicoflagellates is less in comparison to the sponge spicules. The sponge spicules are dominated by Astrophorids. Occurrence of radiolarian taxon *Didyomocyrtis avita* in the studied section is significant as it is a marker of Zanclean from latitude lower than 40°. Presence of *Dictyochafibula ausonia* also clearly indicates the age of the sequence as Zanclean. The abundance and diversity of siliceous microfossils in the Sawai Bay Formation exposed in Car Nicobar Island is remarkably less in comparison to the late Miocene sequence exposed in the Ritchie's Archipelago. The reduced abundance and diversity of siliceous microfossils in the Zanclean may be due to nutrient deficit condition and poor sediment influx from terrigenous sources. There is evidence of biogenic silica crash in the northeast Indian Ocean at about 6 Ma owing to closure of ITF. However, the Zanclean may be earmarked as the short impulse of recovery phase of biogenic silica as evident from the present analysis.

8. **Project— High resolution palaeoclimatic studies from Bay of Bengal** (sponsored by MoES, New Delhi; No. MOES/SIBER/NIO(RN)/11)

Investigators: Jyotsana Rai, Vandana Prasad & Premraj Uddandam

Palynological analyses of 50 surficial sediment samples collected from western Bay of Bengal have been carried out for their dinoflagellate cyst content. Results revealed a total of 40 taxa are present in the samples. Three new genera– *Trapodinium* gen. nov., *Protospinodinium* gen. nov., and *Bengalidinium* gen. nov. are proposed to accommodate round brown protoperidinioid cyst. Nine new dinoflagellate cyst species comprising *Lejeunecysta stariospinosum* sp. nov., *L.*

Stelladinium denticulatum sp.nov

longistraiatum sp. nov., *Trapodinium globulus* sp. nov., *Protospinodinium spongianum* sp. nov., *Bengalidinium matsuokai* sp. nov., *Quinquecuspis pentadinium* sp. nov., *Votadinium bengalensis* sp. nov., *Stelladinium denticulatum* sp. nov., and *Tectatodinium brajnandanaii* sp. nov. are formally described. The study reveals that the unique environmental setting of Bay of Bengal with high runoff discharge, low saline and nutrient rich environment forming a suitable environment for these tropical species to be endemic taxa to this area. Manuscript of this work is finalized. Two other manuscripts, one on the Holocene calcareous nannoplanktons from the western continental shelf of Bay of Bengal, and other on the study of the distribution pattern of dinoflagellate cysts from Bay of Bengal, have also been finalized. Additionally, a Ph.D. thesis draft from the project work is finalized and submitted to Kumaun University.

9. **Project— Late Quaternary climate and glacial study from Dokriani and adjoining area, upper Bhagirathi Valley, Western Himalaya** (sponsored by DST, New Delhi; No. SB/DGH/44/2012).

   Investigators: P.S. Ranhotra, Amalava Bhattacharyya & Ipshita Roy

A 247 years tree-ring chronology (1767-2014 AD) of Chir-pine (*Pinus roxburghii*) has been developed from Mahi Danda near Uttarkashi, western Himalaya. Reconstruction of the winter standardized precipitation evapotranspiration index (SPEI) since 1767 AD for the Uttarkashi region shows extreme drought events as well wet events during late 18th, 19th and 20th century. ~8-16 year cyclicity was dominant in the early 19th century and the high frequency cycles of ~2-8 years reflecting the ENSO mode of variability were prominent during 19th century. Besides, a 399 years tree-ring chronology (1615-2014 AD) of Fir (*Abies spectabilis*) from 89 trees (145 radial cores) growing close to the snout of the Dokiriani glacier has also been developed. Decadal correlation with tree-ring and glacial fluctuations to establish the tree growth and glacier movement relationship and also the investigations of other climatic parameters influencing the growth of trees growing close to the glacier are in continuation.

Based on surface samples, the modern pollen distribution within the Dokriani and adjacent valleys throughout the valley gradient of 3800 m till 2000 m amsl has been established. A good qualitative relationship between pollen dispersal and vegetation distribution has been observed throughout the valley gradient. A distinct altitudinal pollen divide has been observed from the study that also marks the accordance with the modern vegetation distribution along the altitudinal gradient. The quantitative relationship between pollen-vegetation and climate is under progress.

10. **Project— Past climate change and tree line dynamics based on tree-ring data from the Himalayan region** (sponsored by DST, New Delhi; No. SB/S4/ES-621/2012)

    Investigators: S.K. Shah, Amalava Bhattacharyya & Uttam Pandey

A field trip has been undertaken in three forest division of Kashmir Valley during September-October to collect tree-ring samples. Based on the tree-ring samples of *Cedrus deodara* (Deodar) from three sites of Lidder forest division, three tree-ring chronologies have been developed which are ranged as 138 yrs. (AD 1877-2014), 327 yrs. (AD 1688-2014) and 374 yrs. (AD 1640-2013). The three chronologies show good agreement among each other with significant positive correlation for common time period AD 1877-2013. The correlation between tree-ring chronologies and climates shows significant negative relationship with summer (May-August) temperature and positive with May-June precipitation. Based on this relationship, we reconstructed summer temperature since AD 1701. The reconstructed temperature has been assessed for long term cold and warm periods. The long term warm periods (AD 1823-1887, 1909-1948) and cold periods (AD 1807-1822 & 1888-1908) are noted in the reconstructed summer temperature. The lowering of the temperature during AD 1816 to 1819 recorded in the reconstruction might be due to the effects of Tambora volcanic eruption. Additionally, six tree-ring chronologies of *Abies pindrow* (Fir) from high altitude regions of Lidder and Sindh forest division have also been prepared. These chronologies are ranging from 176 to 500 yrs. Also two tree-ring chronologies of *Pinus wallichiana* (Blue pine) from Lidder forest division aged 156 yrs. (1858-2013) and 174 yrs. (AD 1840-2013) are prepared.

11. **Project— Palynological investigations of mangroves from South Andaman Island, India: Implications in vegetation change, palaeoclimate and sea-level fluctuations during Late Quaternary** (Sponsored by DST, New Delhi, No. SR/FTP/ES-97/2012; dated 17.07.2013)

    Investigator: Shilpa Pandey

Extensive field work has been undertaken in and around South Andaman Island. The palynological studies of 65 samples collected from different areas of South Andaman have been completed to understand modern

pollen-vegetation relationship of the area. The pollen assemblages of all samples, in general, showed moderate frequencies of core and mangrove associates. Among core mangroves such as *Rhizophora mucronata, Sonneratia apetala, Aegiceras corniculatum, Xylocarpus, Heritiera fomes, Excoecaria agallocha* and *Avicennia marina* are represented in high values, and mangrove associates as *Barringtonia*, *Lumnitzera*, *Terminalia, Palmae*, *Pongamia pinnata*, etc. are also represented in high frequencies from all the transects. Palynological analysis of four profiles has been completed and interpretation of the results is under progress.

12. **Project— High Resolution palaeoclimatic and palaeoceanographic study on eastern Arabian Sea off Saurashtra based on foraminifera and their geochemical signature** (Sponsored by DST, New Delhi, No. SR/FTP/ES-53/2013, dated 22.11.2013)

Investigators: Pawan Govil & Syed Azharuddin

Three marine sediment cores, already collected during the 243rd cruise of ORV Sagar Kanya, are being used to achieve the objectives. The core samples (of GC/SK-240/505) from off Saurashtra have been processed according to foraminiferal analysis methodology. Dried fraction was sieved through 350, 250, 150 and 63 µm sieves and each fraction was stored in separate 5 ml storage vials. Each dried fraction has been weighed. To understand the past productivity variations, $CaCO_3$ percentage for all 3 sediment cores (SK-240/485, GC/SK-240/496 & GC/SK-240/505; total 336 samples) has been analyzed. The samples from two GC cores (nos. 496 & 505) were dated through AMS radiocarbon dates. The dating has been done on the bulk samples and planktonic foraminifera shell. Picking of minimum 300 planktonic foraminifer's specimen and 70 specimens of *G. ruber* from each sample for geochemical analysis have been done for two marine sediment cores (485 & 496). Sample preparation (de-carbonisation & de-acidification) has been done on one gram powdered sediment sample from all the 3 sediment cores for the isotope analysis. Isotope analysis of organic matter ($\partial^{13}C$, $\partial^{15}N$, TOC & TN) has been done on the core GC/SK-240/496, using Elemental Analyzer coupled with IR-MS. However, core no. SK-240/485 is under process of the same. $\partial^{18}O$ and inorganic $\partial^{13}C$ analysis of planktonic foraminifera has been completed on the core nos. 485 and 496 using GasBench of IR-MS. Using the planktonic (PFA) and benthic (BFA) foraminifera abundance, stable isotope, total organic carbon (TOC), total nitrogen (TN) and sand percentage reveals a major change in the biological productivity and sedimentary influx of NE Arabian Sea sediment core (SK-240/496) during the early-middle Holocene.

13. **Project—Biozonation of the Marwar Supergroup around Jodhpur area western Rajasthan, India** (CSIR sponsored, No. 09/528/(0019)/ 2013/ EMR-I)

Investigator: Shamim Ahmad

The fossils are recorded from the late Neoproterozoic (Jodhpur Sandstone) to the early Cambrian (Nagaur Group). In the study, 13 biozones have been established in the Marwar Supergroup (MSG) on the basis of body fossils (animal & plant both), organo-sedimentary structures (including MISS & stromatolites), trace fossils and microfossils. The lower horizon of MSG i.e. Jodhpur Group consists 5 biozones viz., *Aspidella-Heimalora* zone, *Marsonia* zone, *Vendophycus* zone, *Arumberia* zone, and Ediacaran Disc zone. The successive Bilara Group comprises only 2 biozones namely *Collenia-Conophyton* zone and *Obruchevella* zone, while the Nagaur Group which is top most horizon of MSG comprises 4 biozones namely Priapulid zone, Articulated-Arthropod Tergite zone, *Cruziana-Rusophycus* zone and *Treptichnus* zone. Trail and Burrow zone are present in Jodhpur Group as well as in Nagaur Group. The Acritarch zone holds the maximum extension which starts from Jodhpur Group and ends at the middle part of the Nagaur Group.

Jodhpur Group of MSG is correlated with the Bhander Group of Vindhyan Supergroup on the basis of Ediacaran fossil record (*Arumberia banski* & *Beltanelliformis minuta*). The Marwar Basin is located in proximity to basins in Oman, Pakistan, Madagascar and northern India (Krol-Tal region). Many of these sedimentary sequences show remarkable similarities and there exist possible correlations between these basins. As such the MSG can be correlated with the other parts of the world such as the Salt Range (Pakistan), Krol-Tal (Lesser Himalaya) and the Huqf Supergroup (Oman). All the objectives of the project have been fulfilled and the detailed scientific report has been submitted to CSIR, New Delhi.

14. **Project— Developing snowfall reconstruction for the Lahul-Spiti region and its association with glacier dynamics** (Sponsored by DST, New Delhi, No. SR/DGH-76/2013)

Investigators: K.G. Misra, R.R. Yadav & A.K. Yadava

Tree-ring samples in the form of increment cores

from living and dead trees have been collected from high altitude climate sensitive sites for long term glacier dynamics over the Lahul-Spiti region (HP). Total 320 samples are collected from the tree species of *Betula utilis, Cedrus deodara* and *Juniperus polycorpus*. The tree-ring samples of *Betula utilis* are expected to provide important information on snowfall pattern over the region up to last three centuries as sampled trees growing on steep rocky slope with very thin soil cover. The *Juniperus polycarpos* trees growing over different high-elevation tree-line sites are collected. These trees are expected to provide millennium long climate records and snowfall pattern over the region with Medieval Climate Anomaly and Little Ice Age periods.

15. **Project— Studies on the late Quaternary vegetation and climate change in Jammu and Kashmir, India on the basis of pollen proxy records** (Sponsored by DST, New Delhi, No. SR/FTP/ES-81/2013)

Investigator: M.F. Quamar

Pollen analyses of three sedimentary profiles from Gharana wetland (1.5 m) of R.S. Pura (Jammu District), Nanga wetland (1.6 m) of Samba District, and Bajalta Lake (1.8 m) of Jammu District have been completed. The study revealed that mixed conifer/broad-leaved forest consisting of the dominance of conifers such as *Pinus*, *Cedrus*, *Abies*, *Picea*, *Larix*, etc. and presence of comparatively less number of broad-leaved taxa such as *Betula*, *Alnus*, *Ulmus*, *Quercus*, *Carpinus*, *Corylus* grow in the region under cold and dry climate. Further, the broad-leaved taxa improved and the conifers shows decreasing trend; indicating a warm and humid climate in the regions. In a few cases, pluvial environments were also inferred as envisaged by the presence of sandy deposits and simultaneously no significant pollen was encountered in that phase too. With the record of Cerealia and other culture pollen taxa, the inception and pace of agricultural activity as well as with the encounter of aquatics and algal remains, the fluctuations in lake level will also be inferred in light of tectonism. However, the detailed explanation of all the three sedimentary profiles will be made with the availability of ^{14}C dates, which are awaited. Environmental magnetism and loss-on-ignition studies of the profiles are also completed. The explanation in terms of palaeovegetation and palaeoclimate is in progress. Their correlation will also be made during the course of study.

Besides, a good number of surface samples have also been analysed in order to understand the pollen deposition pattern of the study areas [(Gharana wetland (12), Nanga wetland (12), Bajalta Lake (10) and Udhampur (40)]. The preliminary results revealed the dominance of arboreals- both conifers and broad-leaved taxa over the non-arboreal taxa, which seem to be in accordance with the ground vegetation. The pollen analyses of the samples collected from Reasi (25) and Akhnoor (50) are in progress.

16. **Project— Palaeofloristics of Lower Gondwana sediments of India and Brazil with special reference to palaeowild fire: Implications in palaeoecology, palaeoclimate and biostratigraphy** (Sponsored by DST, New Delhi, w.e.f. 01.04.2014)

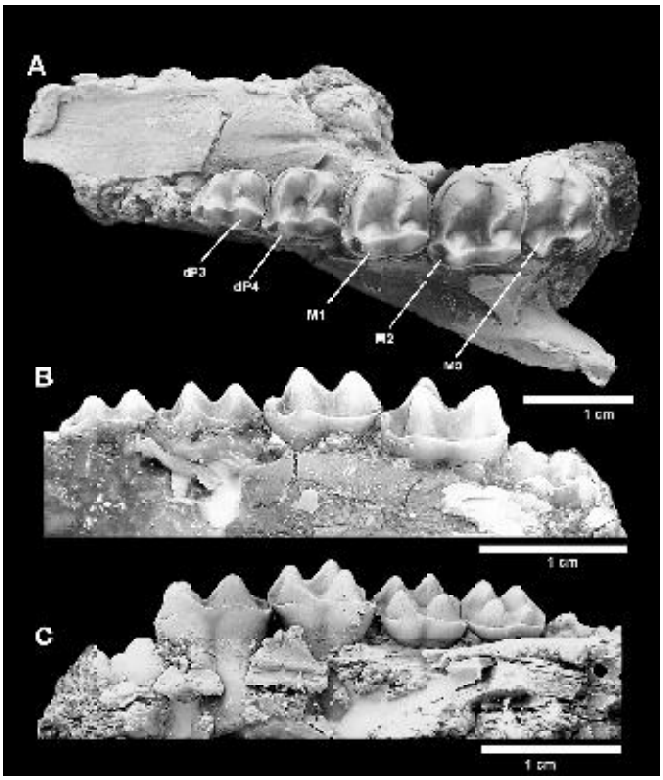
Investigators: Rajni Tewari & Deepa Agnihotri

Palaeofire studies from the VI Top seam of Barakar Formation of the Dhanpuri coal mine, Sohagpur Coalfield (MP), India have been carried out. The continuous presence of macro-charcoal within this particular seam, demonstrates that fires occurred repeatedly in the source vegetation of the seam. Based on these macro-charcoal remains, an anatomical assessment of the diversity and taxonomic composition of the vegetation which experienced wildfires and contributed to the formation of peat/coal has been done. The vegetation that experienced regular fires was dominated by gymnosperms, with a minor component of pteridophytes. The results also support previous studies which suggest a pyrogenic origin for the high inertinite contents of many Permian coals on Gondwana. In addition, a field excursion has been undertaken (by DA) to Rio Bonito Formation of Morro do Papaléo, Parana Basin, RS, Brazil. Well-preserved *Glossopteris* leaves, lycopsids and dispersed seeds are collected from the carbonaceous shale of the sequence. Rock samples are also collected from different levels of the Rio Bonito Formation for the macroscopic charcoal and megaspore studies.

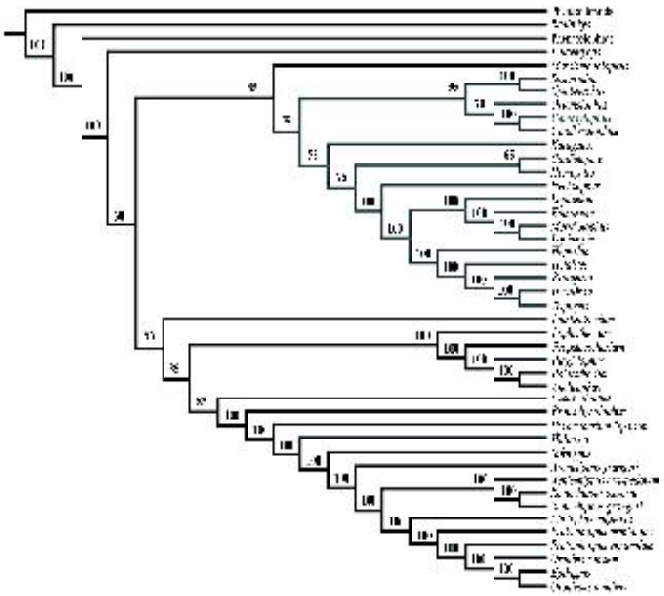
17. **Project— Paleogene vertebrate fauna from the lignite associated sedimentary sequences of western India: Investigations of evolutionary and biogeographic aspects** (Sponsored by DST, New Delhi, No. SR/FTP/ES-49/2012, implemented during 2014-15)

Investigator: V.V. Kapur

All the samples collected from Gurha lignite mine, District Bikaner, Rajasthan have been processed (de-carbonated). Samples analysis (bulk carbon isotope) is completed using the Isotope Ratio Mass Spectrometer.



Cambaylophus vastanensis gen. et sp. nov.IITR/SB/VLM 760, (holotype), right maxillary fragment with dP3–dP4 and M1–M3.A, occlusal view B, buccal view C, lingual view.



50% Majority Rule consensus tree of 40 most parsimonious tree showing the position of *Cambaylophus*. Numbers along branches indicate frequency of clusters in the profile.

Data interpretation is being carried out. A few samples are also processed for microvertebrates but are found unfossiliferous.

A new tapiromorphperissodactyl has been identified and is named *Cambaylophus vastanensis* from the early Eocene Cambay Shale Formation, Gujarat and its evolutionary position has been worked out on the basis of the phylogenetic analysis conducted by PI at BSIP. A paper in this regard has been finalized. The paper discusses the biogeographic implications of this find in a phylogenetic framework.

18. **Project— Vegetation succession and climate oscillation since late Quaternary from northern Assam, northeast India: A multiproxy analysis** (Sponsored by DST, New Delhi, No. SB/EMEQ-225/2014)

Investigator: S.K. Basumatary

A palynological dataset has been established on the Pashumara wetland and Ranga reserve forest of North Lakhimpur district to differentiate flooded and non-flooded area in relation to existing vegetation in Assam. Study reveals that the wetland was a flood prone area as evidence of the admixture of arboreal local and extra-local taxa in the palynoassemblage and not fully matches with present vegetation. The various pollen distributions are observed in continuation to study sites and confirmed that pollen deposition pattern in wetland depend on parent plant grow, flood activity and surrounding vegetation. The studied palynodata of surface samples of Ranga RF mainly indicate the tropical deciduous forest consisting of *Salmalia*, *Dillenia* and *Terminalia* and *Albizia* under warm and humid climatic condition which exactly reflected the current vegetation in the region. The non-flooded area is identified as evidenced by the abundance of local arboreal taxa and absence or trace value of extra-local taxa in the palynoassemblage.

A 1.8 m sedimentary soils profile from the Sakali wetland of Majuli Island has been pollen analysed and observed that the existence of tropical deciduous forest in the Island. The palynodata of first and third phase are strongly indicative of the strong flood episodes as evidenced by the recovery of extra-local arboreal taxa namely *Mesua*, *Castanopsis* and *Rhododendron* in the assemblage. The presence of the cereal pollen along with *Brassica* and *Coriandrum* are suggestive of the anthropogenic activity in and around the area.

19. **Project— Chronology and climate implications of late Quaternary glaciations in the upper Dhauliganga and Alaknanda valleys, central Himalayas, India** (Sponsored by DST, New Delhi, No. SR/FTP/ES-23/2013, w.e.f. August 2014)

Investigator: S. Nawaz Ali

Detailed field mapping of glacial and paraglacial landforms supported by optical and radiocarbon dating is used to reconstruct the history of late Quaternary glaciation and landform evolution in the Trans Himalayan region of the upper Dhauliganga valley. The study identifies four events of glaciations with decreasing magnitude which are termed as Purvi Kamet Stage (PKS)-Ia, PKS-Ib, PKS-II, PKS-III and PKS-IV, respectively. The oldest PKS-Ia and Ib are assigned the Marine Isotopic Stgae-3 (MIS-3), the PKS-II to the Last Glacial Maximum (MIS-2), PKS-III dated to 7.9 ± 0.7 ka, and the PKS-IV is dated to 3.4 ± 0.3 ka and 1.9 ± 0.2 ka, respectively.

The study is also an attempt to reconstruct the glacier fluctuations on the basis of glacial geologic evidence, field stratigraphy and optical and radiocarbon dating of lateral moraines in the monsoon dominated Kosa Valley of the central Himalaya. The study provides evidences of three glaciations during the last 7 ka in the valley. The oldest and most extensive glaciation viz., RBS 3 may have occurred during the younger dryas cooling event, followed by RBS 2 that occurred during the early to mid Holocene (7 & 5 ka) and RBS 1 glaciation can be correlated to the little ice age. The study provides some important insights about the dynamics and evolution of the Holocene glaciations which can be ascribed to the low temperature and progressively decreased precipitation.

Twenty surface samples have been analysed to reconstruct a modern pollen-vegetation relationship, vegetation distribution and pollen transport processes in the alpine scrub/meadow zone (~3700 to ~4750 m asl) of Kalla Bank glacier valley, Dhauliganga Basin (Uttarakhand). The recovered pollen data reveals a higher degree of difference between the extant vegetation of the area and the pollen assemblages. The assemblages reveal that the arboreals especially tree (both conifers & broad-leaved taxa) dominate over the non-arboreals throughout the whole transect. The dominance of these taxa is attributed to their high pollen production, preservation and transport to higher elevation via. upthermic winds.

20. **Project— Palaeoclimate and lake history of Tapovan, Gangotri glacier valley, Garhwal Himalaya** (Sponsored by DST, New Delhi, No. SR/DGH-56/2013)

Investigators: P.S. Ranhotra & Amalava Bhattacharyya

A field work has been carried out in Tapovan, Gangotri, Harsil and surrounding areas for the collection of palynological and tree-ring samples. Over 100 surface samples are collected from the transact of ~40 km with altitudinal range of ~2300 m (4300 to ~2000 m amsl). The palynological processing of the samples for developing the modern pollen-vegetation relationship is under progress. Two subsurface sedimentary profiles are also collected from the Tapovan palaeolake for the past vegetation, climate and glacial reconstruction. Tree-ring samples are collected from three tree taxa viz., *Betula utilis, Pinus wallichiana* and *Cedrus deodara* growing at altitudes respectively at 3800 m, 3600 m and 3000 m amsl, for the annual scale climate reconstruction. The tree-ring samples are processed and the cross dating is under progress.

21. **Project— Characterization of glacial lake deposits of the Ladakh, NW Trans Himalaya: Implications on landscape evolution and palaeoclimate** (Sponsored by DST, New Delhi, No. (No. SR/DGH-69/2013)

Investigators: Binita Phartiyal, Anjum Farooqui & Priyanka Joshi

On the route to Pangong Tso, from Leh, at the Chang La pass, several glacial lakes are exposed near Tsoltak (4732 m). The entire area is a glaciated terrain with moraines, pro-glacial lakes and tons of unconsolidated sediment scattered as slope debris. The dry patches of the palaeolake have been sampled for multiproxy analysis. This topmost layer is composed of clay, silty-clay with some rootlets, with organic-rich layers and dropstones further beneath. The samples collected are being analysed by multi-proxy analysis for palaeoclimate reconstruction. The magnetic susceptibility shows a good variation with higher values concentrated to the lower part of the section. The initial work on the surface samples for biotic forms such as thecamoebians and diatoms is going on. These proxies are short lived and serve as potential indicators of even with the slightest change in the climate induced ecology. Thecamoebians recorded are dominated by *Centropyxissps*. With most of them being agglutinated forms and typical of those surviving in stressed conditions and in varied ecological niche. The diatom population shows a poor species diversity which is suggestive for the presence of somewhat stable environmental condition. As the area is devoid of vegetation the pollens recovered viz., *Pinus, Poaceae, Anemone*, etc. from the surface samples indicate that these may have transferred through air from the southern ranges and is a good proxy to study the wind direction and fluctuation down time. The ongoing studies/work will be able to quantify the number of glacial lakes that presently exist in the Ladakh range, look at the historical and geological record of the receding glaciers

and throw light on the glaciations chronology with a multi-proxy high resolution data of climatic variations from this westerly dominated region.

22. **Project— Analysis of Holocene climate variability using multi-proxy data around Chorabari Glacier (Kedarnath), western Himalaya, India** (CSIR-UGC NET Fellowship, UGC Grant No. F. 2-24/2014(SA-1)

Investigators: Kriti Mishra & Ratan Kar

Geochemical studies of sediments from a profile of 160 cm in the outwash plain of Chorabari Glacier have been carried out in detail to investigate the temporal and spatial variability of different elements. It included analysis of major elements, trace elements and REEs. The Weathering Index of Parker and Index of Compositional Variability have been calculated to determine the changes in the concentration and redistribution of major elements within the sediments. The values thus ascertained reveal that the proglacial environment is geochemically reactive. Trace elements show variable distribution within the profile. Throughout the profile, there are sharp changes in the distribution and concentration of REEs, which may be linked to chemical and biological weathering in the catchment. Furthermore, mineral magnetic data has also been generated for the profile. Besides, palynological studies have been initiated from a 2 m trench dug on the left kame terrace of the Chorabari Glacier. Further work is focused on the integration of multi-proxy data for the reconstruction of climatic oscillations based on palynological, mineral magnetic and geochemical evidences.

23. **Project—Indian Himalayas Climate Change Adaptation Programme (IHCAP) Vulnerability, risks and hazards assessment in Kullu District, Himachal Pradesh** (Indo-Swiss Project, w.e.f. 09.01.2015)**.**

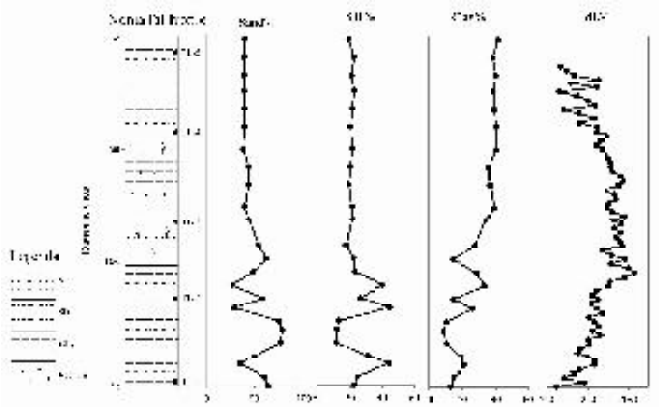
Investigators: Mayank Shekhar & Amalava Bhattacharyya (& Markus Stoffel, Juan Antonio Ballesteros Cánovas, Daniel Trappmann)

Trees impacted by the forces of natural processes such as flash floods, snow avalanches, landslides, rock falls or earthquake will record affect of these events in their growth-ring series. These disturbances provide an excellent signal for the spatio-temporal reconstruction of past natural hazard activity, and a means to date and document past disasters through dendrogeomorphology. In view, dendrogeomorphological investigation has been carried out from the Kulu Himalaya (HP) and Jammu and Kashmir. Several trees of Kulu Himalaya and inventoried from several sites where past process reconstructed namely flash floods with flood history in the Beas and Sainj Rivers as well as snow avalanches in Solang Valley are explored. From Kashmir Himalaya, we made exploratory field survey to understand the flood risk and hazards. Our peak discharge estimation have highlighted the existence of high magnitude flash flood events which exceed considerable the existing records. These values can be useful as baseline to estimate flood-frequency and therefore for the reliability of infrastructure design. The field-based analyses have showed the existence of hot-spot flood disaster sites characterized by different causative factors. The rational analyses of these cases suggest that different actor's involved (i.e. local government, planning engineering & local population) have played an important role on disaster triggering. We have recorded over 51 snow avalanches events for the period 1850–2015 from disturbances on tree-rings; indicating that snow avalanches activity is a common process in the studied area close to Rohtang Pass and proper management may be adopted for protection of national properties.

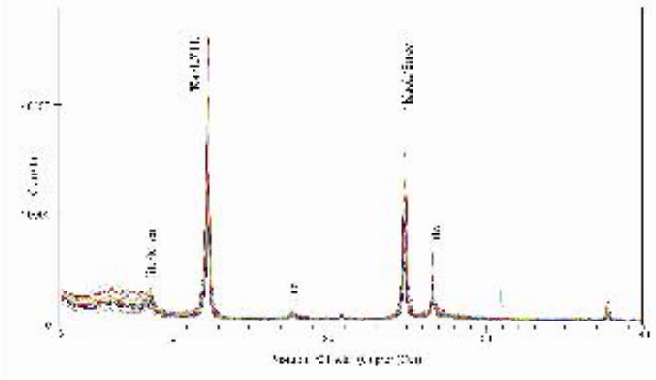
24. **Project— Multiproxy palaeoclimatic studies of Quaternary lake sediments from southern Madhya Pradesh, India** (Sponsored by DST, New Delhi, No. SR/FTP/ES-16/2014)

Investigator: Kamlesh Kumar

A 1.56 m sediment profile has been collected from the Naunia pond (Tal) near Barheta village (District Narsinghpur). Samples are collected by trenching and coring method at 2 cm interval. Five samples for OSL dating are also collected from this profile to establish the chronology. For multiproxy studies, i.e. grain size, TOC, bulk mineralogy, clay mineralogy, stable carbon isotopes,



Grain size and stable carbon isotope ($\delta^{13}C$) variation in Naunia Tal profile



Clay mineral assemblage in Naunia Tal profile

have been carried out. The geochemical study of the profile samples is under progress. 3 samples are sent for AMS dating. Out of 78 samples, selected samples are analysed for clay minerals in the samples.

25. **Project— Mangrove dynamics and relative sea level changes during late Quaternary in Godavari delta** (Sponsored by DST, New Delhi, No. SR/FTP/ES-84/2014)

Investigator: Jyoti Srivastava

Palynomorph content of surface samples from three sea-land transects in a coastal wetland from Godavari River delta have been analyzed. The analysis involves the quantitative relationship between source taxon vegetation frequency and its pollen representation at a community scale. Ordination techniques for individual species using fidelity and dispersibility indices and regression analyses suggests four different floristic groups: i) *Sonneratia-Avicennia* lowland swamp zone, ii) Rhizophoraceae-*Xylocarpus* high salinity seaward zone, iii) *Avicennia-Excoecaria* intermediate zone, and iv) *Lumnitzera-Aegiceras* low salinity landward zone. Detrended correspondence analysis placed these communities on an estuarine to freshwater gradient. Physico-chemical studies reveal that salinity was comparatively high in clayey silt sediment which reveals that clayey silt sediment retains more salts as compared to silt sediment, which is likely affects the coastal habitat. Increased salinity in the sediment >3 PSU is alarming and may limit the physiologically active water available for mangroves as the roots penetrate 1-2 m depth. Thus, salinity in the coastal sediment is a major threat to mangrove habitat and freshwater aquifers.

Palynomorph assemblage at the seaward end of the salinity gradient does not clearly represent the associated vegetation than that at the landward end, probably because the open vegetation at the landward end allows the influx of water and wind-dispersed pollen from adjoining vegetation. More open vegetation types at the 'marine end' of the sequence are likely to be 'overwhelmed' by regional pollen, though the nature of sediment and presence of discriminatory species (*Avicennia marina, Sonneratia* sp.), even in small quantity will help in accurate identification of the local vegetation represented in sedimentary sequences. Box-plot analysis indicates that *A. marina* and *Sonneratia* sp. are highly discriminatory in relation to vegetation type. Rhizophoraceae pollen proportions match its dominance in each zone, but the other mangrove species represent some specific environmental conditions as well. Such as, low proportion of *Avicennia* characterizes saline back swamp conditions and is useful in identifying changes in saltwater wedge. An increase in the salt tolerant *Suaeda* sp. attributes to the increased salinity in the wetland due to high salt accumulation in the root zone which is vulnerable for mangroves.

26. **Project—Chronology of glaciation, palaeoclimate reconstruction and their climatic implications in the Thangu Valley, Sikkim Himalaya, India** (Sponsored by DST, New Delhi, No. SERB DST/SB/DGH-89/2014)

Investigator: S. Nawaz Ali

During the field work studies have been carried out at three important localities– Kalip, Thangu, and Chopta in the north Sikkim. Emphasis is given on understanding the geomorphic evolution of the area. All the three localities have preserved evidences of past glaciations in the form of broad U-shaped valleys and most importantly well-preserved lateral as well as terminal moraines. A palaeo-lake deposit is found near Kalip. The lake deposit is present at a height of approx. 75 m from the present day river bed. It seems that the lake has been formed by the advance of glacier which has resulted into the damming of Teesta River during that time. A 10 m section from this moraine dammed lake has been sampled for multi-proxy studies. A 3 m profile has been sampled for multiproxy studies from the Chopta valley. The upper 2 m mostly consists of organic peat, however the bottom 1 m is constituted of outwash sands. Multi-proxy studies of the 2 m pit profile and the surface samples are in progress.

27. **Project— Reconstruction of climate and dating of geo-hazards related to hydro-geomorphic evidences from Sikkim Himalaya based on tree-ring proxy** (Sponsored by SERB DST, New Delhi, No. SR/FTP/ES-127/2014)

Investigator: Mayank Shekhar

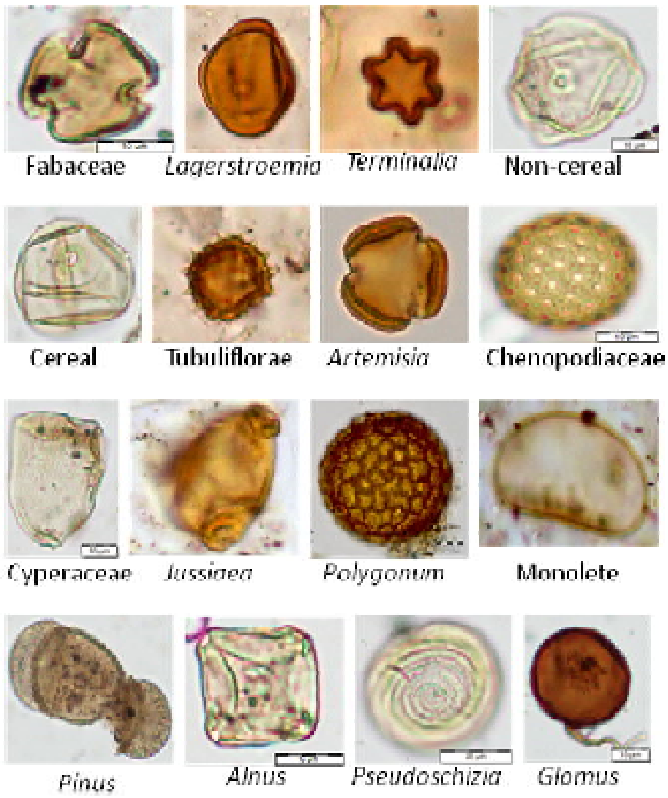
Literature related to palaeoclimate and natural hazards history of Sikkim and adjoining areas, Eastern Himalaya has been surveyed. Downscaling of climate data for entire north-east Himalaya has been completed.

28. **Project— Late Quaternary vegetation and climate oscillation from endangered wetlands and surroundings reserve forests of Manipur, northeast India: based on pollen and NPP records** (Sponsored by SERB DST, New Delhi, No. SR/FTP/ES-141/2014)

Investigator: Swati Tripathi

A field excursion to Imphal east and Bishnupur district has been undertaken, and procured four boreholes and one trenched sedimentary profile for the palaeoclimatic interpretation. Besides, 160 surface samples are also collected in order to understand modern pollen deposition pattern in this region. Maceration of 30 surface samples and one trenched sedimentary profile from Keibul Lamjao National Park, Bishnupur district has been completed and palynological study of same are in progress. A 100 cm deep sedimentary core dated back to 2,200 yrs have been palynologically analysed (with C.M. Nautiyal & Y.R. Singh, Manipur Univ.) for the reconstruction of palaeoecological changes in and around Loktak Lake (Ramsar site), Bishnupur district, which provided insight into the changing vegetation and climatic scenario in this region of Manipur during the late Holocene.

Views of (**A**) Loktak lake (Ramsar site) and (**B**) Keibul Lamjao National Park (sole habitat of endangered 'Sangai deer') of Manipur



Palynoassemblage recovered from sedimentary profile of Loktak lake, Manipur

29. **Project— Facies dynamics of Palaeocene-Eocene carbonates from Meghalaya, N-E India: Palaeoenvironmental implications** (Sponsored by SERB DST, New Delhi, No. SR/FTP/ES-143/2014)

Investigator: Suman Sarkar

An extensive field work has been carried out in the Jaintia Hills with major emphasis upon the carbonate successions outcropping on the Jowai-Badarpur road. For broader analysis and making detailed comparative accounts, field work has also been done in the limestone sections around Cherrapunji (Khasi Hills). All these successions belong to the Lakadong, Umlatdoh and Prang formations of Sylhet Limestone Group. Collection of carbonate samples have been made from the limestone quarries within some cement company premises like Topcem and MCCL, cave sections and road sections. In total, 235 samples have been collected for micropalaeontological work pertaining to analysis of facies

Exposed section in the Limestone Quarry No. 3 (of Topcem Cement Factory) on the Jowai-Badarpur Road

dynamics, palaeoecological parameters and ecosystem modeling. Thin sectioning of the limestones has been initiated and abundant geniculate coralline algae like *Corallina* and *Jania* have been recorded in addition to a wide variety of small as well as larger benthic foraminifera. Multiple non-geniculate corallines have also been observed. The larger benthic foraminifera are represented by *Nummulites*, *Ranikothalia*, *Alveolina*, *Miscellanea*, *Lockhartia*, *Operculina*, etc. Greater diversity of both coralline algae and benthic foraminifera is expected to be recorded with more thin sections. Identification up to the species level is being carried out and highest emphasis is currently being given on the component analysis of different facies recorded from various time slices of the Palaeocene and Eocene carbonates.

30. **Project— Late Quaternary biotic-abiotic interactions from the Harshad estuary, Gujarat, India: Implications on palaeoproductivity and climate** (Sponsored by SERB DST, New Delhi, No. SR/FTP/ES-149/2014)

Investigator: Biswajeet Thakur

A fieldwork at the Harshad estuary has been carried out. The samples are collected from different environmental setting viz., tidal portion of estuary, mangrove bank, tidal inlet and tidal flat regions. The objective is to understand the present environmental conditions and the response of biotic components on different microenvironments. The sampling is carried with the aim to study the variations in primary productivity (diatoms), palynofacies, dinoflagellate cysts and physico-chemical properties in the estuary. The present attempt is to build an analog of various biotic-abiotic interactions and interpret the underlying past environments in core sediments in geological time for palaeoclimatic reconstructions and sea-level changes.

31. **Project— Changes in the biosphere across the transition of Mesoproterozoic-Neoproterozoic succession of Buxa Formation, Sikkim, Lesser Himalaya and its correlation with coeval successions** (Sponsored by SERB DST, New Delhi, No. SR/FTP/ES-151/2014)

Investigator: Shamim Ahmed

A ~800 m thick stratigraphic succession comprising dolomite, fine bands of chert, limestone, phyllite, quartzite, pyritous sericitic and variegated slate constituting the Buxa Formation is being investigated for palaeobiological remains. It is the only remnant of Precambrian age positioned in Rangit Tectonic Window Zone in north eastern region of Lesser Himalaya, Sikkim. The succession is found in between the MBT (below the Daling Group) and MCT (above the Permian Gondwana units). Lithostratigraphic succession of Buxa Formation overlies the Reyang Formation and is covered by the Gondwana Diamictite and is exposed on the both banks of the Rangit River. During the first phase of the Project, field data and samples have been collected from the 3 sections (namely Reshi-Mangalbaria section, Jorethang-Mangalbaria section & Reshi to Naya Bazar) for palaeobiological investigation and IRMS study. Buxa dolomite exposed on the left bank of Rangit River near Tatapani (west Sikkim), shows stromatolites viz., *Colonnella columnaris, Colleniella, Collumnaefacta,* etc. Details of these stromatolites have been documented. At present, the deposition of the Buxa Formation is bracketed between 1000 Ma time span spread over Mesoproterozoic to Neoproterozoic. The present work is targeted to ascertain its proper age.

32. **Project—Analysis of plants and human relationship since late Pleistocene from Dzuko Valley, Nagaland, northeast India** (Sponsored by SERB DST, New Delhi, No. YSS/2015/001193)

Investigator: Sandhya Misra

Initially literature pertaining to climate and vegetation studies from northeast India and Nagaland is surveyed. Later, a field excursion to Dzukou Valley and adjoining areas has been carried out, and surface samples in the form of moss cushion, lichens, sediment, spider web are collected for the modern vegetation distribution study. Various locations in the valley, Viswema village, Khonoma village are surveyed for sub-surface sampling for palaeoclimate and vegetation study. Hence, four profiles are collected. Various living plants are also collected for the reference material for pollen and phytolith study. To understand the varying morphology of phytoliths among bamboos, leaves and sheath of 29 species of bamboos are also collected. To understand the foliaging pattern of honey bees honey is also collected. Collected samples are under chemical processing for the further investigation.

33. **Project—Mesozoic fluvial and coastal deposits of Jaisalmer Basin, Rajasthan: palaeoclimatic, palynostratigraphic and palaeobiogeographic implications based on fossil floras** (Sponsored by SERB DST, New Delhi, No. SB/EMEQ-161/2014)

Investigator: Neelam Das

Literature survey on the theme has been initiated. The work will be scheduled to start from August 2016.

34. **Project—Late Quaternary palaeoclimatic/sea level changes and anthropogenic responses from estuarine complexes of western India: A multi-proxy approach** (Sponsored by SERB DST, New Delhi, No. SB/EMEQ-244/2014)

Investigator: Biswajeet Thakur

The initial literature survey related to the theme of the project has been carried out. The processing of recruitment of JRF has been completed. The procurement of Benchtop Analysis kit is in process.

35. **Project—Subsistence pattern, vegetation dynamics and climate change during Harappan (Indus) and subsequent culture in north-western India: A palaeoethnobotanical approach** (Sponsored by SERB DST, New Delhi, No. EMR/2015/000881)

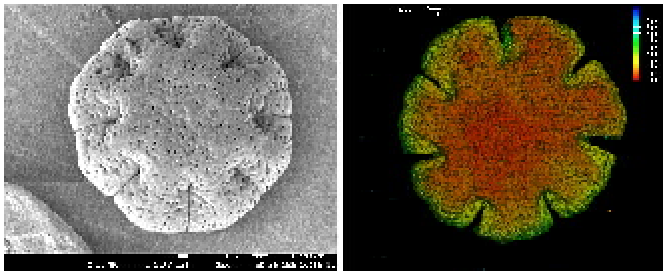
Investigators: A.K. Pokharia & Shalini Sharma

Field excursions have been undertaken to archaeological sites under excavations viz., Chandravati and 4 MSR in Rajasthan and Kanmer in Gujarat to collect macroremains by water floatation technique. Further, soil sediment from archaeological sites and lacustrine deposit near Chandravati archaeological site are also collected. Analysis of macroremains is in progress.

36. **Project—Quantitative reconstruction of the Paleogene climate of paleo-equatorial region based on Indian palynological records** (Sponsored by MoES, New Delhi, No. PO(GeoSci)/36/2014).

Investigators: Vandana Prasad, Madhav Kumar, J. Jeyakumar A.K. Mishra

The study is based on the concept of Nearest Living Relatives (NLRs) of fossil pollen. Since many of the nearest living relatives of Paleocene-Eocene occupy rain forest region, hence a field has been conducted in the Western Ghats rain forest area. A total of 70 plants (trees, shrub & herb) are collected from the evergreen and moist deciduous forest from the region. Pollen slides have been prepared from the living plant material. A comparative morphological study (through light microscopy, SEM & Confocal microscopy) is made between the most typical Paleocene-Eocene pollen flora of India and extant pollen of Western Ghats. The study shows similarity between the fossil palynomorphs and the extant palynomorphs of wet evergreen forest of Western Ghats. Many of the fossil palynomorphs in the study showing affinity with the extant vegetation of Africa, Madagascar and SE Asia and hence providing significant data for the paleobiogeographic interpretations.



SEM image Confocal image

Fossil palynomorph *Ctenolophonidites costatus* shows affinity with the *Ctenolophon englarianus* from Western Africa

37. **Project—Analysis of Holocene climate change in Tripura and Mizoram based on pollen, environmental geomagnetism and isotope data** (DST-Woman Scientist Scheme, No. SR/WOS-A/ES-18/214, w.e.f. 21.03.2016).

Investigator: Nivedita Mehrotra

The surface samples from transect of north to south Tripura have been examined for presence of palynomorphs. Further analysis shall be conducted on this palynological data.

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Banerji U, Pandey S, Bhushan R & Juyal N 2015. Mid-Holocene climate and land-sea interaction along the southern coast of Saurashtra, western India. *J. Asian Earth Sci.*, DOI: http://dx.doi.org/10.1016/j.jseaes.2015.06.021.

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Deputation to Conferences/Seminars/Workshops

Abroad

K.G Misra participated in the *XIX INQUA Congress on Quaternary Perspective on Climate Change, Natural Hazards and Civilization* held at Nagoya, Japan during July 26-August 02, 2015.

K.J. Singh & Anju Saxena participated in the *XVIII International Congress on the Carboniferous and Permian–ICCP-2015* held at Kazan, Russia during August 11-15, 2015.

Sunil Bajpai & R.S. Singh participated in the *12th Symposium on Mesozoic Terrestrial Ecosystem* held at Shenyanghy, China during August 16-20, 2015.

Alpana Singh & R.P. Mathews participated in the *67th ICCP (International Committee for Coal and Organic Petrology) Annual Meeting & Symposium on Coal and Organic Petrology– New Perspectives and Applications: A tribute to Marlies Teichüller (1914-2000)* held at Potsdam, Germany during September 05-11, 2015.

A.K. Ghosh participated in the *11th International Symposium on Fossil Algae* held at Okinawa, Japan during September 16-17, 2015.

Shilpa Pandey participated in the *International Workshop on Land USE 6K- Putting History to Work on Climate Change* held at Paris, France during October 22-23, 2015.

Syed Azharuddin participated in the *CLIVAR-ICTP Workshop on Decadal Climate Variability and Predictability* held at Trieste, Italy during November 16-24, 2015.

In India

Sunil Baipai, Rahul Garg, M.R. Rao, R.S. Singh, Madhav Kumar, Alpana Singh, B.D. Singh, Mahesh Prasad, Jyotsana Rai, Rashmi Srivastava, Vandana Prasad, Anupam Sharma, A.K. Ghosh, Biswajeet Thakur, Hukam Singh, Poonam Verma, Abha Singh, Gaurav Srivastava, Jyoti Srivastava, Shailesh Agrawal, V.V. Kapur, R.P. Mathews, V.P. Singh, Priyanka Monga & Arindam Chakraborty participated in the *National Conference on Paleogene of the Indian Subcontinent* held jointly at GSI (Northern Region) and BSIP, Lucknow during April 23-24, 2015.

Ratan Kar & Pawan Govil participated in the *National Workshop on Evaluation of Research Projectes for Planning the XXXV Indian Scientific Expedition to Antarctica* held at NCAOR, Goa during May 21-22, 2015.

A.K. Ghosh and Arindam Chakraborty participated in the *National Climate Science Conference* held at Divecha Centre for Climate Change, IISc, Bangalore during July 02-03, 2015.

Manoj M.C. participated in the *XII International Symposium on Antarctic Earth Sciences* held at NCAOR, Goa during July 12-18, 2015.

Neha Aggarwal participated in the *National Conference on Cryptogam Research in India: Progress and Prospects* held at CSIR-NBRI, Lucknow during September 28-29, 2015.

Shilpa Pandey participated in the *National Hindi Seminar on Hamare Jiwan me Sagar ki Bhumika- Global Warming and Climate Change* held at INCOIS, Hyderabad during September 28-29, 2015.

R.R. Yadav, Jyotsana Rai, Rajesh Agnihotri, K.G Misra, Debrati Nag, A.K. Yadava, Priyanka Joshi & Vikram Negi participated in the *30th Himalaya-Karakoram-Tibet Workshop* held at WIHG, Dehradun during October 06-08, 2015.

S.K. Shah & Uttam Pandey participated in the *11th JK Science Congress-2015: Scientific, Social and Economical Dimension of Climate Change* held at University of Kashmir, J&K during October 12-14, 2015.

Swati Tripathi participated in the *National Conference on Indian Botanic Gardens* held at CSIR-NBRI, Lucknow during November 18-20, 2015.

Mukund Sharma, Rajni Tewari, Jyotsana Rai, Rajesh Agnihotri, Binita Phartiyal, Biswajeet Thakur, P.S. Ranhotra, Anju Saxena, S.S.K. Pillai & Abha Singh participated in the *Regional Brain Storming Session on 36th International Geological Congress: A Unique Opportunity for Advancement in Geosciences* held at GSI, Lucknow during December 03-04, 2015.

V.K. Singh & S.K. Pandey participated in the *Workshop on Inside RAMAN* held at IISER, Mohali, Chandigarh during December 10-11, 2015.

Shilpa Pandey participated in the *National Hindi*

Scientific Conference held at Jiwaji University, Gwalior during December 11-12, 2015.

C.M. Nautiyal participated in the *National Workshop on Science Films* organized by Vigyan Prasar and held at Regional Science Centre, Bhopal during December 17-19, 2015.

A.K. Pokharia & Shalini Sharma participated in the *Joint Annual Conference of IAS, ISPQS, IHCS* held at University of Hyderabad, Hyderabad during December 17-20, 2015.

B.D. Mandaokar, A.K. Ghosh, M.F. Quamar, Arindam Chakraborty & Syed Azharuddin participated in the *XXV Indian Colloquium on Micropalaeontology and Stratigraphy* held at Institute of Science, Aurangabad (Maharashtra) during December 18-20, 2015.

Anupam Sharma participated in the *National Seminar on Past and Present Geochemical Processes: Impacts on Climate Change* held at School of Environmental Science, JNU, New Delhi during December 22-23, 2015.

Srikanta Murthy & V.K Singh participated in the *103rd Indian Science Congress Association* held at Mysore University, Mysore during January 03-07, 2016.

C.M. Nautiyal participated in the *Workshop on Radiometric Systems of Age Determination and their Role in Archaeology* held at Department of History and Archaeology, Rashtriyasant Tukaram Nagpur University, Nagpur during January 05-07, 2016.

Mahesh Prasad, V.K. Singh & M.F. Quamar participated in the *International Conference on Geosciences and Environment & 32nd Convention of the Indian Association of Sedimentologists & Workshop on Shale Oil & Gas Exploration* held at Annamalai University, Chidambaram during January 07-10, 2016.

Vandana Prasad participated in the *INQUA-HABCOM Workshop on Palaeoanthropological Perspectives on Plant Communities in South Asia* held at French Institute, Pondicherry during January 21-24, 2016.

C.M. Nautiyal participated in the *Symposium on Towards a Green Future* held at Department of Economics, Allahabad University, Allahabad during February 05-06, 2016.

C.M. Nautiyal participated in the *10th Uttarakhand State Science Congess-2016* held at Vigyan Dham, Dehradun during February 09-11, 2016.

Sunil Baipai, R.S. Singh, R.C. Mehrotra, Madhav Kumar, B.D. Singh, Jyotsana Rai, B.D. Mandaokar, Vandana Prasad, Anjum Farooqui, A.K. Ghosh, Anupam Sharma, G.K. Trivedi, Rajesh Agnihotri, Ratan Kar, Binita Phartiyal, Pawan Govil, S.K. Basumatary, Biswajeet Thakur, S.K. Shah, P.S. Ranhotra, Anju Saxena, Poonam Verma, Ruby Ghosh, Anjali Trivedi, K.G Misra, Gaurav Srivastava, Kamlesh Kumar, Abha Singh, Shailesh Agrawal, P. Morthekai, V.V. Kapur, S.N. Ali, Jyoti Srivastava, R.P. Mathews, M.F. Quamar, Suman Sarkar, Nivedita Mehrotra, Arindam Chakraborty, Sandhya Misra, Syed Azharuddin, Ipsita Roy & Shazi Farooqui participated in the *3rd NECLIME (Neogene Climate Evolution of Eurasia) Asian Meeting* held at BSIP, Lucknow during February 23-25, 2016.

O.S. Sarate participated in the *National Conference on Advances and Innovations in Plant Sciences (NCAIPS-2016)* held at Department of Botany, Govt. Vidarbha Institute of Science and Humanities, Amravati during February 29-March 01, 2016.

O.S. Sarate participated in the *National Seminar on Recent Trends in Life Sciences and Materials Science (RTLSMS-2016)* held at Rashtrapita Mahatma Gandhi Arts and Science College, Ghodazari Nagbhid Nagbhid (District Chandrapur), Maharashtra during March 14-15, 2016.

C.M. Nautiyal participated in the *Brain Storming Session on Search for Micro-organisms in Space* organized by ISRO at CSIR-National Centre for Cell Science, Pune during March 2016.

C.M. Nautiyal participated in the *Bhasha Utsav tatha Sangoshthee* organized by Bhartiya Bhasha Pratishthapan Rashtriya Parishad-UP during March 19-20, 2016.

Nilay Govind & Sumit Bisht attended the *Workshop on Recent Advances in Bioinformatics: Agriculture and Biomedical Informatics* held at Biotech Park, Lucknow during July 23-25, 2015.

Y.P. Singh attended the *4th National NKN Workshop* held at Jawaharlal Nehru Technological University, Kukatpally, Hyderabad during January 21-22, 2016.

Manisha Tharu attended the *National Seminar on Dalit Assertion and Empowerment: Reflection on Uttar Pradesh* held at Dept. of Sociology, University of Lucknow during March 30-31, 2016.

Training/Study Visits

Abroad

Deepa Agnihotri visited the Department of Botany and Palaeobotany, Centro Universitário UNIVATES, Lajeado, Rio Grando do Sul, Brazil during March 23-May 13, 2015 in connection with the DST sponsored Indo-Brazilian project.

Neerja Jha visited the Department of Geology and Department of Botany, University of Peradeniya, Peradeniya, Sri Lanka during June 15-25, 2015 under DST sponsored Indo-Sri Lanka Joint Research Project.

P.S. Ranhotra visited the Institute of Botany, Chinese Academy of Sciences, Beijing, China during July 30-September 14, 2015. On invitation worked with Prof. Y.F. Wang and Dr. J.F. Li on palynology of a sedimentary profile from the eastern Tibet region.

Rashmi Srivastava visited USA and The Netherlands under collaborative research programme funded by National Science Foundation during October 11 to November 22, 2015. Worked in the Florida Museum of Natural History (with Prof Steven R. Manchester) and Department of Forest Biomaterials, North Carolina State University, Raleigh (with Prof. E. Wheeler) of USA; and Naturalis and National Herbarium, Leiden University, Leiden (with Dr. Pieter Baas). Also visited the Smithsonian Institution, Washington DC, and Montgomery Botanical Center and the herbarium of Fairchild Tropical Botanical Garden at Miami (Florida).

Ratan Kar & Pawan Govil joined the *35th Indian Scientific Expedition to Antarctica (Summer Batch)* for about three and half months (November 16, 2015- February 28, 2016) to carryout field work in Quaternary deposits.

Mayank Shekhar & Amalava Bhattachryya visited the Dendrolab of University of Bern, Dendrolab, Switzerland under the Indo-Swiss Training Program on 'Assessment of risk and hazard in Kullu district, Himachal Pradesh' and acquired higher training on flood disaster for vulnerability assessment, snow avalanches analysis based on tree-ring studies. The duration of training for AB was from June 04 to July 03, 2015, and for MS was from June 04 to September 06, 2015.

In India

S.K. Shah, K.G. Misra, Anju Saxena, S.S.K. Pillai, M.F. Quamar, A.H. Ansari, Jyoti Srivastava, Neelam Das & Suman Sarkar attended the Refresher Course on Palaeontology and Biostratigraphy held at the Regional Training Institute, Geological Survey of India, Lucknow during May 11-16, 2015.

Neerja Jha attended the Meeting of Subject Expert Committee on Earth and Atmospheric Sciences held at BSIP, Lucknow during September 25-26, 2015.

Binita Phartiyal attended the 1st GMW and Evaluation meeting organized at SV University, Tirupati during November 05-06, 2015.

K.J. Singh, Rajni Tewari, A.K. Ghosh, V.K. Singh, Biswajeet Thakur, Anju Saxena, S.S.K. Pillai, Poonam Verma & Pawan Kumar deputed to attend 35th India International Trade Fair–2015 (for Museum Exhibits Expo under the banner of DST) at Pragati Maidan, New Delhi during November 14-27, 2015.

V.K. Singh, Anju Saxena, P.S. Ranhotra, Poonam Verma, Deepa Agnihotri, M.F. Quamar, Jyoti Srivastava & Manoj M.C. deputed to attend 1st India International Science Festival 2015 at Indian Institute of Technology, New Delhi during December 04-08, 2015.

Madhav Kumar & Rupendra Babu deputed to attend the Annual Festival and Exhibition at Simonee village, Block- Baberoo, District Banda organised under the banner of DST (New Delhi) and SCT (UP) during December 13-17, 2015.

Rashmi Srivastava attended the Executive Council Meeting of the International Society of Plant Morphologists at University of Delhi on December 26, 2015.

Anupam Sharma attended the Programme Advisory Committee meeting under the MoES scheme organized at NCAOR, Goa during January 14-15, 2016.

K.G Misra attended the Project Assessment Committee meeting of DST-RSF Programme organized at M.P. State Council of Science and Technology, Bhopal on January 18, 2016.

Rajesh Agnihotri & P. Morthekai attended the National Excavation of Archaeological Survey of India at 4MSR site (in Binjor, Anupgarh) of western Rajasthan during February 25-March 01, 2016.

Manisha Tharu attended the Youth-Led Sustainable Development Programme on Environment and Sustainability (for SC/ST candidates) held at Centre for Advanced Studies in Social Work, University of Lucknow during March 15-19, 2016.

Lectures Delivered

Gondwanan India: the Cradle of Origin and Early Evolution of Modern Mammals at NCAOR, Goa (July, 2015) – delivered by Sunil Bajpai

Tertiary Mammal Faunas of India: An Overview of Recent Advances (Keynote Lecture) at 3rd NECLIME Asian Meeting, BSIP Lucknow (February 23, 2016) – delivered by Sunil Bajpai

Palaeogene Terrestrial Vertebrates from India: Recent Finds and their Evolutionary and Biogeographic Significance (Foundation Day Week Lecture) at GSI Northern Region, Lucknow (February 29, 2016) – delivered by Sunil Bajpai

Northward Drifting Indian Plate: the Cradle of Origin and Early Evolution of Modern Mammals at IISER, Kolkata (February 06, 2016) – delivered by Sunil Bajpai

An Introduction to BSIP and Application of Palynology in Gondwana Stratigraphy, Phytogeography and Palaeoclimate: A case study in Godavari Graben at Department of Geology, University of Peradeniya, Peradeniya, Sri Lanka (June 19, 2015) – delivered by Neerja Jha

Tertiary flora of India at the Geological Survey of India, Lucknow (May 12, 2015) – delivered by R.C. Mehrotra

Intertrappean flora of Central India at Department of Applied Geology, Dr. H.S. Gaur University, Sagar (January 27, 2016) – delivered by R.C. Mehrotra

Save our Earth at Regional Science City, Lucknow (April 22, 2015) – delivered by Mukund Sharma

Precambrian Palaeontology at Regional Training Institute, Geological Survey of India, Northern Region, Lucknow (May 11, 2015) – delivered by Mukund Sharma

Evidence of Evolution of Early Life from Precambrian Basins of India at University of Petroleum and Energy Studies, Dehradun (September 06, 2015) – delivered by Mukund Sharma

Gondwana Flora for Refresher Course on Palaeontology and Biostratigraphy under the GSI-BSIP joint programme at BSIP, Lucknow (May 12, 2015) – delivered by K.J. Singh

Nannofossils– David Size and Goliath Applications at the Kachchh University, Bhuj (January 20, 2016) – delivered by Jyotsana Rai

Flora of Deccan Intertrappean Sediments of India and its Biogeography at Florida Museum of Natural History, Florida, USA (October 21, 2015) – delivered by Rashmi Srivastava

Palaeoethnobotany at Department of Ancient Indian History and Archaeology, University of Lucknow, Lucknow (May 15, 2015) – delivered by Chanchala Srivastava

Palaeoethnobotany at Department of Ancient Indian History and Archaeology, University of Lucknow, Lucknow (March 11-12, 2016) – delivered by Chanchala Srivastava

Palaeoclimate and Palaeoecology: Past, Present and Future at Brahmanand Post Graduate College, Kanpur (September 18, 2015) – delivered by Anjum Farooqui

Recent Advancements on the studies of Fossil Calcareous Algae (Keynote Lecture) at 25th Indian Colloquium on Micropalaeontology and Stratigraphy held at Institute of Science, Aurangabad (December 16, 2015) – delivered by A.K. Ghosh

Earthquake and Awareness on Lucknow Doordarshan (April 27, 2015) – delivered by C.M. Nautiyal

Isotopes and Astrosciences at Department of Maths and Astronomy, University of Lucknow, Lucknow (May 09, 2015) – delivered by C.M. Nautiyal

Radiocarbon Dating Technique at Training Course on Palaeontology and Biostratigraphy, GSI Northern Region, Lucknow (May 12, 2015) – delivered by C.M. Nautiyal

Dr. APJ Abdul Kalam on Lucknow Doordarshan (July 28, 2015) – delivered by C.M. Nautiyal

Dr. APJ Abdul Kalam: An Innovator on Akashvani (Prasar Bharti), Lucknow (July 28, 2015) – delivered by C.M. Nautiyal

Innovation for the Nation at Allupur Diguria Vidyalaya, Lucknow under District Science Club Programme (August 08, 2015) – delivered by C.M. Nautiyal

Nuclear- and Cosmo-chemistry: In Unraveling the Mysteries of the Histories at National Symposium on Innovative Methods in Chemistry Education & National Convention of Chemistry Teachers, Department of Chemistry, University of Lucknow (October 10, 2015) – delivered by C.M. Nautiyal

The Meaning of Creativity at Children's Creativity and Innovation Workshop, UP-Council of Science & Technology (October 15, 2015) – delivered by C.M. Nautiyal

Climate Change and its Impact at National Agricultural and Rural Bank (NABARD) Training Institute, Lucknow (November 04, 2015) – delivered by C.M. Nautiyal

Writing Science Right, From Print to Screen and *Approaching and Interacting with Scientists* (3 lectures) at National Workshop on Science Films, RSC, Bhopal (December 17-19, 2016) – delivered by C.M. Nautiyal

Bharat me Vigyan Sanchar ka Paridrishya at MP Council for Science & Technology, Bhopal (December 18, 2015) – delivered by C.M. Nautiyal

Face to Face with students during the National Children's Science Congress-2015 (by NCSTC, DST) at Chandigarh University, Chandigarh (December 29, 2015) – Interacted by C.M. Nautiyal

Climate Change Issues (2 lectures) at UGC Human Resource Development Centre, University of Lucknow, Lucknow (December 30, 2015) – delivered by C.M. Nautiyal

Principles and Method of Radiocarbon Dating, Applications of Radiocarbon Dating to Archaeology and *Applications of Radiocarbon to Palaeobotany and Palaeoclimate* (3 lectures) at Department of History & Archaeology, Nagpur University, Nagpur (January 5-7, 2016) – delivered by C.M. Nautiyal

Innovation Awareness at Vikas Khand Sabhagar, Gusain Ganj, Lucknow (January 28, 2016) – delivered by C.M. Nautiyal

Climate Issues: Radicarbon and Palaeoclimate (2 lectures) at UGC Human Resource Development Centre, University of Lucknow, Lucknow (January 12, 2016) – delivered by C.M. Nautiyal

Innovation and Sustainable Development at Gorakhpur Mahotsav, University of Gorakhpur, Gorakhpur (January 29, 2016) – delivered by C.M. Nautiyal

Science Communication, Rural Development and Society (Lead Lecture) at 10th Uttarakhand State Science Congress-2016, Dehradun (February 09, 2016) – delivered by C.M. Nautiyal

Science and Media at Brainstorming Session, 10th Uttarakhand State Science Congress-2016, Dehradun (February 9-11, 2016) – delivered by C.M. Nautiyal

How Old is Old? Radiocarbon Dating (National Science Day Keynote Address) at Uttarakhand Council of Science & Technology, Vigyan Dham, Dehradun (February 28, 2016) – delivered by C.M. Nautiyal

Climate Change and Environment at INSPIRE programme (DST & Uttarakhand CST), Vikas Bhawan, Paudi (February 28, 2016) – delivered by C.M. Nautiyal

Search for Extra-terrestrial Life at INSPIRE programme (DST & Uttarakhand CST), Centre for Biotechnology, Bhimtal (March 12, 2016) – delivered by C.M. Nautiyal

Methods of Dating (2 lectures) at Department of Ancient History and Archaeology, University of Lucknow, Lucknow (March 19, 2016) – delivered by C.M. Nautiyal

Environment and Sustainable Development at Centre for Advanced Studies in Social Work, Human Resource Development Centre, University of Lucknow (March 19, 2016) – delivered by C.M. Nautiyal

Utility of Stable Isotopes in Archaeological Sciences to Post Graduate Diploma students at ASI's excavation camp in Binjor (4MSR), Anupgarh, Rajasthan (February 27, 2016) – delivered by Rajesh Agnihotri.

Poles (Antarctica, Arctic, Third Pole)- Scientific Scope, Opportunities and Challenges at Swyam Siddha Organisation, Lucknow (August 23, 2015) – delivered by Binita Phartiyal

Interpreting the Quaternary Climatic History of the Arctic Region: Multi-proxy Approach and *Investigation of Climatic Changes during the Holocene from Western Himalayan Glaciers: Palynological Implications* in Refresher Course on Climate Change at Academic Staff College, University of Allahabad, Allahabad (March 10, 2016) – delivered by Ratan Kar

On Archaeobotanical Aspects to PGDA students of 1st Semester at Institute of Archaeology, Red Fort, Delhi (December, 2015) – delivered by A.K. Pokharia

Tree-ring based Climate Reconstructions from Lidder Valley, Kashmir Himalaya (Invited talk) at 11th JK Science Congress-2015, University of Kashmir (October 13, 2015) – delivered by S.K. Shah

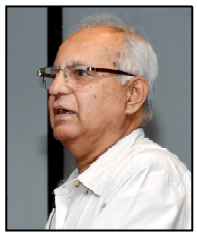
Quaternary Palynology at Department of Ancient Indian History and Archaeology, University of Lucknow, Lucknow (March 11-12, 2016) – delivered by Anjali Trivedi

Pollen and Quaternary Palaeoclimate: Indian Perspectives at Department of Geology, SPPU, Pune (October 23, 2015) – delivered by M.F. Quamar

Luminescence Dating- Basics and Applications to Archaeology to Post Graduate Diploma students at ASI's excavation camp in Binjor (4MSR), Anupgarh, Rajasthan (February 27, 2016) – delivered by P. Morthekai

Role of Biological Proxies in Palaeoclimate Studies at Kohima Science College, Kohima (March 21, 2016) – delivered by Sandhya Misra

Lectures by Visiting Scientists



The New Energy Paradigm (Technology Day Lecture) – delivered by Shri Bibek Bandyopadhyay, Lucknow (May 13, 2015).

Depositional Environment Systems (a series of lectures) – delivered by Prof. I.B. Singh, University of Lucknow (during August 07-20, 2015).

Use of Palynology – delivered by Dr. James B. Riding, British Geological Survey, UK (November 18, 2015).

How to Study Diniflagellate Cysts – delivered by Dr. James B. Riding, British Geological Survey, UK (November 19, 2015).

Evolution of Dinoflagellates – delivered by Dr. James B. Riding, British Geological Survey, UK (November 20, 2015).

How to Prepare Papers in Palynology – delivered by Dr. James B. Riding, British Geological Survey, UK (November 23, 2015).

Safety on Information Highway (Vigilance Awareness Week Lecture) – delivered by Dr. Aravind Chaturvedi, PPS, Additional Superintendent of Police (STF), Lucknow (October 30, 2015).

Changing Facets of Palaeo-Phyto-Science (5th Dr. B.S. Venkatachala Memorial Lecture) – delivered by Dr. Annamraju Rajanikanth, Scientist-F, BSIP, Lucknow (January 04, 2016).

The Arabian Plate: A Permian Garden of Paradise? (2nd Dr. K.R. Surange Memorial Lecture) – delivered by Prof. Hans Kerp, Institute for Geology and Palaeontology, University of Munster, Germany (February 05, 2016)

Mesozoic Cycads and their Living Counterparts (2nd Dr. M.N. Bose Memorial Lecture) – delivered by Prof. D.K. Chauhan, Department of Botany, Allahabad University, Allahabad (March 03, 2016).

Consultancy/Technical Support Rendered

The Radiocarbon Laboratory also served as a national facility for scientists from various organizations and researchers across the country for dating materials like sediments, charcoal, shells and other carbonates, etc. under consultancy. Workers from the following institutions/individuals availed of the consultancy services for radiocarbon dating:

Sambhalpur University, Odisha

Dr. H. Chishi, Dimapur, Nagaland

NSEM, National Centre for Earth System Sciences, Thiruvananthpuram, Kerala

Jnana Pravah Centre for Cultural Studies and Research, Varanasi

Archaeological Survey of India, Bhubneshwar, Odisha

University of Calcutta, Kolkata, West Bengal

Agharkar Research Institute, Pune, Maharashtra

Department of History, Govt. College, Bhavaniptha, Odisha

Dept of Geology, Dnyanopasak College, Parbahani, Maharashtra

University of Kalyani, Kalyani, West Bengal

Consultancy services have been rendered to Oil India Limited, Mizoram on *Biostratigraphical studies on the subsurface samples of well #AIBAWK-1 in Mizoram* (*NELP-VA Block: MZ-ONN-2004/1*) (under OIL-BSIP contract No. 6206428). The sedimentary successions encountered in the well between 2730-4125.30 m intervals have been studied for the palynological constituents of the samples to interpret the age and palaeoenvironment, besides demarcation of unconformities/hiatuses. Study was conducted on 134 cutting samples available for biostratigraphic interpretations. – by Sunil Bajpai, Mukund Sharma, Madhav Kumar, Jyotsana Rai, Vandana Prasad, V.K. Singh & Rahul Garg.

Anju Saxena served as Field Training Faculty to 20-member joint group of GSI and BSIP scientists for two days field visit to Kalpi area under Refresher Course on Palaeontology and Biostratigraphy, a GSI-BSIP joint programme during May 13-14, 2015. Also, coordinated the lab demonstration at BSIP for Junior Geologists staff of GSI on May 15th under the same programme.

In addition, assistance and summer training were imparted to a number of students from the various institutions as detailed below:

Provided scientific assistance in measurements of vitrinite reflectance and observation under fluorescent light on the carbonaceous shale/shale and coal samples of Raniganj Coalfield to Mr. Debadatta Sen and Ms. Anwita, Ph.D. students of the Department of Applied Geology, Indian School of Mines University, Dhanbad (in May 2015). – by B.D. Singh & V.P. Singh

Imparted training in Radiocarbon Dating to Ms. Ayushi Ram, B.Sc. student of the Dharnidhar Autonomous College, Keonjhar, Odisha under the joint scheme of three academies and INSPIRE (in May-June 2015). – by C.M. Nautiyal

Imparted training on Benthic calcareous marine algae and silicified microfossils from the Neogene sequence of Car Nicobar Island to Mr. Ravi Pratap Singh, M.Sc. (II Sem.) student of the Department of Ocean Studies and Marine Biology, Pondicherry University (Port Blair Campus) (in May-June 2015). – by A.K. Ghosh

Imparted Palynological training on the sediments of Tikak Parbat Formation (late Oligocene), Assam to Mr. Rajat Sharma, B.Tech. student of the University of Petroleum and Energy Studies, Dehradun (in June 2015). – by Madhav Kumar

Provided scientific assistance in measurements of vitrinite reflectance and observation under fluorescent light on Permian shale samples of Raniganj Coalfield to Ms. Subhashree Mishra, Ph.D. student of the CSIR-Central Institute of Mining and Fuel Research (Barwa Road Campus), Dhanbad (in June 2015). – by B.D. Singh & V.P. Singh

Imparted training on the topic Palynofossils from Raniganj Coalfield, Damodar Basin to Ms. Sahil Gupta, B.Tech. student of Earth Science Department, University of Petroleum and Energy Studies, Dehradun (in June 2015). – by Srikanta Murthy

Imparted training on Precambrian Acritarchs to Mr. Mohit Agarwal, B. Tech. student of Geoscience Engineering, University of Petroleum and Energy

Studies, Dehradun (in June 2015). – by Veeru K. Singh

Imparted training on the topic Palynology: a tool in coal exploration of Lower Gondwana sediments of Godavari Graben to Mr. Deepander Pratap Singh, M.Sc. (Geology– IV-Semester) student of H.N.B. Garhwal University, Tehri Garhwal, Uttarakhand (in June-July 2015). – by Neha Aggarwal

Provided scientific assistance in measurements of vitrinite reflectance on lignite samples of western India to Mr. Alok Kumar, Ph.D. student of Rajiv Gandhi Institute of Petroleum Technology, Raebareli (in July 2015). – by B.D. Singh & V.P. Singh

Provided scientific assistance in measurement of vitrinite reflectance and fluorescence microscopy on shale samples of Damodar Basin to Mr. Susheel Kumar Srivastav, Sr. Geologist of Great Eastern Energy Corporation Ltd., registered for Ph.D. degree at ISM, Dhanbad (in July-August 2015). – by B.D. Singh and V.P. Singh

Imparted training on the topic Palaeofloristics, age determination and depositional environment of Jhingurdah and Bina collieries, Singrauli Coalfield (MP) to Mr. Yogesh Kumar, M.Sc. student of Department of Geology, University of Lucknow, Lucknow (in July-August 2015). – by Anju Saxena

Imparted training on the plant taxonomy in relation to climate and phytogeography to Ms. Neelum Mishra, M.Sc. student of the Botany Department, University of Lucknow, Lucknow (in July-August 2015). – by Gaurav Srivastava

Provided scientific assistance in measurements of vitrinite reflectance and observation under fluorescent light on coal and shale samples of Auranga Coalfield to Mrs. Divya K. Mishra and Mr. Suresh K. Samad, Ph.D. students of the Department of Applied Geology, Indian School of Mines University, Dhanbad (in September-October 2015). – by B.D. Singh & V.P. Singh

Provided scientific assistance in measurements of vitrinite reflectance on coal and shale samples of Jambad area, Raniganj Coalfield to Ms. Satabdi Misra, Ph.D. student of the Department of Applied Geology, Indian School of Mines University, Dhanbad (in December 2015). – by B.D. Singh

Imparted training in basic techniques and applications of Coal Petrology to Ms. Nishtha Agarwal, M.Sc. student of Indian Institute of Technology, Roorkee (in December 2015). – by B.D. Singh & R.P. Mathews

Rendered technical supports to Mr. Sayantan Pal, Senior Geologist of Mineral Exploration Corporation Limited (a Govt. of India Enterprise), Nagpur for establishing the coal petrographic study facility at MECL (on February 18, 2016). – by B.D. Singh

Imparted training in Quaternary Palynological study to Ms. Priyanka Raja, Ph.D. student of Anna University, Chennai (in February-March 2016). – by Anjum Farooqui

Supervised two integrated B.Sc.-M.Sc. students of Central University of Sikkim, Gangtok for their winter school training at BSIP. – by Anupam Sharma

Recognition

Sunil Bajpai

Inducted as Council Member of the Indian Academy of Sciences, Bengaluru.

Inducted as Member of the Indian National Committee for IUGS-INQUA.

Elected President of the Palaeobotanical Society of India.

Chairperson, Session-IV: *Geodynamic evolution, sedimentation patterns and sequence development (II)* in National Conference on Paleogene of the Indian Subcontinent, GSI & BSIP Lucknow, April 2015.

Rupendra Babu

Elected Fellow of the Palaeobotanical Society of India, Lucknow.

Jyotsana Rai

Elected Fellow of the Palaeobotanical Society of India, Lucknow.

O.S. Sarate

Felicitated by Prof. G.V. Patil, Ex-Vice Chancellor of Sant Gadge Baba Amravati University, Amravati during the National Conference on Advances and Innovations in Plant Sciences held at the Department of Botany, Govt. Vidarbha Institute of Science and Humanities, Amravati (Maharashtra) (on March 01, 2016).

Felicitated by the Vice Chancellor, Dr. N.V. Kalyankar of Gondwana University, Gadchiroli (Maharashtra) during the National Seminar on Recent Trends in Life Sciences and Materials Science held at Ghodazari Nagbhid, Maharashtra for significant contributions in the field of Coal Petrography (on March 14, 2016).

C.M. Nautiyal

Nominated Chairman, National Children's Science Congress State Coordinators' Evaluation Committee by NCSTC (DST) during NCSC-2015 at Chandigarh University, Chandigarh (December 27-31, 2015).

Keynote Speaker for a session and Guest of Honour in the Valedictory Function, Uttarakhand State Science Congress-2016 at Dehradun (February 10-11, 2016).

Keynote Speaker for the Science Day Function at Uttarakhand Council for Science and Technology, Dehradun.

Chairman, Global Warming and Climate Change, Inter-disciplinary Thematic panel, Indian Social Science Congress-2015.

Chaired a session on *Developing Scientific Content for Social Media* during 15th Indian Science Communication Congress at Regional Science City, Lucknow (December 25, 2015).

A.K. Ghosh

Elected President of the International Fossil Algae Association (2015-2019).

Chaired a scientific session in the 11th International Symposium on Fossil Algae during September, 2015 held at Tohuko University, PSJ, GSJ, Japan.

Chaired a scientific session at XXV Indian Colloquium on Micropalaeontology and Stratigraphy during December, 2015 held at Institute of Science, Aurangabad.

Vandana Prasad

Selected as 'Resource Person' for phytolith studies in Archaeology in INQUA-HABCOM Workshop jointly organized by the Sharma Centre for Heritage Education (Chennai) and French Institute

(Pondicherry) and held at Pondicherry in January 2016.

Anupam Sharma

Invited as 'participant' in the NASA (USA) sponsored and INSA (India) supported Group Discussion Meeting on the Srinagar Rains and Floods of 2014 for bringing awareness on climate change.

Binita Phartiyal

Awarded "Dr. P.N. Srivastava Medal-2015" for the best piece of research work done during the last three years, preceding the year of award, in the category of Scientist-D.

Received "Paper of the Month Award– January-February 2015" (declared in May 2015) of BSIP for the paper entitled 'Late-Quaternary geomorphic scenario due to changing depositional regimes in the Tangtse Valley, Trans-Himalaya, NW India' (co-authored by Randheer Singh & G.C. Kothyari) published in *Palaeogeography, Palaeoclimatology, Palaeoecology,* volume 422.

Anjali Trivedi

Awarded "CAS-President's International Fellowship Initiative– Category B: PIFI-2015 Fellowship" of the Chinese Academy of Sciences for Visiting Scientists to work for one year at the Institute of Botany, Beijing.

K.G. Misra

Received "INQUA Young Researcher Grant" to attend XIX INQUA Congress held at Nagoya, Japan in July-August 2015.

S.K. Basumatary

Awarded the "Iyenger-Sahni Medal-2015" in recognition of the best paper published in *The Palaeobotanist* during the two years (2013-2014) preceding the year of award.

Shilpa Pandey

Received "1st Prize for the Best Poster Presentation" of the paper displayed in the *National Hindi Seminar on Global Warming and Climate Change* held at INCOIS, Hyderabad in September 2015.

Gaurav Srivastava

Awarded "Prof. R.C. Misra Gold Medal-2015" by the Wadia Institute of Himalayan Geology, Dehradun for research contributions in Geosciences.

S.K. Pandey

Awarded "CAS-President's International Fellowship Initiative: PIFI-2015 Fellowship" of the Chinese Academy of Sciences for Visiting Scientists to work for six months at the Nanjing Institute of Geology and Palaeontology, PR China.

R.P. Mathews, V.P. Singh & B.D. Singh

Received "One of the Best Poster Presentation Award" of the paper displayed in the *International Conference on 3rd NECLIME Asian Meeting* held at BSIP Lucknow in February 2016.

Jyoti Srivastava & Anjum Farooqui

Received "One of the Best Poster Presentation Award" of the paper displayed in the *International Conference on 3rd NECLIME Asian Meeting* held at BSIP Lucknow in February 2016.

M.F. Quamar

Received "One of the Best Poster Presentation Award" of the paper displayed in the *International Conference on 3rd NECLIME Asian Meeting* held at BSIP Lucknow in February 2016.

Debarati Nag

Awarded "Dr. Pratul Chandra Bhandari Medal-2015" for the best piece of research work done during the last three years, preceding the year of award, amongst the Birbal Sahni Research Scholars.

Arindam Chakraborty

Selected in Newton-Bhabha Ph.D. Placement Programme–2015-16 under the auspices of British Council (UK) and Department of Science and Technology (Govt. of India) for working at Department of Earth Sciences, University College London, United Kingdom.

Ashok Kr. Sharma

Awarded "BSIP Employee Medal-2015" for working diligently and efficiently with extra efforts in discharging the duties of Technical staff (Group I & II).

Indra Kumar

Awarded "BSIP Employee Medal-2015" for working diligently and efficiently with extra efforts in discharging the duties of Multi Tasking staff (Administration).

Representation in Committees/Boards

Sunil Bajpai

- Chief Editor, *The Palaeobotanist*.
- Member, Editorial Board, *Journal of the Geological Society of India* (for Fast Track Articles).
- Member, Editorial Board, *Current Science*.
- Co-Project Investigator, International Geoscience Programe Project (IGCP-608).
- President, Organizing Committee, National Conference on Paleogene of the Indian Subcontinent (GSI & BSIP, April 2015).
- Convener, International Conference on 3rd NECLIME Asian Meeting (BSIP, February 2016).

Neerja Jha

- Vice-President, The Palaeobotanical Society, Lucknow (till December 2015).
- Transparency Officer, BSIP (under RTI Act-2005).
- Member, Subject Expert Committee, Women Scientist Scheme of DST (Earth & Atmospheric Sciences).
- Organizer, 5th Meeting of Subject Expert Committee, WSS-A (at BSIP).

R.S. Singh

- Secretary, The Palaeobotanical Society, Lucknow.

R.R. Yadav

- President, The Palaeobotanical Society, Lucknow (till December 2015).
- Member, Editorial Board, *Himalayan Geology*.
- Member, Editorial Board, *Phytomorphology*.

Rupendra Babu

- Treasurer, The Palaeobotanical Society, Lucknow (since January 2016).
- Member, Judgment Committee for District-level Science Exhibition, Govt. Girls Inter College (Shahmina Rd.), Lucknow organized by District Pariyojna, UP Madhyamik Shiksha Abhiyan.

B.D. Mandaokar

- Joint Secretary, The Palaeobotanical Society of India, Lucknow (till December 2015).

Neeru Prakash

- Editor, *Geophytology* (till December 2015).
- Joint Secretary, The Palaeobotanical Society of India, Lucknow (since January 2016).
- Assistant Transparency Officer, BSIP.

Mahesh Prasad

- Treasurer, The Palaeobotanical Society, Lucknow (till December 2015).

Jyotsana Rai

- Member, Editorial Board, The Palaeontological Society of India, Lucknow.
- Member, Scientific Programming Committee, 3rd NECLIME Conference.
- Member, Publication and Abstract Committee, 3rd NECLIME Conference.

A. Rajanikanth

- Vice-President, The Palaeobotanical Society, Lucknow (since January 2016).

Mukund Sharma

- President, The Society of Earth Scientists, Lucknow.
- Voting Member, ICS, Sub-Commission on Cryogenian Stratigraphy (2012-17)
- Corresponding Member, ICS, Sub-Commission on Ediacaran (2012-17)
- Member, Research Development and Coordination Cell, BSIP.
- Joint Secretary, Executive Council, The Palaeontological Society of India, Lucknow (2014-15).
- Member, Scientific Programming Committee and Publication and Abstract Committee, International Conference on 3rd NECLIME Asian Meeting (BSIP, February 2016).
- Domain Expert, University of Petroleum and Energy Studies, Dehradun.
- Member Board of Studies, Curriculum Development, Baba Saheb Bhimrao Ambedkar University, Lucknow.
- Examiner, M.Sc. Geology– IV Semester Practical, University of Delhi.
- Examiner, Ph.D. Thesis, Department of Geology, University of Delhi.
- Convener, Expert Committee of Peninsular Geology Group at Brain Storming Session, GSI Lucknow, 36th

IGC Cell, Northern Region.

Alpana Singh

- Member, Solid Mineral Fuel Sectional Committee– PCD-7.4: Methods of Analysis Subcommittee, Bureau of Indian Standards, New Delhi.
- Alternate Member, Solid Mineral Fuel Sectional Committee– PCD-7.5: Methods for the Petrographic Analysis of Coal, Coke and Lignite, Bureau of Indian Standards.
- Member, Executive Council, Coal Petrological Society of India.
- Councillor, The Palaeobotanical Society, Lucknow (till December 2015).

B.D. Singh

- Associate Member, International Committee for Coal and Organic Petrology (ICCP).
- Principal Member, Solid Mineral Fuel Sectional Committee– PCD-7.4: Methods of Analysis Subcommittee, Bureau of Indian Standards, New Delhi.
- Member, Executive Council, Coal Petrological Society of India.
- Principal Member, Solid Mineral Fuel Sectional Committee– PCD-7.5: Methods for the Petrographic Analysis of Coal, Coke and Lignite, Bureau of Indian Standards, New Delhi.
- Member, Research Development and Coordination Cell, BSIP.
- Evaluator, Ph.D. Thesis, Department of Applied Geology, Indian School of Mines, Dhanbad.
- Examiner, M.Tech. (Applied Geology), Semester VIII Practical, Kurukshetra University, Kurukshetra.

Chanchala Srivastava

- Executive Member, Indian Society for Prehistoric and Quaternary Studies, Deccan College, Pune.
- Councillor, The Palaeobotanical Society, Lucknow (till December 2015).

Rashmi Srivastava

- Councilor, International Society of Plant Morphologists.
- Member, National Advisory Committee, National Conference on Paleogene of the Indian Subcontinent (BSIP & GSI, April 2015).

Rajni Tewari

- Editor, *The Palaeobotanist*.
- Member, Executive Council, The Palaeontological Society of India, Lucknow.
- Member, National Working Group, IGCP Project-597.

Anjum Farooqui

- Member, International Geological Correlation Programme (IGCP-495).
- Member, International Council for Biodeterioration of Cultural Properties, Lucknow
- Member, International Society of Applied Geochemists, Hyderabad

A.K. Ghosh

- Chief Editor, *Geophytology,* The Palaeobotanical Society, Lucknow (since January 2016).
- Member, Editorial Board, Journal of Environmental Biology.
- Associate Editor, for a special volume of Journal of Environmental Biology.
- Councillor, The Palaeobotanical Society, Lucknow (till December 2015).

C.M. Nautiyal

- Member, Review Committee, National Science Film Festival by Vigyan Prasar (Noida).
- Expert for evaluation of (Hindi) books on Technology, Uttar Pradesh Hindi Sansthan.
- Member, Pre-Examination Meeting (CSIR), University of Hyderabad, Hyderabad.
- Member, Jury for Exotech during Pegasus-2015, La Martiniere College, Lucknow.
- Member, Jury for State Level Model Competition under INSPIRE (DST) Programme.
- Member, Committee for Microbes in Space, ISRO, Bengaluru.
- Member, Science Expo Committee, Regional Science City, Lucknow (NCSM).
- Member, Local Advisory Committee, Regional Science City, Lucknow.
- Member, Outstation, Vigyan Parishad, Prayag.
- Coordinator, Rock Art Documentation Committee, Uttar Pradesh (by IGNCA, New Delhi).
- Vice-Chairperson and Patron, Bhartiya Bhasha Pratishthapan Rashtriya Samiti (UP Branch).
- Member, Working Committee, MR Jaipuria School, Lucknow.
- Adviser, NCSC-Coordination Committee, UP.

Vandana Prasad

- Member, PAC- Climate Change Programme, Ministry of Earth Science.
- Councillor, The Palaeobotanical Society, Lucknow.
- Member, Research Development and Coordination Cell, BSIP.
- Co-Organizing Secretary, National Conference on Paleogene of the Indian Subcontinent (BSIP & GSI, April 2015).
- Organizing Secretary, International Conference on 3rd NECLIME Asian Meeting (BSIP, February 2016).

Anupam Sharma

- Evaluator, Ph.D. Thesis, University of Petroleum and Energy Studies, Dehradun.
- Expert, Ph.D. Viva-Voce, University of Petroleum and Energy Studies, Dehradun.
- Expert, M.Sc. Practical Examination, Deptt. of Environmental Sciences, Central University, Jammu.
- Mentor, for two Post Doctoral Fellows under SERB N-PDF Scheme, DST, New Delhi.
- Member, Supervisor Panel, Joint Science Academies' Summer Research Fellowship Program, supported by all three Science Academies of India.

Ratan Kar

- Member, Terrestrial Working Group, International Arctic Science Committee.
- Assistant Editor, *The Palaeobotanist* (till January 2016).

Binita Phartiyal

- Assistant Editor, *The Palaeobotanist* (since February 2016).
- Councillor, The Palaeobotanical Society, Lucknow (since January 2016).

A.K. Pokharia

- Executive Member, Indian Society for Prehistoric and Quaternary Studies, Pune.
- Councillor, The Palaeobotanical Society, Lucknow (since January 2016).

S.K. Basumatary

- Member, Editorial Board, Bio-Science Letters (an e-journal of Bodoland Univ., Assam)

Shilpa Pandey

- Councillor, The Palaeobotanical Society, Lucknow (since January 2016).

Anju Saxena

- Co-Editor, Editorial Board of an open access journal *Earth Science India*.
- Member, Research Development and Coordination Cell, BSIP.

Vartika Singh

- Scientific Reviewer, International Climate Literacy and Energy Awareness Network, (CLEAN), funded by the National Science Foundation & National Oceanic & Atmospheric Administration, USA.

Biswajeet Thakur

- Co-editor, Earth Science India Website (an Open Access Journal).
- Member, Abstract Review Committee, 3rd NECLIME Conference.
- Judge, Model Display at City Montessori School Rajajipuram Campus-1, National Geography Olympiad & Geofest International-2015 at LDA, Kanpur Road.

Swati Tripathi

- Member, Editorial Board, Journal of Plant Science and Research.

Abha Singh

- External Examiner, Undergraduate Research Project Evaluation, University of Peradeniya, Sri Lanka.
- Member, Publication and Abstract Committee, 3rd NECLIME Conference.

V.V. Kapur

- Editor, Journal *Geophytology* (since January 2016).
- Member, Organizing Committee, National Conference on Paleogene of the Indian Subcontinent (BSIP & GSI, April 2015).

Jyoti Srivastava

- Editor, Journal *Geophytology* (since January 2016).
- Member, Scientific Programming Committee, 3rd NECLIME Conference.
- Member, Publication and Fund Raising Committee, National Conference on Paleogene of the Indian Subcontinent (BSIP & GSI, April 2015).
- Jury Member, Model Display Event in the National Geography Olympiad and Geofest International-2015, City Montessori School, Lucknow.

Ph.D. Programmes

Name of Ph.D. Scholar	Subject	Date of Award/ Registration	University	Supervisor(s)	Title of Ph.D. Thesis
Anjana Vyas	Geology	April 2015 Awarded	Vikram University, Ujjain	Dr. BD Singh (BSIP) Prof. KN Singh	Petrological evaluation of coals from parts of Bisrampur Coalfield, Son Valley, Chhattisgarh
Saurabh Gautam	Botany	November 2015 Awarded	Ravenshaw University, Cuttack	Dr. Rajni Tewari (BSIP) Dr. Shreerup Goswami	Palynostratigraphy of Gondwana sediments in Sohagpur Coalfield, South Rewa Basin, Madhya Pradesh, India
Akhilesh Kumar Yadava	Botany	January 2016 Awarded	University of Lucknow, Lucknow	Dr. RR Yadav (BSIP) Prof. YK Sharma	Application of tree-ring chronologies to understand climate variability in the western Himalaya, India
Chinnappa Chopparapu	Botany	March 2016 Awarded	Andhra University, Visakhapattnam	Dr. A Rajanikanth (BSIP) Prof. YV Rao	Contribution to plant ecosystem of Early Cretaceous sequences of East Coast, India-Floral diversification and ecological implication
Sandeep Kumar	Geology	May 2015 Submitted	Kurukshetra University, Kurukshetra	Dr. Alpana Singh (BSIP) Prof. NN Dogra	Palynostratigraphy and petrology of Panandhro lignites, Kutch Basin, Gujarat, India
Arun Joshi	Botany	July 2015 Submitted	Garhwal University, Srinagar	Dr. Rajni Tewari (BSIP) Dr. RK Jain	The *Glossopteris* flora of Manuguru area, Godavari graben: palaeoecological implications, evolutionary perspectives and basinal correlation
Reshmi Chatterjee	Botany	January 2016 Submitted	Andhra University, Visakhapattnam	Dr. AK Ghosh (BSIP) Prof. GM Narasimha Rao	Floral diversity, biostratigraphy and palaeoecology of the Triassic sequences from the South Rewa and Satpura Gondwana basins
Harinam Joshi	Botany	March 2016 Submitted	Kumaun University, Nainital	Dr. Neerja Jha (BSIP) Dr. Yogesh Joshi	Palynology of subsurface Gondwana sediments in Chintalapudi sub-basin, south India, its stratigraphical and palaeoenvironmental implication
Shreya Mishra	Botany	March 2016 Submitted	Kumaun University, Nainital	Dr. Neerja Jha (BSIP) Prof. SS Gahlain	Permian and Triassic palynology, correlation of Gondwana sediments in Ayyanapalli-Sattupalli-Chintalapudi coal belt and its palaeoenvironmental implications
Priyanka Monga	Botany	March 2016 Submitted	Kumaun University, Nainital	Dr. Madhav Kumar (BSIP) Dr. Yogesh Joshi	Palynostratigraphy, palynofacies and depositional environment of Early Tertiary sediments of Cambay Basin, Gujarat
Ranjana	Botany	March 2016 Submitted	Kumaun University, Nainital	Dr. Anjum Farooqui (BSIP) Dr. Yogesh Joshi	Climate induced relative sea level changes and coastal vegetation in Krishna delta, south east coast of India
Nivedita Mehrotra	Geology	September 2011 Continuing	University of Lucknow, Lucknow	Dr. Amalava Bhattacharyya Prof. Munendra Singh	Analysis of Quaternary climate change in north-east India based on multi-proxy data
Meenakshi Hira	Environ-mental Sciences	July 2012 Continuing	Central Univ. of Himachal Pradesh, Dharamshala & JNU, New Delhi	Dr. Anupam Sharma (BSIP) Dr. Anurag Linda & Dr. Sudesh Yadav	Metal characterization of Computers and Mobile phone e-waste and its impact on different soil types

Vikram Partap Singh	Geology	September 2012 Continuing	Banaras Hindu University, Varanasi	Dr. BD Singh (BSIP) Prof. MP Singh	Petrological and Geochemical characterizations of lignite deposits of Saurashtra Basin (Gujarat), India: Implications to economic potential and depositional setting
Bandana Dimri	Geology	March 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Mukund Sharma (BSIP) Prof. RK Srivastava	Genesis of Mesoproterozoic Chert: A case study from the Salkhan Limestone of the Semri Group, Vindhyan Supergroup and its implication on life in extreme conditions
Debarati Nag	Geology	March 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Binita Phartiyal (BSIP) Prof. Mallickarjun Joshi	Geomorphology, palaeoclimate and neotectonics during Quaternary Period of the Indus Valley between Leh and Batalik, Ladakh Himalaya
Randheer Singh	Geology	March 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Binita Phartiyal (BSIP) Dr. Bindhyachal Pandey	Geomorphology, Tectonics and Climate during Quaternary Period of the Tangtse Valley Ladakh, NW Himalaya
Ruchika Bajpai	Geology	March 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Ratan Kar (BSIP) Prof. AD Singh	Analysis of Climate changes during the Quaternary from glacial sites in India based on multi proxy data
Arindam Chakraborty	Botany	March 2013 Continuing	University of Burdwan, Burdwan	Dr. AK Ghosh (BSIP) Prof. PK Pal	Diversity and palaeoecology of the benthic and planktonic assemblages from the Neogene sequence of Andaman & Nicobar Islands
Surabhi Garg	Geology	September 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Jyotsana Rai (BSIP) Prof. AK Jaitely	Integrated nannofossil-ammonite biostratigraphy of Wagad, Kachchh: palaeoenvironmental and palaeobiogeographic implications
Kriti Misra	Geology	September 2013 Continuing	University of Lucknow, Lucknow	Dr. Ratan Kar (BSIP) Prof. Munendra Singh	Holocene Climatic variability around Chora-Bari Glacier (Kedarnath), Western Himalaya, India
Veeru Kant Singh	Geology	September 2013 Continuing	Banaras Hindu University, Varanasi	Dr. Mukund Sharma (BSIP) Prof. RK Srivastava	Biostratigraphy of the Mesoproterozoic Chhattisgarh Basin exposed in the Bargarh District, Odisha, India
Premraj Uddandam	Botany	November 2013 Continuing	Kumaun University, Nainital	Dr. Vandana Prasad (BSIP) Prof. Hema Joshi	High resolution palaeoclimatic studies from the western Bay of Bengal
Tarasha Chitkara	Geology	July 2014 Continuing	Kurukshetra University, Kurukshetra	Dr. Anupam Sharma (BSIP) Dr. Om Prakash Thakur	Quaternary palaeoclimatic studies using multi-proxy approach around Kurukshetra, Haryana, India,
Nanda Kishore Sahoo	Geology	November 2014 Continuing	Indian School of Mines, Dhanbad	Dr. Sunil Bajpai Dr. Jyotsana Rai (BSIP) Dr. AK Bhaumik	Late Neogene biostratigraphy and climatic changes at Andaman Sea: Planktic foraminiferal and nannoplankton study
Uttam Pandey	Geology	November 2014 Continuing	University of Lucknow, Lucknow	Dr. SK Shah (BSIP) Prof. Munendra Singh	Dendroclimatology of Liddar valley and adjoining areas in Kashmir Himalaya
Tanka Dhar Behra	Geology	February 2015 Continuing	Indian School of Mines, Dhanbad	Dr. Jyotsana Rai (BSIP) Dr. AK Bhaumik	Climatic variation and biostratigraphy of sediments deposited in Krishna-Godavari Basin, Bay of Bengal, India

Units

Publication

Journal— *The Palaeobotanist*

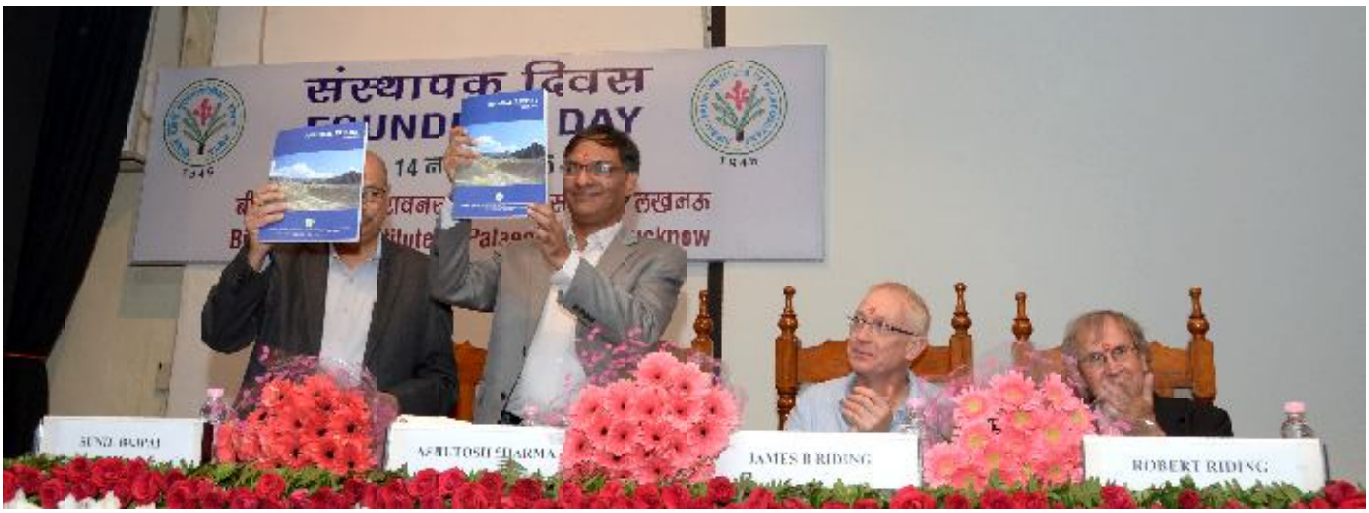
This year three issues of the journal *The Palaeobotanist* have been published. The first 64(1) incorporated 5 research papers. The second 64(2) contained 6 research papers and 1 report. The third 65(1), a special issue on Gondwana, contained 15 papers. The abstracts of all the research papers were also published in Hindi.

Annual Report

Bilingual Annual Report of the Institute was published in Hindi and English containing pertinent information related to research work carried out under different thematic projects during the period April 01, 2014 to March 31, 2015. Besides, research papers published, conference participation, awards/honours, training/deputation, Foundation/ Founders' Day celebrations, reports of different units, annual accounts and related aspects with relevant photographs and graphics were included.

Miscellaneous

Biographical profiles and abstracts of lectures delivered by eminent speakers on various functions were printed. Besides, invitation cards for Foundation Day and Founders' Day and other programmes organized from time to time were also printed.



Knowledge Resource Centre

Knowledge Resource Centre (KRC) is committed to provide best information services and support to its users in the era of information sharing and fulfill its mission to disseminate the knowledge. Besides holding an excellent collection of Palaeobotany and its allied subjects, KRC also provides immediate access of articles by subscribing online databases, e-journals and through National Knowledge Resource Consortium of CSIR-DST. Weekly services of *New Arrivals* having content pages of journals/ books acquired by KRC and *News Clippings* having scientific contents from newspapers and magazines purchased are regularly being communicated to its users. Libsys software supports all in-house operations like cataloguing, circulation, serial control and binding management. The holdings are accessible by OPAC (Online Public Access Catalogue). OPAC is searchable by author, title, accession number, subject and several other fields. The procured new literature is continuously added to the database.

The current holdings of library are as under:

Particulars	Additions during 2015-16	Total
Books (in English)	52	6,302
Journals (bound volumes)	279	17,176
Reprints	-	40,100
Reference Books	-	351
Books (in Hindi)	15	612
Ph.D. Thesis	-	103
Reports	-	46
Maps & Atlases	-	61
Microfilm/ Fisches	-	294
Compact Disk	-	74

(Working hours 09:30–18.00 Monday-Friday)

Currently the library is receiving 157 journals (103 through subscription and 54 through exchange). There are 172 registered card holders using the library facilities.

e-Journals

Web based access of the journals is available over the Institutes' LAN from the following publishers– Elsevier (Science Direct: *http://www.sciencedirect.com/*), John Wiley (*http://onlinelibrary.wiley.com/*), Nature Publishing Group: (Nature: *http://www.nature.com/nature/index.htmal*), Oxford University Press (*http://www.oxfordjournals.org/*), Springer (*http://link.springer.com/*), and Taylor and Francis (*http://www.tandf.co.uk/journals/*).

Databases

Scopus (*http://www.scopus.com/*), Web of Science (*http://apps.webofknowledge.com/*), and JGate@NKRC (*www.jgateplus.com*).

KRC Facilities

KRC resource sharing activities— The library shares its resources with all important academic/ research institutions in India. As a member of NKRC (National Knowledge Resource Consortium), the library keeps close contacts with libraries under DST and CSIR.

Library is for leisure— Library has a separate section for Hindi and English fiction, classic literature, novels, books on general interest and six daily news papers, etc.

Institutional repository— Library has an institutional digital repository available over the web (http://14.139.63.228:8080/pbrep/) and the institute in-house Journal *The Palaeobotanist*, Annual Reports, and Institute Special Publications are accessible over it.

Reprographic activity— KRC has lamination machine to preserve the old and fragile scientific literature.

Exchange Facility

Institutions on exchange panel with our Journal *The Palaeobotanist*	37
Journals received from different institutions on exchange basis	54

Training

KRC is providing 12 months training to two Apprentice trainees for library working.

The following Institutions/Organizations availed the Library facilities: Department of Botany, (Lucknow University, Lucknow), Department of Geology (Lucknow University), University of Kalyani (WB), Annamalai University (Annamalai, TN), Department of A.I.H.C. & Archaeology (BHU, Varanasi), Department of Earth Sciences (IIT Bombay, Mumbai), and University of Petroleum & Energy Studies (Dehradun, Uttarakhand).

Museum

Museum plays a vital role in popularizing and dissemination of the palaeontological knowledge amongst the scholars and students within the country and abroad. Institute's museum continued to remain an attraction and a large number of visitors viewed fossils/exhibits all through the year. BSIP participated and displayed exhibits in various national events throughout the year.

Research materials (megafossils & rock/sediment palynological samples) were collected from 286 localities spreading in different parts of the country by the scientists working on various internal projects as well as on different sponsored projects including DST. Type materials of 35 research papers were submitted by the scientists in the repository during the year. Besides, 6 sets of plant fossils were gifted to various colleges within the country, and fossil specimens were also presented to the distinguished guests as gifts (Mementos) during special occasions in the Institute from time to time.

Museum Holdings

Particulars	Addition during 2015-2016	Total
Type and Figured specimens	484	8,595
Type and figured slides	278	15,006
CDs	25	120

Specimens/samples collected during the field work under different projects:

Project	Specimens (Megafossils)	Samples
Project– 1	9	202
Project– 2	614	10
Project– 3	-	564
Project– 4	246	-
Project– 6	-	130
Project– 7	25	133
Project– 8	-	857
Project– 11	-	51
Project– 13	-	90

Samples deposited in the repository under Sponsored/ Collaborative Projects:

Under MoU between BSIP & GSI	:	100
Contract Research (OIL- 6206428)	:	10
DST Project No.: DST/CCP/PR/07/2011/G	:	67
DST Project Nos.: SR/DGH/44/2012 & SR/DGH/56/2013	:	60
DST Project No.: SB/DGH-69/2013	:	225
DST Project No.: SR/FTP/ES-84/2014	:	122
DST Project No.: SR/FTP/ES-23-2013	:	117
DST Project No.: SR/DGH-56/2013	:	131
DST Project No.: SR/FTP/ES-16/2014	:	120
DST Project No.: SR/FTP/ES-143/2014	:	235
DST Project No.: SR/DGH-89/2014	:	250
DST Project No.: SR/FTP/ES-97/2012	:	302
DST Project No.: SR/FTP/ES-149/2014	:	62
DST Project No.: SR/54/ES/565/2011	:	150
DST Project No.: SR/FTP/ES-141/2014	:	62
DST Project No.: EMR/2015/00081	:	298
BSIP/GSI Collaborative Project	:	43 (+ 2 Specimen)

Specimens / Slides gifted to:

Govt. D.B. Girls' Post Graduate College, Raipur (Chhattisgarh)

Mahatma Gandhi Chitrakoot Gramoday Vishwavidyalaya, Chitrakoot (MP)

Department of Botany, DDU Govt. Girls' Post Graduate College, Rajajipuram, Lucknow (UP)

Head, Department of Botany, Sikkim University, Samdur, PO Tadang, Gangtok (Sikkim)

Dr. Sushovan Bera (Co-ordinator), Post Graduate Department of Botany, Jogamaya Devi College, Kolkata (WB)

Prof. Y Venkateswara Rao, Head, Department of Botany, College of Science & Technology, Andhra University.

Institutional Visitors:

Khandelwal College of Management Science & Technology, Jaipur (Rajasthan)

Serampore College, Post Graduate Department of Botany, Hooghly (West Bengal)

M.L.K. (Post Graduate) College, Balrampur (UP)

Jogamaya Devi College, PG Department of Botany, Shyamaparsad Mukherjee Rd., Kolkata (WB)

Feroze Gandhi College, Raebareli (UP)

Government Digvijaya Autonomous College, Rajnandgaon (Chhattisgarh)

Haflong Government College, Haflong, Dima Hasao (Assam)

National Post Graduate College, Rana Pratap Marg, Lucknow (UP)

Army Public School, Sardar Patel Marg, Lucknow (UP)

St. Thomas School, Civil Lines, Mainpuri (UP)

Electronic Data Processing

National Knowledge Network (NKN) connectivity in the Institute is successfully running and providing 24 hours internet facility to the Institute staff. E-mail accounts for the staff and various Units/Sections have been opened through Google Mail Server on Institute Domain (BSIP.RES.IN). An anti virus program Quick Heal Endpoint Security 6.0 Business edition has been installed with 150 user license to protect the system from viruses and worms.

Computer Section is maintaining and updating the Institute's website regularly. Intranet website has also been launched for Institute users and various utility forms are uploaded in PDF and word format. Notices are regularly updated in Intranet Website. Wireless Internet Connectivity is running within the campus. Institute Facebook page has been created and regularly updated the information with photographs. In addition, Payroll, Form16 and pension packages are also modified as per the requirements of the Account Section.

Computer Section is providing help to the scientists in preparing the multimedia presentations, charts, graphs, lithologs and diagrams for their scientific publications and documentation. Additionally, section personnel delivered related talks on *Manuscript, Table and Graph preparations (MS-Word and MS-Excel)*– delivered by P.S. Katiyar, and on *Preparation of Drawing, Litholog, Figures & Map (Coral Draw)* and another on *Preparation of Poster and Presentation (MS-Powerpoint)*– delivered by Y.P. Singh during the Pre-Ph.D. course work in the Institute on May 18, 2015.

Scanning Electron Microscopy

The SEM unit of the Institute is dedicated for providing help in research and developments for observing morphological and structural characterizations of the samples in the range of micro/nano scale. Scientists from various disciplines studied their samples of varied nature for structural analysis and microphotographs were captured as required. In addition, facility has also been rendered in spare time to the researchers of various other institutions of the country. Recently, the Institute has installed a Field Emission Scanning Electron Microscope (FESEM) model JEOL-7610F with EDS spectroscopy facility for elemental analysis of the samples, which will fulfill the research requirements of the scientists in current global scenario.

Field Emission Scanning Electron Microscope (Model JEOL-7610F)

Section Cutting Workshop

About 600 fossil/rock samples were cut and over 1,570 slides were prepared in the workshop during the year. In addition, about 275 slices were made and polished. A number of scientists, students and teachers visited the Workshop. The visitors were given live demonstration of cutting, grinding, polishing and preparation of thin slides of the fossil material.

Distinguished Visitors

Prof. Ashutosh Sharma, Secretary, Department of Science and Technology, Govt. of India, New Delhi

Padma Bhushan Prof. K.S. Valdiya, Jawaharlal Nehru Centre of Advanced Studies, Bengaluru

Padmashree Prof. M.S. Sodha, Former Vice-Chancellor, Universities of Indore, Bhopal & Lucknow

Prof. S.B. Nimse, Vice-Chancellor, University of Lucknow, Lucknow

Prof. A.K. Tripathi, Director, CSIR-Central Institute for Medicinal and Aromatic Plants, Lucknow

Prof. Robert E. Riding, University of Tennessee, Knoxville, USA

Dr. James B. Riding, British Geological Survey Keyworth, Nottingham, UK

Shri Daljeet Singh Chaudhary, Additional Director General of Police (Law & Order), Uttar Pradesh

Dr. David L. Dilcher, Indiana University, Bloomington, USA

Dr. Volker Mosbrugger, Senckenberg Research Station of Quaternary Palaeontology, Weimar, Germany

Dr. Torsten Utescher, Senchenberg Research Institute and Natural History Museum, Frankfurt; Steinmann Institute, University of Bonn, Germany

Dr. Hans Kerp, University of Munster, Germany

Dr. Arvind Chaturvedi, Additional Superintendent of Police (STF), Lucknow

Prof. D.K. Chauhan, Allahabad University, Allahabad

Prof. Sachhidanand Tripathi, Indian Institute of Technology, Kanpur

Dr. Angela Bruch, ROCEEH Research Centre, Academy of Sciences and Humanities, Heidelberg, Germany

Dr. Susanne Haupt, ROCEEH Research Centre, Academy of Sciences and Humanities, Heidelberg, Germany

Activities in Official Language

The Institute continues to pursue the set goals for official language implementation. The Institute participated in the meeting of *Nagar Rajbhasha Kaaryaanvayan Samiti* during the year 2015-16. The Institute was represented in its meeting in Nagar Rajbhasha Kaaryaanvayan Samiti (Karyaalaya-3) situated in Indian Institute of Sugarcane Research, Lucknow. The scientists and technical officers/employees of the Institute remained active and disseminated science in Hindi through various media. These included popular science lectures in various institutions/schools; radio-talks, TV programmes, interactions during exhibitions and popular science articles.

Hindi Fortnight

Hindi fortnight was celebrated during September 10-24, 2015 in the Institute. During the fortnight, 72 staff members participated in a series of competitions including *Hindi Typing* (*Computer*), *Spot the Errors*, *Noting* and *Scientific Lectures*. Kavi Sammelan was also organized on 23rd September. Prize distribution was held on 8th October 2015 in the main auditorium, in which Hindi books of reputed authors were given away as prizes. The winners were:

Typing	:	I – Ms. Manisha Tharu, II – Mr. Rahul Gupta, III – Saheb Lal Yadav Encouragement – Mr. Raj Kumar
Spot the Errors	:	I – Dr. Anju Saxena, II – Mr. T.K. Mandal, III – Dr. Deepa Agnihotri Encouragement – Dr. Abha Singh, Mrs. Richa Tiwari, Mr. Rahul Gupta, Mr. Ankit Pratap Singh, Mr. Avanish Kumar, Dr. M.F. Quamar & Mr. Raj Kumar
Noting	:	I – Mr. Avanish Kumar, II – Mrs. Sudha Kureel, III – Mr. Rahul Gupta Encouragement – Mr. T.K. Mandal, Ms. Sandhya Singh & Ms. Manisha Tharu
Scientific Lecture	:	I – Dr. Shilpa Pandey, II – Mrs. Kirti Singh, III – Ms. Ranjana Encouragement – Mr. Y.P. Singh & Ms. Bhavna Bajpai

Hindi Workshop

Under mentioned Hindi Workshops were organized. The workshops were followed by lively discussions related to the topics of talks and related terminology:

Paryaavaran ek Nai Drishti by Dr. Pradeep Kumar Srivastava, Ex. Scientist, CDRI Lucknow (on June 19, 2015).

Vatavaran Pradushan by Prof. Sachhidanand Tripathi, IIT Kanpur (on August 24, 2015).

Sambandhon tatha Sampreshan men Bhaavanayon kee Bhoomika by Engr. E.V. Swaminathan (on October 08, 2015).

Dr. Kalaam tatha Navachaar by Padmashree Prof. Mahendra Singh Sodha, ExVice-Chancellor Indore & Lucknow Universities (on October 15, 2015).

A view of Hindi Fortnight Celebrations

Miscellaneous

The computers of the Institute with net facility have access to multi-lingual software. The process of making forms bilingual is near completion. Annual Report of the Institute was published in Hindi also. In the journal of the Institute *The Palaeobotanist*, abstracts of all the research papers in Hindi were also published. Efforts are continued to improve correspondence in Hindi in adherence to the section 3(3) of the Official Language Act 1963.

The Quarterly and Half yearly reports to DST and Nagar Rajbhasha Kaaryaanvayan Samiti (Karyaalaya-3), respectively were prepared and regularly sent. Thus, the Institute is pursuing the implementations of the Official Language policy in all seriousness. Some laboratories were also inspected by committee members and suggestions were made to enhance the use of Hindi.

Governing Body

(w.e.f. 11.03.2014 to 10.03.2017)

Chairman
Prof. Deepak Pental
Former VC, University of Delhi
Director (R&A)
Centre for Genetic Manipulation of Crop Plants
University of Delhi, South Campus, Benito Juarez Road
Dhaula Kuan, New Delhi-110 021

Members

Secretary
(or his nominee)
Department of Science and Technology
Technology Bhavan, New Mehrauli Road
New Delhi-110 016

Finance Adviser
(or his/her nominee)
Department of Science and Technology
Technology Bhavan, New Mehrauli Road
New Delhi-110 016

Prof. Talat Ahmad
Vice Chancellor
Jamia Millia Islamia Central University
Jamia Nagar, New Delhi-110 025

Prof. G.V.R. Prasad
Department of Geology
University of Delhi
Delhi-110 007

Dr. V. Purnachandra Rao
Chief Scientist
CSIR-National Institute of Oceanography
Dona Paula, Goa-403 004

Prof. L.S. Chamyal
Department of Geology
M.S. University
Fatehganj, Vadodara-390 002

Dr. K.J. Ramesh
Scientist-G
Ministry of Earth Sciences
Prithvi Bhavan, IMD Campus, Lodhi Road
New Delhi-110 003

Director General
(Ex-Officio Member)
Geological Survey of India
27, Jawaharlal Nehru Road
Kolkata-700 016

Prof. Sunil Bajpai
Director
Birbal Sahni Institute of Palaeobotany
Lucknow-226 007

Director
(Ex-Officio Member)
Botanical Survey of India
CGO Complex, 3rd MSO Building, Block F,
DF Block, Sector I, Salt Lake City, Kolkata-700 064

Member Secretary
Registrar
Birbal Sahni Institute of Palaeobotany
Lucknow-226 007

Research Advisory Council

(w.e.f. 23.06.2014 to 22.06.2017)

Chairman

Prof. S.K. Tandon
MoES Chair Professor
Department of Earth Science
Indian Institute of Technology, Kanpur-208 016

Member-Convener (Ex-officio)
Director
Birbal Sahni Institute of Palaeobotany, Lucknow

Members

Prof. R. Geeta
Department of Botany
University of Delhi
Delhi-110 007

Prof. G.V.R. Prasad
Department of Geology
University of Delhi
Delhi-110 007

Dr. V.P. Misra
Ex-Dy. Director General, GSI
4/490, Vivek Khand
Gomti Nagar, Lucknow-226 010

Prof. S.D. Biju
Department of Environmental Studies
University of Delhi
Delhi-110 007

Shri S.N. Choudhuri
Director (Geology)
Geological Survey of India
Natural Energy Resources, Mission IIB
Bhu-Bijnan Bhavan, DK-6 Salt Lake
Sector II, Kolkata-700 091

Dr. V. Ravikant
Department of Geology & Geophysics
Indian Institute of Technology
Kharagpur-721 302

Prof. N.N. Dogra
Department of Geology
Kurukshetra University
Kurukshetra-136 119

Dr. Suryendu Dutta
Department of Earth Sciences
Indian Institute of Technology Bombay
Powai, Mumbai-400 076

Shri S.K. Srivastava
Ex-Chairman & Managing Director
Corporate Office, Oil India Limited
Plot No. 9, Near Film City, Sector 16A
Noida-201 301

Member (Ex-officio)
Sr. Deputy Director General
In-charge, Northern Region
Geological Survey of India
GSI Complex, Vasundhara
Sector-E, Aliganj, Lucknow-226 020

Finance and Building Committee

(w.e.f. 23.06.2014 to 22.06.2017)

Chairman (Ex-officio)

Prof. Deepak Pental
Chairman, Governing Body
Birbal Sahni Institute of Palaeobotany

Members

Finance Adviser, DST, New Delhi

Shri B.K. Mishra
Finance and Accounts Officer
Indian Institute of Toxicology Research
M.G Marg, Lucknow-226 001

Shri V.B. Singh
Ex-Chief Engineer (Civil), UPPCL
4/125, Vishal Khand
Gomti Nagar, Lucknow-226 010

Director
Birbal Sahni Institute of Palaeobotany, Lucknow

Non-Member Secretary

Registrar
Birbal Sahni Institute of Palaeobotany, Lucknow

Republic Day (January 26, 2016)

Independence Day (August 15, 2015)

Staff

Director
Prof. Sunil Bajpai

Scientists

Scientist 'G'
Dr. (Mrs) Neerja Jha
Dr. R.S. Singh (w.e.f. 01.07.2015)
Dr. R.R. Yadav (retired w.e.f. 31.01.2016 AN)

Scientist 'F'
Dr. Rupendra Babu
Dr. S.K. Bera (retired w.e.f. 30.04.2015 AN)
Dr. Madhav Kumar
Dr. B.D. Mandaokar (w.e.f. 01.07.2015)
Dr. R.C. Mehrotra
Dr. (Mrs) Neeru Prakash (w.e.f. 01.07.2015)
Dr. Mahesh Prasad
Dr. (Mrs) Jyotsana Rai
Dr. Annamraju Rajanikanth (w.e.f. 01.07.2015)
Dr. O.S. Sarate
Dr. Mukund Sharma
Dr. (Mrs) Alpana Singh (retired w.e.f. 31.12.2015 AN)
Dr. B.D. Singh
Dr. K.J. Singh
Dr. (Mrs) Chanchala Srivastava
Dr. (Mrs) Rashmi Srivastava
Dr. (Mrs) Rajni Tewari

Scientist 'E'
Dr. (Mrs) Anjum Farooqui
Dr. A.K. Ghosh
Dr. K.L. Meena
Dr. C.M. Nautiyal
Dr. (Mrs) Vandana Prasad
Dr. Anupam Sharma
Dr. G.K. Trivedi

Scientist 'D'
Dr. Ratan Kar
Dr. (Mrs) Binita Phartiyal
Dr. A.K. Pokharia

Scientist 'C'
Dr. (Mrs) Deepa Agnihotri (w.e.f. 01.01.2016)
Dr. S.K. Basumatary
Dr. (Ms) Ruby Ghosh
Dr. Pawan Govil
Dr. Kamlesh Kumar (w.e.f. 01.01.2016)
Dr. Abhijit Mazumder
Dr. K.G. Misra
Dr. Srikanta Murthy
Dr. (Mrs) Shilpa Pandey (w.e.f. 01.01.2016)
Dr. S.S.K. Pillai
Dr. P.S. Ranhotra
Dr. (Mrs) K. Pauline Sabina
Dr. (Mrs) Anju Saxena
Dr. S.K. Shah
Dr. (Mrs) Anumeha Shukla (w.e.f. 01.01.2016)
Dr. Hukam Singh
Dr. (Ms) Vartika Singh
Mr. Veeru K. Singh
Dr. Gaurav Srivastava (w.e.f. 01.01.2016)
Dr. Biswajeet Thakur
Dr. (Mrs) Swati Tripathi (w.e.f. 01.01.2016)
Dr. (Mrs) Anjali Trivedi
Dr. (Mrs) Poonam Verma

Scientist 'B'
Dr. (Mrs) Neha Aggarwal
Dr. Shailesh Agrawal
Dr. S.N. Ali
Dr. A.H. Ansari
Dr. V.V. Kapur
Dr. Manoj M.C.
Dr. R.P. Mathews
Dr. P. Morthekai
Dr. (Mrs) Neelam
Dr. S.K. Pandey
Dr. M.F. Quamar
Dr. S.K. Shukla
Dr. (Mrs) Abha Singh
Dr. (Mrs) Jyoti Srivastava

Scientist Emeritus
Dr. Rahul Garg (tenure completed w.e.f. 30.11.2015 AN)
Dr. M.R. Rao (tenure completed w.e.f. 31.07.2015 AN)

(The names are in alphabetical order according to 'surnames')

Birbal Sahni Research Scholar
Ms. Reshmi Chatterjee (tenure completed w.e.f. 30.04.2015)
Mr. Chinnappa Chopparapu (tenure completed w.e.f. 06.11.2015 AN)
Ms. Bandana (Dimri) Shukla (tenure completed w.e.f. 22.10.2015 AN)
Mr. Arun Joshi (tenure completed w.e.f. 24.10.2015 AN)
Mr. Harinam Joshi (tenure completed w.e.f. 26.09.2015 AN)
Ms. Shreya Mishra (tenure completed w.e.f. 01.10.2015 AN)
Ms. Priyanka Monga (tenure completed w.e.f. 15.10.2015 AN)
Ms. Debrati Nag (tenure completed w.e.f. 11.10.2015 AN)
Ms. Ranjana (tenure completed w.e.f. 15.10.2015 AN)
Mr. V.P. Singh (tenure completed w.e.f. 18.10.2015 AN)

Technical Personnel

Technical Officer 'D'
Mrs. Reeta Banerjee (w.e.f. 22.05.2015)
Mr. P.S. Katiyar
Mrs. Sunita Khanna
Mrs. Kavita Kumar
Mr. T.K. Mandal
Mr. R.C. Mishra (w.e.f. 22.05.2015)
Mr. Pradeep Mohan (w.e.f. 22.05.2015)
Mr. Chandra Pal (w.e.f. 22.05.2015)
Mr. V.K. Singh
Mr. V.P. Singh (w.e.f. 22.05.2015)
Mr. Y.P. Singh (w.e.f. 22.05.2015)
Mr. A.K. Srivastava

Technical Officer 'C'
Mr. Madhukar Arvind
Dr. Subodh Kumar
Mr. R.L. Mehra
Mr. V.K. Nigam

Technical Officer 'B'
Mr. S.R. Ali (w.e.f. 22.05.2015)
Mr. D.S. Bisht (w.e.f. 22.05.2015)
Mr. D.K. Pal (w.e.f. 22.05.2015)
Mr. Dhirendra Sharma (w.e.f. 22.05.2015)
Dr. S.K. Singh (w.e.f. 22.05.2015)

Technical Assistant 'E'
Mr. Chandra Bali
Mr. Sumit Bisht
Dr. Nilay Govind
Mr. Avanish Kumar
Mr. M.S. Rana
Mr. S.C. Singh
Mr. A.K. Srivastava
Mr. C. L. Verma

Technical Assistant 'D'
Mr. Pawan Kumar
Ms. Kirti Singh

Technical Assistant 'B'
Mr. J. Baskaran (w.e.f. 22.05.2015)
Mr. A.K. Sharma (w.e.f. 22.05.2015)

Technical Assistant 'A'
Ms. Richa Tiwari
Mr. Ram Ujagar

Administrative Personnel

Registrar: Dr. Ram Shukla (terminated w.e.f. 16.11.2015 AN)
Accounts Officer: Mr. N.B. Tewari
Sr. Private Secretary: Mrs. M. Jagath Janani

Section Officer
Mrs. Ruchita Bose
Mr. Hari Lal
Mrs. Swapna Mazumdar
Mr. K.P. Singh (w.e.f. 31.07.2015 AN)
Mrs. Pennamma Thomas

Stenographer: Mr. Murukan Pillai

Assistant
Mr. Mishri Lal
Mr. S.S. Panwar
Mr. Rameshwar Prasad (w.e.f. 31.07.2015 AN)
Mr. Gopal Singh
Mr. A.K. Srivastava
Mrs. Renu Srivastava
Mr. Koshy Thomas
Mr. N.Unnikannan

Hindi Translator: Mr. Ashok K. Sharma

Upper Division Clerk
Ms. Chitra Chatterjee
Mrs. Sudha Kureel

(The names are in alphabetical order according to 'surnames')

Ms. Manisha Tharu

Lower Division Clerk
Mr. Rahul Gupta
Ms. Anupam Jain
Mr. R.K. Mishra
Mr. Mahesh Nayar
Mr. Manoj Singh

Driver
Mr. Nafis Ahmed ('IV')
Mr. D.K. Mishra ('IV')
Mr. M.M. Mishra ('IV)
Mr. V.P. Singh ('IV')
Mr. P.K. Mishra ('III')

Multi Tasking Staff

MTS: Mr. K.C. Chandola

MTS 'II'
Mr. K.K. Bajpai
Mr. Kesho Ram
Mr. D.B. Kunwar
Mr. M.L. Pal
Mr. Ram Dheeraj
Mr. Mohammad Shakil
Mr. Bam Singh
Mr. Ram Singh

MTS 'I'
Mr. R.K. Awasthi
Ms. Bhawana Bajpai
Mrs. Beena
Mr. V.S. Gaikwad
Mr. Hari Kishan
Mr. Deepak Kumar
Mr. Inder Kumar
Mr. Raj Kumar
Mr. Ramesh Kumar
Mr. Shailesh Kumar
Mr. Suneet Kumar
Mr. Haradhan Mahanti (retired w.e.f. 30.06.2015 AN)
Ms. Nandani
Mr. Kailash Nath
Mr. Mathura Prasad
Mr. Ram Chander
Mrs. Ram Kali
Mr. Ram Kewal
Mr. Ravi Shankar
Mr. A.P. Singh
Ms. Sandhya Singh

Sponsored Project Personnel
Dr. Mayank Shekhar, RA
Dr. A.K. Yadava, RA
Dr. Shambhu Kumar, Young Scientist (resigned w.e.f. 26.02.2016 AN)
Ms. Ruchika Bajpai, SRF (tenure completed w.e.f. 30.06.2015 AN)
Mr. Arindam Chakraborty, DST Inspire Fellow
Ms. Kriti Mishra, CSIR-JRF
Mr. Premraj Uddandam, JRF
Mr. Syed Azharuddin, JRF
Mr. Saurabh Gautam, UGC-JRF
Ms. Ipshita Roy, JRF
Mr. N.K. Sahoo, UGC-JRF (resigned w.e.f. 09.11.2015 AN)
Mr. Uttam Pandey, JRF
Ms. Priyanka Joshi, JRF
Mr. Vikram Singh, JRF
Mr. Ashish Kr. Pal, JRF
Mr. S.L. Yadav, Project Assistant
Ms. Shazi Farooqui, Project Assistant
Mr. R.R. Verma, Field Assistant

Retired Staff


Dr. (Mrs) Alpana Singh


Dr. S.K. Bera


Mr. Haradhan Mahanti


Dr. R.R. Yadav

Appointments

Dr. Rajesh Agnihotri, Scientist 'E' w.e.f. 22.09.2015.

Under BSIP Ph.D. Programme

Mr. Husain Shabbar, Junior Research Fellow (Category II- self supported) w.e.f. 19.06.2015.

Ms. Jyotsana Dubey, Junior Research Fellow (Category II- self supported) w.e.f. 03.07.2015 (resigned w.e.f. 22.09.2015 AN).

Ms. Shivangi Tiwari, Junior Research Fellow (Category II- self supported) w.e.f. 13.07.2015.

Ms. Shalini Sharma, Junior Research Fellow (Category II- self supported) w.e.f. 05.08.2015.

Mr. Anand Prakash, Junior Research Fellow (Category I- CSIR-UGC NET supported) w.e.f. 14.08.2015.

Sponsored Project Personnel

Dr. Suman Sarkar, Principal Investigator w.e.f. 09.09.2015.

Dr. Shamim Ahmed, Principal Investigator/Post-Doctoral Fellow w.e.f. 09.09.2015.

Dr. Sandhya Misra, Principal Investigator w.e.f. 04.11.2015.

Dr. S. Jeyakumar, Research Associate w.e.f. 03.12.2015.

Mr. Ashish Kumar Mishra, Junior Research Fellow (MOES sponsored) w.e.f. 26.11.2015.

Ms. Jyotsana Dubey, Junior Research Fellow (DST sponsored) w.e.f. 23.09.2015.

Ms. Shivani, Junior Research Fellow (DST sponsored) w.e.f. 07.12.2015.

Ms. Ruchika Bajpai, Women Scientist (under WOS-A Scheme) w.e.f. 18.03.2016.

Mrs. Nivedita Mehrotra, Women Scientist (under WOS-A Scheme) w.e.f. 21.03.2016.

Reservations and Concessions

The Institute is following General Reservation Orders of the Government of India as applicable to Autonomous Bodies and amended from time to time for the reservations and concessions of Scheduled Castes (SC), Scheduled Tribes (ST), Other Backward Classes (OBC) and Physically Handicapped Persons for the posts meant for direct recruitment in Group 'A', 'B', 'C' and 'D' as per Govt. of India Orders.

Obituary

Shri Om Prakash
Technical Assistant 'D'
passed away on
09.05.2015.

Shri Shree Ram
Ex-Multi Tasking Staff 'I'
passed away on
26.05.2015.

Shri Ghanshyam Singh
Ex-Accounts Officer
passed away on
12.06.2015.

Dr. S.M. Vethanayagam
Technical Officer 'B'
passed away on
12.09.2015.

Shri Rajaram
Ex-Attendant 'III'
passed away on
25.09.2015.

Dr. D.C. Saini
Ex-Scientist 'F'
passed away on
30.10.2015.

Shri K.N. Yadav
Attendant 'II'
passed away on
18.11.2015.

Shri Prem Prakash
Ex-Technical Officer 'D'
passed away on
03.12.2015.

Dr. Anand Prakash
Ex-Scientist 'F'
passed away on
12.12.2015.

Shri Bishnu Dutt Joshi
Ex-Chowkidar
passed away on
26.03.2016.

AUDITOR'S REPORT

To the Governing Body of 'The Birbal Sahni Institute of Palaeobotany, 53, University Road, Lucknow

Report on the Financial Statements

1. We have examined the Balance Sheet of **M/s Birbal Sahni Institute of Palaeobotany, 53, University Road, Lucknow** as at 31st March 2016 and also the Income & Expenditure Account and Receipt and Payment Account for the year ended on that date and a summary of significant accounting policies and other explanatory information, attached herewith**.**

Management's Responsibility for the Financial Statements

2. Management is responsible for the preparation of these financial statements that give a true and fair view of the financial position and financial performance of the society in accordance with the Accounting Standards issued by the Institute of Chartered Accountants of India. This responsibility also includes maintenance of adequate accounting records in accordance with the provisions of the Act for safeguarding of the assets of the Institute and for preventing and detecting frauds and other irregularities; selection and application of appropriate accounting policies; making judgments and estimates that are reasonable and prudent; and design, implementation and maintenance of adequate internal financial controls, that were operating effectively for ensuring the accuracy and completeness of the accounting records, relevant to the preparation and presentation of the financial statements that give a true and fair view and are free from material misstatement, whether due to fraud or error.

Auditor's Responsibility

3. Our responsibility is to express an opinion on these financial statements based on our audit. We conducted our audit in accordance with Standards on auditing issued by the Institute of Chartered Accountants of India. Those Standards require that we comply with the ethical requirement and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement(s).

4. An audit includes performing procedures to obtain audit evidence about the amounts and disclosures in the financial statements. The procedures selected depend on the auditor's judgment, including the assessment of the risks of material misstatement of the financial statements, whether due to fraud or error. In making those risk assessments, the auditor considers internal control relevant to the Company's preparation and fair presentation of the financial statements in order to design audit procedure that are appropriate in the circumstances, but not for the purpose of expressing an opinion on the effectiveness of entity's internal control. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

5. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our audit opinion.

Opinion

6. **Subject to our comments in Annexure-A to our audit report attached**, in our opinion and to the best of our information and according to explanations given to us, the said accounts, read with notes thereon, if any give a true and fair view in conformity with the accounting principles generally accepted in India:

   i. In the case of the Balance Sheet, of the state of the affairs of the society as at 31st March, 2016, and

   ii. In the case of the Income & Expenditure account, of the surplus of the society for the year ended on that date.

iii. In the case of the Receipt & Payment account, of the receipts and payments of the society for the year ended on that date.

Report on Other Legal and Regulatory Requirements

7. As required by Section 12A(b) of Income Tax Act, 1961:

a) We have sought and obtained all the information and explanations, which, to the best of our knowledge and belief, were necessary for the purposes of the audit.

b) In our opinion, proper books of account have been kept by the society so far as appears from our examination of the books.

c) The balance sheet, the Income & Expenditure Account and the Receipt & Payment account are in agreement with the books of account maintained at the head office at Lucknow.

d) In our opinion there are no observations or comments on the financial transactions, which may have an adverse effect on the functioning of the Society.

For: Singh Agarwal & Associates
Chartered Accountants

Mukesh Kumar Agarwal
FCA, DISA (ICAI)
Partner
Membership No - 073355

Place: Lucknow

Date: 07th September 2016

ANNEXURE - 'A'

(Annexed to and forming part of the Audit Report for the year ended 31st March, 2016)

COMMENTS / AUDIT OBSERVATIONS ON ACCOUNTS OF 'BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY' - LUCKNOW

LOANS & ADVANCES:

01. Advances (capital head) unsettled and pending for recovery / adjustment as on 31.03.2016 under different heads, since long, are to be properly taken care of at the Institute level for early adjustment thereof. Details of which are as under:

PARTICULARS	YEAR	AMOUNT
Advances for Furniture and fixture	2013-14	24000.00
Deputy controller of Accounts	2014-15	3001.00
Skytech Systems (India) Private Limited, Thane	2012-13	40087.00

02. A sum of Rs. 736830/- is being reflected as Credit balance as on 31st of March 2016 in case of M/s Thermo Fisher Scientific Austria. The credit balance is wrongly reflected in the account. The same is on account of "Interest on FDR" not accounted for in the books of accounts of FDR pledged for opening LC in favor of M/s Thermo Fisher. The amount to be transferred to the "Interest on FDR.

03. A sum of Re 1.00 is being reflected as Credit balance as on 31st of March 2016 in case of M/s Agilent technologies, Singapore. Appropriate adjustment of the same is to be done.

04. Register of Advance is not updated and reconciled with financial accounts on regular basis. As on 31st March 2016, a sum of Rs. 3860348/- is outstanding as "Advances for Expenses" which includes the following advances which are outstanding for more than one year and needs to be properly taken care of at the Institute level for early adjustment thereof. Details of which are as under:

NAME OF PERSON/ STAFF	PENDING SINCE	AMOUNT
Ram Avtar	2013-14	25000.00
Perkin Elmer (Advance for maintenance of Equipment)	2013-14	33708.00
V. Nirmala	2013-14	8845.00
Geological Society of India	Before 2012-2013	12000.00

05. Further, a sum of Rs. 13848/-(Credit balance) is being reflected in account in case of Mrs. Swapna Mazumdar as on 31/03/2016. A sum of Rs. 13848/- was given as advance in 2013-2014 and was booked directly in expenditure. The advance was adjusted on 27/03/2015 and the expenditure was again debited and the account of Mrs. Swapna Mazumdar was credited resulting in Credit balance in account. The same is required to be adjusted appropriately.

LIBRARY AND PUBLICATION:

6. Physical verification of the stock of the library books has not been conducted during the financial year 2015-16 or after that date. Physical verification is to be done on yearly basis to reconcile the physical balance available with the book balances.

STORES AND WORKS & BUILDING:

7. Maintenance & up-dation of Fixed Assets register & Stores register needs to be strengthened. The value of fixed assets as per fixed assets register and stores register must match with the value in the fixed assets schedule. Proper reconciliation needs to be done and registers to be updated on regular basis.

8. Physical Verification of the assets is not being done on time. Physical verification of Non-Consumable assets for the year ended 31.03.2016 was done in April 2016 to June, 2016. While verification no summary of Fixed Assets were being prepared. Only a certificate has been issued that "Physical Verification has been done as per books and no discrepancies have been noticed". Mere submission of a certificate will not serve the purpose. Complete verification is required to be done.

9. Physical Verification of the Consumable Items for the year 2015-16 was done on 13th April, 2016. While verification no Summary of Assets/Working Sheet were being prepared. Only a certificate has been issued that "Physical Verification has been done as per books and no discrepancies have been noticed". Mere submission of a certificate will not serve the purpose. Complete verification is required to be done.

LEGAL CASES AND CONTINGENT LIABILITY:

10. List of Legal Cases was provided to us but amount of 'contingent liability', if any, is not mentioned. As per list provided to us, 10 cases are pending as on 31st March 2016 but updated position of the cases that are pending is yet to be provided. Reporting of 'Contingent Liability' is also to be done by the Institute through 'note to accounts'.

For: Singh Agarwal & Associates
Chartered Accountants

Mukesh Kumar Agarwal
FCA, DISA (ICAI)
Partner
Membership No - 073355

Place: Lucknow

Date: 07th September 2016

ANNEXURE - 'A'

(Annexed to and forming part of the Audit Report for the year ended 31.03.2016)
BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, LUCKNOW

AUDIT OBSERVATIONS - FINANCIAL YEAR - 2015-2016

<table>
<tr><th>Sr. No.</th><th>Particulars/observations</th><th>Action Taken</th></tr>
<tr><td>1.</td><td>Advances (capital head) unsettled and pending for recovery / adjustment as on 31.03.2016 under different heads, since long, are to be properly taken care of at the Institute level for early adjustment thereof. Details of which are as under:
<table>
<tr><th>Particulars</th><th>Year</th><th>Amount</th></tr>
<tr><td>Advances for Furniture and fixture</td><td>2013-14</td><td>24000.00</td></tr>
<tr><td>Deputy controller of Accounts</td><td>2014-15</td><td>3001.00</td></tr>
<tr><td>Skytech Systems (India) Private Limited, Thane</td><td>2012-13</td><td>40087.00</td></tr>
</table></td><td>Advance mentioned are outstanding prior to implementation of double entry system of accounting. Most of the cases have already been checked, examined and adjusted. Efforts are being made to adjust the advance mentioned.</td></tr>
<tr><td>2.</td><td>A sum of Rs. 736830/- is being reflected as Credit balance as on 31st of March 2016 in case of M/s Thermo Fisher Scientific Austria. The credit balance is wrongly reflected in the account. The same is on account of "Interest on FDR" not accounted for in the books of accounts of FDR pledged for opening LC in favor of M/s Thermo Fisher. The amount to be transferred to the "Interest on FDR.</td><td>The amount transferred to "Interest on FDR" Head of account.</td></tr>
<tr><td>3.</td><td>A sum of Re 1.00 is being reflected as Credit balance as on 31st of March 2016 in case of M/s Agilent technologies, Singapore. Appropriate adjustment of the same is to be done.</td><td>Adjustment made as per observation.</td></tr>
<tr><td>4.</td><td>A sum of ₹ 3860348/- is outstanding as "Advances for Expenses" which includes the following advances which are outstanding for more than one year and needs to be properly taken care of at the Institute level for early adjustment thereof. Details of which are as under:
<table>
<tr><th>Name of Person/Staff</th><th>Pending since</th><th>Amount (in ₹)</th></tr>
<tr><td>Ram Avtar</td><td>2013-14</td><td>25000</td></tr>
<tr><td>Perkin Elmer (Advance for maintenance of Equipment)</td><td>2013-14</td><td>33708</td></tr>
<tr><td>V. Nirmala</td><td>2013-14</td><td>8845</td></tr>
<tr><td>George Society of India</td><td>Before 2012-2013</td><td>12000</td></tr>
</table></td><td>Out of the sum of ₹ 3860348/- outstanding as advance, a sum of ₹ 17,04,327.00 is to be adjusted and efforts are being made.</td></tr>
</table>

5.	Further, a sum of ₹ 13848/-(Credit balance) is being reflected in account in case of Mrs. Swapna Mazumdar as on 31/03/2016. A sum of ₹ 13848/- was given as advance in 2013-2014 and was booked directly in expenditure. The advance was adjusted on 27/03/2015 and the expenditure was again debited and the account of Mrs. Swapna Mazumdar was credited resulting in Credit balance in account. The same is required to be adjusted appropriately.	Amount adjusted by debiting the same to the individual account.
6.	Physical verification of the stock of the library books has not been conducted during the financial year 2015-16 or after that date. Physical verification is to be done on yearly basis to reconcile the physical balance available with the book balances.	Matter with regard to Physical verification of library for the Financial Year 2015-16 & 2016-17 has been initiated. Report will be shown to audit.
7.	Maintenance & up-dation of Fixed Assets register & Stores register needs to be strengthened. The value of fixed assets as per fixed assets register and stores register must match with the value in the fixed assets schedule. Proper reconciliation needs to be done and registers to be updated on regular basis.	Fixed asset has been reconciled and being updated as suggested by the audit.
8.	Physical Verification of the assets is not being done on time. Physical verification of Non-Consumable assets for the year ended 31.03.2016 was done in April 2016 to June, 2016. While verification no summary of Fixed Assets were being prepared. Only a certificate has been issued that "Physical Verification has been done as per books and no discrepancies have been noticed". Mere submission of a certificate will not serve the purpose. Complete verification is required to be done.	As suggested by audit complete verification will be done and shown to audit.
9.	Physical Verification of the Consumable Items for the year 2015-16 was done on 13th April, 2016. While verification no Summary of Assets/Working Sheet were being prepared. Only a certificate has been issued that "Physical Verification has been done as per books and no discrepancies have been noticed". Mere submission of a certificate will not serve the purpose. Complete verification is required to be done..	As suggested by audit complete verification will be done and shown to audit.
10.	List of Legal Cases was provided to us but amount of 'contingent liability', if any, is not mentioned. As per list provided to us, 10 cases are pending as on 31st March 2016 but updated position of the cases that are pending is yet to be provided. Reporting of 'Contingent Liability' is also to be done by the Institute through 'note to accounts'.	Section concern has been instructed to work out the "contingent liability" and will be put up to audit at the earliest.

(N B Tewari)
Accounts Officer

(R.S. Singh)
Registrar

(Sunil Bajpai)
Director

Form of Financial Statements (Non-Profit Organizations)

Birbal Sahni Institute of Palaeobotany, Lucknow

Balance Sheet as at March 31, 2016

(Amount - Rs.)

Particulars	Schedule No.	Current Year 31.3.2016	Previous Year 31.3.2015
CORPUS/CAPITAL FUND AND LIABILITIES			
CORPUS/CAPITAL FUND	1	24,56,14,530.71	20,73,31,084.72
RESERVES ANS SURPLUS	2	3,32,10,903.00	3,32,10,903.00
EARMARKED/ENDOWMENT FUNDS	3	32,36,98,173.85	30,29,59,341.98
SECURED LOANS AND BORROWINGS	4	-	-
UNSECURED LOANS AND BORROWINGS	5	-	-
DEFERRED CREDIT LIABILITIES	6	-	-
CURRENT LIABILITIES AND PROVISIONS	7	2,42,31,758.31	1,80,60,814.64
TOTAL		**62,67,55,365.87**	**56,15,62,144.34**
ASSETS			
FIXED ASSETS	8	20,72,72,159.69	9,35,19,397.54
INVESTMENTS-FROM EARMARKED/ENDOWMENT FUNDS	9	32,36,98,173.85	30,29,59,341.98
INVESTMENTS-OTHERS	10	3,29,23,041.00	2,31,87,598.00
CURRENT ASSETS,LOANS,ADVANCES ETC.	11	6,28,61,991.33	14,18,95,806.82
MISCELLANEOUS EXPENDITURE			
(to the extent not written off or adjusted)			
TOTAL		**62,67,55,365.87**	**561562144.34**
SIGNIFICANT ACCOUNTING POLICIES	24		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	25		

For **Singh Agarwal & Associates**
Chartered Accountants

CA. Mukesh Kumar Agarwal
(Partner)

(N B Tewari)
Accounts Officer

(R.S. Singh)
Registrar

(Sunil Bajpai)
Director

Form of Financial Statements (Non-Profit Organizations)

Birbal Sahni Institute of Palaeobotany, Lucknow

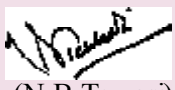
Income and Expenditure Account for the period / year ending March 31, 2015

Fig. in Rupees

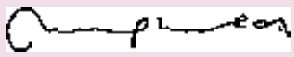
Particulars	Schedule	Current Year 2015-16	Previous Year 2014-15
INCOME			
Income from Sales/Services	**12**	5,34,400.00	7,17,488.00
Grants/subsidies (OB, Deposit A/C and Transfer from Cap. Fund)	**13**	30,50,00,000.00	27,67,70,000.00
Fees/Subscriptions	**14**	-	-
Income from Investments (Income on Invest. From earmarked/endow. Funds transferred to Funds)	**15**	40,34,330.00	53,44,126.81
Income from Royalty,Publication etc.	**16**	1,05,996.00	4,28,964.00
Interest Earned	**17**	12,16,544.00	10,09,753.00
Other Income/Adjustments	**18**	38,07,214.95	20,50,994.00
Increase/(decrease)in stock of Finished goods and works-in-progress	**19**	-	-
TOTAL(A)		**31,46,98,484.95**	**28,63,21,325.81**
EXPENDITURE			
Establishment Expenses	**20**	19,42,09,012.00	18,94,63,568.00
Other Administrative Expenses etc.	**21**	4,81,48,538.30	3,80,14,851.00
Expenditure on Grants,Subsidies etc.	**22**	-	-
Interest	**23**	-	-
Depreciation (Net Total at the year-end-corresponding to Schedule 8)		3,40,57,488.66	1,41,28,086.43
TOTAL (B)		**27,64,15,038.96**	**24,16,06,505.43**
Balance being excess of Income over Expenditure(**A-B)**		3,82,83,445.99	4,47,14,820.38
Transfer to Special Reserve (Sepecify each)		-	2,60,00,000.00
Transfer to/from General Reserve to Pension Fund		-	2,00,00,000.00
BALANCE BEING SURPLUS/DEFICIT CARRIED TO CORPUS/CAPITAL FUND		**3,82,83,445.99**	**(12,85,179.62)**
SIGNIFICANT ACCOUNTING POLICIES	**24**		
CONTINGENT LIABILITIES AND NOTES ON ACCOUNTS	**25**		

For **Singh Agarwal & Associates**
Chartered Accountants

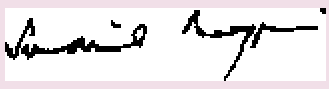
CA. Mukesh Kumar Agarwal
(Partner)



(N B Tewari)
Accounts Officer



(R.S. Singh)
Registrar



(Sunil Bajpai)
Director

Form of Financial Statements (Non-Profit Organizations)
Birbal Sahni Institute of Palaeobotany, Lucknow
Receipts and Payments Account for the period / year ended March 31, 2016

Fig.in Rupees

RECEIPTS	Current Year 2015-16	Previous Year 2014-15	PAYMENTS	Current Year 2015-16	Previous Year 2014-15
I. Opening Balances			I) Expenses		
a) Cash in hand			a) Establishment Expenses (Corresponding to Schedule 20)	19,422,09,002.00	18,97,08,911.00
b) Bank Balances	1,69,92,404.98	57,77,487.52	b) Administrative Expenses (Corresponding to Schedule 21)	4,81,48,538.30	9,97,00,038.20
i) In current accounts					
ii) In deposit accounts					
iii) Endowment deposits					
iv) TDS on other grant	62,580.00				
II. Grants Received					
a) From Government of India	25,61,45,000.00	21,46,03,000.00	II) Payments made against funds for various projects	9,46,64,561.20	1,21,59,790.00
b) From State Government			(Name of the fund or project should be shown along with the particulars of payments made for each project)		
c) From other sources (details)	-	-			
(Grant for capital &revenue exp. To be shown separately)	4,88,55,000.00	6,21,67,000.00			
d) Deposit Account					
III. Income and investment from			III. Investments and deposits made		
a) Earmarked/Endow. Funds	-	-	a) Out of Earmarked/Endowment funds		
b) Own Funds (Others)			b) Out of Own Funds (Investments-Others)		
IV. Interest Received			IV. Expenditure on Fixed Assets & Capital Work-in-Progress		
a) On Bank deposits	40,94,980.00	51,44,125.81	a) Purchase of Fixed Assets	14,78,10,250.31	629,7,589.00
b) Loans, Advances etc.	12,16,544.00	10,05,570.00	b) Expenditure on Capital Work-in-Progress		
V. Other income (specify)			V. Refund of surplus money/ Loans	8,29,199.00	
i) Sale proceeds of Publications	1,05,996.00	4,95,964.00			
ii) Miscellaneous Income	98,07,214.96	20,44,594.00	a) To the Government of India		
iii) Sale of Services (Consultancy)	5,34,400.00	10,88,937.00	b) To the State Government		
iv) Group Insurance			c) To other providers of funds		
VI. Amount Borrowed	21,65,414.87		VI. Finance Charges (Interest)		
VII. Any other receipts (give details)			VII. Other Payments (Specify)		
(Pension Contribution)			i) Advances to Staff	15,38,494.00	1,29,92,751.00
Transfer from Reserve Fund	4,90,00,000.00	4,00,00,000.00	ii) Earnest Money Refunded	7,00,000.00	1,98,400.00
Net Receipt from Project	9,32,96,994.00	2,44,34,448.00	iii) Advances to Parties	15,09,59,189.55	7,55,84,484.29
TDS Refund	11,41,860.00	5,56,210.00	iv) Pension Fund		60,00,000.00
i) Recovery of Advances	21,78,19,096.00	4,19,65,128.39	v) Transfer to reserve & surplus	5,27,35,448.00	4,00,00,000.00
ii) Earnest Money Deposit	10,000.00	1,98,400.00	VIII. Closing Balances		
iii) EDC Refund			a) Cash in hand		
iv) Recovery from Parties			b) Bank Balances		
			i) In current accounts		
			ii) In deposit accounts		
			iii) Saving account	2,24,52,704.89	1,69,92,404.98
			iv) Endowment deposit account		
			v) TDS on other grant	62,580.00	62,580.00
TOTAL	65,41,86,574.75	99,95,58,184.52		65,41,86,574.75	99,95,58,184.52

CA. Mukesh Kumar Agarwal
(Partner)

(N B Tewari)
Accounts Officer

(R.S. Singh)
Registrar

(Sunil Bajpai)
Director

Trees plantation by Prof. Deepak Pental, Chairman Governing Body (above) and
Prof. A.K. Tripathi, Director CSIR-CIMAP (below) a step forward to make the Campus greener

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